ORTHOPAEDIC
—TRAUMA—
ASSOCIATION

9400 West Higgins Road, Suite 305
Rosemont, IL 60018-4975
Phone: (847) 698-1631
FAX: (847) 430-5140
E-mail: ota@ota.org

Steven A. Olson, MD

Welcome to the Orthopaedic Trauma Association's (OTA) 32nd Annual Meeting!

The Program Committee, under the leadership of Bob O'Toole and Mike McKee have created an outstanding program that includes cutting edge clinical and basic research from around the world. The quality of scientific sessions is evidenced by the observation that one quarter of all podium presentations this year are reporting on prospective randomized trials. Each attendee can benefit from this year's Annual Meeting in some way, and I encourage you to carefully review the program and select a track that best suits your needs. As our organization has grown so have the opportunities for attendees to take advantage of. These include the Basic Science Focus Forum, International Forum, OTA Grant Writing Workshop, Orthopaedic Trauma for PA & NPs and a plethora of full and mini-symposia, including Industry and Health policy symposia.

Additionally, the Annual Meeting will offer an unprecedented number of opportunities to network and interact with friends and colleagues. This year's venue at the Gaylord National Hotel & Convention Center is exceptional. There are social events every evening: the international reception on Wednesday, the welcome reception and fund raising auction on Thursday at the Gaylord National, and "suds and science" guided poster tours with beer and wine in the exhibit hall on Friday evening. Please also join me in extending a special welcome to our guest nation attendees from India, international attendees, and SIGN scholars from Kenya and the Philippines.

Allow me to thank Jean-Claude G. D'Alleyrand, MD our local host. Finally, I want to thank all of our OTA members who have contributed to this year's fantastic program, including the many committee members, presenters, faculty, and other volunteers. The spirit of volunteerism dedicated to the Mission Vision, and Values of the OTA is alive and well among our membership.

Sincerely,

Steven A. Olson, MD
President, Orthopaedic Trauma Association

Welcome

Find a Surgeon

OTA Membership Directory available at www.ota.org.
Search by name or location. Directory updated weekly.
Email addresses available via the 'Members Only' page.

Attendance at the OTA Annual Meeting authorizes the OTA to capture your image or likeness in photographic, digital video, or other electronic format, and authorizes the OTA to use said image or likeness in marketing materials to promote OTA, including print, electronic and on the internet. OTA warrants that its use of the image or likeness will not be in a negative manner.
OTA has no control over the use of the image or likeness by third parties and therefore makes no express or implied warranties on any use by third parties.

Orthopaedic Trauma Association
9400 W. Higgins Road, Suite 305
Rosemont, IL 60018-4975, USA
Phone: (847)698-1631
Fax: (847)430-5140
e-mail: OTA@ota.org
Home Page: www.ota.org

TABLE OF CONTENTS

SCIENTIFIC POSTERS and **TECHNICAL EXHIBITS**
Prince George's Exhibit Hall D/E

(See complete listing on pages 663 - 664)

Open:	Thursday	2:30 pm	- 6:30 pm
	Friday	7:00 am	- 10:00 am
		12:15 pm	- 1:15 pm
		3:30 pm	- 6:15 pm
	Saturday	7:00 am	- 11:00 am
		12:00 pm	- 1:30 pm

SPEAKER READY ROOM *Potomac Coat Check*

4:00 pm - 6:00 pm – Tuesday
Open 6:00 am - 6:30 pm – Wednesday thru Saturday.

OTA VIDEO THEATER *Prince George's Exhibit Hall D/E*

Open 6:30 am - 5:00 pm – Wednesday thru Saturday.

NOTE: Cameras (including cell phone cameras) may NOT be used in any portion of the meeting.

ACKNOWLEDGMENTS

The Orthopaedic Trauma Association gratefully acknowledges the following foundations, companies, and individuals for their generous financial support received through OTA and through OREF to fund OTA reviewed research grants.

2016 OTA RESEARCH & EDUCATION DONORS
(as of September 6, 2016)

Platinum Award ($150,000 - $249,999)

DePuy Synthes **Smith & Nephew** **Zimmer Biomet**

Gold Award ($100,000 - $149,999)

Stryker

Bronze Award ($50,000 - $74,999)

Foundation for Orthopedic Trauma

Copper Award ($25,000 - $49,999)

Acelity

Sponsor Award ($5,000 - $24,999)

Arthrex **Bioventus**
Medtronic **PFS Med., Inc.**

Members Award ($1,000 - $4,999)

The Geneva Foundation

Sincere Appreciation to
2016 Donors to the OTA Annual Meeting
Pre-Meeting Events:

Bioventus
DePuy Synthes
FOT
PFS Med, Inc.
Smith & Nephew
Stryker
Zimmer Biomet

Thank You

OTA Legacy Society

The OTA is pleased to honor the following individuals and organizations who have reached a lifetime giving level of $10,000 or greater.

Jeffrey O. Anglen, MD
Atlantic Provinces Orthopedic Society
James C. Binski, MD
Christopher T. Born, MD
Michael J. Bosse, MD
Timothy J. Bray, MD
Dr. and Mrs. Joseph Cass
Peter A. Cole, MD
William R. Creevy, MD
Gregory J. Della Rocca, MD, PhD, FACS
Florida Orthopaedic Institute, Tampa, Florida
James A. Goulet, MD
Ramon B. Gustilo, MD
Kyle J. Jeray, MD
Alan L. Jones, MD
Clifford B. Jones, MD, FACS
Gerald J. Lang, MD
Ross K. Leighton, MD
Todd W. and Jennifer Mailly
Theodore Miclau, III, MD
Steven J. Morgan, MD
Steven A. Olson, MD
OrthoArizona, Phoenix, Arizona
Andrew N. Pollak, MD
Robert A. Probe, MD
Mark Cameron Reilly, MD
William M. Ricci, MD
Thomas (Toney) A. Russell, MD
Andrew H. Schmidt, MD
John Schwappach, MD
Brian A. Sears, MD
Jeffrey M. Smith, MD
Marc F. Swiontkowski, MD
David C. Teague, MD
David C. Templeman, MD
Paul Tornetta, III, MD
USCF/SFGH Orthopaedic Trauma Institute

2016 Members Award ($1,000 - $4,999)

Michael T. Archdeacon, Curt P. Comstock, William Creevy, James A. Goulet, Alan L. Jones, Kevin M. Kuhn, Simon C. Mears, Steven J. Morgan, Eric J. Pagenkopf, Brendan M. Patterson, Edward A. Perez, Robert A. Probe, David C. Teague, Paul Tornetta III, Heather A. Vallier, George Karl Van Osten III, Ryan E. Will, Sharese M. White

2016 Friends Award ($250 - $999)

Mark R. Adams, Jeffrey O. Anglen, Paul T. Appleton, Bruce R. Buhr, Lisa K. Cannada, Kathleen Caswell, Michael W. Chapman, Daniel John Coll, Brett Duane Crist, Nicholas Joseph DiNicola, Thomas G. DiPasquale, Robert Fischer, Darin Friess, Gerald Greenfield, Roman A. Hayda, David E. Karges, Justin R. Kauk, William T. Kurtz, Gerald J. Lang, Ross K. Leighton, Eric Lindvall, Cindy Kay Malson-Fischer in honor of Dr. Patrick J. Wiater, Toni M. McLaurin, James Frederick Mautner, Theodore Miclau III, Anna N. Miller, Berton R. Moed, Brent L. Norris, William T. Obremskey, Steven A. Olson, Mark Cameron Reilly, Regis Louis Renard, Edward Kenneth Rodriguez, Melvin P. Rosenwasser, Milton L. Routt, David W. Sanders, Susan A. Scherl, Robert S. Schulz, Michael S. Sirkin, Carla S. Smith, Raymond Malcolm Smith, John W. Staeheli, Michael P. Swords, Mark S. Vrahas, John T. Watson, John Charles Weinlein, John J. Wixted, Patrick Yoon

2016 Associates Award (up to $249)

Eben A. Carroll, Thomas M. Large, Angela Majed, Richard John Myers

ACKNOWLEDGMENTS

2015 OTA RESEARCH & EDUCATION DONORS

Platinum Award ($150,000 - $249,999)

DePuy Synthes
Smith & Nephew

Gold Award ($100,000 - $149,999)

Pacira Pharmaceuticals
Stryker
Zimmer

Silver Award ($75,000 - $99,999)

Cardinal Health

Bronze Award ($50,000 - $74,999)

Foundation for Orthopedic Trauma

Copper Award ($25,000 - $49,999)

Biomet

Sponsor Award ($5,000 - $24,999)

Bioventus
PFS Med, Inc.

Sincere

ACKNOWLEDGMENTS

2015 Sponsors Award ($5,000 - $24,000)
Dr. and Mrs. Joseph Cass,
Dr. and Mrs. Todd Mailly, San Francisco General Hospital

2015 Members Award ($1,000 - $4,999)
Peter Althausen, Mark Anders, Michael Archdeacon, Emil Azer, David F. Beigler, Christopher T. Born, Michael J. Bosse, Peter A. Cole, Curt Comstock, William Creevy, Thomas A. DeCoster, Gregory J. Della Rocca, William DeLong, Ken Egol, John T. Gorczyca, James A. Goulet, Greenfield Hospital System, David J. Hak, IU Health Methodist Orthopaedic Trauma, Kyle Jeray, Alan Jones, John P. Ketz, Joseph Lane, Richard T. Laughlin, Ross Leighton, Douglas W. Lundy, Theodore Miclau III, Steve J. Morgan, Todd Michael Oliver, Steven A. Olson, Timothy O'Mara, Robert F. Ostrum, James M. Pape, Brendan M. Patterson, Edward A. Perez, Robert A. Probe, William M. Ricci, Matthew Rudloff, Brian Sears, Jeffrey M. Smith, Marc F. Swiontkowski, David Teague, Paul Tornetta, Heather Vallier, John Charles Weinlein, David S. Weisman, Sharese M. White

2015 Friends Award ($250 - $999)
Mark R. Adams, Jaimo Ahn, Paul T. Appleton, Emil Azer, Daniel B. Bazylewicz, David Beigler, James C. Binski, Yelena Bogdan, Christopher T. Born, Christina L. Boulton, Edwin Bovill, Bruce R. Buhr, Lisa Cannada, Kathleen Caswell, Peter Cole, Brett Crist, Eliana Delgado, Nicholas DiNicola, Christopher Doro, W. Andrew Eglseder, Darin Friess, Michael J. Gardner, David Goodspeed, John Gorczyca, Melissa A. Gorman, Gerald Greenfield, Sigvard T. Hansen, Erik A. Hasenboehler, Roman A. Hayda, David L. Helfet, Daniel Horwitz, Catherine Humphrey, Utku Kandemir, Stephen Kates, Alan Kawaguchi, John Ketz, Brian Kistler, Peter C. Krause, William Kurtz, Mark Laberte, Paul M. Lafferty, Gerald Lang, Richard Laughlin, Dean G. Lorich, Douglas Lundy, Bruce Lutz, Theodore T. Manson, Meir Marmor, Robert T. McClellan, Theodore Miclau, Saam Morshed, Jason W. Nascone, Greg M. Osgood, Robert V. O'Toole, Murat Pekmezci, Andrew N. Pollack, Michael Prayson, Regis Renard, Edward K. Rodriguez, David Sanders, Bruce J. Sangeorzan, Andrew Saterbak, Susan Scherl, Gregory J. Schmeling, Robert S. Schultz, John R. Schwappach, Marcus F. Sciadini, Babar Shafiq, Robert B. Simpson Jr., Michael S. Sirkin, Gerard P. Slobogean, R. Malcolm Smith, Gillian L. Soles, James P. Stannard, Jason W. Stoneback, Julie A. Switzer, Michael P. Swords, Lisa A. Taitsman, Nirmal C. Tejwani, Charles N. Versteeg, Darius G. Viskontas, David A. Volgas, Gregory A.Vrabec, J. Tracy Watson, Paul Spencer Whiting, Allison Paige Whittle, Ryan E. Will, Jennifer H. Wood, Lewis G. Zirkle

2015 Associates Award (up to $249)
Charles and Linda Bertolami, Daniel Coll, Diane Vetrovec Dobberstein, Reza Firoozabadi, Nancy Franzon, Harold M. Frisch, Ariel Goldman, Marley Hambourger, Michael J. Henjna, Paul M. Hiller, James M. Jackman, Ritesh Khokhar, Paul K. Kosmatka, Sharon Moore, David Rothberg, Daniel Vinson Sheerin, Todd A. Swenning, Laura L. Tosi, David Brian Weiss, Jason R. Wild, Seth Robert Yarboro, Marc A. Zussman

Thanks

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT
ACKNOWLEDGMENTS

COTA acknowledges the generous 2016-2017 financial support from

Stryker	**$500,000**
Smith & Nephew	**$342,000**
DePuy Synthes Trauma	**$150,000**
Medtronic	**$75,000**

2016-17 COTA Board of Directors:

Mark W. Richardson, MD, *Chair*
Alan L. Jones, MD, *President*
Maureen Finnegan, MD, *Secretary/Treasurer*
Heather A. Vallier, MD, *Vice-Chair*
Marc F. Swiontkowski, MD, *Member-at-Large*
Brendan M. Patterson, MD, *Member-at-Large*
Gerald Lang, MD, *Member-at-Large*

Kathleen Caswell, *OTA Executive Director*
Bonnie Emberton, *OTA Fund Development*
Rachel O'Connell, *COTA Administrator*

website: www.cotagrants.org

ORTHOPAEDIC TRAUMA ASSOCIATION

2016 Basic Science Focus Forum

Wednesday, October 5, 2016

(Potomac 1 - 3)

6:00 am **Speaker Ready Room**
(Potomac Coat Check)

6:30 am **Registration**

Continental Breakfast
(Potomac 1 - 3 Lobby)

7:30 am **Introduction**
Edward J. Harvey, MD, Program Chair

7:35 – 8:45 am **SYMPOSIUM 1: BIOMECHANICS-HOT TOPICS 2016**

Moderators: *Edward J. Harvey, MD*
Brett D. Crist, MD

7:35 am **No-Motion, Micro-Motion and Macro-Motion: What is Going on at the Fracture?**
Mitchell Bernstein, MD

7:50 am **Why I Still Use Plates for Intertrochanteric Femur Fractures**
Mark A. Lee, MD

8:05 am **When Should We Weight Bear Lower Extremity Periarticular Fractures-Science Behind the Anecdote**
John D. Adams, MD

8:20 am **High Energy Young Femoral Neck Fractures-The Unsolved Fracture**
Christopher Finkemeier, MD

8:35 am Discussion

8:45 am Refreshment Break

Key: Δ = presentation was funded by an OTA administered grant
Names in bold = **Presenter**

See pages 49 - 106 for financial disclosure information.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

8:55 – 9:55 am PAPER SESSION 1: APPLIED BIOMECHANICS

Moderators: *Brett D. Crist, MD*
Mark A. Lee, MD

8:55 am **Overview**
Brett D. Crist, MD

9:00 am (p. 107) PAPER #1 **Dynamization of Simple Fractures with Active Locking Plates Delivers Faster and Stronger Healing Relative to Conventional Compression Plating**
Michael Bottlang, PhD; *Stanley Tsai, MS; Emily Bliven, MS; Brigitte von Rechenberg, MD; Julia Henschel, BS; Peter Augat, PhD; Daniel Fitzpatrick, MS, MD; Steven Madey, MD*

9:06 am (p. 109) PAPER #2 **Vascular Anatomy of the Medial Femoral Neck and Implications for Surface Plate Fixation - Preliminary Results**
Sara Putnam, MD*; Cory A. Collinge, MD; Michael J. Gardner, MD; William M. Ricci, MD; Christopher McAndrew, MD, MSc*

9:12 am (p. 111) PAPER #3 **A Biomechanical Comparison of Intrapelvic and Extrapelvic Fixation for Associated Acetabular Fractures of the Quadrilateral Plate**
Sharon Babcock, MD*; Gregory Gillispie, BS; Philip Brown, PhD; Kyle McNamara, BS; Arun Aneja, MD; Joel Stitzel, PhD; Eben Carroll, MD*

9:18 am Discussion

9:28 am (p. 113) PAPER #4 **A New and More Sensitive View for the Detection of Syndesmotic Instability**
Nayla G. Papadopoulos, MD*; Georges-Yves Laflamme, MD, FRCSC; Jérémie Ménard, Ing; Stéphane Leduc, MD; Dominique Rouleau, MD, MSc, FRCSC; Jonah Hebert-Davies, MD; Marie-Lyne Nault, MD, PhD*

9:34 am (p. 115) PAPER #5 **Reducing the Syndesmosis Under Direct Vision: Where Should I Look?**
Paul Tornetta III, MD; ***Mark Yakavonis, MD;*** *David Veltre, MD; Anjan Shah, MD*

9:40 am (p. 117) PAPER #6 **Location Location Location: Does the Distance of Fixation from the Plafond Affect Reduction of the Syndesmosis?**
Michael Beebe, MD; *Kyle Stoops, MD; Sean Lannon, MD; Charles Clark, MD; David Watson, MD; Paul Tornetta III, MD; Roy Sanders, MD; Hassan R. Mir, MD; Anjan Shah, MD*

9:46 am Discussion

See pages 49 - 106 for financial disclosure information.

9:55 – 11:05 am

SYMPOSIUM 2: OUTSIDE THE BONE - WHAT IS HAPPENING

Moderators: *Emil H. Schemitsch, MD*
Stephen L. Kates, MD

9:55 am — **Osteoporosis Management: What the Trauma Surgeon Needs to Know!**
Stephen L. Kates, MD

10:10 am — **The Trauma Patient with a Fracture: Role of Vitamin C and D**
Brad A. Petrisor, MD

10:25 am — **Atypical Fractures: Best Practices in 2016**
Sanjit R. Konda, MD

10:40 am — **Nonunions: How Important is Nutrition and Medical Management?**
Michael D. McKee, MD

10:55 am — Discussion

11:05 am — Refreshment Break

11:15 – 11:55 am

PAPER SESSION 2: THE SCIENCE OF TRAUMA

Moderators: *Edward J. Harvey, MD*
CAPT. Eric A. Elster, MD, FACS, MC, USN

11:15 am — **Overview**
Edward J. Harvey, MD

11:20 am (p. 119) PAPER #7 — **The Severity of Compartment Syndrome - Associated Microvascular Dysfunction May Be Diminished by the Neutralization of Pro-Inflammatory Cytokines**
***Erin Donohoe, MB, BCh, BAO**; David Sanders, MD; Aurelia Bihari, MS; Abdel-Rahman Lawendy, MD, PhD, FRCSC*

11:26 am (p. 121) PAPER #8 — **The Dose-response Effect of Ketotifen Fumarate on Substance P-Containing Nerves Mast Cells and Myofibroblasts in Posttraumatic Joint Contractures**
***Prism Schneider, MD, PhD, FRCSC**; Herman Johal, MD, MPH; Mei Zhang, PhD; David Hart, PhD; A. Befus, PhD; Paul Salo, MD, FRCSC; Cun-Yi Fan, PhD; Xiangdang Liang, PhD; Kevin Hildebrand, MD, FRCSC*

11:32 am (p. 123) PAPER #9 — **Reamed Intramedullary Nailing Affects Trauma-induced Coagulopathy Based on Thrombelastography**
***Prism Schneider, MD**; Elizabeth Davis, BS; Matthew Galpin, RC; Robert Hudson, BS; Patrick Mitcham, BS; Mark Prasarn, MD; Joshua Gary, MD*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Basic Science Focus Forum – WEDNESDAY, OCTOBER 5, 2016

11:38 am
(p. 125)
PAPER #10

Compartment Release in Austere Locations (CORAL): A Pilot Study of Telesurgery for Compartment Syndrome
Max Talbot, MD, FRCSC*; Rudolph Reindl, MD, FRCSC; Gregory Berry, MD, FRCSC; Homer Tien, MD, FRCSC; Gerard P. Slobogean, MD; Edward Harvey, MD, MSc, FRCSC; CORAL Collaborators*

11:44 am — Discussion

12:15 pm - 1:15 pm — **International Industry Lunch**

1:25 – 2:35 pm

SYMPOSIUM 3: MANAGEMENT OF MANGLED EXTREMITIES AND ORTHOPAEDIC WAR INJURIES

Moderators: *Todd O. McKinley, MD*
CAPT. Eric A. Elster, MD, FACS, MS, USN

1:25 pm — **Orthopaedic Management of Combat Extremity Injuries from Recent Conflicts**
Jean-Claude G. D'Alleyrand, MD

1:40 pm — **Advancements in Soft Tissue Coverage Methods and Science in Mangled Extremities and War Wounds**
Ian L. Valerio, MD

1:55 pm — **Integrating Computational Clinical Decision Making Tools to Optimize Outcomes in Severe Extremity Wounds: Experience of the Surgical Critical Care Initiative**
Seth Schobel, MD

2:10 pm — **Advancements in Osteointegrated Prostheses for Lower Extremity Amputations**
Kevin Tetsworth, MD

2:25 pm — Discussion

See pages 49 - 106 for financial disclosure information.

2:35 – 3:45 pm SYMPOSIUM 4: FRACTURE HEALING ADJUNCTS - THE WORLD'S PERSPECTIVE

Moderators: *Joseph Borrelli Jr, MD*
Peter V. Giannoudis, MD

2:35 pm **Introduction**
Joseph Borrelli Jr, MD

2:40 pm **Is There a Role for Allograft?**
Gerhard Schmidmaier, MD

2:50 pm **Induced Membrane Technique: What Have We Learned?**
Peter V. Giannoudis, MD

3:00 pm **Titanium Cages: How We Can Enhance Their Success**
Ronald W. Lindsey, MD

3:10 pm **Intramedullary Lengthening Devices: Do They Always Work?**
Christian Krettek, MD

3:20 pm **Bone Transport and Treatment of the Docking Site: My Preferred Method**
David W. Lowenberg, MD

3:30 pm Discussion

3:45 pm Refreshment Break

3:55 – 4:55 pm PAPER SESSION 3: NEW APPROACHES FOR BONE HEALING

Moderators: *Joseph Borrelli Jr, MD*
Peter V. Giannoudis, MD

3:55 pm **Overview**
Peter V. Giannoudis, MD

4:00 pm (p. 127) PAPER #11 **Acceleration of Fracture Healing Modulated by Compounds that Stimulate Inducible Nitric Oxide Synthase**
Rebecca Rajfer Trueblood, MD; *Ayhan Kilic, MD; Su Hlaing, BS; Leah Schulte, MD; Andrew Neviaser, MD; Edward Ebramzadeh, PhD; Monica Ferrini, PhD; Sang Hyun Park, PhD*

4:06 pm (p. 128) PAPER #12 **Doxycycline-Loaded Coaxial Nanofiber Coating Enhances Osseointegration and Inhibits Infection**
David Markel, MD; Wei Song, PhD; Shi Tong, MS; Nancy Jackson, PhD; Chris Bergum, MS; Jeffrey Flynn, PhD; ***Weiping Ren, MD***

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Basic Science Focus Forum – WEDNESDAY, OCTOBER 5, 2016

4:12 pm (p. 130) PAPER #13	**Three Dimensional Printed Scaffolds for Segmental Defects in Long Bones** ***Sandeep Pandit, MD;*** *Todd Goldstein, PhD; James Mullen, MD; Mikael Starecki, MD; Lewis Lane, MD; Daniel Grande, PhD; Katy Nellans, MD*
4:18 pm	Discussion
4:28 pm (p. 132) PAPER #14	**Δ Investigating an Endothelial Progenitor Cell Dose Response for the Healing of Critical Size Bone Defects** ***David Ramnaraign, MSc;*** *Charles Godbout, PhD; Emil H. Schemitsch, MD; Aaron Nauth, MD, FRCSC*
4:34 pm (p. 135) PAPER #15	**The Impact of Surgical Fixation on Fracture Healing: Radiographic Analysis of a Novel Fracture Model in Rats** ***Alejandro Marquez-Lara, MD;*** *Ian Hutchinson, MD; Thomas Smith, PhD; Anna Miller, MD, FACS*
4:40 pm (p. 137) PAPER #16	**Assessment of RIA Filtrate Osteoinductive Potential in an Ectopic In Vivo Model** ***Alexander Wessel, MD****; James Stannard, MD; James Cook, DVM, PhD; Brett D Crist, MD; Gregory Della Rocca, MD, PhD, FACS*
4:46 pm	Discussion
4:55 pm	Adjourn for the Day

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

ORTHOPAEDIC TRAUMA ASSOCIATION

2016 Basic Science Focus Forum

Thursday, October 6, 2016

(Potomac 1 - 3)

6:00 am **Speaker Ready Room**
(Potomac Coat Check)

6:30 am **Registration**

Continental Breakfast
(Potomac 1 - 3 Lobby)

7:30 am **Introduction**
Edward J. Harvey, MD, Program Chair

7:35 – 8:25 am **SYMPOSIUM 5: PATIENT RELATED OUTCOMES - HELPFUL OR NOT SO MUCH?**

Moderators: *William T. Obremskey, MD, MPH*
Douglas W. Lundy, MD

7:35 am **Are the Currently Available PROs Adequate for Research in Orthopaedic Trauma?**
Thomas F. Higgins, MD

7:45 am **Which PROs are the Most Appropriate for Outcomes in Trauma and How Do We Account for the Lack of Pre-Injury Measures?**
William T. Obremskey, MD, MPH

7:55 am **Mobility as Validated PRO for an Assessment of General Health**
Janet A. Prvu Bettger, ScD, FAHA

8:05 am **How PROs Will be Used by Others: Granting Agencies, Insurers, FDA, CMS, NQF**
Mark S. Vrahas, MD

8:15 am Discussion

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

8:25 – 8:58 am

PAPER SESSION 4: HOW WE MEASURE OUTCOMES

Moderator: *Douglas W. Lundy, MD*

8:25 am — **Overview**
Douglas W. Lundy, MD

8:30 am (p. 139) PAPER #17 — **Does the Modified RUST Score Correlate with the Biomechanical Properties of Bone? Evaluation in a Murine Model**
Paul Tornetta III, MD; ***Margaret Cooke, MD;*** *Amira Hussein, PhD; Jody Litrenta, MD; William M. Ricci, MD; Jason Nascone, MD; Robert V. O'Toole, MD; Louis Gerstenfeld, PhD*

8:36 am (p. 141) PAPER #18 — **Does a Patient's Self-Reported Ability to Weight-Bear Immediately After Injury Predict Stability for Ankle Fractures?**
Bonnie Chien, MD*; Kurt Hofmann, MD; Mohammad Ghorbanhoseini, MD; David Zurakowski, PhD; Edward Rodriguez, MD; Paul Appleton, MD; John Ellington, MD; John Kwon, MD*

8:42 am (p. 142) PAPER #19 — **Δ Health-Related Quality of Life Following Operative Management of Open Fractures**
Brad Petrisor, MD; ***Kyle Jeray, MD;*** *Sheila Sprague, PhD; Paula McKay, BSc; Gordon Guyatt, MD; Stephen D. Walter, BSc; Emil H. Schemitsch, MD; Susan Liew, MD; Diane Heels-Ansdell, MSc; Sun Makosso-Kallyth, PhD; Mohit Bhandari, MD; FLOW Investigators*

8:48 am — Discussion

8:58 am — Refreshment Break

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

9:05 – 10:00 am — SYMPOSIUM 6: THE BASICS: A PRINCIPLE-BASED APPROACH TO NONUNION MANAGEMENT

Moderators: *Aaron Nauth, MD*
Philipp Leucht, MD

9:05 am **Managing Infection in the Setting of Nonunion**
Paul Tornetta III, MD

9:14 am **Bone Grafting: What is the Ideal Type?**
Philipp Leucht, MD

9:23 am **Biological Therapies for Nonunion**
Michael J. Gardner, MD

9:32 am **Cell-based Therapies for Nonunion Management**
Mark A. Lee, MD

9:41 am **Metabollic Workup of Nonunion**
Mark R. Brinker, MD

9:50 am Discussion

10:00 – 11:00 am — PAPER SESSION 5: NEW APPROACHES TO HEALING

Moderators: *Aaron Nauth, MD*
Philipp Leucht, MD

10:00 am **Overview**
Aaron Nauth, MD

10:05 am (p. 144) PAPER #20 **Selective Serotonin Re-Uptake Inhibitors Impair Fracture Healing**
Vivian Bradaschia Correa, DDS, PhD; Devan Mehta, BS; Anna Josephson, BS; Jason Huo, BS; Matthew Mizrahi, BS; Kenneth A. Egol, MD; ***Philipp Leucht, MD, PhD***

10:11 am (p. 146) PAPER #21 **Pharmacokinetics of Depot Administered Vancomycin Powder in a Rat Femur Fracture Model: Retention Time is Brief**
Zachary Working, MD*; Hunter Frederiksen, BS; Alex Drew, BS; Catherine Loc Carrillo, PhD; Erik Kubiak, MD*

10:17 am (p. 148) PAPER #22 **Δ The Effect of Timing of Aminobisphosphonate Therapy on Fracture Healing: A Rabbit Osteoporosis Model**
Jesse Otero, MD; Rory Metcalf, BS; Nicole Watson, PhD; Emily Peterson, DVM; Douglas Fredericks, MD; ***Michael Wiley, MD***

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Basic Science Focus Forum – THURSDAY, OCTOBER 6, 2016

10:23 am	Discussion
10:33 am (p. 150) PAPER #23	**Proprionibacterium Acnes Colonization Impairs Fracture Healing in a Rat Model of an Open Femur Fracture Treated with Intramedullary Fixation** ***Robert Duerr, MD****; Mark Longwell, BS; Michael Florack, MD; Laura Nistico, PhD; Daniel Altman, MD; Gregory Altman, MD; Rachael Kreft*
10:39 am (p. 152) PAPER #24	**Δ Impedance Measurements Correlate to Callus Maturation of Mice Tibia Fractures** ***Monica Lin, BS****; Frank Yang, BS; Safa Herfat, PhD; Chelsea Bahney, PhD; Michel Maharbiz, PhD; Meir Marmor, MD*
10:45 am	Discussion
11:00 am	**Adjourn to Industry Symposia**

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

ORTHOPAEDIC TRAUMA ASSOCIATION

2016 Annual Meeting

Thursday, October 6, 2016

(Potomac Ballroom ABCD)

6:00 am **Speaker Ready Room**
(Potomac Coat Check)

6:30 am **Registration**

11:15 am **INDUSTRY SYMPOSIA** *(On-site Registration Available)*
Boxed Lunch Included

1:00 pm **Welcome and Donor Awards** *(Potomac Ballroom ABCD)*
Steven A. Olson, MD – OTA President
Robert V. O'Toole, MD – Program Committee Chair
Jean-Claude Gregoire D'Alleyrand, MD – Local Host

1:15 pm **OTA Honorary Member Acknowledgment** *(Potomac Ballroom ABCD)*
Prof. Dr. med. Dr. h.c. Stephan M. Perren

(Potomac Ballroom ABCD)

SYMPOSIUM I:
A PRIMER ON PROSTHETICS, ADVANCED ORTHOTICS AND AMPUTEE CARE FOR THE ORTHOPAEDIC TRAUMA SURGEON

1:20 – 2:50 pm

SPONSORED BY THE SOCIETY OF MILITARY ORTHOPAEDIC SURGEONS

Moderator: *Christopher T. LeBrun, MD*
Faculty: *Jean-Claude G. D'Alleyrand, MD; Joseph R. Hsu, MD; Ellen Mackenzie, PhD; Joseph A. Miller, PhD*

1:20 pm **Introduction**
Christopher T. LeBrun, MD

1:25 pm **Overview of Prosthetic Components and Design**
Joseph A. Miller, PhD

1:40 pm **Limb Salvage vs. Amputation LEAP/METALS**
Ellen Mackenzie, PhD

Key: Δ = presentation was funded by an OTA administered grant
Names in bold = **Presenter**

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

THURSDAY, OCTOBER 6, 2016

1:55 pm **Integrated Orthotic and Rehabilitation Initiative**
Joseph R. Hsu, MD

2:05 pm **Prevention and Management of Common Complications in Amputees**
Christopher T. LeBrun, MD

2:20 pm **New Horizons in Amputee Care**
Jean-Claude G. D'Alleyrand, MD

2:35 pm **Symposium Panel, Case Presentations, Discussion, Questions**

2:50 pm Refreshment Break (Exhibit Hall opens at 2:30)
Visit Scientific Posters & Technical Exhibits
(Prince George's Exhibit Hall D/E)
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

(Potomac Ballroom ABCD) **SCIENTIFIC PAPER SESSION 1**
PROGRAM COMMITTEE HIGHLIGHT PAPERS:
HIGH LEVEL RANDOMIZED CONTROLLED TRIALS

3:20 – 4:30 pm **Moderators - Robert V. O'Toole, MD & Michael D. McKee, MD**

3:20 pm (p. 157) PAPER #25 **Better Clinical and Radiographic Outcomes with Suture Endobutton Compared to Syndesmotic Screw in Treatment of Syndesmotic Injuries: A Randomized Controlled Trial**
Mette Andersen, MD; *Frede Frihagen, MD, PhD; Johan Hellund, MD, PhD; Jan Erik Madsen, MD, PhD; Wender Figved, MD, PhD*

3:26 pm (p. 159) PAPER #26 **Single versus Continuous Nerve Block for Extremity Fractures: A Comparative Study**
Abhishek Ganta, MD; *David Ding, MD; Nina Fisher, BS; Sudheer Jain, MD; Nirmal C. Tejwani, MD*

3:32 pm Discussion

3:37 pm (p. 160) PAPER #27 **Plate Fixation versus Nonoperative Treatment for Displaced Midshaft Clavicular Fractures: A Multicenter Randomized Controlled Trial**
Sarah Woltz, MD; *S. Stegeman, MD, PhD; P. Krijnen, PhD; Bart van Dijkman, MD, PhD; Thom van Thiel, MD, PhD; N.W.L. Schep, MD, MSc, PhD; Piet de Rijcke, MD, PhD; Jan Paul Frolke, MD; I.B. Schipper, MD, PhD*

3:43 pm (p. 161) PAPER #28 **Δ Simple Decompression versus Anterior Transposition of the Ulnar Nerve for Distal Humerus Fractures Treated with Plate Fixation: A Multi Centre Randomized Controlled Trial**
Emil H. Schemitsch, MD*; Niloofar Dehghan, MD, MS, FRCSC; Milena Vicente, RN; Aaron Nauth, MD, FRCSC; Jeremy Hall, MD, FRCS (ORTHO), MEd; Michael D. McKee, MD; COTS (Canadian Orthopaedic Trauma Society)*

3:49 pm Discussion

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

3:54 pm (p. 163) PAPER #29 — **EUSOL® versus Antibiotic-Loaded Collagen Granules (Co-Mupimet®) as a Dressing Agentin the Management of Traumatic Wounds**
Rajiv Maharjan, MBBS, MD; *Amit Shah, MBBS, MD; Pashupati Chaudhary, MBBS, MS*

4:00 pm (p. 164) PAPER #30 — **Tranexamic Acid Safely Reduced Blood Loss in Hip Arthroplasty for Acute Femoral Neck Fracture**
Chad Watts, MD; Matthew Houdek, MD; ***Stephen Sems, MD;*** *William Cross, MD; Mark Pagnano, MD*

4:06 pm — Discussion

(Potomac Ballroom ABCD)
4:11 – 4:26 pm

SYMPOSIUM II: WORLD PREMIER OF THE MULTINATIONAL FAITH HIP FRACTURE TRIAL: AND THE ANSWER IS…?

4:11 pm — Introduction: *Mohit Bhandari, MD*

4:14 pm — **FAITH Trial Presentation**
Marc F. Swiontkowski, MD

(p. 166) PAPER #31 — **Fixation using Alternative Implants for the Treatment of Hip Fractures: A Large Blinded International Multicenter Randomized Trial**
FAITH Investigators

4:22 pm — Discussion

4:30 pm – 5:00 pm

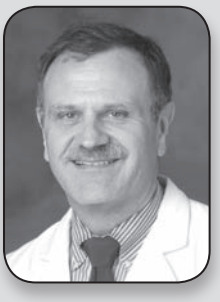
President's Message

(Potomac Ballroom ABCD)

"Of Mysteries, Mentors, and Things that Make a Trauma Career"

Steven A. Olson, MD
OTA President

Introduction: Timothy J. Bray, MD



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

THURSDAY, OCTOBER 6, 2016

5:00 pm – 6:00 pm **OTA BUSINESS MEETING**
(OTA Members Only) *(General Session Room - Potomac Ballroom ABCD)*

6:00 pm – 8:00 pm **WELCOME RECEPTION**
(Gaylord National Harbor Orchard Terrace)
Join your colleagues for cocktails and hors d'oeuvres on the Orchard Terrace of the Gaylord National Harbor, just outside the exhibit hall.

Annual Meeting attendees will once again enjoy wonderful offerings at the live auction during the Welcome Reception.

See pages 49 - 106 for financial disclosure information.

ORTHOPAEDIC TRAUMA ASSOCIATION

2016 Annual Meeting

Friday, October 7, 2016

(Potomac Ballroom ABCD)

6:00 am	**Speaker Ready Room** *(Potomac Coat Check)*
6:15 am	**Registration**
6:30 am - 7:30 am	**Concurrent Breakout Sessions –** Seating available first come, first-served. Case Presentations and Mini Symposium
6:30 am	**Continental Breakfast** *(Outside Breakout Session Rooms)*

6:30 – 7:30 am	**MINI SYMPOSIA AND CASE PRESENTATIONS**	***No Tickets Required***

Limb Reconstruction in Crisis and Conflict Related Injuries *(Potomac 5 - 6)*
Mini Symposium
Moderator: *Daniel J. Stinner, MD, MAJ*
Faculty: *Michael J. Beltran, MD; Cory A. Collinge, MD; Joseph R. Hsu, MD* and *Christopher S. Smith, MD, LCDR*

Distal Radius Fractures: Stand Up and Take Charge for Best Results – Case Presentation *(Potomac 1 - 2)*
Moderator: *Lisa K. Cannada, MD*
Faculty: *Edward J. Harvey, MD; Frank A. Liporace, MD* and *Thomas F. Varecka, MD*

Pelvis and Acetabulum Fractures *(Potomac Ballroom ABCD)*
Case Presentation
Moderator: *Paul Tornetta III, MD*
Faculty: *Daniel S. Horwitz, MD; Theodore T. Manson, MD; Hassan Riaz Mir, MD, MBA* and *David C. Templeman, MD*

How to Improve the Results in Tibia Plateau Fractures *(Potomac 3 - 4)*
Mini Symposium
Moderator: *Utku Kandemir, MD*
Faculty: *Jackson Lee, MD* and *Saam Morshed, MD*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

7:00 am **Scientific Posters & Technical Exhibits**
(Prince George's Exhibit Hall D/E)

7:45 am - 9:30 am **Concurrent Sessions**
(General Session, Skills Labs, and Mini Symposia run concurrently.)
Scientific Paper Session 2: Tibial Shaft, Distal Femur, Knee (7:45 am - 9:25 am)
Skills Labs (8:00 am - 9:00 am)
Mini-Symposia (8:00 am - 9:30 am)

(Potomac Ballroom ABCD)
7:45 – 9:25 am

SCIENTIFIC PAPER SESSION 2
TIBIAL SHAFT, DISTAL FEMUR, KNEE

Moderators - David J. Hak, MD & Cyril Mauffrey, MD

7:45 am (p. 167) PAPER #32
Parapatellar Semi-Extended and Flexed Knee Tibial Nailing Techniques are Equivalent in Regards to Knee Pain: A Randomized Controlled Trial
David Rothberg, MD; *Ami Stuart, PhD; Angela Presson, PhD; Thomas Higgins, MD; Erik Kubiak, MD*

7:51 am (p. 169) PAPER #33
Is Septic Knee Arthritis a Realistic Concern Following Suprapatellar Nailing of Open Tibia Fractures?
Frances Broghammer, BS*; John Scolaro, MD; Caroline Tougas, MD; Luke Nicholson, MD; Geoffrey Marecek, MD*

7:57 am (p. 171) PAPER #34
Effect of Infrapatellar Nerve Block on Chronic Anterior Knee Pain After Tibial Nailing: A Randomized Double-Blind Placebo-Controlled Study (INCOP)
M.S. Leliveld, MD, MsC; *S.J. M. Kamphuis, MD; M.H.J. Verhofstad, MD, PhD*

8:03 am Discussion

8:08 am (p. 173) PAPER #35
Δ LIPUS Health Utility and Economic Analysis
Paul Tornetta III, MD; ***Jason Busse, DC, PhD****; Mohit Bhandari, MD, FRCSC, PhD; Gordon Guyatt, MD; Thomas Einhorn, MD; James Heckman, MD; Kwok-Sui Leung, MD; Emil H. Schemitsch, MD; Stephen D. Walter, BSc, ARCS, PhD; Natasha Burke, MSc; Rob Hopkins, BA, BSc, MBA, PhD*

8:14 am (p. 174) PAPER #36
The Trajectory of Short- and Long-Term Functional Recovery of Tibial Shaft Fractures Following Intramedullary Nail Fixation
Sebastian Ko, MD; *Peter O'Brien, MD, FRCSC; Pierre Guy, MD; Henry Broekhuyse, MD; Piotr Blachut, MD, FRCSC; Kelly Lefaivre, MD*

8:20 am (p. 175) PAPER #37
Progression of Healing Using RUST: Can We Eliminate The Cost of Early Radiographs?
Robert Wojahn, MD; *Torgom Abraamyan, BS; Amanda Spraggs-Hughes, BS, MA; Michael J. Gardner, MD; William M. Ricci, MD; Christopher McAndrew, MD*

8:26 am Discussion

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

8:31 am (p. 177) PAPER #38
Percutaneous or Open Reduction of Closed Tibial Shaft Fractures During Intramedullary Nailing Does Not Increase Wound Complications, Infection, or Nonunion Rates
Darryl Auston, MD, PhD*; Jordan Meiss, MD; Rafa Serrano, MD; Brian Kistler, MD; Thomas Sellers, MD; Michael Beebe, MD; Jonathan Quade, MD; Timothy Hoggard, BS; Benjamin Maxson, DO; Anthony Infante, DO; David Watson, MD; Anjan Shah, MD; Hassan R. Mir, MD*

8:37 am (p. 179) PAPER #39
Radiographic Investigation of the Distal Extension of Fractures into the Articular Surface of the Tibia (The RIDE FAST Study)
Lucas Marchand, MD; *Ajinkya Rane, MD; Zachary Working, MD; Lance Jacobson, MD; Erik Kubiak, MD; Thomas Higgins, MD; David Rothberg, MD*

8:43 am (p. 182) PAPER #40
Extreme Nailing: Is It Safe to Allow Immediate Weight Bearing of Extra-Articular Distal Tibia Fractures (OTA 43-A) Treated with Intramedullary Fixation?
Michael Beebe, MD; *Rafael Serrano-Riera, MD; Jonathan Quade, MD; Darryl Auston, MD, PhD; Anthony Infante, DO; Anjan Shah, MD; Benjamin Maxson, DO; David Watson, MD; Roy Sanders, MD; Hassan R. Mir, MD*

8:49 am
Discussion

8:54 am (p. 184) PAPER #41
In-vivo Stiffness Measurements for Distal Femur Fractures Fixed with Locked Plating
Christopher Parks, MD; *Michael J. Gardner, MD; William M. Ricci, MD; Christopher McAndrew, MD, MSc*

9:00 am (p. 186) PAPER #42
Δ The Effect of Coronal Plane Angulation on the Outcomes of Operatively Treated Distal Femur Fractures
Paul Tornetta III, MD; ***Margaret Cooke, MD;*** *Kenneth A. Egol, MD; Clifford Jones, MD, FACS; Janos Ertl, MD; Brian Mullis, MD; Ed Perez, MD; Cory A. Collinge, MD; Robert Ostrum, MD; Catherine Humphrey, MD; Robert Dunbar, MD; William M. Ricci, MD; Laura Phieffer, MD; David Teague, MD; Christopher Born, MD; Alan Zonno, MD; Judith Siegel, MD; Henry Sagi, MD; Andrew Schmidt, MD; Stephen Sems, MD; Darin Friess, MD*

9:06 am (p. 188) PAPER #43
Should We Throw Away the External Fixator for Knee Dislocations?
Robert Corey, MD; *Nathan Park, BS; Scott Kaar, MD; Lisa K. Cannada, MD*

9:12 am (p. 190) PAPER #44
Fixed Angle Locking Plate Fixation of Complex Comminuted Patellar Fractures
Tyler Moore, MD; *Bharat Sampathi, BA; Martin Tynan, MD; David Zamorano, MD; John Scolaro, MD*

9:18 am
Discussion

9:25 am
Refreshment Break
Visit Scientific Posters & Technical Exhibits
(Prince George's Exhibit Hall D/E)
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

8:00 am - 9:30 am **Concurrent Breakout Sessions**
(Skills Labs, Mini Symposia, and General Session run concurrently.)
Skills Labs
Mini-Symposia
Scientific Paper Session 2: Tibial Shaft, Distal Femur, Knee

8:00 – 9:00 am **SKILLS LABS** *No Tickets Required*

(SL1) **Fixation of Proximal Humeral Fractures** *(National Harbor 2)*
Lab Leader: *Andrew R. Fras, MD*
Faculty: *Michael Blankstein, MD; Aaron M. Perdue, MD; David J. Polga, MD; Mark Hake, MD* and *Daniel J. Stinner, MD*

(SL2) **SIGN Fracture Care International** *(National Harbor 3)*
Lab Leader: *Lewis G. Zirkle Jr., MD*
Faculty: *SIGN Fracture Care International: Anthony Brown, MD; Carlito Chee Kee (Jun) Valera Jr., MD; Geletaw Tessema, MD; Elsa Chavez, MD; Carla Smith, MD; Kristopher Roa; Anthony Maina, MD* and *David Shearer, MD*

8:00 – 9:30 am **MINI SYMPOSIA** *No Tickets Required*

Proximal Humerus Fractures: *(Potomac 5 - 6)*
Optimizing Surgical Management and Technique in 2016
Moderator: *Emil H. Schemitsch, MD*
Faculty: *Niloofar Dehghan, MD; Edward J. Harvey, MD; Michael D. McKee, MD* and *Aaron Nauth, MD*

Minute to Win-It "Crises in Health Policy" *(Potomac 1 - 2)*
Moderator: *Douglas W. Lundy, MD*
Faculty: *Bruce D. Browner, MD; John D. Campbell, MD; A. Alex Jahangir, MD; Clifford B. Jones, MD; Gerald J. Lang, MD; Manish K. Sethi, MD; Michael Suk, MD, JD; Todd A. Swenning, MD* and *Nirmal C. Tejwani, MD*

Mangled Extremity Evaluation and Management *(Potomac 3 - 4)*
Moderator: *Raymond A. Pensy, MD*
Faculty: *Michael J. Bosse, MD* and *L. Scott Levin, MD*

From Good to Great: *(National Harbor 6 - 7)*
Improving Your Treatment of Femoral Head Fractures
Moderators: *Jaimo Ahn, MD; John A. Scolaro, MD*
Faculty: *David L. Helfet, MD; Mark C. Reilly, MD; Milton L. Routt, MD; H. Claude Sagi, MD* and *Mark S. Vrahas, MD*

See pages 49 - 106 for financial disclosure information.

(Potomac Ballroom ABCD)

9:55 – 11:15 am

SYMPOSIUM III: FRACTURE HEALING CONTROVERSIES: THE PROBLEMS AND SOLUTIONS YOU NEED TO KNOW ABOUT IN 2016!

Moderator: *Emil H. Schemitsch, MD*
Faculty: *Mohit Bhandari, MD; Kenneth A. Egol, MD; Michael D. McKee, MD; Aaron Nauth, MD; Paul Tornetta III, MD*

9:55 am **Fracture Union: Can it be Defined and Predicted?**
Paul Tornetta III, MD

10:05 am **Critical Size Defects: Is There a Consensus on Diagnosis and Treatment?**
Emil H. Schemitsch, MD

10:15 am **Atypical Femur Fractures: How to Improve Surgical Outcomes!**
Kenneth A. Egol, MD

10:25 am **The Infected Fracture: Is There a Gold Standard for Management?**
Michael D. McKee, MD

10:35 am **The Extreme Fragility Fracture: What I Do Differently!**
Aaron Nauth, MD

10:45 am **Augmentation of Fracture Repair: Is Anything Ready for Prime Time?**
Mohit Bhandari, MD

10:55 am **Cases, Questions, Discussion, Consensus**
All Faculty

11:15 am – 11:45 am

Guest Nation – India

(General Session Room - Potomac Ballroom ABCD)

The OTA is honored to welcome India as the 2016 Guest Nation. We are pleased to have the opportunity for collaboration with our Indian colleagues, and a chance to recognize their contributions and achievements.

Best International Forum Paper:
3D Navigation Reduces Radiation Exposure and Operative Time in Lumbopelvic Fixations
Martin Hoffmann; Thomas Schildhauer
BG-University Hospital Bergmannsheil, Ruhr-University, Bochum, GERMANY

Guest Nation Introduction
***Steven A. Olson, MD**, OTA President*

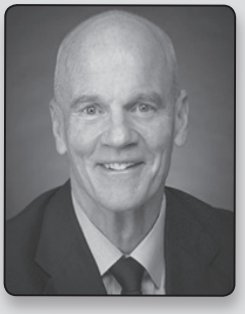
Guest Nation Presentation
Evolution of Trauma Care in India: Current Status and Future Directions

Professor Sudhir K. Kapoor
Hon. Treasurer Indian Orthopaedic Association (IOA); Dean, ESI Post Graduate Institute of Medical Sciences and Research; Professor & HOD Orthopaedics, New Delhi, Delhi, INDIA

Discussion

11:45 am – 12:15 pm

John Border, MD Memorial Lecturer



(General Session Room - Potomac Ballroom ABCD)

Keith A. Mayo, MD
Medical Director,
Hansjörg Wyss Hip & Pelvis Center
Seattle, Washington

"In a Climate of Healthcare as a Commodity, What is the Role of the Individual Surgeon?"

Introduction: Mark C. Reilly, MD

See pages 49 - 106 for financial disclosure information.

12:15 pm - 1:15 pm — Lunch and
Visit Scientific Posters & Technical Exhibits *(Prince George's Exhibit Hall D/E)*
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

12:15 pm – 1:15 pm — **New Member Luncheon** *(tickets required)* (*National Harbor 6 - 7)*

12:15 pm – 1:15 pm — ***Kathy Cramer, MD Memorial*** **Women in Orthopaedic Trauma Luncheon** *(tickets required)* *(National Harbor 4 - 5)*

Chairs: *Toni McLaurin, MD and Carla Smith, MD*

12:30 pm – 1:15 pm **GUIDED POSTER TOURS** ***Tickets Required***

(PT1) **Hip/Femur** *(Prince George's Exhibit Hall D/E)*
Guide: *Thomas F. Higgins, MD*

(PT2) **International** *(Prince George's Exhibit Hall D/E)*
Guide: *Peter V. Giannoudis, MD*

1:15 pm - 2:45 pm — **Concurrent Sessions**
(General Session, Skills Labs, and Mini Symposia run concurrently.)
Scientific Paper Session 3: Acetabulum, Pelvis, and Spine (1:15 pm - 2:35 pm)
Skills Labs (1:15 pm - 2:15 pm)
Mini-Symposia (1:15 pm - 2:45 pm)

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 3
ACETABULUM, PELVIS, AND SPINE

1:15 – 2:35 pm

Moderators - David W. Sanders, MD & Pierre Guy, MD

1:15 pm (p. 192) PAPER #45
ORIF vs Arthroplasty of Geriatric Acetabular Fractures: Results of a Prospective Randomized Controlled Trial
Theodore Manson, MD*; Robert V. O'Toole, MD*

1:21 pm (p. 194) PAPER #46
Risk Factors for Early Reoperation Following Operative Treatment of Acetabular Fractures
Anthony Ding, MD*; Robert V. O'Toole, MD; Renan Castillo, PhD; George Reahl, BS; Ryan Montalvo, BS; Marcus Sciadini, MD; Jason Nascone, MD; Theodore Manson, MD*

1:27 pm Discussion

1:32 pm (p. 196) PAPER #47
Does Prehospital Spinal Immobilization Influence Inhospital Decision to Obtain Imaging after Trauma?
Joseph Drain, BS*; Timothy Moore, MD; Heather Vallier, MD*

1:38 pm (p. 197) PAPER #48
A Randomized Controlled Clinical Trial of Indigenized Innovative Negative Pressure Device for the Management of Stage 3 and 4 Pressure Ulcer in Traumatic Paraplegia Patients
Rajeshwar Srivastava, MS*; Mukesh Dwivedi, MSc, PhD Scholar; Amit Bhagat, MSc, PhD Scholar; Saloni Raj, MBBS*

1:44 pm (p. 198) PAPER #49
Indications for CT Angiography of the Vertebral Arteries after Trauma
Joseph Drain, BS*; Douglas Weinberg, MD; James Ramey, BS; Timothy Moore, MD; Heather Vallier, MD*

1:50 pm Discussion

1:55 pm (p. 200) PAPER #50
A Randomized Controlled Trial Using Neuromuscular Electrical Stimulation with Pelvic Fracture Rehabilitation: An Interim Analysis
Jessica Rich, MRes, MSc, BSc; *Peter Bates, FRCS (Tr & Orth), BSc; Paul Culpan, BSc, MBChB, FRCS (Tr & Orth)*

2:01 pm (p. 202) PAPER #51
Relationship of Sacral Fractures to Nerve Injury: Is the Denis Classification Still Accurate?
Jannat Khan, BS; Alejandro Marquez-Lara, MD; ***Anna Miller, MD, FACS***

2:07 pm Discussion

2:12 pm (p. 204) PAPER #52
Does Operative Intervention Provide Early Pain Relief for Patients with Undisplaced Unilateral Sacral Fractures?
Paul Tornetta III, MD*; Julie Agel, ATC; Anna Miller, MD, FACS; Joshua Gary, MD; Clifford Jones, MD; Jason Lowe, MD; Darin Friess, MD; Ross Leighton, MD, FRCSC, FACS; William M. Ricci, MD; Erik Kubiak, MD; Laurence Kempton, MD; Heather Vallier, MD; Brian Mullis, MD; Sean Nork, MD; Zachary Roberts, MD*

See pages 49 - 106 for financial disclosure information.

2:18 pm (p. 206) PAPER #53 — **INFIX versus Plating for Pelvic Fractures with Symphyseal Disruption**
Rahul Vaidya, MD; ***Adam Martin, MS;*** *Matthew Roth, MS; Frederick Tonnos, DO; Kerellos Nasr, MD*

2:24 pm (p. 208) PAPER #54 — **Predictors of Unplanned Reoperation after Operative Treatment of Pelvic Ring Injuries**
George Ochenjele, MD; *Kristoff Reid, MD; Renan Castillo, MD; Carrie Schoonover, BS; Ryan Montalvo, BS; Theodore Manson, MD; Marcus Sciadini, MD; Jason Nascone, MD; Robert V. O'Toole, MD*

2:30 pm — Discussion

1:15 pm - 2:45 pm — **Concurrent Breakout Sessions**
(Skills Labs, Mini Symposia, and General Session run concurrently.)
Skills Labs
Mini-Symposia
Scientific Paper Session 3: Acetabulum, Pelvis, and Spine

1:15 – 2:15 pm **SKILLS LABS** *No Tickets Required*

(SL3) **Distal Femur Plating** *(National Harbor 2)*
Lab Leader: *Gerard P. Slobogean, MD*
Faculty: *Greg Gaski, MD; Jennifer Hagen, MD; Michael Gardner, MD* and *Jason Nascone, MD*

(SL4) **Clavicle and AC Joint Fixation** *(National Harbor 3)*
Lab Leader: *Michael D. McKee, MD*
Faculty: *Michael Blankstein, MD; Lisa Cannada, MD; Niloofar Dehghan, MD* and *Nirmal Tejwani, MD*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

1:15 – 2:45 pm **MINI SYMPOSIA** *No Tickets Required*

Fragility Fractures and Bone Health: What You Need to Do to Establish and Run a Fragility Fracture Program *(Potomac 5 - 6)*
Moderator: *James A. Goulet, MD*
Faculty: *Kyle J. Jeray, MD; Clifford B. Jones, MD; Joseph M. Lane, MD; Debra Sietsema PhD, RN* and *Marc F. Swiontkowski, MD*

Getting It Out: The Trials and Tribulations of Hardware Removal *(Potomac 3 - 4)*
Moderator: *David J. Hak, MD*
Faculty: *Christian Krettek, MD; Cyril Mauffrey, MD, FACS, FRCS* and *Greg M. Osgood, MD*

Treatment of Complex Knee Dislocations *(Potomac 1 - 2)*
Moderator: *William T. Obremskey, MD, MPH*
Faculty: *John D. Adams, MD; Frank R. Avilucea, MD* and *William H. Harvin, MD*

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 4 UPPER EXTREMITY I: HUMERAL SHAFT, ELBOW, WRIST

2:35 – 3:38 pm **Moderators - Robert V. O'Toole, MD & Gregory J. Della Rocca, MD, PhD, FACS**

2:35 pm (p. 210) PAPER #55
The Post-Sarmiento Era: Is It Time to Rethink Expectations of Functional Bracing for Humeral Shaft Fractures?
Rafael Serrano-Riera, MD; *Benjamin Maxson, DO; Anthony Infante, DO; David Watson, MD; Roy Sanders, MD; Hassan R. Mir, MD; Anjan Shah, MD*

2:41 pm (p. 212) PAPER #56
A Firm Shake Leads to a Strong Union: Stability Six Weeks following Humeral Shaft Fracture Predicts Healing
Adam Driesman, BA, *Nina Fisher, BS; Sanjit Konda, MD; Kenneth A. Egol, MD*

2:47 pm Discussion

2:52 pm (p. 213) PAPER #57
A Prospective Randomized Trial of Nonoperative versus Operative Management of Olecranon Fractures in the Elderly
Andrew Duckworth, MBChB*; BSc, MRCSEd, MSc, PhD,* *Nicholas Clement, MRCSEd, PhD; Jane McEachan, FRCSEd; Timothy White, MD, FRCSEd; Charles Court-Brown, MD, FRCSEd; Margaret McQueen, MD, FRCS*

See pages 49 - 106 for financial disclosure information.

2:58 pm (p. 214) PAPER #58
Comparison of the Henry versus Thompson Approaches for Fixation of Proximal Radial Shaft Fractures: A Multicenter Study
Jesse Dashe, MD; *Brett Murray, BS, MA; Paul Tornetta III, MD; Kelly Grott, BS; Brian Mullis, MD; Kate D. Bellevue, MD; Reza Firoozabadi, MD, MA; Harish Kempegowda, MD; Daniel S. Horwitz, MD; Philip Fontenot, MD; Shaan Patel, MD; Hassan R. Mir, MD; John Ruder, MD; CAPT (ret) Michael J. Bosse, MD; Jerald Westberg, BA; Benjamin Sandberg, MD; Kasey J. Bramlett, PA-C; Andrew J. Marcantonio, DO, MBA; Alex J. Sadauskas, BS; Lisa K. Cannada, MD; Alexandra Goodwin, MD; Anna N. Miller, MD, FACS; Samuel H. Klatman, MD; Mary P. George, MD; Peter Krause, MD*

3:04 pm (p. 216) PAPER #59
A Prospective Randomized Trial of Plate Fixation versus Tension Band Wire for Olecranon Fractures
Andrew Duckworth, MBChB, BSc, MRCSEd, MSc, PhD*; Nicholas Clement, MRCSEd, PhD; Timothy White, MD, FRCSEd; Charles Court-Brown, MD, FRCSEd; Margaret McQueen, MD, FRCS*

3:10 pm (p. 217) PAPER #60
Δ Long-Term Outcomes of Total Elbow Arthroplasty for Distal Humeral Fracture: Results from a Prior Randomized Clinical Trial
Niloofar Dehghan, MD, MS, FRCSC; *Matthew Furey, MD; Emil H. Schemitsch, MD; Christine Schemitsch, BS; Michael D. McKee, MD*

3:16 pm Discussion

3:21 pm (p. 219)- PAPER #61
Intraoperative O-Arm Imaging of AO/OTA C2 and C3 Distal Radius Fractures Identifies Malreduced Final Reductions in up to 30% of Cases
Brian Vickaryous, MD*; J. Dean Cole, MD; Bob Meuret, MD*

3:27 pm (p. 221) PAPER #62
Digital Edema Predicts Early Progression to Functional Plateau Following Volar Locked Plating for Distal Radius Fractures
Michael Maceroli, MD*; Edward Shields, MD; John Ketz, MD; John Elfar, MD; Jonathan Gross, MD; Warren Hammert, MD, DDS*

3:33 pm Discussion

3:40 pm Refreshment Break (Hall open 3:30 pm-6:15 pm)
Visit Scientific Posters & Technical Exhibits
(Prince George's Exhibit Hall D/E)
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

4:10 - 5:30 pm **Concurrent Sessions**
(Mini Symposia and General Session run concurrently.)
Mini-Symposia
Scientific Paper Session 5: Nonunion/General Interest I (4:16 pm - 5:36 pm)

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

4:10 – 5:30 pm **MINI SYMPOSIA** *No Tickets Required*

Syndesmosis Injury: How Times have Changed *(Potomac 5 - 6)*
Moderator: *Lisa K. Cannada, MD*
Faculty: *Samuel Adams, MD; Thomas Jones, MD; Seth R. Yarboro, MD* and *Robert D. Zura, MD*

ORIF versus Acute Arthroplasty for Common Extremity Injuries: What Does Evidence-based Medicine Tell Us? *(Potomac 3 - 4)*
Moderator: *Emil H. Schemitsch, MD, FRCSC*
Faculty: *Hans J. Kreder, MD, FRCSC; Michael D. McKee, MD, FRCSC; Aaron Nauth, MD, FRCSC* and *Andrew H. Schmidt, MD, FRCSC*

Techniques and Controversies in Treatment of Acetabular Fractures *(Potomac 1 - 2)*
Moderator: *Marcus F. Sciadini, MD*
Faculty: *Michael T. Archdeacon, MD; Tim Chesser, MB, BS, FRCS; Conor P. Kleweno, MD; Mark C. Reilly, MD* and *Adam J. Starr, MD*

(Potomac Ballroom ABCD) **SCIENTIFIC PAPER SESSION 5**
NONUNION AND GENERAL INTEREST I

4:16 – 5:36 pm **Moderator - Thomas F. Higgins, MD & Christopher Doro, MD**

4:10 pm (p. 223) PAPER #63 — **Taylor Spatial Frame Stacked Transport for Tibial Infected Nonunions with Bone Loss: Long-Term Functional Outcomes**
Joshua Napora, MD*; Douglas Weinberg, MD; Blake Eagle; Bram Kaufman, MD; John Sontich, MD*

4:16 pm (p. 225) PAPER #64 — **Can a Tibia Shaft Nonunion Be Predicted at Initial Fixation? Applying the Nonunion Risk Determination (NURD) Score to the SPRINT Trial Database**
Gerard P. Slobogean, MD*; Kevin O'Halloran, MD; Nathan O'Hara, MHA; Renan Castillo, PhD; Sheila Sprague, PhD; Mohit Bhandari, MD, FRCSC, PhD; Robert V. O'Toole, MD; SPRINT Investigators*

4:22 pm — Discussion

4:27 pm (p. 227) PAPER #65 — **Patient Reported Pain Following Successful Nonunion Surgery: Can We Completely Eliminate It?**
Nina Fisher, BS*; Adam S. Driesman, BA; Sanjit Konda, MD; Kenneth A. Egol, MD*

4:33 pm (p. 229) PAPER #66 — **Intertrochanteric Osteotomy for Femoral Neck Nonunion: Does "Undercorrection" Result in an Acceptable Rate of Femoral Neck Union?**
Brandon Yuan, MD*; David Shearer, MD, MPH; David Barei, MD, FRCS(C); Sean Nork, MD*

See pages 49 - 106 for financial disclosure information.

4:39 pm (p. 230) PAPER #67
Any Cortical Bridging Predicts Healing of Supracondylar Femur Fractures
Patrick Strotman, MD*; Madhav Karunakar, MD; Tammy Rhoda, MPH****;*** *Rachel Seymour, PhD; William Lack, MD*

4:45 pm
Discussion

4:50 pm (p. 232) PAPER #68
Δ Are Large Clinical Trials in Orthopaedic Trauma Justified?
Sheila Sprague, PhD; Paul Tornetta III, MD; ***Gerard P. Slobogean, MD;***
Nathan O'Hara, MHA; Paula McKay, BSc; Diane Heels-Ansdell, MSc; Brad Petrisor, MD; Kyle Jeray, MD; Emil H. Schemitsch, MD; David Sanders, MD; Mohit Bhandari, MD, FRCSC, PhD; FLOW Investigators

4:56 pm (p. 234) PAPER #69
An Evaluation of the Relationship between 6-week Post-Discharge Risk Classification and 6-Month Outcomes Following Orthopaedic Trauma
Renan Castillo, MD*; Kristin Archer, PhD; CAPT (ret) Michael Bosse, MD; Robert Hymes, MD; Andrew Pollak, MD; Heather Vallier, MD; Anna Bradford, PhD, MSW; Susan Collins, MSc; Katherine Frey, RN, MPH; Yanjie Huang, ScM; Daniel Scharfstein, ScD; Elizabeth Wysocki, MS; Stephen Wegener, PhD; Ellen MacKenzie, PhD; (Consortium) METRC*

5:02 pm
Discussion

5:07 pm (p. 236) PAPER #70
Are Early Career Orthopaedic Trauma Surgeons Performing Enough Complex Trauma Surgery?
Jacob Gire, MD*; Michael J. Gardner, MD; Alex Harris, PhD; Julius Bishop, MD*

5:13 pm (p. 238) PAPER #71
Management of Complex Orthopaedic Trauma: Is the Balance Shifting Away from Level I Trauma Centers?
Meir Marmor, MD; *Saam Morshed, MD; Arash Rezaei, MD Candidate*

5:19 pm (p. 239) PAPER #72
Surgical Management and Reconstruction Training (SMART) Course for International Orthopedic Surgeons: Saving Limbs after Traumatic Injury
Hao-Hua Wu, BA; *Kushal Patel, MD; Amber Caldwell, BA; Richard Coughlin, MD; Scott Hansen, MD; Joseph Carey, MD*

5:25 pm (p. 241) PAPER #73
"Red-Yellow-Green": Effect of an Initiative to Guide Surgeon Choice of Orthopaedic Trauma Implants
Kanu Okike, MD, MPH; *Rachael Pollak, BA; Robert V. O'Toole, MD; Andrew Pollak, MD*

5:31 pm
Discussion

5:36 pm
ADJOURN to Poster Tours

5:36 - 6:30 pm
Military Reception
(Potomac 5 - 6 Foyer)
All Active Duty Military, Retired Military, and Landstuhl Distinguished Visiting Scholar participants are welcome to attend.

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FRIDAY, OCTOBER 7, 2016

5:40 – 6:15 pm	'SUDS AND SCIENCE' GUIDED POSTER TOURS	*Tickets Required*

(PT3) **Foot and Ankle** *(Prince George's Exhibit Hall D/E)*
Guide: *Paul Tornetta III, MD*

(PT4) **General Interest** *(Prince George's Exhibit Hall D/E)*
Guide: *Michael J. Gardner, MD*

See pages 49 - 106 for financial disclosure information.

ORTHOPAEDIC TRAUMA ASSOCIATION

2016 Annual Meeting

Saturday, October 8, 2016

(Potomac Ballroom ABCD)

6:00 am **Speaker Ready Room**
(Potomac Coat Check)

6:15 am **Registration**

6:30 am - 7:30 am **Concurrent Breakout Sessions –** Seating available first come, first-served.
Mini Symposia
Case Presentations

6:30 am **Continental Breakfast**
(Outside Breakout Session Rooms)

6:30 – 7:30 am **MINI SYMPOSIA AND CASE PRESENTATIONS** ***No Tickets Required***

Distal Humerus Fractures: Tips and Tricks *(Potomac 3 - 4)*
Case Presentations
Moderator: *Utku Kandemir, MD*
Faculty: *Michael J. Gardner, MD; John T. Gorczyca, MD; Michael D. McKee, MD* and *Milan K. Sen, MD*

Developing and Maintaining a Successful *(Potomac 5 - 6)*
Clinical Research Program – Mini Symposium
Moderator: *Heather A. Vallier, MD*
Faculty: *Julie Agel, ATC; Mary A. Breslin, BA* and *William T. Obremskey, MD, MPH*

Pelvic Ring Disruption Decision Making: *(Potomac Ballroom ABCD)*
Deciding What Needs Fixed and How – Mini Symposium
Moderator: *Jason W. Nascone, MD*
Faculty: *Pierre Guy, MD; H. Claude Sagi, MD* and *Adam J. Starr, MD*

A Piece of Tibia is Missing, What are My Options? *(Potomac 1 - 2)*
Case Presentations
Moderator: *Cyril Mauffrey, MD*
Faculty: *Gregory J. Della Rocca, MD, PhD, FACS; Peter V. Giannoudis, MD* and *Kyros R. Ipaktchi, MD*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

SATURDAY, OCTOBER 8, 2016

7:00 am **Scientific Posters & Technical Exhibits**
(Prince George's Exhibit Hall D/E)

(Potomac Ballroom ABCD)

7:45 – 9:00 am

SYMPOSIUM IV: FEMORAL NECK FRACTURES: WHO TO FIX, WHO TO REPLACE, AND HOW TO DO IT

Moderator: *Theodore T. Manson, MD*
Faculty: *Joshua L. Gary, MD; Dean G. Lorich, MD; Andrew H. Schmidt, MD; Gerard P. Slobogean, MD*

7:45 am **Decision Making for Femoral Neck Fractures, Who Should We Fix and Who Should We Replace?**
Gerard P. Slobogean, MD

7:55 am **Decision Making for Femoral Neck Fractures- Does Fixation Construct Matter or Is It All in the Reduction?**
Joshua L. Gary, MD

8:05 am **Surgical Techniques for Reduction and Fixation of Femoral Neck Fractures in both Young and Old Patients?**
Dean G. Lorich, MD

8:20 am **Decision Making for Older Femoral Neck Fractures- Who Gets a Hemi and Who Gets a Total Hip? Do I Use Cement or Press Fit?**
Andrew H. Schmidt, MD

8:35 am **Surgical Techniques for Total Hip Replacement for Femoral Neck Fracture:**
Theodore T. Manson, MD

8:50 am **Case Presentations**
All Faculty

9:00 am - 10:25 am **Concurrent Sessions**
(General Session, Skills Lab, and Mini Symposia run concurrently.)
Scientific Paper Session 6: Hip Fractures: Young and Old (9:00 am - 10:15 am)
Skills Lab (9:10 am - 10:10 am)
Mini-Symposia (9:10 am - 10:25 am)

See pages 49 - 106 for financial disclosure information.

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 6
HIP FRACTURES: YOUNG AND OLD

9:00 – 10:15 am

Moderators - Gilbert R. Ortega, MD & Holly Tyler-Paris Pilson, MD

9:00 am
(p. 243)
PAPER #74

Failure Patterns of Young Femoral Neck Fractures: Which Complication Should We Choose?
David Stockton, MD; Karan Dua, MD; Peter O'Brien, MD, FRCSC; Andrew Pollak, MD; ***Gerard P. Slobogean, MD***

9:06 am
(p. 244)
PAPER #75

Open Reduction Internal Fixation versus Closed Reduction Internal Fixation in Treatment of Young Adults with Femoral Neck Fractures: A Multicenter Retrospective Cohort Study
Keisuke Ishii, MD*; Hao-Hua Wu, BA; Paul Tornetta III, MD; Darin Friess, MD; Clifford Jones, MD; Ross Leighton, MD, FRCSC, FACS; Ari Levine, MD; Jeff Maclean, MD; Brian Mullis, MD; William T. Obremskey, MD, MPH; Robert Ostrum, MD; Anas Saleh, MD; Andrew Schmidt, MD; David Teague, MD; Antonios Tsismenakis, MD; Theodore Miclau, MD; Saam Morshed, MD*

9:12 am
(p. 246)
PAPER #76

Immediate Weight Bearing as Tolerated has Improved Outcomes Without an Increased Risk of Reoperation after Intramedullary Fixation for Subtrochanteric Fractures Compared to Modified Weight Bearing
Brian P. Cunningham, MD*; Ashley Ali, MD; Saif Zaman, MD; Ryan Montalvo, BS; Bradley Reahl, MD; Guiliana Rotuno, BS; John Kark, BS; Mark Bender, BS; Brian Miller, MD; Hrayr Basmajian, MD; Ryan McLemore, PhD; David Shearer, MD, MPH; Robert V. O'Toole, MD; William T. Obremskey, MD, MPH; H. Claude Sagi, MD*

9:18 am

Discussion

9:23 am
(p. 248)
PAPER #77

Is Vitamin D Associated with Improved Physical Function and Reduced Re-Operation Rates in Elderly Patients with Femoral Neck Fractures Treated with Internal Fixation?
Sheila Sprague, PhD; ***Gerard P. Slobogean, MD;*** *Earl Bogoch, MD; Brad Petrisor, MD; Alisha Garibaldi, MSc; Nathan O'Hara, MHA; Mohit Bhandari, MD, FRCSC, PhD; FAITH Investigators*

9:29 am
(p. 250)
PAPER #78

Predictors of Cephalomedullary Nail Failure in the Treatment of Pertrochanteric and Intertrochanteric Hip Fractures
David Ciufo, MD; *Douglas Zaruta, MD; Jason Lipof, MD; John Gorczyca, MD; Catherine Humphrey, MD; Gillian Soles, MD; Kyle Judd, MS, MD; John Ketz, MD*

9:35 am
(p. 252)
PAPER #79

Frailty is a Better Marker than Age in Predicting Postoperative Mortality and Complications Following Pelvis and Lower Extremity Trauma
Cathy (CatPhuong) Vu, BS*; Robert Runner, MD; William Reisman, MD; Mara Schenker, MD*

9:41 am

Discussion

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

SATURDAY, OCTOBER 8, 2016

9:46 am (p. 254) PAPER #80	**Hip Fracture Patient on Warfarin: Is Delay of Surgery Necessary?** ***Matthew Cohn, BS****; Ashley Levack, MD, MAS; Nikunj Trivedi, BS; Jordan Villa, MD; Joseph Koressel, BS; David Wellman, MD; John Lyden, MD; Dean Lorich, MD; Joseph Lane, MD*
9:52 am (p. 256) PAPER #81	**Can Evidence-Based Guidelines Decrease Unnecessary Echocardiograms for Preoperative Evaluation of Hip Fracture Patients?** ***Chris Adair, MD;*** *Eric Swart, MD; Rachel Seymour, PhD; Joshua Patt, MD, MPH; Madhav Karunakar, MD*
9:58 am (p. 258) PAPER #82	**Hip Arthroplasty for Fracture vs. Elective Patients: One Bundle Does Not Fit All** ***Siddharth Mahure, MD;*** *Richard Yoon, MD; Lorraine Hutzler, MS; Nirmal C. Tejwani, MD; Frank Liporace, MD; Joseph Bosco, MD; Kenneth A. Egol, MD*
10:04 am (p. 260) PAPER #83	**Effect of Hospital and Surgeon Volume on Mortality After Hip Fracture** ***Kanu Okike, MD, MPH;*** *Priscilla Chan, BS, MS; Liz Paxton, MA*
10:10 am	Discussion
10:15 am	Refreshment Break Visit Scientific Posters & Technical Exhibits *(Prince George's Exhibit Hall D/E)* Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*
9:10 am - 10:25 am	**Concurrent Breakout Sessions** ***(Skills Lab, Mini Symposia, and General Session run concurrently.)*** Skills Lab Mini-Symposia Scientific Paper Session 6: Hip Fractures: Young and Old

9:10 – 10:10 am **SKILLS LAB**

(SL5) **Intramedullary Nailing of Proximal Tibia Fractures** *(National Harbor 2)*
Lab Leader: *Paul Tornetta III, MD*
Faculty: *Cory A. Collinge, MD; Reza Firoozabadi, MD, MA; Daniel S. Horwitz, MD; Clifford Jones, MD, FACS; Erik Kubiak, MD; Hassan R. Mir, MD, MBA, FACS; Brian H. Mullis, MD* and *Judith A. Siegel, MD*

See pages 49 - 106 for financial disclosure information.

9:10 – 10:25 am **MINI SYMPOSIA** *No Tickets Required*

Rib Fracture Fixation and the Surgical Management of Flail Chest Injuries: State of the Art *(Potomac 5 - 6)*
Moderator: *Michael D. McKee, MD*
Faculty: *Niloofar Dehghan, MD; T. Ty Fowler, MD; Aaron Nauth, MD; Emil H. Schemitsch, MD* and *Gerard P. Slobogean, MD*

Translational Research and Future Technologies in Orthopaedic Trauma Infections *(Potomac 1 - 2)*
Moderator: *Mark E. Shirtliff, PhD*
Faculty: *Javad Parvizi, MD, FRCS; Joseph C. (Josh) Wenke, PhD* and *Robert V. O'Toole, MD*

Critical Aspects of Orthopaedic Trauma in 2016 that can Impact Your Financial Future *(Potomac 3 - 4)*
Moderator: *Peter L. Althausen, MD*
Faculty: *Timothy J. Bray, MD; J. Scott Broderick, MD, MPH; Chris McBride, MBA; Justin Walker, MD* and *Anthony Williams ChFC, RFC, CLU*

10:25 am Refreshment Break
Visit Scientific Posters & Technical Exhibits
(Prince George's Exhibit Hall D/E)
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

10:45 am - 12:28 pm **Concurrent Sessions**
(Mini Symposia and General Session run concurrently.)
Mini-Symposia (10:45 am - 12:15 pm)
Scientific Paper Session 7: Pain Management, Pediatrics, and Infection (10:45 am - 12:28 pm)

10:45 am – 12:15 pm **MINI SYMPOSIA** *No Tickets Required*

The 8 Practices of Highly Successful Surgeons *(Potomac 1 - 2)*
Moderator: *Jeffrey M. Smith, MD*
Faculty: *Philip Stahel, MD*

Elbow Trauma: How to Maximize Outcome *(Potomac 3 - 4)*
Moderator: *William T. Obremskey, MD, MPH*
Faculty: *Lisa K. Cannada MD; Chad M. Corrigan, MD; Niloofar Dehghan, MD, FRCSC; Michael D. McKee, MD, FRCSC* and *Emil H. Schemitsch, MD, FRCSC*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

SATURDAY, OCTOBER 8, 2016

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 7
PAIN MANAGEMENT, PEDIATRICS, AND INFECTION

10:45 am – 12:28 pm

Moderators - Michael D. McKee, MD & Hassan R. Mir, MD

10:45 am
(p. 262)
PAPER #84

Efficacy of Peri-Incisional Multimodal Drug Injection Following Operative Management of Femur Fractures
Daniel Koehler, MD*; Larry Marsh, MD; Matthew Karam, MD; Catherine Fruehling, BA; Michael Willey, MD*

10:51 am
(p. 264)
PAPER #85

Are Continuous Femoral Nerve Catheters Beneficial for Pain Management After Operative Fixation of Tibial Plateau Fractures? A Randomized Trial
Paul Tornetta III, MD; ***Margaret Cooke, MD;*** *Tyler Welch, MD; Oleg Gusakov, MD*

10:57 am

Discussion

11:02 am
(p. 266)
PAPER #86

Δ Patient Coping and Expectations About Recovery Predict Development of Chronic Post-Surgical Pain Pain Interference and Reduced Quality of Life After Traumatic Open Extremity Fracture
Jason Busse, DC, PhD, Assistant Professor; *Sun Makosso-Kallyth, PhD; Brad Petrisor, MD; Kyle Jeray, MD; Ted Tufescu, MD; Georges-Yves Laflamme, MD, FRCSC; Paula McKay, BSc; Randi McCabe, PhD, MA; Yannick Le Manach, MD, MSc, PhD; Mohit Bhandari, MD, FRCSC, PhD; FLOW Investigators*

11:08 am
(p. 267)
PAPER #87

Is Scheduled Perioperative Intravenous Acetaminophen Use In Geriatric Hip Fractures Cost-Effective?
Alan Edwards, MD; *Alexander Bollinge, MD; Thomas Wenzlick, BS; Terrence Endres, MD*

11:14 am
(p. 268)
PAPER #88

Continuous Infraclavicular Brachial Plexus Block Versus Single Shot Nerve Block for Distal Radius Surgery: A Prospective Randomized Comparative Trial
Abhishek Ganta, MD; *David Ding, MD; Nina Fisher, BS; Sudheer Jain, MD; Nirmal C. Tejwani, MD*

11:20 am

Discussion

11:25 am

POSNA PEDIATRIC ORTHOPAEDIC SOCIETY OF NORTH AMERICA

Best Trauma Paper of the 2016 POSNA Annual Meeting

(p. 269)
PAPER #89

Functional Bracing for Treatment of Pediatric Diaphyseal Femur Fractures: An Alternative to Spica Casting
Andrea S. Kramer, MD*; Colin Woon, MD; David Speers, CPO, LPO*

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

11:31 am (p. 270) PAPER #90	**Randomized Controlled Trial Comparing the Outcome of Titanium Elastic Nailing versus Stainless Steel Nailing in the Management of Pediatric Diaphyseal Femur Fractures** ***Rajiv Maharjan, MBBS, MD;*** *Kumud Limbu, MBBS, MD; Raju Rijal, MBBS, MD*
11:37 am (p. 271) PAPER #91	**Comparison of the Outcome of Above-Knee and Below-Knee Cast for Isolated Tibial Shaft Fractures in Children: A Randomized Trial** ***Rajiv Maharjan, MBBS, MD;*** *Amit Limbu, MBBS, MD; Shiva Paneru, MBBS, MD*
11:43 am	Discussion
11:48 am (p. 272) PAPER #92	**Pediatric Supracondylar Humerus Fractures: Does After-hours Treatment Influence Outcomes?** *Gabrielle Paci, MD; Kali Tileston, MD; John Vorhies, MD;* ***Julius Bishop, MD***
11:54 am (p. 273) PAPER #93	**Pulseless Supracondylar Humerus Fracture with AIN or Median Nerve Injury – An Absolute Indication for Open Reduction?** ***Paul Choi, MD;*** *Liam Harris, BS; Alexander Broom, BA; Joseph Yellin, BA; Ashley Miller, BS; John Roaten, MD; Jeffrey Sawyer, MD; Patrick Whitlock, MD; Alexandre Arkader, MD; John Flynn, MD; David Skaggs, MD, MMM*
12:00 pm	Discussion
12:05 pm (p. 275) PAPER #94	**Clinical Validation of a Novel ELISA Serum Assay Test for Detection of Staphylococcus aureus Biofilm Antibodies in Serum of Orthopedic Trauma Patients** *Janet Harro, PhD; Ryan Montalvo, BS; Theodore Manson, MD; Robert V. O'Toole, MD; Manjari Joshi, MD; Timothy Zerhusen, BS; Roman Natoli, MD;* ***Mark Shirtliff, PhD***
12:11 pm (p. 277) PAPER #95	**Intraoperative Temperature in Hip Fractures: Effect on Complications and Outcome** ***Andrew Pepper, MD;*** *Nicholas Frisch, MD, MBA; Stuart Guthrie, MD; Craig Silverton, DO*
12:17 pm (p. 282) PAPER #96	**Nasal Decolonization with Povidone-Iodine Decreases Surgical Site Infection in the Elderly with Intracapsular Femur Fractures** ***Rafael Serrano-Riera, MD;*** *Anthony Infante, DO; Benjamin Maxson, DO; Anjan Shah, MD; Roy Sanders, MD; Hassan R. Mir, MD; David Watson, MD*
12:23 pm	Discussion
12:30 pm	Lunch and LAST OPPORTUNITY to Visit Scientific Posters & Technical Exhibits *(Prince George's Exhibit Hall D/E)* Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

SATURDAY, OCTOBER 8, 2016

12:30 pm – 1:15 pm **GUIDED POSTER TOURS** *Tickets Required*

(PT5) **Knee/Tibia** *(Prince George's Exhibit Hall D/E)*
Guide: *J. Tracy Watson, MD*

(PT6) **Upper Extremity** *(Prince George's Exhibit Hall D/E)*
Guide: *Michael D. McKee, MD*

1:30 pm - 2:40 pm **Concurrent Sessions**
(General Session and Mini Symposia Breakouts run concurrently.)
Scientific Paper Session 8: Upper Extemity II (1:30 pm - 2:39 pm)
Mini-Symposia (1:30 pm - 2:40 pm)

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 8
UPPER EXTREMITY II:
SCAPULA, CLAVICLE, AND PROXIMAL HUMERUS

1:30 – 2:39 pm **Moderator - Gerard P. Slobogean, MD & Frank A. Liporace, MD**

1:30 pm (p. 284) PAPER #97 **Should Displaced Scapular Body Fractures Be Operatively Treated? A Randomized Controlled Trial**
Clifford Jones, MD; *Debra Sietsema, PhD; James Ringler, MD; Terrence Endres, MD*

1:36 pm (p. 285) PAPER #98 **5-10 Year Outcomes of Operatively Treated Scapula Fractures**
Jeffrey Gilbertson, BA*; Joscelyn Tatro, MS; Lisa Schroder, BS, MBA; Peter Cole, MD*

1:42 pm Discussion

1:47 pm (p. 287) PAPER #99 **Plate Fixation Does Not Beat Nonoperative Treatment for Displaced Midshaft Clavicular Fractures: A Meta-Analysis of Randomized Controlled Trials**
Sarah Woltz, MD; *P. Krijnen, PhD; I.B. Schipper, MD, PhD*

1:53 pm (p. 288) PAPER #100 **Operative Treatment of Displaced Midshaft Clavicle Fractures: Have Evidence-Based Recommendations Changed Practice Patterns?**
Prism Schneider, MD, PhD, FRCSC*; Julie Agel, ATC; Richard Bransford, MD; Edward Harvey, MD, MSc, FRCSC*

1:59 pm (p. 290) PAPER #101 **Midshaft Clavicle Fractures: A Meta-Analysis Comparing Surgical Fixation via Anteroinferior Plating versus Superior Plating**
Alex Nourian, BS; Satvinder Dhaliwal, MPH; Sitaram Vangala, MS; ***Peter Vezeridis, MD***

2:05 pm Discussion

See pages 49 - 106 for financial disclosure information.

2:10 pm (p. 293) PAPER #102 — **Pre-operative Humeral Head Thickness Predicts Screw Cutout After Locked Plating of Proximal Humerus Fractures**
Lorraine Stern, MD; *John Gorczyca, MD*

2:16 pm (p. 295) PAPER #103 — **Proximal Humerus Fracture Fixation Failure: A Retrospective Review**
John Williams, MD; ***William Uffmann, MD;*** *Joshua Harmer, BS; Robert Tashjian, MD; Erik Kubiak, MD*

2:22 pm (p. 297) PAPER #104 — **Reverse Shoulder Arthroplasty for Proximal Humerus Fractures: Outcomes Comparing Primary Reverse Arthroplasty for Fracture versus Reverse Arthroplasty After Failed Osteosynthesis**
Steven Shannon, MD*; Eric Wagner, MD; Matthew Houdek, MD; William Cross, MD; Joaquin Sanchez-Sotelo, MD*

2:28 pm (p. 301) PAPER #105 — **Intermediate to Long-Term Outcomes Following Initial Treatment of Proximal Humerus Fractures in Ontario Canada: A Population-Based Retrospective Cohort**
Lauren Nowak, MSc*; Michael D. McKee, MD; Aaron Nauth, MD, FRCSC; Milena Vicente, RN; Marissa Bonyun, MD; Emil H. Schemitsch, MD*

2:34 pm — Discussion

2:40 pm — Refreshment Break
No Poster or Technical Exhibits
Visit Annual Meeting On Demand Video Demonstrations *(Potomac Foyer)*

1:30 pm - 2:40 pm — **Concurrent Breakout Sessions**
(Mini Symposia and General Session run concurrently.)
Mini-Symposia
Scientific Paper Session 8: Upper Extemity II

1:30 – 2:40 pm **MINI SYMPOSIA** *No Tickets Required*

How to Use Ring Fixators (TSF and Ilizarov) for Tibia Fractures *(Potomac 1 - 2)*
Moderator: *Theodore T. Manson, MD*
Faculty: *Joseph R. Hsu, MD; Robert V. O'Toole, MD* and *Stephen M. Quinnan, MD*

Lower Extremity Arthroplasty: Unreconstructable Articular Fractures, Periprosthetic Fractures, and Failed Fixation *(Potomac 3 - 4)*
Moderator: *Adam Sassoon, MD*
Faculty: *George J. Haidukewych, MD; Conor P. Kleweno, MD* and *Emil H. Schemitsch, MD*

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

(Potomac Ballroom ABCD)

SCIENTIFIC PAPER SESSION 9
FOOT & ANKLE, AMPUTATION, OPEN FRACTURES, AND GENERAL INTEREST II

3:00 – 5:10 pm

Moderators - Stephen A. Kottmeier, MD & Clifford B. Jones, MD

3:00 pm
(p. 303)
PAPER #106

Can You Drive Before You Walk?
Driving Tests for Patients with Surgically Treated Ankle Fractures
Sean Ho, MBBS, M.Med (Ortho); *Mei Leng Chan, Doctor of Philosophy (OT); Ernest Kwek, FRCS (Edin) (Ortho)*

3:06 pm
(p. 305)
PAPER #107

PROMIS Computer Adaptive Tests Compared with Time to Brake in Patients with Complex Lower Extremity Trauma
Seewan Kim, BS*; Daniel Wiznia, MD; Leon Averbukh, BS; Andrea Torres, BS; Edward Kong, BS; Chang-Yeon Kim, BS; Michael Leslie, DO*

3:12 pm
(p. 307)
PAPER #108

Serial Radiographs Do Not Change the Clinical Course of Nonoperative Stable Weber B Ankle Fractures
Lucas Marchand, MD; *Zachary Working, MD; Ajinkya Rane, MD; Lance Jacobson, MD; Erik Kubiak, MD; Thomas Higgins, MD; David Rothberg, MD*

3:18 pm
(p. 309)
PAPER #109

Equivalent Functional Outcomes Following Injury-Specific Fixation of Posterior Malleolar Fractures and Equivalent Ligamentous Injuries
Ashley Levack, MD, MAS; *Stephen Warner, MD, PhD; Elizabeth Gausden, MD; David Helfet, MD; Dean Lorich, MD*

3:24 pm

Discussion

3:29 pm
(p. 311)
PAPER #110

Δ Articular Inflammatory Cytokine Response is Greater in Acute Plafond Fractures than in Acute Tibial Plateau Fractures
Justin Haller, MD; Lucas Marchand, MD; David Rothberg, MD; Erik Kubiak, MD; ***Thomas Higgins, MD***

3:35 pm
(p. 313)
PAPER #111

Δ Negative Pressure Therapy Dressings versus Standard Dressings for Closed Calcaneus Fractures: Preliminary Results of a Prospective Randomized Study of Wound Complications
Camille Connelly, MD; ***Amanda Schroeder, MD****; Michael Archdeacon, MD; Ryan Finnan, MD; Frank Avilucea, MD; Theodore Toan Le, MD; John Wyrick, MD; Michael Archdeacon, MD*

3:41 pm
(p. 314)
PAPER #112

Treatment of Primary Ligamentous Lisfranc Injuries: Comparison between Screw Fixation and Tightrope Fixation
Harish Kempegowda, MD; *Shannon Alejandro, MD; Amrut Borade, MD; Benjamin Wagner, MD; Jove Graham, PhD; Gerard Cush, MD; James Gotoff, BS; Daniel Horwitz, MD*

3:47 pm

Discussion

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

3:52 pm (p. 316) PAPER #113
An Osseointegrated Percutaneous Prosthetic System for Treatment of Transfemoral Amputees: Medium and Projected Long-Term Follow-Up
Örjan Berlin, MD, PhD; *Kerstin Hagberg, PT, PhD; Katarzyna Kulbacka-Ortiz, Research Assistant; Rickard Brånemark, MD, PhD*

3:58 pm (p. 318) PAPER #114
Improved Function and Quality of Life Following Osseointegrated Reconstruction of Posttraumatic Amputees
Vaida Glatt, PhD; Munjed Al Muderis, FRACS, FRCS (Ortho), MB, ChB; ***Kevin Tetsworth, MD***

4:04 pm
Discussion

4:09 pm (p. 320) PAPER #115
Combined Presentation of Papers 115 & 116
Δ Prognostic Factors for Predicting Reoperations after Operative Management of Open Fractures
Mohit Bhandari, MD, FRCSC, PhD; Kyle Jeray, MD; Brad Petrisor, MD; Jeffrey Anglen, MD, FACS; Gregory Della Rocca, MD, PhD, FACS; PJ Devereaux, MD; Diane Heels-Ansdell, MSc; Clifford Jones, MD, FACS; Hans Kreder, MD; Susan Liew, MD; Kim Madden, MSc; Sun Makosso-Kallyth, PhD; Paula McKay, BSc; Steven Papp, MD, FRCPC; Parag Sancheti, MD; Emil H. Schemitsch, MD; Sheila Sprague, PhD; Stephanie Tanner, MS; ***Paul Tornetta III, MD****; Ted Tufescu, MD; Stephen D. Walter, BSc, ARCS, PhD; Gordon Guyatt, MD; FLOW Investigators*

(p. 324) PAPER #116
Δ What Factors are Associated with Infection in Open Fractures? A Predictive Model Based on a Prospective Evaluation of 2338 Patients
Paul Tornetta III, MD; Gregory Della Rocca, MD, PhD, FACS; Saam Morshed, MD; Clifford Jones, MD, FACS; Diane Heels-Ansdell, MSc; Sheila Sprague, PhD; Brad Petrisor, MD; Kyle Jeray, MD; Mohit Bhandari, MD, FRCSC, PhD; FLOW Investigators

4:15 pm (p. 328) PAPER #117
A Pilot Randomized Clinical Trial to Compare Intramedullary Nailing to Uniplanar External Fixation for Open Tibial Shaft Fractures in Tanzania
Max Liu, BA; David Shearer, MD; ***Kurt Yusi, MD;*** *Saam Morshed, MD; Edmund Eliezer, MD; Billy Haonga, MD*

4:21 pm (p. 330) PAPER #118
Clinically Important Subgroups within a Large Cohort of Gustilo Type IIIB Open Tibia Fractures: An Analysis of Surgical Rehospitalizations
Reza Firoozabadi, MD, MA; *Renan Castillo, MD; Robert V. O'Toole, MD; Anthony Carlini, PhD; CAPT (ret) Michael Bosse, MD; METRC Consortium*

4:27 pm
Discussion

4:32 pm (p. 332) PAPER #119
Operative Stabilization of Unstable Flail Chest Injuries Reduces Mortality to that of Stable Chest Wall Injuries
Niloofar Dehghan, MD, MS, FRCSC*; Emil H. Schemitsch, MD; Milena Vicente, RN****;*** *Aaron Nauth, MD; Michael D. McKee, MD*

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

SATURDAY, OCTOBER 8, 2016

4:38 pm (p. 334) PAPER #120
Influence of Timing of Femur Fracture Fixation on Outcomes Following Major Trauma
James Byrne, MD; *Avery Nathens, MD, PhD; David Gomez, MD, PhD; Richard Jenkinson, MD, MSc*

4:42 pm Discussion

4:47 pm (p. 337) PAPER #121
Prospective Evaluation of PTSD and Depression in Orthopedic Injury Patients With and Without Concomitant Traumatic Brain Injury
Jaicus Solis, MD*; Alan Jones, MD; Kenleigh Roden-Foreman, BA; Evan Rainey, MS; Monica Bennett, PhD; Michael Foreman, MD; Ann Marie Warren, PhD*

4:53 pm (p. 338) PAPER #122
Combined Orthopaedic and Vascular Injuries: A Multicenter Analysis
Paul Tornetta III, MD; ***Amir Shahien, MD;*** *Matthew Sullivan, MD; Reza Firoozabadi, MD, MA; Keyin Lu, BS; Lisa K. Cannada, MD; Mark Timmel, BS; Ashley Ali, MD; Kasey Bramlett, PA-C; Andrew Marcantonio, DO, MBA; Megan Flynn, MD; Heather Vallier, MD; Rick Nicolay, BS; Brian Mullis, MD; Alexandra Goodwin, MD; Anna Miller, MD, FACS; Peter Krause, MD; Hassan R. Mir, MD*

4:59 pm (p. 340) PAPER #123
MRI of Trauma Patients Treated with Contemporary External Fixation Devices Is without Significant Adverse Events: A Multicenter Study
Brett Hayden, MD*; Raminta Theriault, BS; Kasey Bramlett, PA-C; Robert Lucas, BA; Michael McTague, MD; Robert Ward, MD; Michael Weaver, MD; Andrew Marcantonio, DO, MBA; Scott Ryan, MD*

5:06 pm Discussion

5:10 pm Closing Remarks and ADJOURN

See you next year in Vancouver, CANADA, October 11 - 14, 2017

See pages 49 - 106 for financial disclosure information.

Abraamyan, Torgom	*(n); Submitted on: 05/24/2016*
Abreu, Francis	*3A (Roche); Submitted on: 09/01/2016*
Abzug, Joshua	*3B (Axogen); 7 (Springer); Submitted on: 04/04/2016*
Achor, Timothy	*3B (Synthes); Submitted on: 04/29/2016*
Adair, Chris	*(n); Submitted on: 05/31/2016*
Adams, John D.	*(n); Submitted on: 05/20/2016*
Adams, Mark	*(n); Submitted on: 06/17/2016*
Adams, Samuel	*2 (Sonoma Orthopaedics); 3B (4web; Medshape; Regeneration Technologies, Inc.; Sonoma Orthopaedics; Stryker); 4 (Medshape); 9 (American Orthopaedic Foot and Ankle Society); Submitted on: 04/18/2016*
Agel, Julie	*9 (American Orthopaedic Society for Sports Medicine; Orthopaedic Trauma Association); Submitted on: 05/12/2016*
Ahn, Jaimo	*3B (Merck; Synthes); 4 (Skelegen LLC); 7 (Cochrane); 8 (Fronteirs in Surgery; Journal of Orthopaedic Trauma); 9 (AAOS; American Board of Orthopaedic Surgery, Inc.; American Orthopaedic Association; American Physician Scientists Association; Foundation for Orthopaedic Trauma; Orthopaedic Research Society; Orthopaedic Trauma Association); Submitted on: 05/28/2016*
Ajgaonkar, Amit	*(n); Submitted on: 01/11/2016*
Al Muderis, Munjed	*1 (Amplitude Orthopaedics; OI Implants Pty Ltd; Osseointegration International Pty Ltd; Permedica); 3B (Amplitude Orthopaedic Pty Ltd; AQ Implants (GmBH); CORIN Australia; Global Orthopaedic Technology; Lima Orthopedics); 4 (Amplitude Orthopaedics); 8 (Journal of Military and Veterans' Health; World Journal of Orthopaedics); Submitted on: 05/01/2016*
Al Nouri, Mason	*(n); Submitted on: 08/16/2016*
Albitar, Ferras	*(n); Submitted on: 05/30/2016*
Alejandro, Shannon	*(n); Submitted on: 06/10/2016*
Alhammoud, Abduljabbar	*(n); Submitted on: 05/14/2016*
Ali, Ashley	*(n); Submitted on: 04/16/2016*
Allen, Jerad	*(n); Submitted on: 05/27/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Althausen, Peter L.	*4 (The Orthopedic Implant Company); 5 (Smith & Nephew); 8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association); Submitted on: 08/16/2016*
Altman, Daniel	*(n); Submitted on: 06/27/2016*
Altman, Gregory	*(n); Submitted on: 06/15/2016*
Amar, Eyal	*(n); Submitted on: 05/26/2016*
Amaral, Ney	*9 (Orthopaedic Trauma Association); Submitted on: 04/08/2016*
Andersen, Mette	*(n); Submitted on: 06/06/2016*
Anderson, Donald	*4 (Iowa Simulation Solutions, LLC); Submitted on: 06/09/2016*
Andruszkow, Hagen	*(n); Submitted on: 08/23/2016*
Aneja, Arun	*(n); Submitted on: 05/02/2016*
Anglen, Jeffrey O.	*3B (DJ Orthopaedics; Eli Lilly); 5 (FLOW Investigators); Submitted on: 05/02/2016*
Anoushiravani, Afshin	*(n); Submitted on: 05/31/2016*
Appleton, Paul	*9 (Orthopaedic Trauma Association); Submitted on: 06/08/2016*
Arbash, Mahmood Ali	*(n); Submitted on: 08/18/2016*
Archdeacon, Michael T.	*1 (Stryker); 3B (Stryker); 7 (SLACK Incorporated); 8 (Journal of the American Academy of Orthopaedic Surgeons); 9 (Ohio Orthopaedic Soceity; Orthopaedic Trauma Association); Submitted on: 05/02/2016*
Archer Swygert, Kristin	*8 (Physical Therapy); 5 (METRC); 9 (American Physical Therapy Association); Submitted on: 04/29/2016*
Arkader, Alexandre	*3C (Orthopediatrics SAB) Submitted on: 05/01/2016*
Arts, Jacobus (Chris)	*2 (Biomet; Cambioceramics; DSM; Stryker); 3B (BonAlive; DSM); 5 (Cambioceramics; DSM); 3C (Vivorte); 6 (Bonalive; Stryker); 9 (Dutch Orthopaedica Association Workgroup Biotechnology; Dutch Orthopaedic Association Workgroup WOW; Dutch Society of Biomaterials and Tissue Engineering; European Society of Tissue Regeneration in Orthopaedics and Trauma (ESTROT); Submitted on: 05/26/2016*
Arvesen, John	*(n); Submitted on: 02/01/2016*
Asher, Dean	*(n); Submitted on: 01/11/2016*
Attias, Naftaly	*(n); Submitted on: 04/10/2016*
Attum, Basem	*(n); Submitted on: 05/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Au, Brigham	*(n); Submitted on: 04/04/2016*
Augat, Peter	*5 (aap; Aesculap/B.Braun; Stryker; Servier; Eli Lilly; Apex Medical; Arthrex, Inc; Citieffe; Orthofix, Inc.; Smith & Nephew); 6 (Synthes; Ulrich); 8 (Biomedizinische Technik; Archives of Orthopaedic and Trauma Surgery; European Journal of Trauma and Emergency Surgery); 9 (International Society for Fracture Repair; Deutsche Gesellschaft fuer Biomechanik); Submitted on: 05/30/2016*
Auran, Richard Lawrence (Tim)	*(n); Submitted on: 05/22/2016*
Auston, Darryl	*(n); Submitted on: 05/30/2016*
Averbukh, Leon	*(n); Submitted on: 01/11/2016*
Avilucea, Frank R.	*(n); Submitted on: 05/20/2016*
Aviram, Galit	*(n); Submitted on: 08/23/2016*
Azari, Feredun	*(n); Submitted on: 05/27/2016*
Babcock, Sharon	*(n); Submitted on: 05/31/2016*
Babhulkar, Sushrut	*(n); Submitted on: 08/16/2016*
Bahney, Chelsea	*3B (SI Bone); 8 (European Cell and Matrix Journal); 9 (Orthopaedic Research Society); Submitted on: 06/06/2016*
Bakdash, Kenaz	*(n); Submitted on: 08/16/2016*
Bakhsh, Wajeeh	*3A (Norvartis); Submitted on: 05/31/2016*
Barcak, Eric	*(n); Submitted on: 10/06/2015*
Barei, David	*3B (Synthes); 9 (AO/ASIF); Submitted on: 06/11/2016*
Barinaga, Gonzalo	*(n); Submitted on: 05/31/2016*
Barlow, Ian	*1 (Limacorporate SpA); 2 (Limacorporate SpA); 3B (Limacorporate SpA); 5 (Limacorporate SpA); Submitted on: 05/30/2016*
Barnard, Eric	*(n); Submitted on: 05/15/2016*
Bartlett III, Craig	*3B (SI Bone; Stryker); 4 (Johnson & Johnson; Merck); Submitted on: 07/22/2016*
Basmajian, Hrayr	*3B (Smith & Nephew); Submitted on: 04/04/2016*
Bates, Peter	*2 (DePuy, A Johnson & Johnson Company); 3B (ITS; Orthofix, Inc.); Submitted on: 06/24/2016*
Beebe, Michael	*(n); Submitted on: 04/18/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Befus, A. Dean	*(n); Submitted on: 08/26/2016*
Beingessner, Daphne	*2 (AO North America); 3B (Synthes); 5 (Synthes); Submitted on: 04/23/2016*
Bellevue, Kate	*(n); Submitted on: 05/31/2016*
Belmustakov, Stephen	*(n); Submitted on: 08/21/2016*
Beltran, Michael	*(n); Submitted on: 08/16/2016*
Bennett, Monica	*(n); Submitted on: 08/24/2016*
Benson, Emily	*9 (Orthopaedic Trauma Association); Submitted on: 08/30/2016*
Ben-Tov, Tomer	*(n); Submitted on: 01/11/2016*
Bercik, Michael	*6 (LIMA- Attended sponsored shoulder course); Submitted on: 05/21/2016*
Berger, Peter	*(n); Submitted on: 06/16/2016*
Bergin, Patrick	*2 (Acumed, LLC; Synthes); 5 (Synthes,Major Extremity Trauma Research Consortium (METRC)); Submitted on: 05/02/2016*
Bergum, Christopher	*(n); Submitted on: 05/03/2016*
Berhaneselase, Eleni	*(n); Submitted on: 06/16/2016*
Berlin, Örjan	*(n); Submitted on: 06/01/2016*
Bernstein, Mitchell	*3B (Ellipse; Smith & Nephew; Synthes); Submitted on: 04/06/2016*
Berry, Gregory	*5 (CORAL Collaborators); Submitted on: 08/23/2016*
Bess, Robert Shay	*1 (Pioneer Spine; k2 medical); 2 (Nuvasive; k2 medical); 3B (allosource; Nuvasive; k2 medical); 5 (DePuy, A Johnson & Johnson Company; tinnovasis; Medtronic Sofamor Danek; Stryker); 9 (North American Spine Society; Scoliosis Research Society); Submitted on: 05/14/2016*
Bhagat, Amit	*(n); Submitted on: 05/26/2016*
Bhandari, Mohit	*3B (Amgen Co; Eli Lilly;Stryker; Smith & Nephew; Zimmer; Stryker; Moximed; Bioventus; CONMED Linvatec; DJ Orthopaedics; Eli Lilly; Ferring Pharmaceuticals; Merck; Sanofi-Aventis); 5 (Smith & Nephew; DePuy, A Johnson & Johnson Company; Eli Lily; Bioventus; FAITH Investigators; FLOW Investigators; SPRINT Investigators); Submitted on: 05/24/2016*
Bhat, Suneel	*(n); Submitted on: 05/16/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Bice, Miranda	*(n); Submitted on: 04/08/2016*
Bickers, Anna	*(n); Submitted on: 01/11/2016*
Bihari, Aurelia	*(n); Submitted on: 06/02/2016*
Birch, Christopher	*(n); Submitted on: 05/30/2016*
Bishop, Julius	*1 (Innomed); 3B (Globus Medical); 5 (Zimmer); 6 (Synthes); Submitted on: 04/26/2016*
Blachut, Piotr	*5 (Synthes); 6 (Synthes); Submitted on: 08/16/2016*
Blankstein, Michael	*(n); Submitted on: 05/26/2016*
Blevins, Charles	*(n); Submitted on: 05/30/2016*
Bliven, Emily	*(n); Submitted on: 05/24/2016*
Boden, Kaeleen	*(n); Submitted on: 05/16/2016*
Bodendorfer, Blake	*(n); Submitted on: 04/12/2016*
Bogoch, Earl	*8 (Journal of Rheumatology); 9 (International Osteoporosis Foundation; Osteoporosis Canada); Submitted on: 05/30/2016*
Bollinger, Alexander	*3B (Mallinckrodt Pharmaceuticals); Submitted on: 08/29/2016*
Bonyun, Marissa	*(n); Submitted on: 05/16/2016*
Borade, Amrut	*(n); Submitted on: 06/01/2016*
Born, Christopher	*3B (Illuminoss; Stryker); 3C (Biointraface); 4 (Biointraface; Illuminoss); 5 (Stryker); 9 (American College of Surgeons; Orthopaedic Trauma Association; AAOS; Foundation for Orthopaedic Trauma); Submitted on: 04/01/2016*
Borrelli, Joseph	*2 (Eli Lilly); 3B (Eli Lilly); 7 (Springer); Submitted on: 09/07/2016*
Bosco, Joseph	*1 (Genovel); 2 (Pacira); 3B (Genovel; Labrador healthcare; Medtronic; Surgical Directions Consulting); 4 (Genovel); 8 (Bulletin of The Hospital for Joint Diseases; Journal of Bone and Joint Surgery - American); 9 (Association of Professionals in Infection Control (APIC); The Orthopaedic Learning Center); Submitted on: 04/28/2016*
Bosse, CAPT (ret) Michael J.	*4 (Orthopaedic Implant Company); 5 (FLOW Investigators; METRC); Submitted on 06/26/2016*
Bostian, Phillip	*9 (West Virginia Orthopaedic Society Board Member); Submitted on: 04/06/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Bottlang, Michael	*1 (Synthes; Zimmer); 2 (Synthes; Zimmer); 3A (APEX Biomedical); 3B (Synthes; Zimmer); 5 (Zimmer); Submitted on: 05/19/2016*
Boulton, Christina	*(n); Submitted on: 08/23/2016*
Boyce, Robert	*(n); Submitted on: 06/06/2016*
Boyer, Preston	*3A (Bristol-Meyers Squibb); Submitted on: 06/01/2016*
Bozic, Kevin	*3B (Centers for Medicare and Medicaid Services; Harvard Business School; Yale-New Haven Center for Outcomes Research); 9 (AAOS; American Joint Replacement Registry; Orthopaedic Research and Education Foundation); Submitted on: 04/27/2016*
Bradaschia Correa, Vivian	*(n); Submitted on: 05/23/2016*
Bradford Newcomb, Anna	*(n); Submitted on: 08/24/2016*
Bradley, Alexander	*(n); Submitted on: 06/02/2016*
Bramer, Michelle	*(n); Submitted on: 04/07/2016*
Bramlett, Kasey	*3B (International Geriatric Fracture Society); Submitted on: 05/16/2016*
Brånemark, Rickard	*4 (Integrum); 9 (Orthopaedic Surgical Osseointegration Society); Submitted on: 05/31/2016*
Bransford, Richard J.	*2 (AO Spine North America); 5 (DePuy, A Johnson & Johnson Company); Submitted on: 06/01/2016*
Bray, Timothy J.	*3C (Anthem Orthopaedics, FlexFix, Orthopaedic Implant Company); 4 (Anthem Orthopaedics, Orthopaedic Implant Company, FlexFix); 5 (Musculoskeletal Orthopaedic Research & Education (MORE)); 6 (Renown Regional Medical Center-Fellowship Funding, COTA/OTA -Fellowship Funding, & Musculoskeletal Orthopaedic Research & Education (MORE)); 8 (Orthopaedic Trauma Association, Past President 2010-2011); Submitted on: 06/02/2016*
Breazeale, Stephen	*(n); Submitted on: 06/28/2016*
Brennan, Michael	*3B (Stryker); Submitted on: 05/31/2016*
Breslin, Mary	*(n); Submitted on: 06/01/2016*
Brighton, Brian	*3B (DePuy, A Johnson & Johnson Company); 9 (American College of Surgeons; Pediatric Orthopaedic Society of North America); Submitted on: 05/11/2016*
Brink, Ole	*6 (Stryker); 9 (OTC); Submitted on: 05/28/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Brinker, Mark	*Current disclosure not available at time of print.*
Brinkmann, Elyse	*3A (Biogen Idec); 9 (AAOS); Submitted on: 05/31/2016*
Broderick, J. Scott	*2 (AONA); 9 (Orthopaedic Trauma Association; South Carolina Orthopaedic Association); Submitted on: 09/02/2016*
Broekhuyse, Henry	*5 (Synthes); 8 (Journal of Orthopaedic Trauma); 9 (AAOS; AOA - CORD governing council); Submitted on: 05/25/2016*
Broghammer, Frances	*(n); Submitted on: 06/01/2016*
Broom, Alexander	*(n); Submitted on: 05/18/2016*
Brown, Anthony	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Brown, Bryan	*(n); Submitted on: 06/01/2016*
Brown, James	*(n); Submitted on: 06/01/2016*
Brown, Philip	*1 (Merit Medical); Submitted on: 09/01/2016*
Browner, Bruce D.	*7 (Saunders/Mosby - Elsevier); 8 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Bone and Joint Decade USA); Submitted on: 08/18/2016*
Bryson, David	*(n); Submitted on: 08/23/2016*
Buckley, Richard E.	*Current disclosure not available at time of print.*
Bunker, Nicholas	*2 (Bi02); Submitted on: 06/07/2016*
Burgos, Eduardo	*(n); Submitted on: 08/23/2016*
Burke, Natasha	*(n); Submitted on: 08/16/2016*
Buser, Zorica	*3B (Xenco Medical): 4 (Biogen; Gilead); Submitted on: 04/26/2016*
Busse, Jason	*5 (Smith & Nephew); Submitted on: 08/23/2016*
Byrne, James	*(n); Submitted on: 06/01/2016*
Byun, Young-Soo	*(n); Submitted on: 06/14/2016*
Cagle, Paul	*(n); Submitted on: 04/04/2016*
Caldwell, Amber	*(n); Submitted on: 06/06/2016*
Campbell, John D.	*9 (AAOS); Submitted on: 08/24/2016*
Campbell, Kerry	*(n); Submitted on: 06/01/2016*
Cannada, Lisa K.	*9 (Orthopaedic Trauma Association); Submitted on: 04/04/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Carayannopoulos, Nikoletta	*(n); Submitted on: 04/12/2016*
Carey, Joseph	*(n); Submitted on: 06/06/2016*
Carlini, Anthony	*(n); Submitted on: 05/31/2016*
Carroll, Eben	*2 (Smith & Nephew; Synthes); 3B (Smith & Nephew; Synthes); 5 (Smith & Nephew; Synthes; METRC); 6 (Smith & Nephew; Synthes); 8 (Journal of the American Academy of Orthopaedic Surgeons); Submitted on: 04/04/2016*
Carrothers, Andrew	*(n); Submitted on: 05/23/2016*
Castillo, Renan	*5 (SPRINT Investigators); Submitted on: 04/28/2016*
Caswell, Kathleen A. (Staff)	*(n); Submitted on: 04/04/2016*
Cavallero, Matthew	*3A (Gilead Sciences); 4 (Gilead Sciences); Submitted on: 06/01/2016*
Caviglia, Horacio	*(n); Submitted on: 08/29/2016*
Centrone, Shari M. (Staff)	*(n); Submitted on: 08/24/2016*
Chambers, Monique	*(n); Submitted on: 05/23/2016*
Chan, Daniel S.	*3B (Biomet; Smith & Nephew; Synthes); 5 (METRC); Submitted on: 08/26/2016*
Chan, Priscilla	*(n); Submitted on: 05/19/2016*
Chan, Mei Leng	*(n); Submitted on: 06/07/2016*
Chaudhary, Pashupati	*(n); Submitted on: 05/31/2016*
Chavez, Elsa	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Cheesman, J. Samuel	*(n); Submitted on: 06/01/2016*
Chesser, Timothy	*2 (Stryker); 3B (Acumed LLC; Stryker); 5 (Stryker); 9 (British Orthopaedic Association; Falls and Fragility Fracture Audit Program; Orthopaedic Trauma Society); Submitted on: 08/25/2016*
Chien, Bonnie	*(n); Submitted on: 05/14/2016*
Childs, Sean	*(n); Submitted on: 04/28/2016*
Childs, Benjamin	*4 (Edwards Life Sciences); Submitted on: 02/13/2016*
Chlebeck, Jesse	*(n); Submitted on: 06/01/2016*
Choi, Paul	*2 (Stryker); 3B (Integra; Stryker); Submitted on 05/10/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Christ, Alexander	*(n); Submitted on: 04/04/2016*
Christian, Matthew	*(n); Submitted on: 04/04/2016*
Churchill, Christine	*(n); Submitted on: 05/31/2016*
Churchman, Sarah	*(n); Submitted on: 06/01/2016*
Ciufo, David	*(n); Submitted on: 05/22/2016*
Cizmic, Zlatan	*(n); Submitted on: 05/18/2016*
Clark, Charles	*(n); Submitted on: 06/08/2016*
Clement, Nicholas	*(n); Submitted on: 05/31/2016*
Coale, Max	*(n); Submitted on: 06/28/2016*
Cohn, Matthew	*(n); Submitted on: 05/26/2016*
Cole, J Dean	*1 (Synthes); Submitted on: 05/31/2016*
Cole, Peter	*4 (BoneFoams Inc, LLC); 5 (Stryker; Synthes); Submitted on: 04/07/2016*
Coll, Daniel J.	*3B (Pacira Pharmaceuticals - One Time Consulting Fee for Exparel at 2014 Meeting); 4 (Merck; Orthopaedic Impant Company - OIC); Submitted on: 09/02/2016*
Collinge, Cory A.	*1 (Biomet; Smith & Nephew; Advanced Orthopedic Solutions, Synthes); 3B (Biomet, Stryker, and Smith&Nephew); 8 (Journal of Orthopaedic Trauma); 9 (Foundation for Orthopedic Trauma); Submitted on: 05/30/2016*
Collins, Susan	*(n); Submitted on: 08/23/2016*
Como, John	*(n); Submitted on: 06/01/2016*
Connelly, Camille	*(n); Submitted on: 05/28/2016*
Cook, James	*1(Arthrex, Inc); 2 (Arthex, Inc.); 3B (Arthrex, Inc; CONMED Linvatec; Eli Lilly; Schwartz Biomedical); 5 (Arthrex, Inc; Coulter Foundation; DePuy, A Johnson & Johnson Company; Musculoskeletal Transplant Foundation; National Institutes of Health (NIAMS & NICHD; Nutramax; U.S. Department of Defense; Zimmer); 7 (Thieme); 8 (Journal of Knee Surgery); 9 (Musculoskeletal Transplant Foundation); Submitted on: 04/28/2016*
Cooke, Margaret	*(n); Submitted on: 05/30/2016*
Corey, Robert	*(n); Submitted on: 05/18/2016*
Corrigan, Chad M.	*(n); Submitted on: 08/30/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Costales, Timothy	*(n); Submitted on: 06/13/2016*
Coughlin, Tim	*(n); Submitted on: 05/10/2016*
Coughlin, R. Richard	*9 (AAOS International Committee; Institute for Global Orthopaedics and Traumatology/UCSF); Submitted on: 06/06/2016*
Court-Brown, Charles	*7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Bone and Joint Surgery – American); Submitted on: 06/18/2016*
Criner, Seth	*(n); Submitted on: 04/07/2016*
Crist, Brett D	*2 (KCI); 3B (DePuy, A Johnson & Johnson Company; KCI); 4 (Amedica Coporation; Orthopaedic Implant Company); 5 (KCI; Synthes); 6 (Arthrex, Inc; Globus Medical); 8 (Journal of Orthopaedic Trauma; Journal of the American Academy of Orthopaedic Surgeons); 9 (International Geriatric Fracture Society; Mid-America Orthopaedic Association; Orthopaedic Trauma Association); Submitted on: 07/06/2016*
Croom, William	*(n); Submitted on: 06/14/2016*
Cross, William	*(n); Submitted on: 04/18/2016*
Cruz, Dana	*(n); Submitted on: 05/01/2016*
Culpan, Paul	*1 (ITS); Submitted on: 07/01/2016*
Cunningham, Brian	*(n); Submitted on: 03/02/2016*
Cush, Gerard	*2 (Orthofix, Inc.; Trimed; Tornier/Orthohelix); 3B (Orthofix, Inc.; Tornier/Orthohelix); Submitted on: 06/01/2016*
Cutrera, Norele	*4 (Eli Lilly); Submitted on: 06/05/2016*
Cutshall, Andrew	*3A (DePuy, A Johnson & Johnson Company); Submited on: 08/16/2016*
Dailey, Steven	*(n); Submitted on: 05/27/2016*
D'Alleyrand, Jean-Claude G.	*(n); Submitted on: 08/25/2016*
Daly, Michael	*(n); Submitted on: 04/22/2016*
Das, Avishek	*(n); Submitted on: 08/29/2016*
Dashe, Jesse	*4 (Abbott); Submitted on: 04/04/2016*
Davarinos, Nikolaos	*(n); Submitted on: 08/16/2016*
Davidovitch, Roy	*3B (Pacira; Stryker); Submitted on: 04/06/2016*
Davis, Elizabeth	*(n); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Davis, Jason	*(n); Submitted on: 06/01/2016*
Davis, Lauren	*(n); Submitted on: 08/16/2016*
De Giacomo, Anthony	*(n); Submitted on: 06/02/2016*
de Jong, Joost	*(n); Submitted on: 06/05/2016*
de la Huerta, Fernando	*(n); Submitted on: 06/21/2016*
de Ridder, Victor	*(n); Submitted on: 08/23/2016*
de Rijcke, Piet	*(n); Submitted on: 01/11/2016*
Dean, Daniel	*(n); Submitted on: 08/16/2016*
deAngelis, Paolo	*(n); Submitted on: 08/16/2016*
Dehghan, Niloofar	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 04/12/2016*
Della Rocca, Gregory J. (Program Committee)	*2 (Synthes); 3B (Bioventus); 4 (Amedica; Mergenet; The Orthopaedic Implant Company); 5 (Synthes); 8 (Geriatric Orthopaedic Surgery and Rehabilitation; Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of the American Academy of Orthopaedic Surgeons); 9 (AAOS; Orthopaedic Trauma Association; American College of Surgeons; American Orthopaedic Association); Submitted on: 04/04/2016*
Deshpande, Chetan	*(n); Submitted on: 06/21/2016*
Devana, Sai	*(n); Submitted on: 05/23/2016*
Devereaux, PJ	*5 (Abbott; Boehringer-Ingelheim; Covidien; Roche; FAITH Investigators); Submitted on: 06/23/2016*
DeVries Watson, Nicole	*(n); Submitted on: 08/16/2016*
Dhaliwal, Satvinder	*(n); Submitted on: 06/13/2016*
Dibbern, Kevin	*(n); Submitted on: 08/29/2016*
Didesch, Jacob	*(n); Submitted on: 04/05/2016*
Dietz, Matthew	*(n); Submitted on: 05/10/2016*
Dillner, Jeanne	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Dimovski, Radomir	*(n); Submitted on: 06/01/2016*
Ding, Anthony	*(n); Submitted on: 05/30/2016*
Ding, David	*(n); Submitted on: 05/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

DiSilvio, Frank	*(n); Submitted on: 06/28/2016*
Dodd, Ashley	*(n); Submitted on: 05/05/2016*
Dombrowski, Derek	*Current disclosure not available at time of print.*
Domes, Christopher	*(n); Submitted on: 07/06/2016*
Donohoe, Erin	*(n); Submitted on: 06/01/2016*
Doro, Christopher	*(n); Submitted on: 01/11/2016*
D'Oro, Anthony	*(n); Submitted on: 04/24/2016*
Drain, Joseph	*(n); Submitted on: 04/30/2016*
Drew, Alex	*(n); Submitted on: 04/28/2016*
Drexler, Michael	*(n); Submitted on: 04/13/2016*
Driesman, Adam	*(n); Submitted on: 04/12/2016*
Dromsky, David	*(n); Submitted on: 01/11/2016*
Dua, Karan	*(n); Submitted on: 05/10/2016*
Dubois-Ferrière, Victor	*(n); Submitted on: 08/16/2016*
Duckworth, Andrew	*7 (CRC Press/Taylor and Francis; Saunders/Mosby-Elsevier); 8 (BMC Musculoskeletal Disorders; Journal of Bone and Joint Surgery - American); Submitted on: 04/12/2016*
Dudda, Marcel	*(n); Submitted on: 05/28/2016*
Duerr, Robert	*(n); Submitted on: 05/25/2016*
Duffy, Ryan	*(n); Submitted on: 05/31/2016*
Dunbar, Robert	*6 (innovision Corp.); 8 (Journal of Orthopaedics and Traumatology; OrthoInfo); 9 (AAOS); Submitted on: 10/21/2015*
Dwivedi, Mukesh	*(n); Submitted on: 05/22/2016*
Eagle, Blake	*(n); Submitted on: 05/30/2016*
Ebramzadeh, Edward	*3B Corin U.S.A; 5 (Amgen Co; AOS; Arthrex, Inc; Biomet; Extremity Medical; I-Spine; Synthes; Tri-Med; Zimmer); 8 (Journal of Bone and Joint Surgery – American; Journal of of Applied Biomaterials and Functional Materials; Journal of Orthopaedic Trauma; Submited on: 05/16/2016*
Eccles, Joshua	*(n); Submitted on: 08/07/2016*
Edwards, Alan	*Current disclosure not available at time of print.*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Egol, Kenneth A.	*1 (Exactech, Inc); 3B (Exactech, Inc); 3C (Polypid); 5 (Synthes); 7 (SLACK Incorporated; Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Orthopaedic Trauma Association); Submitted on: 04/05/2016*
Ehrlichman, Lauren K.	*(n); Submitted on: 05/27/2016*
Eickhoff, Alexander	*(n); Submitted on: 08/16/2016*
Einhorn, Thomas	*2 (Bioventus); 3B (Agnovos; Bioventus; Kuros); 4 (HealthpointCapital; NeoStem; PolyPid); 7 (Journal of Bone and Joint Surgery - American; Lippincott Williams and Wilkins); 8 (Journal of Bone and Joint Surgery - American); Submitted on: 04/14/2016*
Eisenberg, Gilad	*(n); Submitted on: 08/29/2016*
Eisenstein, Emmanuel	*(n); Submitted on: 04/04/2016*
Elfar, John	*9 (J. Robert Gladden Orthopaedic Society; American Society for Surgery of the Hand); Submitted on 04/10/2016*
Eliezer, Edmund	*(n); Submitted on: 06/12/2016*
Ellington, John	*1 (Arthrex, Inc; BME); 2 (Arthrex, Inc; BME); 3B (Amniox; Arthrex, Inc; BME; Conventusortho; Zimmer); 4 (Medshape); 5 (Amniox); Submitted on: 04/06/2016*
Elliott, Iain	*(n); Submitted on: 06/01/2016*
El-Othmani, Mouhanad	*(n); Submitted on: 05/02/2016*
Elster, CAPT Eric A.	*(n); Submitted on: 01/11/2016*
Emberton, Bonnie (Staff)	*(n); Submitted on: 08/29/2016*
Emery, Paul	*Current disclosure not available at time of print.*
Endres, Terrence	*2 (AONA); 3B (Clinical Advisor - Orthorpaedic Trauma - Spectrum Health Hospitals Grand Rapids); 8 (Journal of the American Academy of Orthopaedic Surgeons); 9 (Michigan Professional Insurance Exchange (MPIE)); Submitted on: 06/02/2016*
Eng, Michael	*(n); Submitted on: 06/13/2016*
Ernat, Justin	*(n); Submitted on: 04/14/2016*
Ertl, Janos	*(n); Submitted on: 04/26/2016*
Evans, Jason	*(n); Submitted on: 07/27/16*
Fan, Cun-Yi	*(n); Submitted on: 08/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Feeley, Brian	*9 (AAOS; American Orthopaedic Society for Sports Medicine); 8 (Knee); Submitted on: 06/01/2016*
Feldman, David	*1 (Orthopediatrics); 3B (Orthopediatrics); Submitted on: 06/28/2016*
Ferrini, Monica	*(n); Submitted on: 05/30/2016*
Fiedler, Carina	*(n); Submitted on: 01/11/2016*
Figved, Wender	*6 (Ortomedic AS, Norway (Distributor of products from DePuy Synthes): Submitted on: 06/08/2016*
Finkemeier, Christopher	*2 (Synthes); 3B (DePuy, A Johnson & Johnson Company); 3C (Acumed, LLC); Submitted on: 10/18/2015*
Firoozabadi, Reza	*3B (Smith & Nephew); Submitted on: 04/04/2016*
Fisher, Nina	*(n); Submitted on: 04/04/2016*
Fitzpatrick, Daniel	*1 (Synthes CMF; Zimmer); 2 (Zimmer); 3B (Zimmer); Submitted on: 04/04/2016*
Florack, Michael	*(n); Submitted on: 06/05/2016*
Flores, Jose	*(n); Submitted on: 01/11/2016*
Flynn, Jeffrey	*(n); Submitted on: 06/01/2016*
Flynn, John (Jack M.)	*1 (Biomet); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Orthopaedics Today); 9 (AAOS; American Board of Orthopaedic Surgery Inc.; Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 09/01/2016*
Flynn, Megan	*(n); Submitted on: 05/28/2016*
Fontenot, Philip	*(n); Submitted on: 04/28/2016*
Foreman, Michael	*(n); Submitted on: 08/16/2016*
Forsberg, Jonathan A.	*3B (Clementia Pharmaceuticals, Inc.); 5 (Biomet); Submitted on: 05/21/2016*
Forward, Daren	*(n); Submitted on: 09/01/2016*
Fowler, Justin	*(n); Submitted on: 05/31/2016*
Fowler, T. Ty	*2 (Synthes); 5 (Synthes); Submitted on: 05/31/2016*
Foxall, Julia	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 08/30/2016*
Foyil, Sarah	*(n); Submitted on: 01/11/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

France, John C.	*9 (AAOS; Cervical Spine Research Society committee, Scoliosis research Society education committee, AAOS spine program committee; Scoliosis Research Society); Submitted on: 04/04/2016*
Fras, Andrew R.	*(n); Submitted on: 06/01/2016*
Frechette, Gregory	*(n); Submitted on: 06/13/2016*
Fredericks, Douglas C.	*5 (Berkeley Advanced Biomaterials; Biostructures; Bioventus; Orthogem; OrthoRebirth; Sirakoss); Submitted on: 08/29/2016*
Frederiksen, Hunter	*(n); Submitted on: 06/20/2016*
Frenkel Rutenberg, Tal	*(n); Submitted on: 06/21/2016*
Frey, Katherine	*(n); Submitted on: 08/16/2016*
Frick, Steve	*3C (Orthopaediatrics); 9 (AAOS; American Orthopaedic Association; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America); Submitted on: 04/23/2016*
Friess, Darin	*3B (Acumed, LLC); Submitted on: 04/13/2016*
Frihagen, Frede	*2 (Eli Lilly); 6 (Eli Lilly); Submitted on: 06/10/2016*
Frisch, Nicholas	*(n); Submitted on: 05/24/2016*
Frolke, Jan Paul	*(n); Submitted on: 05/18/2016*
Fruehling, Catherine	*(n); Submitted on: 05/31/2016*
Fuchs, Daniel	*(n); Submitted on: 8/25/2016*
Fuller, David A.	*(n); Submitted on: 03/07/2016*
Furey, Matthew	*(n); Submitted on: 06/01/2016*
Galpin, Matthew	*(n); Submitted on: 05/29/2016*
Gangavalli, Anup	*(n); Submitted on: 05/26/2016*
Ganta, Abhishek	*(n); Submitted on: 04/06/2016*
Gardner, Michael J.	*3B (BoneSupport AB; KCI; Pacira Pharmaceuticals; Stryker; Synthes); 5 (Synthes); 7 (Journal of Bone and Joint Surgery - American; Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Current Opinion in Orthopaedics); 9 (Orthopaedic Trauma Association); Submitted on: 04/12/2016*
Garibaldi, Alisha	*(n); Submitted on: 05/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Gary, Joshua L.	*2 (Smith & Nephew); 4 (Summitt Medventures); 5 (METRC); 8 (Journal of Bone and Joint Surgery – American; Wolters Kluwer Health – Lippincott Williams & Willkins); 9 (Orthopaedic Trauma Association); Submitted on: 05/20/2016*
Gaski, Greg	*(n); Submitted on: 05/30/2016*
Gausden, Elizabeth	*(n); Submitted on: 04/04/2016*
Gebhard, Florian	*9 (AO Foundation; German Trauma Society); Submitted on: 08/23/2016*
Gehlert, Rick	*3B (Aesculap/B.Braun); Submitted on: 10/10/2015*
George, Mary	*(n); Submitted on: 05/26/2016*
George, Albert	*(n); Submitted on: 06/02/2016*
Gerstenfeld, Louis	*8 (Bone; Journal of Orthopaedic Research); Submitted on: 06/13/2016*
Geusens, Piet	*(n); Submitted on: 01/11/2016*
Ghorbanhoseini, Mohammad	*(n); Submitted on: 06/14/2016*
Giannoudis, Peter V.	*1 (Biomet); 2 (DePuy, A Johnson & Johnson Company; Medtronic); 3B (Stryker); 5 (Biomet; DePuy, A Johnson & Johnson Company; Stryker); 7 (Injury Journal); 8 (BMC Musculoskeletal Disorders; Injury Journal; Orthopaedic Trauma; European Journal of Trauma; Open Journal of Orthopaedics; Expert Opinion on Drug Safety; Springer); 9 (European Federation of National Associations of Orthopedics and Traumatology; Orthopaedic Trauma Association; British Trauma Society; British Orthopaedic Association); Submitted on: 04/14/2016*
Giannoudis, Vasileios	*8 (Injury); Submitted on: 08/19/2016*
Gibson, Peter	*1 (Biomet); 2 (DePuy, A Johnson & Johnson Company; Medtronic); 3B (Stryker); 5 (Biomet; DePuy, A Johnson & Johnson Company; Stryker); 7 (Injury Journal); 8 (BMC Musculoskeletal Disorders,Injury,Journal Orthopaedic Trauma,European Journal of Trauma,Open Journal of Orthopaedics,Expert Opinion on Drug Safety; Springer); 9 (Orthopaedic Trauma Association, British Trauma Society,British Orthopaedic Association; ,European Federation of National Associations of Orthopedics and Traumatology); Submitted on: 04/14/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Gilbertson, Jeffrey	*(n); Submitted on: 05/20/2016*
Gillispie, Gregory	*(n); Submitted on: 08/16/2016*
Giotikas, Dimitrios	*2 (Orthofix, Inc.); 3B (Olympus Biotech; Orthofix, Inc.); Submitted on: 04/05/2016*
Gire, Jacob	*(n); Submitted on: 05/12/2016*
Gitajn, I. Leah	*(n); Submitted on: 05/30/2016*
Githens, Michael	*(n); Submitted on: 05/31/2016*
Glatt, Vaida	*(n); Submitted on: 04/05/2016*
Goch, Abraham	*(n); Submitted on: 05/22/2016*
Godbout, Charles	*(n); Submitted on: 06/14/2016*
Godfried, David	*(n); Submitted on: 04/08/2016*
Gold, Stuart	*2 (Orthofix; Smith & Nephew; Stryker); 3B (Orthofix; Smith & Nephew; Stryker); 5 (Synthes; Stryker; Smith & Nephew; Zimmer); Submitted on: 08/23/2016*
Goldstein, Todd	*(n); Submitted on: 08/23/2016*
Golob, Jr., Joseph	*(n); Submitted on: 06/01/2016*
Gomez, David	*(n); Submitted on: 08/17/2016*
Gonzalez, Tyler	*(n); Submitted on: 04/06/2016*
Gooding, Christopher	*(n); Submitted on: 05/23/2016*
Goodwin, Alexandra	*(n); Submitted on: 05/25/2016*
Gorczyca, John T.	*8 (The Journal of Orthopaedic Trauma); Submitted on: 04/04/2016*
Gordon, J. Eric	*1 (Orthopediatrics); 2 (Smith & Nephew); 3B (Orthopediatrics; Smith & Nephew); 9 (Pediatric Orthopaedic Society of North America); Submitted on: 04/04/2016*
Gotoff, James	*(n); Submitted on: 05/19/2016*
Goulet, James A.	*1 (Zimmer); 9 (American Orthopaedic Association); Submitted on: 06/21/2016*
Graham, Jove	*5 (Abbott); Submitted on: 06/01/2016*
Grande, Daniel	*9 (ICRS); Submitted on 05/18/2016*
Graves, Matthew	*2 (Synthes); 3B (Synthes); 5 (Synthes,Stryker); 8 (Journal of Orthopaedic Trauma); Submitted on: 04/29/2016*
Gray, Lewis	*(n); Submitted on: 01/11/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Gregory, Dennis C.	*(n); Submitted on: 08/24/2016*
Greven, Johannes	*(n); Submitted on: 01/11/2016*
Griffith, Cullen	*(n); Submitted on: 05/30/2016*
Grimberg, Dominic	*(n); Submitted on: 08/23/2016*
Gross, Jonathan M.	*(n); Submitted on 08/29/2016*
Groth, Meghan	*(n); Submitted on: 05/28/2016*
Grott, Kelly	*(n); Submitted on: 09/05/2016*
Guerado, Enrique	*3B (Stryker); 9 (Sociedad Española de Cirugía Ortopédica y Traumatología); Submitted on: 08/16/2016*
Guimarães, João Antonio Matheus	*(n); Submitted on: 08/25/2016*
Gurnea, Taylor	*(n); Submitted on: 08/17/2016*
Gusakov, Oleg	*(n); Submitted on: 09/01/2016*
Guthrie, Stuart	*9 (Michigan Orthopaedic Society); Submitted on 04/23/2016*
Guy, Pierre	*2 (Stryker); 3B (Stryker); 4 (Traumis Surgical Systems Inc.); 5 (DePuy, A Johnson & Johnson Company; Synthes); 9 (Canadian Orthopedic Foundation; Orthopaedic Trauma Association; West Coast Hip Fracture Society); Submitted on: 05/03/2016*
Guyatt, Gordon	*5 (FAITH Investigators; FLOW Investigators; SPRINT Investigators); Submitted on: 05/26/2016*
Haac, Bryce	*(n); Submitted on: 05/31/2016*
Hadeed, Michael	*(n); Submitted on: 04/28/2016*
Hafezi, Poopak	*(n); Submitted on: 05/31/2016*
Hagag, Ahmed	*(n); Submitted on: 04/04/2016*
Hagberg, Kerstin	*8 (Prosthetics and Orthotics International); 9 (International Society Prosthetics and Orthotics); Submitted on: 06/01/2016*
Hagen, Jennifer	*(n); Submitted on: 04/06/2016*
Haidukewych, George J.	*1 (DePuy, A Johnson & Johnson Company; Biomet); 3B (Biomet; DePuy, A Johnson & Johnson Company; Synthes); 4 (Orthopediatrics, Institute for Better Bone Health); 6 (Synthes); 8 (Journal of Orthopedic Trauma); 9 (AAOS); Submitted on: 04/29/2016*
Haile, Nathan	*(n); Submitted on: 05/31/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Hak, David J. (Program Committee)	*3B (Globus Medical; Invibio; Merck); 5 (METRC); 7 (SLACK Incorporated); 8 (Orthopedics; Journal of Orthopaedic Trauma; European Journal of Orthopaedic Surgery); 9 (AAOS; International Society for Fracture Repair; Orthopaedic Trauma Association); Submitted on: 04/10/2016*
Hake, Mark	*8 (European Journal of Orthopaedic Surgery and Traumatology); Submitted on: 05/24/2016*
Hakeos, William	*4 (Sentio MMG); Submitted on: 06/02/2016*
Hall, Jeremy	*2 (Stryker; Zimmer); 3B (Zimmer); 5 (Pfizer; Zimmer; Synthes; Stryker; Smith & Nephew; Amgen Co; Biomimetic; Canadian Orthopaedic Trauma Society); 6 (Pfizer; Zimmer; Synthes; Stryker; Smith & Nephew; Amgen Co;); Submitted on: 04/07/2016*
Haller, Justin	*(n); Submitted on: 04/17/2016*
Halvorson, Jason	*(n); Submitted on: 06/01/2016*
Hamdy, Reggie	*7 (Springer); 8 (BMC Musculoskeletal Disorders); 9 (Limb Lengthening Research Society); Submitted on: 04/26/2016*
Hammert, Warren	*(n); Submitted on: 05/30/2016*
Han, Chris	*(n); Submitted on: 04/19/2016*
Hansen, Scott	*(n); Submitted on: 08/17/2016*
Haonga, Billy	*(n); Submitted on: 05/27/2016*
Harmer, Joshua	*(n); Submitted on: 08/16/2016*
Harper, Katharine	*(n); Submitted on: 05/12/2016*
Harris, Alex	*(n); Submitted on: 05/30/2016*
Harris, Liam	*(n); Submitted on: 05/02/2016*
Harris, Mitchel	*9 (North American Spine Society;); Submitted on: 04/06/2016*
Harro, Janet	*(n); Submitted on: 09/01/2016*
Hart, David	*8 (BMJ Case Reports; British Journal of Sports Medicine; International Journal of Inflammation; Journal of Orthopaedic Research); Submitted on: 08/23/2016*
Hart, Gavin	*(n); Submitted on: 05/26/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Harvey, Edward J.	*3C (Greybox Solutions); 4 (NxtSens); 5 (Synthes; CORAL Collaborators); 7 (Canadian Journal of Surgery); 8 (Canadian Journal of Surgery; J Ortho Trauma); 9 (Canadian Orthopaedic Association; Orthopaedic Trauma Association); Submitted on: 05/30/2016*
Harvin, William H.	*(n); Submitted on: 05/31/2016*
Hatch III, George	*3B (Arthrex); Submitted on 05/09/2016*
Haudenschild, Dominik	*8 (Cartilage (CRS Journal) published by SAGE Journals; Journal of Orthopaedic Research; 9 (Orthopaedic Research Society); Submitted on: 08/23/2016*
Hayden, Brett	*(n); Submitted on: 05/10/2016*
Hebert-Davies, Jonah	*(n); Submitted on: 05/17/2016*
Heckman, James	*7 (Journal of Bone and Joint Surgery - American; Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Bone and Joint Surgery - American); Submitted on: 05/27/2016*
Heckmann, Nathanael	*4 (Masimo; Materialise NV; Nuvasive); Submitted on: 07/28/2016*
Hedgecock, Jon	*(n); Submitted on: 05/23/2016*
Heels-Ansdell, Diane	*(n); Submitted on: 05/25/2016*
Heetveld, Martin J.	*5 (FAITH Investigators); Submitted on: 08/22/2016*
Helfet, David L.	*3C (OHK, Healthpoint Capital, TriMedics); 4 (OHK Medical Devices; FxDevices); Submitted on: 06/01/2016*
Hellund, Johan	*(n); Submitted on: 07/04/2016*
Heng, Marilyn	*(n); Submitted on: 06/28/2016*
Henn, III, R.	*(n); Submitted on: 05/04/2016*
Henschel, Julia	*(n); Submitted on: 05/27/2016*
Herfat, Safa	*(n); Submitted on: 05/01/2016*
Herman, Amir	*(n); Submitted on: 05/12/2016*
Hess, Matthew	*(n); Submitted on: 05/19/2016*
Heyer, Frans	*(n); Submitted on: 08/25/2016*
Higgins, Thomas F. (Program Committee)	*3B (DePuy Synthes); 4 (NT nPhase; Orthogrid; Summit Medical Ventures); Submitted on: 05/01/2016*
Hightower, R.	*Current disclosure not available at time of print.*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Hildebrand, Frank	*8 (Wolters Kluwer Health - Lippincott Williams & Wilkinsshock (Journal); Submitted on: 08/17/2016*
Hildebrand, Kevin	*9 (Canadian Orthopaedic Foundation); Submitted on: 04/04/2016*
Hill, Brian	*(n); Submitted on: 08/23/2016*
Hill, Jeffrey Ryan	*(n); Submitted on: 05/27/2016*
Hill, Lauren	*(n); Submitted on: 06/01/2016*
Hiller, Paul (Staff)	*(n); Submitted on: 04/04/2016*
Hire, Justin	*(n); Submitted on: 06/17/2016*
Hlaing, Su	*(n); Submitted on: 05/31/2016*
Ho, Bryant	*(n); Submitted on: 05/30/2016*
Ho, Christine	*7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Pediatric Orthopaedic Society of North America); Submitted on: 10/13/2015*
Ho, Wei Loong Sean	*(n); Submitted on: 06/02/2016*
Hoegler, Joseph	*(n); Submitted on: 04/28/2016*
Hoffmann, Martin	*(n); Submitted on: 04/05/2016*
Hofman, Martijn	*(n); Submitted on: 01/11/2016*
Hofmann, Kurt	*(n); Submitted on: 04/04/2016*
Hoggard, Timothy	*(n); Submitted on: 08/30/2016*
Hopkins, Rob	*(n); Submitted on: 09/01/2016*
Horn, Bernard D.	*4 (Johnson & Johnson); 7 (JayPee Brothers Medical Publishing Company); Submitted on: 04/04/2016*
Horst, Taylor	*(n); Submitted on: 06/01/2016*
Horwitz, Daniel S.	*1 (Biomet); 3B (Biomet); 5 (Synthes); 8 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (AAOS,Foundation for Orthopaedic Trauma); Submitted on: 06/01/2016*
Houdek, Matthew	*(n); Submitted on: 04/10/2016*
Howenstein, Abby	*(n); Submitted on: 06/08/2016*
Hsu, Joseph	*2 (Smith & Nephew); 3B (Acumed, LLC); 9 (Limb Lengthening Research Society); Submitted on: 05/28/2016*
Huang, Yanjie	*(n); Submitted on: 05/04/2016*
Hudson, Robert	*(n); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Huff, Nathan	*(n); Submitted on: 08/16/2016*
Hull, Peter	*(n); Submitted on: 06/16/2016*
Humphrey, Catherine	*(n); Submitted on: 05/27/2016*
Huo, Jason	*(n); Submitted on: 09/01/2016*
Hussein, Amira	*(n); Submitted on: 06/13/2016*
Hutchinson, Ian	*(n); Submitted on: 05/23/2016*
Hutson, James	*8 (Journal of Orthopaedic Trauma,); Submitted on: 05/31/2016*
Hutzler, Lorraine	*(n); Submitted on: 05/12/2016*
Hwang, John	*(n); Submitted on: 04/26/2016*
Hwang, Kyu Tae	*(n); Submitted on: 05/25/2016*
Hymes, Robert	*3B (Stryker); 4 (Johnson & Johnson); 5 (Synthes; METRC); Submitted on: 06/01/2016*
Ilyas, Asif	*1 (Globus Medical); 2 (DePuy, A Johnson & Johnson Company); 3B (Globus Medical); 7 (Jaypee Medical Publishers); 9 (PA Ortho Society); Submitted on: 04/04/2016*
Infante, Anthony	*1 (Orthopaedic Synergy); 3B (Arthrosurface,Orthopaedic Synergy); 4 (Arthrosurface ,Orthopaedic Synergy); 5 (Orthopaedic Synergy); Submitted on: 04/27/2016*
Ipaktchi, Kyros R.	*Current disclosure not available at time of print.*
Ippolito, Joseph	*(n); Submitted on: 05/22/2016*
Ishii, Keisuke	*(n); Submitted on: 06/01/2016*
Israel, Heidi	*(n); Submitted on: 05/26/2016*
Jackson, Nancy	*(n); Submitted on: 06/01/2016*
Jacobs, Cale	*5 (Biomet; Stryker; Zimmer); Submitted on: 04/28/2016*
Jacobson, Lance	*(n); Submitted on: 05/25/2016*
Jahangir, Amir	*4 (Carbofix); 7 (Springer); 9 (AAOS; Orthopaedic Trauma Association); Submitted on: 05/02/2016*
Jain, Sudheer	*(n); Submitted on: 05/31/2016*
Janes, Gillian	*(n); Submitted on: 08/24/2016*
Jarrell, Jenifer	*(n); Submitted on: 05/31/2016*
Jazini, Ehsan	*(n); Submitted on: 05/02/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Jenkinson, Richard	*5 (Biomet; Smith & Nephew; Synthes; Zimmer); Submitted on: 06/03/2016*
Jensen, Andrew	*(n); Submitted on: 05/11/2016*
Jeray, Kyle	*3B (Zimmer); 3C (Bioventus, LLC); 5 (Synthes; FAITH Investigators; FLOW Investigators); 8 (Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of the American Academy of Orthopaedic Surgeons); 9 (American Orthopaedic Association; American Orthopaedic Association; American Orthopaedic Association; Orthopaedic Trauma Association; Southeastern Fracture Consortium); Submitted on: 05/26/2016*
Johal, Herman	*(n); Submitted on: 05/31/2016*
Johnson, Andrew S.	*(n); Submitted on: 08/29/2016*
Johnson, Christine	*(n); Submitted on: 05/15/2016*
Johnson, Julie	*(n); Submitted on: 05/10/2016*
Jones, Alan	*9 (COTA); Submitted on: 04/04/2016*
Jones, Clifford B.	*1 (Lippincott); 5 (METRC); 8 (Journal of Bone and Joint Surgery - American; Journal of Orthopaedics and Traumatology); 9 (Mid Americian Orthopaedic Society; Orthopaedic Trauma Association); Submitted on: 04/13/2016*
Jones, Elena	*2 (Miltenyi Biotec GmbH); 5 (Nuvasive); Submitted on: 06/01/2016*
Jones, Lynne	*3B (Johnson & Johnson; TissueGene; UpToDate; Zimmer); 8 (Journal of Arthroplasty; Journal of Biomedical Materials Research); 9 (Society for Biomaterials; ARCO International; Rocky Mountain Bioengineering Symposium; AIMBE; AAOS); Submitted on: 05/10/2016*
Jones, Thomas	*(n); Submitted on: 04/13/2016*
Josephson, Anna	*(n); Submitted on: 05/15/2016*
Joshi, Manjari	*3B (Pfizer); 8 (IDCP); Submitted on: 08/29/2016*
Joyce, David	*(n); Submitted on: 05/17/2016*
Judd, Kyle	*(n); Submitted on: 04/05/2016*
Jung, Gu-Hee	*(n); Submitted on: 06/14/2016*
Jupiter, Daniel	*(n); Submitted on: 06/07/2016*
Kaar, Scott	*(n); Submitted on: 05/31/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Kadakia, Anish	*1 (Acumed, LLC; Biomedical Enterprises); 2 (Acumed, LLC; SpineSmith USA); 3B (Acumed, LLC; BME; SpineSmith USA); 4 (Carbofix); 5 (Acumed, LLC; Synthes); 7 (Elsevier; LWW); 8 (Journal of Orthopedic Surgery and Research); 9 (AAOS; American Orthopaedic Foot and Ankle Society); Submitted on: 06/02/2016*
Kain, Michael	*9 (New England Orthopaedic Society); Submitted on: 01/26/2016*
Kakazu, Rafael	*(n); Submitted on: 05/18/2016*
Kamphuis, S.J.M.	*(n); Submitted on: 06/01/2016*
Kanakaris, Nikolaos	*2 (Celgentek; Medtronic; Pfizer; Stryker; Zimmer); 3B (Cittieffe; Stryker; Zimmer); 8 (BioMed Research International; Case Reports in Orthopedics; Hard Tissue; Open Access Trauma); Submitted on: 06/01/2016*
Kandemir, Utku	*2 (AO North America; Stryker); 5 (Biomet; Stryker; Synthes); Submitted on: 04/04/2016*
Kandil, Abdurrahman	*(n); Submitted on: 04/04/2016*
Kapoor, Sudhir K.	*9 (Indian Orthopaedic Association); Submitted on: 01/11/2016*
Karam, Matthew	*(n); Submitted on: 04/25/2016*
Karunakar, Madhav	*8 (Journal of Orthopaedic Trauma); 9 (AAOS; Orthopaedic Trauma Association); Submitted on: 05/30/2016*
Kates, Stephen L.	*2 (AO Foundation); 5 (DePuy, A Johnson & Johnson Company); 7 (Sage Publications); 8 (Sage Publications); 9 (AAOS; AO-Trauma; Orthopaedic Trauma Association); Submitted on: 06/25/2016*
Kaufman, Bram	*(n); Submitted on: 06/01/2016*
Kaushik, Devwart	*(n); Submitted on: 01/11/2016*
Keller, Robert	*(n); Submitted on: 05/12/2016*
Kelley, Benjamin	*(n); Submitted on: 05/31/2016*
Kempegowda, Harish	*5 (Synthes); Submitted on 05/26/2016*
Kempton, Laurence	*(n); Submitted on: 05/02/2016*
Kennedy, Gannon	*(n); Submitted on: 01/11/2016*
Ketz, John	*5 (Biomimetic); Submitted on: 04/15/2016*
Khan, Tanvir	*(n); Submitted on: 05/24/2016*
Khan, Jannat	*(n); Submitted on: 05/26/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Khanal, Guru Prasad	*(n); Submitted on: 05/31/2016*
Kilcoyne, Kelly	*(n); Submitted on: 05/18/2016*
Kilic, Ayhan	*(n); Submitted on: 05/31/2016*
Kim, Chang-Yeon	*(n); Submitted on: 01/11/2016*
Kim, Christopher	*(n); Submitted on: 04/12/2016*
Kim, Ji-Wan	*(n); Submitted on: 05/30/2016*
Kim, Joon-Woo	*(n); Submitted on: 05/25/2016*
Kim, Seewan	*(n); Submitted on: 08/16/2016*
Kirk, Rachel	*(n); Submitted on: 08/24/2016*
Kistler, Brian	*(n); Submitted on: 07/06/2016*
Klatman, Samuel	*(n); Submitted on: 06/02/2016*
Kleweno, Conor P.	*(n); Submitted on: 10/05/2015*
Ko, Sebastian	*(n); Submitted on: 05/13/2016*
Koehler, Daniel	*(n); Submitted on: 04/04/2016*
Komatsu, David	*(n); Submitted on: 05/31/2016*
Konda, Sanjit R.	*8 (American Journal of Orthoapedics); Submitted on 05/23/16*
Kong, Edward	*3A (Pfizer); 4 (Celgene); Submitted on: 08/19/2016*
Kopp, Ben	*(n); Submitted on: 05/20/2016*
Koressel, Joseph	*(n); Submitted on: 06/01/2016*
Kottmeier, Stephen A. (Program Committee)	*8 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Orthopaedic Trauma Association); Submitted on: 04/13/2016*
Koury, Kenneth	*(n); Submitted on: 04/04/2016*
Kramer, Andrea S.	*(n); Submitted on: 08/25/2016*
Kramer, Erik	*(n); Submitted on: 05/26/2016*
Krause, Peter	*4 (Medtronic); Submitted on: 04/06/2016*
Kreder, Hans	*3B (Immediate family consultant for Synthes); 5 (Synthes; Biomet; Zimmer); 7 (Elsevier Publishing; AO North America); 9 (Canadian Orthopaedic Association, AO Trustee); Submitted on: 05/27/2016*
Krettek, Christian	*1 (Synthes); 2 (Synthes); 6 (Stryker); 8 (Saunders/Mosby-Elsevier; Springer); Submitted on: 08/31/2016*
Krijnen, Pieta	*(n); Submitted on: 08/29/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Kristiansen, Thomas	*(n); Submitted on: 08/17/2016*
Krkovic, Matija	*(n); Submitted on: 06/14/2016*
Kruppa, Christiane	*(n); Submitted on: 05/28/2016*
Kubiak, Erik	*3B (DePuy, A Johnson & Johnson Company; DJ Orthopaedics); 4 (Connextions Medical, Inc.; OrthoGrid Technologies, Inc.); 5 (Zimmer); 8 (Journal of Orthopaedic Trauma); 9 (Foundation for Orthopaedic Trauma); Submitted on: 05/03/2016*
Kuhn, Kevin	*(n); Submitted on: 05/31/2016*
Kulbacka-Ortiz, Katarzyna	*3A (Integrum AB); Submitted on: 08/17/2016*
Kulkarni, Sunil	*(n); Submitted on: 08/25/2016*
Kumar, Rakesh	*(n); Submitted on: 01/11/2016*
Kumar, Gunasekaran	*3B (Smith & Nephew); Submitted on: 04/18/2016*
Kunz, Monica	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 06/22/2016*
Kusnezov, Nicholas	*(n); Submitted on: 05/28/2016*
Kwek, Ernest	*(n); Submitted on: 05/19/2016*
Kwon, John	*1 (Paragon 28; Trimed); 3B (Medline; Medshape; Paragon 28); 4 (Medshape); Submitted on: 06/02/2016*
Lack, William	*(n); Submitted on: 04/04/2016*
Lafferty, Paul M.	*5 (METRC); 8 (Clinical Orthopaedics and Related Research; Journal of Bone and Joint Surgery; Journal of Orthopaedic Trauma); Submitted on: 08/26/2016*
Laflamme, Georges-Yves	*3B (Stryker); Submitted on: 04/07/2016*
Lakomkin, Nikita	*(n); Submitted on: 05/10/2016*
Lang, Gerald J.	*8 (Journal of Hand Surgery); 9 (AAOS; Wisconsin Orthopedic Society); Submitted on: 04/04/2016*
Lane, Joseph M.	*3B (Agnovos; Amgen Co; Bone Therapeutics, Inc. CollPlant; Eli Lilly; Grafty's; Harvest, Inc., ISTO, BiologicsMD; Kuros); 4 (CollPlant, Inc); 5 (Merck); 9 (Orthopaedic Research Society; Musculoskeletal Tumor Society; AAOS; Association of Bone and Joint Surgeons, AOA, ASBMR); Submitted on: 04/04/2016*
Lane, Lewis	*9 (American Orthopaedic Association; American Society for Surgery of the Hand); Submitted on: 05/14/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Langdahl, Bente	*2 (Amgen Co.; Eli Lilly; Merck); 3B (Amgen Co.; Eli Lilly; Merck; UCB); 5 (Amgen Co.; Eli Lilly; Merck; Novo Nordisk; Orkla Health); 8 (Bone; Calcified Tissues International; European Journal of Endocrinology; Osteoporosis International); 9 (European Calcified Tissue Society; International Federation of Musculoskeletal Research Societies); Submitted on: 05/30/2016*
Langford, Joshua	*1 (Advanced Orhopaedic Solutions); 2 (Smith & Nephew); 3B (Stryker); 4 (Core Orthopaedics; Institute for Better Bone Health, LLC); Submitted on: 04/30/2016*
Lannon, Sean	*(n); Submitted on: 05/29/2016*
Laratta, Joseph	*(n); Submitted on: 04/22/2016*
Lawendy, Abdel-Rahman	*(n); Submitted on: 06/03/2016*
Le, Theodore Toan	*(n); Submitted on: 06/07/2016*
Le Manach, Yannick	*(n); Submitted on: 05/26/2016*
LeBrun, Christopher	*8 (Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association; Society of Military Orthopaedic Surgeons); Submitted on: 04/05/2016*
Leduc, Stéphane	*2 (Stryker); 3B (Stryker); 5 (Amgen Co; DePuy, A Johnson & Johnson Company; Synthes; Stryker; Smith & Nephew); 6 (Amgen Co; Eli Lilly; Norvartis; Sanofi-Aventis); Submitted on: 04/04/2016*
Lee, Edwin	*3A (Gilead Sciences); 4 (Eli Lilly; Johnson & Johnson, Pfizer); Submitted on: 08/30/2016*
Lee, Mark A.	*2 (Synthes); 3B (Synthes); 5 (Synthes); 6 (Synthes/Fellowship Support); 9 (Orthopaedic Trauma Association); Submitted on: 08/23/2016*
Lee, Yongkoo	*(n); Submitted on: 06/15/2016*
Lee, Jackson	*2 (DePuy, A Johnson & Johnson Company); Submitted on: 06/10/2016*
Lefaivre, Kelly	*5 (Synthes; Zimmer); Submitted on: 06/10/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Leighton, Ross	*1 (Zimmer); 2 (Biomet; Biomet; DePuy, A Johnson & Johnson Company; Etex; Etex; Smith & Nephew; Smith & Nephew; Stryker; Stryker; Synthes; Synthes; Zimmer); 3B (Etex); 5 (Synthes); 6 (DePuy, A Johnson & Johnson Company; Smith & Nephew; Stryker); 9 (Canadian Orthopaedic Association; Innovision; Orthopaedic Trauma Association); Submitted on: 05/26/2016*
Leliveld, M.S.	*5 (Synthes; Zimmer); Submitted on: 06/10/2016*
Lenchik, Leon	*(n); Submitted on: 06/01/2016*
Leslie, Michael P.	*3B (Globus Medical); Submitted on: 08/23/2016*
Leu, David	*Current disclosure not available at time of print.*
Leucht, Philipp	*3B (Ankasa Regenerative Therapeutics); 9 (AAOS Biological Implants Committee); Submitted on: 04/12/2016*
Leung, Kwok-Sui	*(n); Submitted on: 01/11/2016*
Levack, Ashley	*(n); Submitted on: 05/29/2016*
Levin, L. Scott	*1 (Mavrek, Inc.); 5 (AxoGen, Inc.); 9 (American College of Surgeons; American Society for Reconstructive Microsurgery; American Society for Surgery of the Hand; International Hand and Composite Tissue Allotransplantation Society; United Network for Organ Sharing; Vascularized Composite Allograft Transplantation Committee; World Society for Reconstructive Microsurgery); Submitted on: 04/22/2016*
Levine, Ari	*(n); Submitted on: 05/24/2016*
Liang, Xiangdang	*(n); Submitted on: 08/25/2016*
Liew, Susan	*5 (FAITH Investigators; FLOW Investigators); Submitted on: 05/25/2016*
Limbu, Amit	*(n); Submitted on: 05/31/2016*
Limbu, Kumud	*(n); Submitted on: 05/31/2016*
Lin, Monica	*(n); Submitted on: 06/07/2016*
Lin, Albert	*8 (Annals in Joint; Frontiers in Orthopaedic Surgery; Knee Surgery; Sports Traumatology; Arthroscopy); Submitted on: 05/29/2016*
Lindsey, Ronald W.	*8 (Springer; Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of Trauma; Journal of trauma); Submitted on: 04/26/2016*
Lipof, Jason	*(n); Submitted on: 05/22/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Liporace, Frank A.	*1 (Biomet); 2 (Biomet; Stryker; Synthes); 3B (Biomet; Medtronic; Synthes; Stryker); 3C (AO); Submitted on: 05/02/2016*
Litrenta, Jody	*(n); Submitted on: 06/02/2016*
Liu, Jane	*(n); Submitted on: 05/28/2016*
Liu, Max	*(n); Submitted on: 05/31/2016*
Liu, Jiayong	*(n); Submitted on: 06/01/2016*
Lobo, Dileep	*(n); Submitted on: 01/11/2016*
Loc Carrillo, Catherine	*(n); Submitted on: 08/16/2016*
Longwell, Mark	*(n); Submitted on: 06/06/2016*
Lorenzana, Daniel	*(n); Submitted on: 05/26/2016*
Lorich, Dean G.	*(n); Submitted on: 05/05/2016*
Lotzien, Sebastian	*(n); Submitted on: 06/01/2016*
Lourenco, Paulo Roberto	*2 (DePuy, A Johnson & Johnson Company; Zimmer); 3B (Synthes); 3C (Synthes); 8 (Current Opinion in Orthopaedics); 9 (Brazilian Orthopaedic Society (2016); Brazilian Orthopaedic Trauma Society (President 2015); Submitted on: 08/23/2016*
Lowe, Jason	*3B (Acumed, LLC; Stryker); 5 (Stryker); Submitted on: 04/13/2016*
Lowenberg, David	*2 (Stryker); 3B (Stryker); 9 (Foundation for Orthopaedic Trauma); Submitted on: 04/10/2016*
Lu, Keyin	*(n); Submitted on: 05/27/2016*
Lucas, Robert	*(n); Submitted on: 04/09/2016*
Lucas, Justin	*(n); Submitted on: 05/30/2016*
Luly, Jason	*(n); Submitted on: 06/27/2016*
Lundy, Douglas W.	*3B (Synthes); 8 (AAOS Now; Clinical Orthopaedics and Related Research; Journal of Orthopaedic Trauma; Journal of the Southern Medical Association; Orthopedics); 9 (AAOS; American Board of Orthopaedic Surgery, Inc.; American College of Surgeons; American Orthopaedic Association; Orthopaedic Trauma Association); Submitted on: 07/06/2016*
Lyden, John	*(n); Submitted on: 06/03/2016*
Macaulay, Alec	*(n); Submitted on: 05/31/2016*
Maceroli, Michael	*(n); Submitted on: 05/30/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

MacKenzie, Ellen	*(n); Submitted on: 06/26/2016*
Madden, Kim	*(n); Submitted on: 05/12/2016*
Madey, Steven	*1 (Zimmer; Synthes); 3C (Zimmer; Synthes); Submitted on: 05/31/2016*
Madsen, Jan Erik	*8 (Acta Orthopaedica; JBJS Case Connecector); Submitted on: 06/08/2016*
Maharbiz, Michel	*(n); Submitted on: 06/02/2016*
Maharjan, Rajiv	*(n); Submitted on: 05/29/2016*
Mahure, Siddharth	*(n); Submitted on: 06/01/2016*
Maina, Anthony	*6 (SIGN Fracture Care International); Submitted on: 08/16/2016*
Makosso-Kallyth, Sun	*(n); Submitted on: 05/31/2016*
Maley, Margaret M.	*(n); Submitted on: 06/15/2016*
Malige, Ajith	*(n); Submitted on: 05/06/2016*
Malik, Awais	*(n); Submitted on: 05/24/2016*
Mamczak, Christiaan N.	*2 (AO North America; Smith & Nephew); 7 (Springer); 9 (American Osteopathic Association of Orthopaedics; Orthopaedic Trauma Association); Submitted on: 05/12/2016*
Maniar, Hemil	*(n); Submitted on: 06/01/2016*
Manson, Theodore T.	*3B (Globus Medical; Smith & Nephew; Stryker); 5 (DePuy, A Johnson & Johnson Company; Synthes); 8 (Clinical Orthopaedics and Related Research; Journal of Arthroplasty); 9 (AAOS; American Association of Hip and Knee Surgeons); Submitted on: 04/22/2016*
Marcantonio, Andrew	*6 (AOTrauma North America (Honorarium, Travel Expenses)); 9 (New England Orthopedic Society); Submitted on: 04/06/2016*
Marchand, Lucas	*(n); Submitted on: 04/30/2016*
Mardam-Bey, Sami	*(n); Submitted on: 04/04/2016*
Marecek, Geoffrey	*9 (AAOS); Submitted on: 05/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Markel, David	*1 (Stryker); 2 (Stryker); 3B (Stryker); 4 (The CORE institute); 5 (OREF; Stryker); 8 (Clinical Orthopaedics and Related Research; Journal of Arthroplasty; Journal of Bone and Joint Surgery - American; Osteoarthritis and Cartilage); 9 (Michigan Orthopaedic Society, AAHKS, Mid America Ortho Assoc); Submitted on: 05/02/2016*
Marmor, Meir	*(n); Submitted on: 04/05/2016*
Marquez-Lara, Alejandro	*(n); Submitted on: 05/03/2016*
Marriott, Tricia	*(n); Submitted on: 01/11/2016*
Marseille, Elliot	*Current disclosure not available at time of print.*
Marsh, J. Lawrence	*1 (Biomet; Tornier); 4 (FxRedux); 7 (Oxford Press); 9 (American Board of Orthopaedic Surgery, Inc.; American Orthopaedic Association; Mid American Orthopadics; NBME; RRC-(chair, orthopaedic surgery)); Submitted on: 05/23/2016*
Martin, Adam	*(n); Submitted on: 05/19/2016*
Martin, David	*4 (Exactech; Johnson & Johnson); Submitted on: 08/23/2016*
Mathis, Taylor	*(n); Submitted on: 06/16/2016*
Matityahu, Amir	*2 (AO Foundation; DePuy-Synthes, A Johnson & Johnson Company); 3B (Acumed, LLC); 4 (Anthem Orthopedics, LLC; Episode Solutions, LLC; EPIX Orthopaedics, Inc; PDP Holdings, LLC); 9 (AO Foundation; Orthopaedic Trauma Association); Submitted on: 06/16/2016*
Matuszewski, Paul	*(n); Submitted on: 06/01/2016*
Mauffrey, Cyril	*3B (Stryker); 3C (Stryker); 5 (Carbofix; osteomed); 6 (Abbott; DePuy, A Johnson & Johnson Company); 7 (Springer); 8 (International Orthopaedics; Patient safety in surgery; The european journal of orthopaedic surgery and traumatology; Current Opinion in Orthopaedics); 9 (La Societe Internationale de Chirurgie Orthopedique et de Traumatologie; Orthopaedic Trauma Association); Submitted on: 05/28/2016*
Maxson, Benjamin	*(n); Submitted on: 05/23/2016*
Mayo, Keith A.	*1 (Synthes); 2 (Stryker; Synthes); 3B (Siemens); Submitted on: 02/02/2016*
Mazz, Bakry	*(n); Submitted on: 01/11/2016*
McAndrew, Christopher	*2 (Synthes); 7 (Journal of Bone and Joint Surgery - American); Submitted on: 05/18/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

McBride, Chris	*(n); Submitted on: 08/25/2016*
McCabe, Randi	*7 (UptoDate); Submitted on 05/26/2016*
McCarroll, Tyler	*(n); Submitted on: 08/16/2016*
McCormack, Robert G.	*2 (Pendopharm Pharmaceutical); 5 (Canadian Institutes of Health Research; Canadian Orthopaedic Foundation; National Institutes of Health (NIAMS & NICHD); Stryker; Synthes; Canadian Orthopaedic Trauma Society); 8 (Arthroscopy Clinical Journal of Sport Medicine); 9 (Canadian Orthopaedic Association); Submitted on: 05/31/2016*
McDonald, Amy	*(n); Submitted on: 06/01/2016*
McDonald, Erik	*3A (Boston Scientific); 4 (Abbvie; Boston Scientific); Submitted on: 08/24/2016*
McEachan, Jane	*(n); Submitted on: 01/11/2016*
McGonagle, Dennis	*(n); Submitted on: 07/01/2016*
McKay, Paula	*(n); Submitted on: 05/31/2016*
McKee, Michael D. (Program Committee)	*1 (Elsevier Inc; Springer; Stryker); 3B (Acumed, LLC; Stryker; Synthes; Zimmer); 5 (Olympus Biotech; Zimmer; Canadian Orthopaedic Trauma Society); 7 (Springer; Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Orthopaedics and Traumatology; Orthopedics Today); 9 (Canadian Orthopaedic Association; Orthopaedic Trauma Association); Submitted on: 04/05/2016*
McKinley, Todd O.	*3B (Bioventus); 5 (METRC); 9 (Orthopaedic Trauma Association); Submitted on: 04/06/2016*
McKnight, Braden	*(n); Submitted on: 06/01/2016*
McLaurin, Toni M.	*6 (Stryker); 8 (Bulletin Hospital for Joint Diseases); 9 (Orthopaedic Trauma Association); Submitted on: 06/02/2016*
McLemore, Ryan	*4 (Sonoran Biosciences); 5 (Astellas Pharmaceuticals); Submitted on: 08/24/2016*
McMillian, Wesley	*(n); Submitted on: 05/28/2016*
McNamara, Kyle	*(n); Submitted on: 08/24/2016*
McPhilamy, Austin M.	*(n); Submitted on: 08/23/2016*
McQueen, Margaret	*7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Wolters Kluwer Health - Lippincott Williams & Wilkins); Submitted on: 08/24/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

McTague, Michael	*(n); Submitted on: 05/19/2016*
McVicker, Zachary	*(n); Submitted on: 05/16/2016*
Mehta, Devan	*(n); Submitted on: 06/16/2016*
Mehta, Samir	*2 (Zimmer; ; Smith & Nephew; AO North America); 3B (Smith & Nephew; Synthes); 5 (Amgen Co; Medtronic; Smith & Nephew); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Current Opinion in Orthopaedics); 9 (Pennsylvania Orthopaedic Society); Submitted on: 04/06/2016*
Meiss, Jordan	*(n); Submitted on: 09/01/2016*
Melton-Kreft, Rachael	*(n); Submitted on: 08/23/2016*
Memarzadeh, Arman	*(n); Submitted on: 04/13/2016*
Ménard, Jérémie	*(n); Submitted on: 08/16/2016*
Merlin, Garbriel	*(n); Submitted on: 04/04/2016*
Metcalf, Rory	*(n); Submitted on: 08/24/2016*
Metzger, Cameron	*(n); Submitted on: 08/16/2016*
Meuret, Robert	*Current disclosure not available at time of print.*
Meyer, Darlene A. (Staff)	*(n); Submitted on: 07/15/2016*
Miclau III, Theodore	*5 (Baxter; Synthes); 9 (Foundation for Orthopaedic Trauma; Inman Abbott Society; Orthopaedic Research Society; Orthopaedic Trauma Association; Osteosynthesis and Trauma Care Foundation); Submitted on: 04/06/2016*
Miles, Daniel	*(n); Submitted on: 06/01/2016*
Miller, Anna	*8 (Journal of Orthopaedic Trauma); 9 (AAOS; American College of Surgeons; AOTrauma North America; Orthopaedic Trauma Association); Submitted on: 04/01/2016*
Miller, Ashley	*(n); Submitted on: 05/15/2016*
Miller, Brian	*(n); Submitted on: 04/13/2016*
Miller, Joseph A.	*1 (Tai-Lore Made Prosthetics, LLC); Submitted on: 09/06/2016*
Ming, Bryan	*(n); Submitted on: 06/18/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Mir, Hassan R.	*2 (Synthes); 3B (Smith & Nephew); 4 (Core Orthopaedics); 8 (Journal of Orthopaedic Trauma Associate Editor; OsteoSynthesis, The JOT Online Discussion Forum Editor; OTA Newsletter Editor); 9 (AAOS Council on Advocacy; AAOS Diversity Advisory Board; FOT Nominating and Membership Committees; OTA PR Committee); Submitted on: 04/29/2016*
Mirza, Amer	*3C (Seattle Information Systems; Acumed, LLC); Submitted on: 06/01/2016*
Mitcham, Patrick	*(n); Submitted on: 06/01/2016*
Mitchell, Justin	*(n); Submitted on: 05/16/2016*
Mitchell, Phillip	*(n); Submitted on: 05/27/2016*
Mizrahi, Matthew	*(n); Submitted on: 09/01/2016*
Mohamad, Morad	*(n); Submitted on: 08/19/2016*
Moloney, Gele	*(n); Submitted on: 06/01/2016*
Mombell, Kyle	*(n); Submitted on: 06/01/2016*
Montalvo, Ryan	*(n); Submitted on: 05/30/2016*
Moody, Alistair	*(n); Submitted on: 01/11/2016*
Moore, Sharon M. (Staff)	*(n); Submitted on: 04/01/2016*
Moore, Timothy A.	*(n); Submitted on: 06/21/2016*
Moore, Tyler	*(n); Submitted on: 05/22/2016*
Moran, Christopher	*2 (Smith & Nephew); 8 (International Editorial Board); 9 (British Othopaedic Association; Trauma Audit and Research Network); Submitted on: 08/30/2016*
Morgan, Steven J	*3B (Cardinal Health); 4 (Johnson & Johnson); 7 (SLACK Incorporated); 8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association); Submitted on: 10/04/2015*
Morris-Berry, Christina	*(n); Submitted on: 08/16/2016*
Morrison, Avery	*(n); Submitted on: 05/31/2016*
Morrissey, Patrick	*(n); Submitted on: 04/15/2016*
Morshed, Saam	*9 (Orthopaedic Research Society; Orthopaedic Trauma Association); Submitted on: 05/03/2016*
Moss, James	*(n); Submitted on: 06/01/2016*
Moss, Lewis	*(n); Submitted on: 06/04/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Mostofi, Amir	*(n); Submitted on: 06/06/2016*
Muchow, Ryan	*(n); Submitted on: 04/04/2016*
Mudgal, Chaitanya	*2 (AO North America); 3C (GenOssis); 8 (Techniques in hand and upper extremity surgery); Submitted on: 05/02/2016*
Mullen, James	*(n); Submitted on: 04/12/2016*
Mullis, Brian	*2 (Zimmer Biomet); 3B (Convatec; Zimmer Biomet); Submitted on: 04/04/2016*
Murr, Kevin	*(n); Submitted on: 05/27/2016*
Murray, Brett	*(n); Submitted on: 06/13/2016*
Mustafa, Mohamed	*(n); Submitted on: 06/01/2016*
Nam, Diane	*2 (DePuy Synthes); 5 (Canadian Orthopaedic Trauma Society); Submitted on: 04/26/2016*
Nahm, Nickolas	*(n); Submitted on: 06/01/2016*
Nandamuru, Praveen	*(n); Submitted on: 08/29/2016*
Napora, Joshua	*(n); Submitted on: 04/04/2016*
Nascone, Jason W.	*1 (IMDS; Synthes); 2 (Smith & Nephew; Synthes); 3B (IMDS; Smith & Nephew); 8 (Journal of Orthopaedic Trauma); 9 (AONA; Orthopaedic Trauma Association); Submitted on: 04/06/2016*
Nasr, Kerellos	*(n); Submitted on: 06/01/2016*
Nathens, Avery	*(n); Submitted on: 06/03/2016*
Natoli, Roman	*(n); Submitted on: 04/04/2016*
Nault, Marie-Lyne	*(n); Submitted on: 04/21/2016*
Nauth, Aaron	*5 (Capital Sports Entertainment; Synthes, Stryker; Sonoma Orthopaedics; Canadian Orthopaedic Trauma Society); 9 (Orthopaedic Trauma Association); Submitted on: 06/01/2016*
Nazarian, Ara	*(n); Submitted on: 06/17/2016*
Nellans, Kate	*(n); Submitted on: 05/30/2016*
Nellestein, Andrew	*(n); Submitted on: 06/01/2016*
Neviaser, Andrew	*(n); Submitted on: 04/06/2016*
Ngahyoma, Joshua	*(n); Submitted on: 01/11/2016*
Nguyen, Mai	*(n); Submitted on: 05/25/2016*
Nicholson, Luke	*(n); Submitted on: 05/22/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Nicolay, Richard	*(n); Submitted on: 05/30/2016*
Nicolescu, Razvan	*(n); Submitted on: 05/23/2016*
Nightingale, Jessica	*(n); Submitted on: 08/30/2016*
Nistico, Laura	*(n); Submitted on: 06/01/2016*
Nixon, Devon	*(n); Submitted on: 04/04/2016*
Nork, Sean	*2 (AONA; DePuy, A Johnson & Johnson Company); 3B (DePuy, A Johnson & Johnson Company); 5 (AONA, OTA, Synthes); Submitted on: 05/30/2016*
Norris, Brent	*3B (Acumed, LLC; Synthes); 4 (Norris Surgical, LLC); 5 (AONA); 6 (RMD); 9 (Orthopaedic Trauma Association); Submitted on: 05/15/2016*
Norrish, Alan	*3C (Cambridge BioAugmentation Systems); Submitted on: 06/23/2016*
Nourian, Alex	*4 (Abbott; Pfizer); Submitted on: 06/21/2016*
Novicoff, Wendy	*(n); Submitted on: 05/03/2016*
Nowak, Lauren	*(n); Submitted on: 04/29/2016*
Nwachuku, Chinenye	*(n); Submitted on: 05/07/2016*
Nwosa, Chinedu	*(n); Submitted on: 01/11/2016*
Obremskey, William T.	*8 (Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of the American Academy of Orthopaedic Surgeons); 9 (Orthopaedic Trauma Association; Southeastern Fracture Consortium); Submitted on: 04/12/2016*
O'Brien, Peter	*2 (Zimmer); 3B (Zimmer); 5 (DePuy, A Johnson & Johnson Company; Synthes;; Zimmer); 8 (Journal of Orthopaedic Trauma); Submitted on: 04/15/2016*
Ochenjele, George	*(n); Submitted on: 05/30/2016*
O'Connell, Rachel (Staff)	*(n); Submitted on: 02/16/2016*
O'Donnell, Jeffrey	*(n); Submitted on: 06/21/2016*
Oh, Chang-Wug	*2 (Synthes); 3C (Zimmer); 5 (Synthes); Submitted on: 05/27/2016*
Oh, Jong-Keon	*5 (DePuy, A Johnson & Johnson Company); 8 (Archives of Orthopaedic And Trauma Surgery); Submitted on 06/01/2016*
O'Halloran, Kevin	*5 (SPRINT Investigators); Submitted on: 05/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

O'Hara, Nathan	*5 (SPRINT Investigators); 9 (Global Partners in Anesthesia and Surgery); Submitted on: 04/20/2016*
Okike, Kanu	*5 (OREF; DePuy, A Johnson & Johnson Company); 6 (Zimmer; DePuy, A Johnson & Johnson Company; Stryker; Synthes); Submitted on: 04/04/2016*
O'Leary, Ronan	*(n); Submitted on: 08/29/2016*
Oliphant, Bryant	*2 (Synthes); 4 (PersonalRN); Submitted on: 06/21/2016*
Ollivere, Ben	*5 (Smith & Nephew); 7 (Journal of Bone and Joint Surgery - British); 8 (Journal of Bone and Joint Surgery - British); 9 (AO UK); Submitted on: 08/24/2016*
Olson, Steven A.	*5 (Synthes); 9 (Orthopaedic Trauma Association); Submitted on: 04/01/2016*
Omid, Reza	*1 (Integra; Medacta); 3B (Integra; Medacta; Smith & Nephew); Submitted on: 04/12/2016*
O'Neil, Joseph	*(n); Submitted on: 05/30/2016*
Ong, Joshua	*(n); Submitted on: 05/23/2016*
Ortega, Gilbert R. (Program Committee)	*2 (Smith & Nephew); 3B (Smith & Nephew); Submitted on: 12/03/2015*
Ortiz-Catalan, Max	*3A (Integrum AB); 6 (Integrum AB); Submitted on: 05/31/2016*
Osgood, Greg M.	*2 (Bioventus, Inc.; DePuy, A Johnson & Johnson Company; Synthes); 3B (Bioventus, Inc.; Synthes; Stryker); 5 (Carestream; DePuy, A Johnson & Johnson Company; Siemens; Synthes); 8 (Clinical Orthopaedics and Related Research; Journal of Orthopaedics and Traumatology; Techniques in Orthopaedics; Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Orthopaedic Trauma Association; Foundation for Orthopaedic Trauma); Submitted on: 06/01/2016*
Osterhoff, Georg	*5 (DePuy, A Johnson & Johnson Company; Medtronic; Synthes); Submitted on: 06/24/2016*
Ostrum, Robert F.	*3B (Bioventus); 7 (SLACK Incorporated); 8 (Clinical Orthopaedics and Related Research; Journal of Orthopaedics and Traumatology); 9 (Orthopaedic Trauma Association); Submitted on: 04/24/2016*
Otero, Jesse	*(n); Submitted on: 05/27/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

O'Toole, Robert V. (Program Committee)	*3B (iMDS; Smith & Nephew); 5 (Synthes; Stryker; SPRINT Investigators); 9 (Orthopaedic Trauma Association); Submitted on: 05/25/2016*
Otsuka, Norman	*8 (American Journal of Orthopedics; Journal of Children's Orthopaedics; Journal of Orthopaedic Surgical Advances; Journal of Pediatric Orthopedics, Part B); 9 (AAOS; American Academy of Pediatrics; American College of Surgeons; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America); Submitted on: 06/10/2016*
Owen, Julian	*(n); Submitted on: 01/11/2016*
Paci, Gabrielle	*(n); Submitted on: 05/12/2016*
Pagnano, Mark	*1 (DePuy, A Johnson & Johnson Company; Stryker); 3B (Pacira); 9 (Hip Society; Knee Society); Submitted on: 04/04/2016*
Paksima, Nader	*2 (Stryker); 3B (Stryker); 8 (bulletin of the Hospital for Joint Diseases; Journal of the American Academy of Orthopaedic Surgeons); Submitted on: 05/13/2016*
Pally, Elliott	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 06/05/2016*
Pan, Tiffany	*(n); Submitted on: 08/25/2016*
Pandit, Sandeep	*(n); Submitted on: 06/05/2016*
Paneru, Shivaraj	*(n); Submitted on: 05/31/2016*
Pannell, William	*(n); Submitted on: 05/26/2016*
Panteli, Michalis	*(n); Submitted on: 06/01/2016*
Papadopoulos, Nayla	*(n); Submitted on: 05/27/2016*
Pape, Hans-Christoph	*Current disclosure not available at time of print.*
Papp, Steven Ray	*2 (Stryker); 5 (Synthes; Canadian Orthopaedic Trauma Society); Submitted on: 04/04/2016*
Parikh, Hardik	*(n); Submitted on: 05/31/2016*
Parisien, Robert	*(n); Submitted on: 05/20/2016*
Park, Ki-Chul	*(n); Submitted on: 05/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Park, Kyeong-Hyeon	*(n); Submitted on: 05/30/2016*
Park, Nathan	*(n); Submitted on: 08/29/2016*
Park, Sang Hyun	*5 (DePuy, A Johnson & Johnson Company; KLRM, LLC); Submitted on: 05/31/2016*
Parks, Christopher	*(n); Submitted on: 06/01/2016*
Parvizi, Javad	*3B (Smith & Nephew; Zimmer); 4 (CD Diagnostics; Hip Innovation Technology; PRN); 5 (3M; Cempra; CeramTec; DePuy, A Johnson & Johnson Company; National Institutes of Health (NIAMS and NICHD); OREF; Smith & Nephew; StelKast; Stryker; Zimmer); 7 (Datatrace; Elsevier; Jaypee Publishing; SLACK; Wolters Kluwer Health – Lippincott Williams & Wilkins); 8 (Journal of Arthroplasty; Journal of Bone and Joint Surgery – American; Journal of Bone and Joint Surgery – British); 9 (Eastern Orthopaedic Association; Muller Foundation); Submitted on: 04/26/2016*
Patel, Devan D.	*(n); Submitted on: 01/11/2016*
Patel, Kushal	*(n); Submitted on: 01/23/2016*
Patel, Shaan	*(n); Submitted on: 05/27/2016*
Patel, Vandan	*(n); Submitted on: 05/23/2016*
Patt, Joshua	*9 (AAOS; American Orthopaedic Association; Musculoskeletal Tumor Society); Submitted on: 05/02/2016*
Patterson, Brendan	*9 (Orthopaedic Trauma Association); Submitted on: 04/05/2016*
Patterson, Joseph	*(n); Submitted on: 04/04/2016*
Paxton, Liz	*(n); Submitted on: 04/04/2016*
Pean, Christian	*(n); Submitted on: 05/17/2016*
Pearle, Andrew	*1 (Zimmer); 3B (Arthrex, Inc; Stryker; Zimmer); Submitted on: 06/01/2016*
Pedri, Tony	*(n); Submitted on: 08/17/2016*
Pensy, Raymond A.	*(n); Submitted on: 05/29/2016*
Pepper, Andrew	*(n); Submitted on: 04/04/2016*
Perdue, Aaron M.	*3B (Globus Medical; Zimmer); Submitted on: 08/17/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Perez, Ed	*2 (Smith & Nephew); 3B (Cardinal Health); 4 (Bristol-Myers Squibb; Pfizer; Stryker; Cardinal Health; Johnson & Johnson); 7 (Saunders/Mosby-Elsevier); 9 (Orthopaedic Trauma Association); Submitted on: 04/29/2016*
Perez-Viloria, Miguel Enrique	*(n); Submitted on: 08/29/2016*
Perkins, Crystal	*(n); Submitted on: 04/26/2016*
Peterson, Emily	*Current disclosure not available at time of print.*
Petrigliano, Frank	*2 (Biomet); 5 (Musculoskeletal Transplant Foundation); Submitted on: 06/01/2016*
Petrisor, Brad	*2 (Stryker); 3B (Stryker); 5 (Stryker; Zimmer; FLOW Investigators; Canadian Orthopaedic Trauma Society); 6 (Pfizer); Submitted on: 04/04/2016*
Pfeifer, Roman	*(n); Submitted on: 01/11/2016*
Pham, Vuong-Iam	*(n); Submitted on: 06/01/2016*
Phieffer, Laura S.	*9 (AAOS); Submitted on: 05/23/2016*
Phillips, Caleb	*(n); Submitted on: 05/31/2016*
Phisitkul, Phinit	*3B (Arthrex, Inc; Smith & Nephew); 4 (First Ray; Mortise Medical); 9 (American Orthopaedic Foot and Ankle Society); Submitted on: 04/04/2016*
Pierrie, Sarah	*9 (Society of Military Orthopaedic Surgeons); Submitted on 05/18/2016*
Pilson, Holly Tyler-Paris	*(n); Submitted on: 08/23/2016*
Pina, Matthew	*(n); Submitted on: 05/25/2016*
Podeszwa, David	*9 (Pediatric Orthopaedic Society of North America; AAOS); Submitted on: 06/01/2016*
Poeze, Martijn	*(n); Submitted on: 06/07/2016*
Polga, David J.	*Current disclosure not available at time of print.*
Pollak, Andrew N.	*1 (Zimmer); 5 (METRC); 7 (AAOS - JBL - Orange Book Series); 9 (National Trauma Institute); Submitted on: 05/30/2016*
Pollak, Rachael	*1 (Zimmer); Submitted on 05/15/2016*
Ponton, Ryan	*(n); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Potter, Benjamin K.	*3C (Biomet); 8 (Clinical Orthopaedics and Related Research; Journal of Orthopaedic Trauma; Journal of Surgical Orthopaedic Advances); 9 (Society of Military Orthopaedic Surgeons); Submitted on: 05/31/2016*
Prasarn, Mark	*2 (DePuy, A Johnson & Johnson Company; Eli Lilly; Stryker); 3B (Stryker); Submitted on: 05/02/2016*
Prayson, Michael	*2 (AO Faculty; Bioventus); 3B (Bioventus); 8 (Acta Orthopaedica; Journal of Orthopaedic Trauma; Journal of Trauma); 9 (Orthopaedic Trauma Association; Wright State Physicians); Submitted on: 08/29/2016*
Prayson, Nicholas	*7 (Saunders/Mosby-Elsevier; Springer); 8 (American Journal of Clinical Pathology; American Journal of Surgical Pathology; Archives of Pathology and Laboratory Medicine; Journal on Women and Aging; The Journal of Immunohistochemistry and Molecular Morphology); Submitted on: 06/16/2016*
Presson, Angela	*(n); Submitted on: 06/01/2016*
Prvu Bettger, Janet A.	*(n); Submitted on: 06/01/2016*
Putnam, Sara	*(n); Submitted on: 05/19/2016*
Qeadan, Faers	*(n); Submitted on: 08/16/2016*
Quade, Jonathan	*(n); Submitted on: 04/27/2016*
Queally, Joseph	*(n); Submitted on: 08/23/2016*
Quinn, Courtney	*(n); Submitted on: 04/13/2016*
Quinnan, Stephen	*3B (DePuy, A Johnson & Johnson Company; Globus Medical; Microbion; Smith & Nephew); 5 (DePuy, A Johnson & Johnson Company); Submitted on: 04/04/2016*
Rainey, Evan	*(n); Submitted on: 08/16/2016*
Raj, Saloni	*(n); Submitted on: 06/13/2016*
Rajfer Trueblood, Rebecca	*6 (KLRM, LLC); Submitted on: 05/30/2016*
Ramadan, Samy	*(n); Submitted on: 05/31/2016*
Ramey, James	*3A (Eli Lilly); 4 (Eli Lilly); Submitted on: 08/25/2016*
Ramnaraign, David	*(n); Submitted on: 06/02/2016*
Ramsey, Frederick	*(n); Submitted on: 06/21/2016*
Rane, Ajinkya	*(n); Submitted on: 05/27/2016*
Rao, Karan	*(n); Submitted on: 08/16/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Rath, Ehud	*(n); Submitted on: 04/06/2016*
Ravinsky, Robert	*(n); Submitted on: 06/15/2016*
Raymond, Loveita	*(n); Submitted on: 04/07/2016*
Reahl, George	*(n); Submitted on: 06/01/2016*
Redfern, Jenessa	*(n); Submitted on: 05/28/2016*
Redko, Mariya	*(n); Submitted on: 06/16/2016*
Reed, Lori	*9 (Orthopaedic Trauma Association); Submitted on: 01/25/2016*
Rehman, Saqib	*2 (Synthes); 7 (Jaypee Medical Publishing); 8 (Orthopedic Clinics of North America); 9 (Orthopaedic Trauma Association); Submitted on: 04/09/2016*
Reich, Michael	*(n); Submitted on: 05/25/2016*
Reid, Kristoff	*(n); Submitted on: 06/27/2016*
Reilly, Mark C.	*2 (Stryker); 3B (Stryker); Submitted on: 04/12/2016*
Reindl, Rudolf	*5 (Synthes; CORAL Collaborators); Submitted on 04/12/16*
Reisman, William	*(n); Submitted on: 04/12/2016*
Ren, Weiping	*(n); Submitted on: 05/13/2016*
Replogle, William	*3A (Allergan); Submitted on: 06/03/2016*
Rezaei, Arash	*(n); Submitted on: 06/01/2016*
Rhoda, Tammy	*(n); Submitted on: 08/18/2016*
Ricci, William M.	*1 (MicroPort; Smith & Nephew); 3B (Smith & Nephew; Zimmer-Biomet); 5 (Smith & Nephew; Synthes); 6 (Cable Fix LLC; McGinley Orthopaedics); 7 (Journal of Bone and Joint Surgery - American; Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Orthopaedic Trauma; OKU Trauma/AAOS; Rockwood & Green Fracture in Adults/Wolters Kluwer Health - Lippinott Williams & Wilkins); 9 (Orthopaedic Trauma Association); Submitted on: 04/09/2016*
Riccio, Anthony I.	*5 (Synthes); 7 (Saunders/Mosby-Elsevier); 9 (Pediatric Orthopaedic Society of North America); Submitted on: 04/05/2016*
Rich, James	*3B (Biocomposites Ltd; Hyaltech Ltd, A Carl Zeiss Meditec Company; Mathys Ltd); Submitted on: 06/28/2016*
Rich, Jessica	*6 (DJ Orthopaedics); Submitted on: 08/19/2016*
Richard, Raveesh	*(n); Submitted on: 06/01/2016*
Rijal, Raju	*(n); Submitted on: 05/31/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Ringler, James	*(n); Submitted on: 06/01/2016*
Roa, Kristopher	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Roaten, John	*(n); Submitted on: 08/23/2016*
Roberts, Craig	*7 (Skeletal Trauma royalties from Elsevier; External Fixation royalties from Elsevier); 8 (Injury (Deputy Editor); Journal of Orthopaedic Trauma (Editorial Board)); 9 (Mid-America Orthopaedic Association; Orthopaedic Trauma Association); Submitted on: 04/06/2016*
Roberts, Lauren	*(n); Submitted on: 06/23/2016*
Roberts, Zachary	*4 (Pfizer;); Submitted on: 04/12/2016*
Roden-Foreman, Kenleigh	*(n); Submitted on: 08/17/2016*
Rodriguez, Edward	*1 (Zimmer); 3B (MXO; Riversdie partners); 4 (MXO Orthopedics); 5 (Synthes); Submitted on: 04/05/2016*
Rodts, Megan	*3A (DePuy, A Johnson & Johnson Company); 4 (Bristol-Meyers Squibb; Eli Lilly); 7 (Orthopaedic Nursing); 8 (Orthopaedic Nursing); Submitted on: 05/30/2016*
Rollins, Katie	*(n); Submitted on: 08/24/2016*
Ross, Daniel	*(n); Submitted on: 06/24/2016*
Ross, Keir	*(n); Submitted on: 06/25/2016*
Roth, Matthew	*(n); Submitted on: 05/24/2016*
Rothberg, David	*(n); Submitted on: 05/31/2016*
Rouleau, Dominique	*2 (Bioventus; Smith & Nephew;); 5 (DePuy, A Johnson & Johnson Company; KCI; Smith & Nephew; Stryker; Synthes; Zimmer; Tornier); 6 (Arthrex, Inc; Smith & Nephew; Tornier); 8 (OTSR-Elsevier); Submitted on: 05/30/2016*
Roulette, Paulvalery	*(n); Submitted on: 05/17/2016*
Routt, Milton	*2 (AONA; Stryker; Synthes); Submitted on: 06/30/2016*
Row, Elliot	*(n); Submitted on: 07/11/2016*
Rowe, Lattisha	*(n); Submitted on: 01/15/2016*
Rozen, Galia	*(n); Submitted on: 01/11/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Rubash, Harry	*1 (Ceramtec; Stryker); 3B (Flexion; Pacira); 4 (Orthopaedic Technology Group); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Hip Society); Submitted on: 04/27/2016*
Ruder, John	*(n); Submitted on: 04/15/2016*
Runner, Robert	*(n); Submitted on: 04/18/2016*
Russell, Rebecca	*(n); Submitted on: 08/16/2016*
Russell, Thomas A	*1 (Zimmer; Smith & Nephew); 2 (Zimmer); 3A (Innovision); 3B (Zimmer); 4 (CelgenTek Innovations Corporation); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (American Orthopaedic Association; Orthopaedic Trauma Association); Submited on: 08/23/2016*
Ryan, Scott	*2 (Smith & Nephew); Submitted on: 05/27/2016*
Rzheuskaya, Valeryia	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 06/17/2016*
Sadauskas, Alex	*(n); Submitted on: 05/26/2016*
Saffarzadeh, Mona	*(n); Submitted on: 06/01/2016*
Sagi, H. Claude	*1 (Stryker); 2 (Synthes; Stryker; Smith & Nephew); 3B (Synthes; Stryker; Smith & Nephew); 5 (Stryker; Smith & Nephew); 8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association); Submitted on: 08/23/2016*
Saleh, Anas	*(n); Submitted on: 04/04/2016*
Saleh, Hesham	*(n); Submitted on: 04/21/2016*
Saleh, Khaled J.	*1 (Aesculap/B. Braun); 2 (Aesculap/B. Braun); 3B (Aesculap/B. Braun; Memorial Medical Center Co-Management Orthopaedic Board; Watermark Inc - DSMB); 7 (Elsevier Science - Book Royalties); 9 (Journal of Bone and Joint Surgery - American); 9 (AAOS; American Board of Orthopaedic Surgeons Oral Examiner; American Orthopaedic Association; American Orthopaedic Association Finance Committee; BOS; OREF Clinical Research Awards Committee; Orthopaedic Research and Education Foundation Industry Relations Committee; Performance Measure Committee); Submitted on: 08/30/2016*
Salo, Paul	*(n); Submitted on: 08/22/2016*
Sampathi, Bharat	*(n); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Sancheti, Parag	*5 (FLOW Investigators); Submitted on: 05/30/2016*
Sanchez-Sotelo, Joaquin	*1 (Stryker); 2 (Merck; Stryker); 3B (Tornier); 5 (Stryker); 7 (Elsevier; Journal of Shoulder and Elbow Surgery); 8 (Journal of Shoulder and Elbow Surgery); 9 (American Shoulder and Elbow Surgeons); Submitted on: 04/20/2016*
Sandberg, Benjamin	*6 (Stryker); Submitted on 05/28/16*
Sanders, David W. (Program Committee)	*3B (Smith & Nephew); 5 (Arthrex, Inc; Smith & Nephew; Synthes; SPRINT Investigators); 8 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (Orthopaedic Trauma Association); Submitted on: 04/12/2016*
Sanders, Roy	*1 (CONMED Linvatec; Biomet; Smith & Nephew; Stryker); 2 (Biomet; Smith & Nephew; Zimmer); 3B (Smith & Nephew; Stryker; Zimmer); 5 (Health and Human Services; National Institutes of Health (NIAMS & NICHD); Medtronic; Smith & Nephew; Stryker,METRC (DOD), OTA,); 7 (Journal of Orthopaedic Trauma); 8 (Journal of Orthopaedic Trauma; Orthopedics Today); 9 (Orthopaedic Trauma Association); Submitted on: 04/27/2016*
Sassoon, Adam	*(n); Submitted on: 04/20/2016*
Savakus, Jonathan	*(n); Submitted on: 06/01/2016*
Sawyer, Jeffrey	*2 (DePuy, A Johnson & Johnson Company; Nuvasive); 5 (Medicrea Spine); 7 (Mosby; Wolters Kluwer Health - Lippincott Williams & Wilkins); 9 (AAOS; Pediatric Orthopaedic Society of North America; Campbell Foundation); Submitted on: 04/11/2016*
Sayeed, Zain	*(n); Submitted on: 05/21/2016*
Sayeed, Yousuf	*(n); Submitted on: 06/13/2016*
Sayers, Adrian	*9 (National Joint Registry of England and Wales); Submitted on: 09/01/2016*
Scannell, Brian	*(n); Submitted on: 04/04/2016*
Schemitsch, Christine	*1 (Stryker); 3B (Sanofi-Aventis; Smith & Nephew; Styrker; Zimmer); 7 (Sanders/Mosby-Elsevier); 8 (Journal of Orthopaedic Trauma); 9 (Canadian Orthopaedic Association; Hip Society; Orthopaedic Trauma Assocaition); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Schemitsch, Emil H.	*1 (Stryker); 3B (Acumed, LLC; Sanofi-Aventis; Smith & Nephew; Stryker; Zimmer); 5 (Smith & Nephew; FAITH Investigators; FLOW Investigators, Canadian Orthopaedic Trauma Society; SPRINT Investigators); 6 (Canadian Institutes of Health Research (CIHR); OMEGA; Smith & Nephew; Zimmer; Stryker; Synthes); 7 (Saunders/Mosby-Elsevier); 8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association; Canadian Orthopaedic Association; Osteosynthesis and Trauma Care Foundation); Submitted on: 05/18/2016*
Schenker, Mara	*3B (Carmell Therapeutics); Submitted on 04/07/2016*
Schep, N.W.L.	*(n); Submitted on: 06/30/2016*
Schiffman, Brett	*(n); Submitted on: 05/31/2016*
Schildhauer, Thomas	*2 (Aesculap/B. Braun; BayerHealthCare; Stryker); 8 (Journal of Orthopaedic Trauma); Submitted on: 05/31/2016*
Schipper, I.B.	*8 (British Journal of Surgery; Current Trauma Reports); 9 (ACS/Committee On Trauma; Netherlands Society of Trauma Surgery; Netherlands Surgical Society); Submitted on: 08/17/2016*
Schmidmaier, Gerhard	*(n); Submitted on: 01/11/2016*
Schmidt, Andrew H.	*3B (Acumed, LLC; Bone Support AB; Conventus Orthopedics; St. Jude Medical); 4 (Conventus Orthopaedics; Epien; Epix VAN; International Spine and Orthopaedic Instititute; Twin Star Medical); 5 (METRC); 7 (Thieme, Inc.); 8 (Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of Knee Surgery); Submitted on: 04/04/2016*
Schmitt, Daniel	*(n); Submitted on: 05/22/2016*
Schneider, Prism	*(n); Submitted on: 05/29/2016*
Schobel, Seth A.	*(n); Submitted on: 09/01/2016*
Schoonover, Carrie	*(n); Submitted on: 04/27/2016*
Schottel, Patrick	*3B (CD Diagnostic); Submitted on: 04/04/2016*
Schreiber, Christine (Staff)	*(n); Submitted on: 08/23/2016*
Schreiber, Joseph	*(n); Submitted on: 05/24/2016*
Schroder, Lisa	*(n); Submitted on: 05/31/2016*
Schroeder, Amanda	*(n); Submitted on: 05/04/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Schulte, Leah	*(n); Submitted on: 04/04/2016*
Sciadini, Marcus F.	*3B (Stryker); 4 (Stryker); Submitted on: 04/30/2016*
Scolaro, John A.	*1 (Globus Medical); 3B (Globus Medical; Smith & Nephew; Stryker); 6 (Synthes); Submitted on: 04/12/2016*
Seah, Matthew	*(n); Submitted on: 08/16/2016*
Sellers, Thomas	*(n); Submitted on: 05/30/2016*
Sems, S. Andrew	*1 (Biomet); 3B (Biomet); Submitted on: 04/18/2016*
Sen, Milan	*2 (Smith & Nephew; Stryker); 3B (Stryker); Submitted on: 05/04/2016*
Serrano-Riera, Rafael	*(n); Submitted on: 05/23/2016*
Sethi, Manish K.	*(n); Submitted on: 05/05/2016*
Seymour, Rachel	*(n); Submitted on: 04/29/2016*
Shabtai, Lior	*(n); Submitted on: 08/23/2016*
Shafiq, Babar	*3B (Synthes); Submitted on: 04/12/2016*
Shah, Amit	*(n); Submitted on: 01/11/2016*
Shah, Anjan	*2 (Smith & Nephew); 3B (Stabilize); Submitted on: 06/03/2016*
Shahien, Amir	*(n); Submitted on: 05/27/2016*
Shannon, Steven	*(n); Submitted on: 04/18/2016*
Shaw, Jeremy	*(n); Submitted on: 05/21/2016*
Shearer, David	*6 (SIGN Fracture Care International); Submitted on: 04/05/2016*
Shields, Edward	*(n); Submitted on: 04/05/2016*
Shirtliff, Mark E.	*4 (difusion); 5 (MedImmune); 7 (UpToDate); Submitted on: 08/29/2016*
Shoji, Kristin	*(n); Submitted on: 06/01/2016*
Shorten, Peter	*(n); Submitted on: 04/21/2016*
Shozda, Barbara (Staff)	*(n); Submitted on: 07/28/2016*
Shrestha, Bikram Prasad	*(n); Submitted on: 05/31/2016*
Siegel, Judith (Jodi)	*7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); Submitted on: 04/07/2016*
Sietsema, Debra	*2 (Eli Lilly); 3B (Eli Lilly); 9 (American Orthopaedic Association; National Association of Orthopaedic Nurses); Submitted on: 05/16/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Silverton, Craig	*1 (Biomet); 9 (MOAOS); Submitted on: 05/28/2016*
Sim, Jae-Ang	*(n); Submitted on: 06/01/2016*
Simunovic, Nicole	*(n); Submitted on: 05/31/2016*
Sing, David	*(n); Submitted on: 05/17/2016*
Sirkin, Michael	*2 (Biomet); 7 (Saunders/Mosby-Elsevier); 8 (Journal of the American Academy of Orthopaedic Surgeons,journal of trauma; Journal of Orthopaedics and Traumatology); 9 (AO Board of trustees; AONA Education Committee; Orthopaedic Trauma Association); Submitted on: 04/29/2016*
Sivasundaram, Lakshmanan	*(n); Submitted on: 05/26/2016*
Skaggs, David	*1 (Biomet; Wolters Kluwer Health - Lippincott Williams & Wilkins); 2 (Biomet; Johnson & Johnson; Medtronic); 3B (Grand Rounds; Medtronic; Biomet; Orthobullets; Zipline Medical, Inc.); 4 (Zipline Medical, Inc.); 6 (Biomet; Medtronic); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Childrens Orthopaedics; Spine Deformity); 9 (Growing Spine Foundation; Growing Spine Study Group; Scoliosis Research Society); Submitted on: 04/29/2016*
Slobogean, Gerard P. (Program Committee)	*5 (CORAL Collaborators); 8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association); Submitted on: 04/12/2016*
Smith, Carla S.	*6 (SIGN Fracture Care International); 9 (Fracture Care International; Orthopedics Overseas; Spokane County Medical Society); Submitted on: 08/16/2016*
Smith, Christopher S.	*9 (Orthopaedic Trauma Association); Submitted on: 04/04/2016*
Smith, Jeffrey M.	*2 (Stryker); 9 (Orthopaedic Trauma Association (Public Relations Committee Chairman)); Submitted on: 05/02/2016*
Smith, Thomas	*4 (Orthovative, LLC); 5 (KeraNetics; NuTech Medical; Synthes); 8 (Journal of Surgical Orthopaedic Advances); Submitted on: 06/01/2016*
Smith, Wade R.	*3B (Acumed LLC); 8 (Journal of Patient Safety in Surgery); 9 (American College of Surgeons); Submitted on: 08/28/2016*
Snir, Nimrod	*(n); Submitted on: 06/01/2016*
Snoap, Tyler	*(n); Submitted on: 05/31/2016*
Soles, Gillian	*(n); Submitted on: 05/22/2016*
Solis, Jaicus	*(n); Submitted on: 08/16/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Song, Wei	*(n); Submitted on: 09/01/2016*
Song, Xuyang	*(n); Submitted on: 04/13/2016*
Sontich, John	*1 (Stryker); 2 (Smith & Nephew,); 3B (Stryker; Smith & Nephew,); 9 (Limb Lengthening Research Society); Submitted on: 10/26/2015*
SooHoo, Nelson	*8 (Orthopedics Today); 9 (AAOS; American Orthopaedic Foot and Ankle Society); Submitted on: 05/31/2016*
Sorkin, Anthony	*2 (Stryker); 3B (Stryker); 4 (Johnson & Johnson; Stryker); Submitted on: 05/31/2016*
Sparks, Charisse Y.	*2 (DePuy, A Johnson & Johnson Company; Synthes); 3A (DePuy, A Johnson & Johnson Company); 4 (Johnson & Johnson; Synthes); Submitted on: 06/10/2016*
Speers, David	*3A (Scheck and Siress Prosthetics); 4 (Scheck and Siress Prosthetics); 6 (Scheck and Siress Prosthetics); Submitted on: 09/01/2016*
Spellman, Aimee (Staff)	*(n); Submitted on: 01/25/2016*
Sperling, Michael	*(n); Submitted on: 04/06/2016*
Spitler, Clay	*2 (AO Trauma); 5 (Synthes); 8 (Journal of Bone and Joint Surgery - American); 9 (AAOS); Submitted on: 06/04/2016*
Spraggs-Hughes, Amanda	*(n); Submitted on: 05/06/2016*
Sprague, Sheila	*3A (Global Research Solutions Inc.; McMaster University); 5 (SPRINT Investigators); Submitted on: 05/25/2016*
Springer, Bryan	*1 (Stryker); 3B (Convatec; Stryker); 6 (Joint Purifications Systems); 8 (Arthroplasty Today; Journal of Arthroplasty); 9 (AJRR; Knee Society); Submitted on: 04/29/2016*
Srivastava, Rajeshwar	*(n); Submitted on: 06/11/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Stahel, Philip F.	*5 (COPIC - extramural research grant funding; Kypha - extramural research grant funding; Stryker - extramural research grant funding); 6 (Synthes); 8 (European Journal of Orthopaedic Surgery and Traumatology; European Journal of Trauma and Emergency Surgery - Section Editor; International Journal of Neuropathology - Associate Editor; Journal of Trauma and Acute Care Surgery; Orthopaedics - Section Editor; Patient Safety in Surgery - Editor-in-Chief; Safety in Health; Scandinavian Journal of Trauma, Resuscitation, and Emergency Medicine - Section Editor; Southern Medical Journal - Associate Editor; World Journal of Emergency Surgery); Submitted on: 08/30/2016*
Stahl, Daniel	*3B (Arthrex, Inc); Submitted on: 06/21/2016*
Stannard, James P.	*3B (Arthrex, Inc; DePuy, A Johnson & Johnson Company; Nuvasive; Regeneration Technologies, Inc.; Smith & Nephew); 5 (Arthrex, Inc; Coulter Foundation; U.S. Department of Defense); 7 (Thieme); 8 (Journal of Knee Surgery); 9 (AO Board of Trustees; AO Research Review Commission; Orthopaedic Trauma Association); Submitted on: 04/29/2016*
Starecki, Mikael	*(n); Submitted on: 04/12/2016*
Starr, Adam J.	*1 (Starrframe, LLC); 8 (Journal of Orthopaedic Trauma); Submitted on: 06/15/2016*
Steen, R. Grant	*3A (Smith & Nephew); Submitted on 06/02/2016*
Steenburg, Scott	*(n); Submitted on: 08/16/2016*
Steffner, Robert	*(n); Submitted on: 04/04/2016*
Stegeman, Sylvia	*(n); Submitted on: 08/25/2016*
Stein, Deborah	*(n); Submitted on 06/03/2016*
Steinberg, Ely	*8 (Injury); Submitted on: 06/15/2016*
Steinberg, Yohai	*(n); Submitted on: 01/11/2016*
Stern, Lorraine	*(n); Submitted on: 05/27/2016*
Steverson, Barbara	*(n); Submitted on: 04/19/2016*
Stinner, Daniel	*9 (AAOS; Orthopaedic Trauma Association; Society of Military Orthopaedic Surgeons); Submitted on: 06/06/2016*
Stitzel, Joel	*(n); Submitted on: 07/11/2016*
Stockton, David	*(n); Submitted on: 06/01/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Stollenwerck, Guido	*(n); Submitted on: 06/06/2016*
Stoops, Kyle	*(n); Submitted on: 06/13/2016*
Stronach, Benjamin	*9 (Mississippi Orthopaedic Society); Submitted on 06/13/2016*
Strotman, Patrick	*(n); Submitted on: 04/26/2016*
Stuart, Ami	*3A (CoNextions Medical Inc.); Submitted on: 06/02/2016*
Studnek, Jonathan	*(n); Submitted on: 08/16/2016*
Suk, Michael J.	*3B (Acumed, LLC; DJ Orthopaedics; Stryker; Synthes); 8 (American Journal of Orthopedics; Military Medicine; Journal of Trauma Management and Outcomes); 9 (AAOS; Orthopaedic Trauma Association; AO International); Submitted on: 04/12/2016*
Sullivan, Matthew	*(n); Submitted on: 05/26/2016*
Sultana, Nigar	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 06/03/2016*
Summers, Hobie	*(n); Submitted on: 05/01/2016*
Swart, Eric	*(n); Submitted on: 05/06/2016*
Swenning, Todd A.	*2 (Mallinckrodt Pharmaceuticals); 3B (Stryker); 9 (Orthopaedic Trauma Association); Submitted on: 04/07/2016*
Swiontkowski, Marc	*5 (FAITH Investigators); 6 (US Department of Defense- Chair METRC DSMB; USDOD; SPRINT Investigators); 7 (Journal of Bone and Joint Surgery - American; Saunders/Mosby-Elsevier; Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Bone and Joint Surgery - American); 9 (American Orthopaedic Association; Mid America Orthopaedic Assoc); Submitted on: 04/06/2016*
Talbot, Max	*5 (CORAL Collaborators); Submitted on: 08/30/2016*
Tanner, Stephanie	*(n); Submitted on: 05/25/2016*
Tarkin, Ivan	*2 (Synthes; Zimmer;); 5 (Synthes; Zimmer; Pittsburgh Foundation); Submitted on: 05/31/2016*
Tashjian, Robert	*1 (Cayenne Medical; IMASCAP; Shoulder Innovations); 3B (Cayenne Medical; Mitek); 4 (Conextions; INTRAFUSE; KATOR); 7 (Journal of Bone and Joint Surgery – American); 8 (Journal of Orthopaedic Trauma); Submitted on: 04/13/2016*
Tatro, Joscelyn	*(n); Submitted on: 05/23/2016*
Tawari, Akhil	*5 (Synthes); Submitted on: 06/03/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Tay, Bobby	*2 (Biomet; Synthes; Stryker); 5 (AOSpine North American; Globus Medical; Nuvasive); Submitted on: 04/13/2016*
Teague, David	*8 (Journal of Orthopaedic Trauma); 9 (Orthopaedic Trauma Association); Submitted on: 05/29/2016*
Tei, Randi	*(n); Submitted on: 05/28/2016*
Tejwani, Nirmal C.	*2 (Zimmer; Stryker); 3B (Zimmer; Stryker); 9 (AAOS; Orthopaedic Trauma Association; Federation of Orthopaedic Trauma.); Submitted on: 04/12/2016*
Templeman, David C.	*1 (Zimmer); 2 (Stryker; Zimmer); 3B (Orthofix, Inc.; Stryker; Zimmer); 4 (Naroflex); 9 (AAOS); Submitted on: 05/19/2016*
Terres, George	*(n); Submitted on: 01/11/2016*
Tessema, Geletaw	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Tetsworth, Kevin	*2 (Smith & Nephew; Stryker); 3B (Smith & Nephew; Stryker); 9 (AAOS; ASAMI-BR (Association for the Study and Advancement of the Methods of Ilizarov - Bone Reconstruction (President); Australasian Limb Lengthening and Reconstruction Society (President): Submitted on: 05/02/2016*
Teuben, Michel	*(n); Submitted on: 01/11/2016*
Thabane, Lehana	*5 (FAITH Investigators); Submitted on: 08/22/2016*
Theologis, Alexander	*5 (Synthes); Submitted on 04/27/2016*
Theriault, Raminta	*(n); Submitted on: 05/13/2016*
Thompson, John	*(n); Submitted on: 06/01/2016*
Tien, Homer	*3B (Monroe Solutions Group); 5 (CORAL Collaborators); 7 (Canadian Journal of Surgery); Submitted on: 07/05/2016*
Tileston, Kali	*(n); Submitted on: 05/26/2016*
Timmel, Mark	*(n); Submitted on: 05/28/2016*
Tissingh, Elizabeth	*(n); Submitted on: 05/28/2016*
Tong, Shi	*(n); Submitted on: 08/30/2016*
Tonnos, Frederick	*(n); Submitted on: 04/07/2016*
Tornetta III, Paul	*1 (Smith & Nephew); 5 (FLOW Investigators); 5 (SPRINT Investigators); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); 8 (Journal of Orthopaedic Trauma); Submitted on: 04/04/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Torres, Andrea	*(n); Submitted on: 05/26/2016*
Tosounidis, Theodoros H.	*(n); Submitted on: 06/01/2016*
Tougas, Caroline	*(n); Submitted on: 06/01/2016*
Trask, Kelly	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 04/25/2016*
Trenholm, J. Andrew I.	*3C (Cartiva); 5 (Canadian Orthopaedic Trauma Society); 6 (DePuy, A Johnson & Johnson Company); 9 (Orthopaedic Trauma Association); Submitted on: 06/16/2016*
Triantafillou, Kostantinos	*(n); Submitted on 08/29/2016*
Tripp, Michael	*(n); Submitted on: 06/07/2016*
Trivedi, Nikunj	*(n); Submitted on: 06/13/2016*
Tsai, Stanley	*(n); Submitted on: 05/24/2016*
Tsismenakis, Antonios	*(n); Submitted on: 05/24/2016*
Tufescu, Ted	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 06/02/2016*
Tynan, Martin	*(n); Submitted on: 06/17/2016*
Uffmann, William	*(n); Submitted on: 08/20/2016*
Unno, Florence	*(n); Submitted on: 06/23/2016*
Usoro, Andrew	*(n); Submitted on: 05/14/2016*
Vaidya, Rahul	*1 (Smith & Nephew; Synthes); 2 (Synthes; Stryker); 3B (Stryker; Stryker); 3C (Stryker); 5 (Synthes); 6 (Synthes); 8 (European Spine Journal); Submitted on: 06/01/2016*
Valera, Carlito Chee Kee (Jun) Jr.	*6 (SIGN Fracture Care International); Submitted on: 08/30/2016*
Valerio, Ian L.	*Current disclosure not available at time of print.*
Vallier, Heather A.	*5 (METRC); 8 (Journal of Orthopaedics and Traumatology); 9 (AAOS; Center for Orthopaedic Trauma Advancement; Orthopaedic Trauma Association); Submitted on: 04/12/2016*
van den Bergh, Joop	*Current disclosure not available at time of print.*
van der Linde, Rens	*(n); Submitted on: 08/23/2016*
van der List, Jelle	*(n); Submitted on: 05/25/2016*
van Dijkman, Bart	*(n); Submitted on: 01/11/2016*
Van Eck, Carola	*(n); Submitted on: 04/20/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

van Helden, Sven	*(n); Submitted on: 01/11/2016*
van Rietbergen, Bert	*3B (Scanco Medical AG); Submitted on 08/29/2016*
van Thiel, T.P.H. (Tom)	*(n); Submitted on: 09/05/2016*
Vanderhave, Kelly	*(n); Submitted on: 04/05/2016*
Vangala, Sitaram	*(n); Submitted on: 06/03/2016*
Varecka, Thomas F	*(n); Submitted on 04/12/2016*
Vegt, Paul	*(n); Submitted on: 01/11/2016*
Veltre, David	*(n); Submitted on: 05/23/2016*
Verbeek, Diederik	*(n); Submitted on: 08/24/2016*
Verhofstad, M.H.J	*2 (Synthes); 3C (DePuy, A Johnson & Johnson Company); 9 (Dutch Surgical Society, Dutch Trauma Society, AO); Submitted on: 06/06/2016*
Verhotz, Daniel	*(n); Submitted on: 05/31/2016*
Vezeridis, Peter	*(n); Submitted on: 06/01/2016*
Vicente, Milena	*5 (Canadian Orthopaedic Trauma Society); Submitted on: 08/23/2016*
Vickaryous, Brian	*5 (GameReady); Submitted on: 05/30/2016*
Villa, Jordan	*(n); Submitted on: 05/31/2016*
Virkus, Walter	*2 (Smith & Nephew; Stryker); 3A (Novartis); 3B (Stryker); 4 (Stryker; Johnson & Johnson); 7 (SLACK Incorporated); 8 (American Journal of Orthopedics; Journal of Bone and Joint Surgery - American; Clinical Orthopaedics and Related Research; Journal of Orthopaedics and Traumatology); Submitted on: 05/02/2016*
Volgas, David	*(n); Submitted on: 06/07/2016*
von Rechenberg, Brigitte	*(n); Submitted on: 05/24/2016*
Vorhies, John	*(n); Submitted on: 05/29/2016*
Vrahas, Mark S.	*3B (AOPOC inc); Submitted on: 04/04/2016*
Vu, Cathy (CatPhuong)	*(n); Submitted on: 06/13/2016*
Wagner, Benjamin	*(n); Submitted on: 06/03/2016*
Wagner, Eric	*(n); Submitted on: 05/23/2016*
Wahba Morcos, Mina Waheed	*(n); Submitted on: 05/31/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Walker, Justin A.	*4 (Orthopaedic Implant Company); Submitted on: 08/27/2016*
Walley, Kempland	*(n); Submitted on: 04/25/2016*
Walter, Stephen D.	*5 (FAITH Investigators; FLOW Investigators; SPRINT Investigators); Submitted on: 05/27/2016*
Walters, Samuel	*(n); Submitted on: 01/11/2016*
Wang, Dean	*(n); Submitted on: 05/03/2016*
Wang, Jeffrey	*1 (Aesculap/B.Braun; Amedica; Biomet; Seaspine; Synthes); 4 (Alphatec Spine; Amedica; Benevenue; Bone Biologics; Corespine; Electrocore; Expanding Ortho; Fziomed; Nexgen; Paradigm Spine; Pearldiver; Promethean Spine; Surgitech; Vertiflex); 8 (Evidence Based Spine Journal, The Global Spine Journal, Spine, The Spine Journal, The Journal of Spinal Disorders and Techniques; The Journal of the American Academy of Orthopaedic Surgeons); 9 (AOSpine International; Cervical Spine Research Society; North American Spine Foundation; North American Spine Society); Submitted on: 04/04/2016*
Wang, Mark	*3B (Synthes); Submitted on: 05/14/2016*
Wang, Pengfei	*(n); Submitted on: 01/11/2016*
Wang, Zhe	*(n); Submitted on: 01/11/2016*
Ward, Robert J.	*(n); Submitted on: 09/01/2016*
Warner, Stephen	*(n); Submitted on: 04/07/2016*
Warren, Ann Marie	*8 (Journal Sexuality and Disability); Submitted on: 08/25/2016*
Warschawski, Yaniv	*(n); Submitted on: 06/25/2016*
Wasilko, Scott	*(n); Submitted on: 05/28/2016*
Waterman, Brian	*7 (Elsevier); 8 (American Journal of Orthopedics; Arthroscopy); 9 (Arthroscopy Association of North America; Society of Military Orthopaedic Surgeons); Submitted on: 04/17/2016*
Watson, David	*2 (Corin U.S.A.; Smith & Nephew); 3B (Corin U.S.A.; Smith & Nephew); Submitted on: 05/01/2016*
Watson, J. Tracy	*1 (Biomet; Smith & Nephew); 2 (Smith & Nephew); 3B (Acumed, LLC; bioventus; Nuvasive); 8 (ortho knowlege online); 9 (AAOS; Orthopaedic Trauma Association; Orthopaedic Trauma Association); Submitted on: 05/10/2016*
Watts, Chad	*(n); Submitted on: 04/12/2016*
Weaver, Ashley	*(n); Submitted on: 05/17/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Weaver, Holly	*(n); Submitted on: 08/31/2016*
Weaver, Michael	*(n); Submitted on: 05/17/2016*
Wegener, Stephen	*7 (Rehabilitation Psychology - American Psychological Association); Submitted on: 01/08/2016*
Weiland, Andrew	*3B (Acumed, LLC; Arthrex, Inc.); 8 (Journal of Bone and Joint Surgery – American); Submitted on: 04/04/2016*
Weinberg, Douglas	*(n); Submitted on: 04/30/2016*
Weiss, David B.	*2 (Synthes); 7 (Saunders/Mosby-Elsevier); 9 (Orthopaedic Trauma Association); Submitted on: 04/04/2016*
Welch, Tyler	*5 (Ossur); Submitted on: 08/23/2016*
Wellman, David	*2 (Synthes); 8 (HSS Journal); Submitted on: 05/08/2016*
Wenke, Joseph C. (Josh)	*6 (Next Science, LLC); 8 (Tissue Engineering, Journal of Surgical Orthopaedic Advances); Submitted on: 06/13/2016*
Wenzlick, Thomas	*(n); Submitted on: 05/22/2016*
Wessel, Alexander	*(n); Submitted on: 05/29/2016*
West, Robert	*(n); Submitted on: 01/11/2016*
Westberg, Jerald	*(n); Submitted on: 05/26/2016*
Westermann, Robert	*(n); Submitted on: 05/17/2016*
Wetzel, Robert	*1 (Innomed); Submitted on: 06/02/2016*
White, Eric	*(n); Submitted on: 06/01/2016*
White, Timothy	*(n); Submitted on: 08/23/2016*
WhiteHouse, Michael	*5 (DePuy, A Johnson & Johnson Company; Heraeus; Stryker); 6 (Zimmer); 8 (Hip International); Submitted on: 08/23/2016*
Whiting, Paul	*(n); Submitted on: 04/05/2016*
Whitlock, Patrick	*(n); Submitted on: 05/18/2016*
Wiechert, Gabriele	*(n); Submitted on: 06/28/2016*
Wiley, Marcel	*(n); Submitted on: 04/04/2016*
Willems, Paul	*(n); Submitted on: 01/11/2016*
Willey, Michael	*5 (Biomet); Submitted on 05/26/2016*
Williams, Anthony C.	*(n); Submitted on: 09/01/2016*
Williams, John	*(n); Submitted on: 04/04/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Wilson, Alison	*3B (Arsenal Medical); 9 (American Association for the Surgery of Trauma; American College of Surgeons; Eastern Association for the Surgery of Trauma; Michael E DeBakey International Surgical Society); Submitted on: 04/11/2016*
Wimberly, R. Lane	*5 (Orthopaediatrics; Smith & Nephew); 6 (Ellipse Technologies); 7 (Elsevier); Submitted on: 04/18/2016*
Wiznia, Daniel	*(n); Submitted on: 08/23/2016*
Wojahn, Robert	*(n); Submitted on: 05/31/2016*
Wolinsky, Philip	*2 (Biomet); 3B (Zimmer); 5 (Synthes); 8 (Journal of Orthopedic Trauma); 9 (OTA, AAOS, AOA, ACS); Submitted on: 04/04/2016*
Woltz, Sarah	*(n); Submitted on: 06/05/2016*
Woods, Justin	*(n); Submitted on: 04/10/2016*
Woon, Yi-Loong (Colin)	*(n); Submitted on: 05/25/2016*
Working, Zachary	*(n); Submitted on: 04/05/2016*
Wozasek, Gerald E.	*(n); Submitted on: 08/24/2016*
Wright, Erik	*(n); Submitted on: 05/19/2016*
Wu, Albert	*3B (Bristol-Myers Squibb; Johnson & Johnson; Pfizer); Submitted on: 08/16/2016*
Wu, Hao-Hua	*(n); Submitted on: 06/13/2016*
Wuertzer, Scott	*(n); Submitted on: 05/29/2016*
Wysocki, Elizabeth	*(n); Submitted on: 08/29/2016*
Xiong, Ze	*6 (Bioventus); Submitted on: 08/31/2016*
Yakavonis, Mark	*(n); Submitted on: 05/27/2016*
Yamaguchi, Kent	*(n); Submitted on: 06/12/2016*
Yang, Frank	*(n); Submitted on: 06/13/2016*
Yarboro, Seth R.	*(n); Submitted on: 05/20/2016*
Yazdi, Hamidreza	*(n); Submitted on: 01/11/2016*
Yellin, Joseph	*4 (Eli Lilly; Merck); Submitted on 05/19/2016*
Yin, Jonathan	*(n); Submitted on: 06/14/2016*
Yoon, Richard	*(n); Submitted on: 05/11/2016*
Yoon, Yong-Cheol	*(n); Submitted on: 06/20/2016*
Yuan, Brandon	*(n); Submitted on: 05/10/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

DISCLOSURE LISTING – ALPHABETICAL

Yukelis, Sarah Nicole	*(n); Submitted on: 08/29/2016*
Yusi, Kurt	*(n); Submitted on: 06/16/2016*
Zaman, Saif	*(n); Submitted on: 08/29/2016*
Zamorano, David	*3B (Smith & Nephew); Submitted on: 06/05/2016*
Zaruta, Douglas	*(n); Submitted on: 05/22/2016*
Zelenty, William	*(n); Submitted on: 05/17/2016*
Zerhusen, Timothy	*(n); Submitted on: 05/04/2016*
Zhang, Alan	*(n); Submitted on: 04/26/2016*
Zhang, Kun	*(n); Submitted on: 01/11/2016*
Zhang, Mei	*(n); Submitted on: 05/26/2016*
Zhuang, Yan	*(n); Submitted on: 01/11/2016*
Zirkle Jr., Lewis G.	*3C (SIGN); Submitted on: 04/05/2016*
Zomar, Mauri L.	*(n); Submitted on: 05/31/2016*
Zonno, Alan	*(n); Submitted on: 07/14/2016*
Zura, Robert D.	*2 (Bioventus; Cardinal Health); 3B (Cardinal Health; Smith & Nephew; Bioventus); 5 (Synthes); 6 (Synthes fellowship); Submitted on: 05/16/2016*
Zurakowski, David	*(n); Submitted on: 08/25/2016*

Disclosure:
(n) = Respondent answered 'No' to all items indicating no conflicts; 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society. *= Not available at time of printing. Refer to pages 657 - 659.

Dynamization of Simple Fractures with Active Locking Plates Delivers Faster and Stronger Healing Relative to Conventional Compression Plating

Michael Bottlang, PhD*[1]*; *Stanley Tsai, MS*[1]*; Emily Bliven, MS*[1]*; Brigitte von Rechenberg, MD*[2]*; Julia Henschel, BS*[3]*; Peter Augat, PhD*[3]*; Daniel Fitzpatrick, MS, MD*[4]*; Steven Madey, MD*[1]
[1]*Legacy Research Institute Portland, Oregon, USA;*
[2]*Equine Hospital, Vetsuisse Faculty, University of Zurich, Zürich, SWITZERLAND;*
[3]*Institute of Biomechanics, Murnau, GERMANY;*
[4]*Slocum Center for Orthopaedics, Eugene, Oregon, USA*

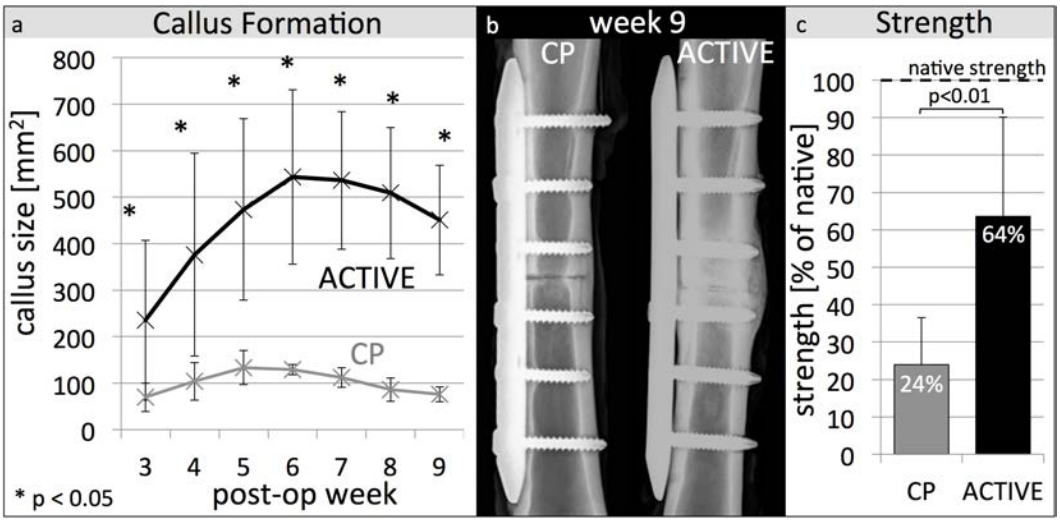
Background/Purpose: Controlled axial dynamization of fractures promotes healing by callus formation, while overly stiff fixation constructs can suppress healing. Novel active locking plates provide axial dynamization of a fracture by elastic suspension of locking holes within the plate. For bridge plating, active locking plates delivered stronger and faster healing of a 3-mm fracture gap compared to rigid fixation with standard locking plates. This in vivo study evaluated the effect of active plating on healing of a simple, anatomically reduced fracture. We hypothesized that dynamic fixation with an active locking plate delivers faster and stronger healing of an anatomically reduced fracture compared to standard compression plating.

Methods: Fracture healing was quantified using the established ovine tibia osteotomy model. 12 sheep were randomized to receive either a standard compression plate (CP group, n = 6) or an active locking plate (ACTIVE group, n = 6) for stabilization of an anatomically reduced tibial osteotomy. Both groups used titanium large fragment plates. In the CP group, absolute stability was achieved with six 4.5-mm cortical screws, applied in accordance with dynamic compression principles, including eccentric screw placement and mild overbending of the plate to ensure interfragmentary compression at the far cortex. In contrast, in the ACTIVE group, relative stability was achieved with six 5.0-mm locking screws, inserted in the active locking plate after anatomic fracture reduction. Locking holes were elastically suspended within the active locking plates by means of elastomer envelopes, permitting up to 0.5 mm of axial motion to retain controlled axial flexibility. Beginning at postoperative week 3, fracture healing was assessed on AP and lateral radiographs to measure callus size each week. Tibiae were harvested at week 9 postsurgery. CT scans were obtained to extract callus volume and distribution. Soft tissue in contact with active plates was evaluated for potential reaction to the elastomer. After implant removal, tibiae were biomechanically tested in torsion to failure to assess the strength of healing. For normalization to the native strength of tibiae, contralateral intact tibiae were tested to failure.

Results: At each time point from postoperative weeks 3 through 9, the ACTIVE group had significantly more callus ($P < 0.05$) than the CP group (Fig. 1a). At the earliest time point (week 3), the average callus size in the ACTIVE group (235 ± 172 mm2) was already over 3 times greater than in the CP group (70 ± 31 mm2). At week 9, the average callus volume in the ACTIVE group (451 ± 118 cm2) was over 4 times greater than in the CP group (76 ± 16 cm2) (Fig. 1b). After sacrifice at week 9, no soft-tissue reaction to the elastomer envelopes of active plates was detectable. Torsion testing after plate removal demonstrated that ACTIVE specimens required 2.5 times more energy to induce failure than CP specimens ($P < 0.05$).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Normalized to contralateral intact tibiae, ACTIVE specimens had regained 64% of their native strength, while CP specimens had regained 24% of their native strength (P <0.01) (Fig. 1c).



Conclusion: It is known that active plating of gap fractures results in more reliable and robust fracture healing. This study confirms that in the setting of a simple fracture, significantly improved fracture healing can be expected using active locking plates relative to conventional compression plating. This finding furthermore challenges the currently accepted axiom of compression plating for simple fracture patterns.

See pages 49 - 106 for financial disclosure information.

Vascular Anatomy of the Medial Femoral Neck and Implications for Surface Plate Fixation: Preliminary Results

Sara Putnam, MD[1]*; Cory A. Collinge, MD*[2]*; Michael J. Gardner, MD*[3]*; William M. Ricci, MD*[1]*; Christopher McAndrew, MD, MSc*[1]
[1]*Washington University in Saint Louis, Saint Louis, Missouri, USA;*
[2]*Vanderbilt Medical Center, Nashville, Tennessee, USA;*
[3]*Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA*

Purpose: Vertical femoral neck fractures are frequently the result of high-energy trauma and often occur in young adults. Urgent reduction and internal fixation is recommended for these fractures, yet optimal fixation has not been defined and complications are frequent. The vertical orientation of these fractures is ideal for fixation with buttress plating along the medial neck, yet the medial blood supply to the femoral head via the inferior retinacular artery (IRA) must be preserved to minimize morbidity. This study aimed to describe the course of the IRA as encountered from an anterior approach to the hip and define the intra-articular position of the IRA relative to the medial femoral neck.

Methods: Eight hips of four fresh cadavers (three males and one female) were studied. Cadavers ranged in age from 73 to 90 years. The common femoral arteries of fresh cadavers were injected with India ink and blue latex. The hips were dissected via an anterior (Smith-Peterson) approach. The origination of the IRA from the medial femoral circumflex artery (MFCA) was identified, and its extra-articular course was carefully dissected. The intra-articular course of the IRA was followed along the medial femoral neck and was referenced using a clock-face system, where 12:00 is superior/lateral, 3:00 is anterior, 6:00 is inferior/medial (the expected position of the plate), and 9:00 is posterior.

Results: In all hips, the IRA originated from the MFCA. In all but one hip, the IRA was a single intra-articular vessel that traveled within Weitbrecht's ligament, a mobile fold of retinacular tissue along the medial femoral neck. In one hip, the IRA divided intra-articularly into two vessels traveling within Weitbrecht's ligament. The intra-articular position of the IRA was 7:00 in four hips, 7:30 in three hips, and 8:00 in one hip (Fig. 1). In all hips, the IRA was 30 minutes anterior to the lesser trochanter. The average intra-articular length of the IRA was 19 mm (range, 11-23), and the average extra-articular length of the IRA was 21 mm (range, 19-23).

Conclusion: Current methods of fixation for vertical femoral neck fractures have high rates of complications and unsatisfactory outcomes. A buttress plate along the medial femoral neck may enhance the stability of current fixation methods by better resisting the shear forces inherent in vertical fracture patterns. Our results demonstrate the intra-articular course of the IRA along the femoral neck would be posterior to the location of a medial buttress plate at the 6:00 position. As such, a medial buttress plate is not only potentially biomechanically advantageous in vertical femoral neck fractures, but is also a safe method of fixation that does not risk the contribution of the IRA to the blood supply of the femoral head.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

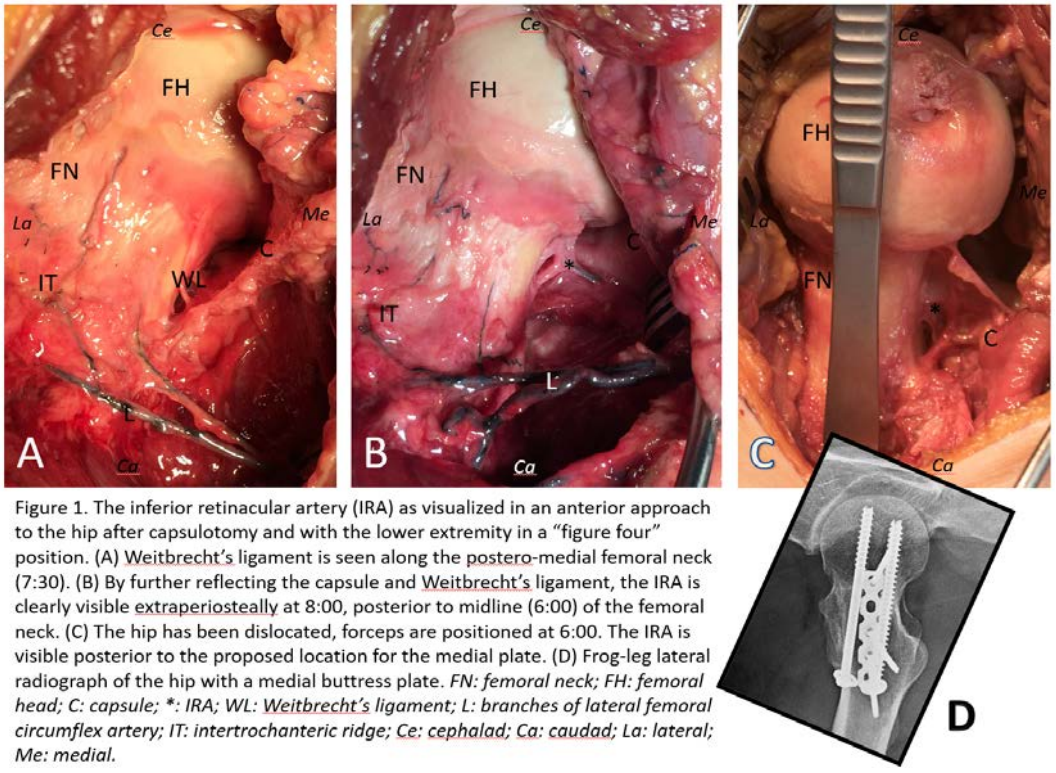


Figure 1. The inferior retinacular artery (IRA) as visualized in an anterior approach to the hip after capsulotomy and with the lower extremity in a "figure four" position. (A) Weitbrecht's ligament is seen along the postero-medial femoral neck (7:30). (B) By further reflecting the capsule and Weitbrecht's ligament, the IRA is clearly visible extraperiosteally at 8:00, posterior to midline (6:00) of the femoral neck. (C) The hip has been dislocated, forceps are positioned at 6:00. The IRA is visible posterior to the proposed location for the medial plate. (D) Frog-leg lateral radiograph of the hip with a medial buttress plate. *FN: femoral neck; FH: femoral head; C: capsule; *: IRA; WL: Weitbrecht's ligament; L: branches of lateral femoral circumflex artery; IT: intertrochanteric ridge; Ce: cephalad; Ca: caudad; La: lateral; Me: medial.*

See pages 49 - 106 for financial disclosure information.

A Biomechanical Comparison of Intrapelvic and Extrapelvic Fixation for Associated Acetabular Fractures of the Quadrilateral Plate

Sharon Babcock, MD[1]*; Gregory Gillispie, BS*[2]*; Philip Brown, PhD*[2]*; Kyle McNamara, BS*[1]*; Arun Aneja, MD*[1]*; Joel Stitzel, PhD*[2]*; Eben Carroll, MD*[3]
[1]*Wake Forest School of Medicine, Winston Salem, North Carolina, USA;*
[2]*Virginia Tech - Wake Forest Center for Injury Biomechanics, Winston Salem, North Carolina, USA;*
[3]*Wake Forest Baptist Medical Center, Winston Salem, North Carolina, USA*

Purpose: Acetabular fractures resulting from low-energy trauma, such as direct fall from standing onto the greater trochanter, are common among elderly patients. This patient cohort represents the fastest-growing group sustaining acetabular fractures. Anterior column fracture patterns are one of the most common types of acetabular fractures seen in the elderly and have been associated with early failure after open reduction and internal fixation, necessitating arthroplasty. This fracture pattern can be treated with either extrapelvic or intrapelvic plating schemes. This study intends to quantify and compare the strength of intrapelvic and extrapelvic fixation through cadaveric biomechanical testing of a variant anterior column fracture pattern involving the quadrilateral plate.

Methods: Ten fresh-frozen cadaveric pelves were used. Quantitative CT scans were completed prior to intervention. Pelves were divided at the pubic symphysis and sacroiliac joints with one hemipelvis assigned to the extrapelvic and the other to the intrapelvic group. A standardized anterior column variant fracture was created using an oscillating saw. Fracture fixation was performed using randomization with one hemipelvis receiving fixation with a standardized extrapelvic construct, and the opposite hemipelvis with additional quadrilateral plate fixation (intrapelvic construct). Each hemipelvis was potted in polyurethane prior to testing. Appropriately sized acetabular trial cups were attached to the servohydraulic uniaxial loading system. Specimens were loaded at 50% of the donor's body weight (BW) for 3 axial loading cycles. The loading direction was chosen to model the most common fracture mechanism (falling on the hip), as well as that of a bedridden patient lying on their side. After the final cycle, destructive testing was conducted at a rate of 1 mm/s until the force dropped below 75% of the maximum or displacement reached 30 mm. Force and displacement were recorded for all tests and used to calculate stiffnesses and energies. For the 50% BW test, stiffness and displacement were calculated. For the destructive test, stiffness, elastic energy, and plastic energy were calculated. Yield point, force at clinical failure (defined at 2 mm of displacement), and maximum force were also identified.

Results: Specimens included 5 males and 5 females with a mean age of 76 years (range, 62-89) and mean body mass index (BMI) of 27 kg/m2 (range, 15-48). A Wilcoxon matched-pairs t test was used to analyze the data, and $t < 0.05$ signified statistical significance. When testing 50% BW, the intrapelvic group had a 28.3% decrease in fracture displacement, which was nearly significant ($t = 0.089$). No difference in stiffness for 50% BW testing was noted ($t = 0.216$). On average for destructive testing, the intrapelvic group performed better in all testing parameters (Table 1), with statistical significance being reached for yield force, maximum force, and plastic energy. All other parameters excluding yield displacement were nearly significant.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Destructive Testing	Stiffness (N/mm)	Clinical Failure Force* (N)	Elastic Energy (J)	Yield Disp. (mm)	Yield Force (N)	Plastic Energy (J)	Max Force (N)
Extrapelvic Avg.	326 (182)	640 (334)	3562 (2616)	4.9 (1.4)	1266 (787)	25894 (14338)	1608 (896)
Intrapelvic Avg.	404 (188)	787 (337)	4562 (2384)	5.1 (1.1)	1594 (688)	38147 (17352)	2128 (832)
% Difference	21.4%	20.6%	24.6%	4.0%	22.9%	38.3%	27.8%
t value	0.063	0.056	0.0749	0.366	0.011	<0.001	<0.001

Table 1. Summary of destructive test data *Clinical failure was defined as 2 mm of displacement

Conclusion: The addition of intrapelvic fixation significantly increases the ability of the fracture to resist catastrophic failure. Lower forces represented by 50% BW did not result in statistically significant differences. Intrapelvic plate contributes significant strength when higher loads are reached. This may have clinical correlation in preventing failure of fracture fixation or displacement in this common elderly fracture pattern.

See pages 49 - 106 for financial disclosure information.

A New and More Sensitive View for the Detection of Syndesmotic Instability
Track Basic Science Focus Forum

Nayla G. Papadopoulos, MD[1]*; Georges-Yves Laflamme, MD, FRCSC*[2]*; Jérémie Ménard, Ing*[3]*; Stéphane Leduc, MD*[1]*; Dominique Rouleau, MD, MSc, FRCSC*[3]*; Jonah Hebert-Davies, MD*[4]*; Marie-Lyne Nault, MD, PhD*[1]
[1]*Université de Montréal, Quebec, CANADA;*
[2]*Université de Montréal, Hôpital du Sacré-Coeur de Montréal, Quebec, CANADA;*
[3]*Hopital du Sacré-Coeur de Montréal, Quebec, CANADA;*
[4]*Programme d'orthopedie Edouard-Samson, Quebec, CANADA*

Purpose: Persistent syndesmotic instability following fibular fixation in ankle fractures is difficult to assess. Intraoperatively, orthopaedic surgeons evaluate the ankle syndesmosis with anteroposterior, mortise, and lateral fluoroscopic views. In order to facilitate imaging, we hypothesize that a single syndesmotic view (SV) capturing both sagittal and coronal tibiofibular displacement is more sensitive than a single mortise view (MV) to diagnose syndesmosis instability.

Methods: Ten fresh-frozen human lower limbs secured to a custom-built stabilizing frame were progressively dissected at the syndesmotic level to simulate three stages of ligamentous injury. In stage one, the anterior inferior tibiofibular ligament (AiTFL) was sectioned. Stage two was obtained by sectioning both the AiTFL and the interosseous membrane (IOM). Stage three corresponded to the addition of the posterior inferior tibiofibular ligament (PiTFL) sectioning. At each stage, syndesmotic instability was tested with two classic stress tests: the external rotation stress test (ERST) and the lateral hook stress test (LHST). Using tibiofibular clear space (TFCS), tibiofibular displacement was measured on a true MV and on a new SV. Student paired t tests were used to compare TFCS difference between

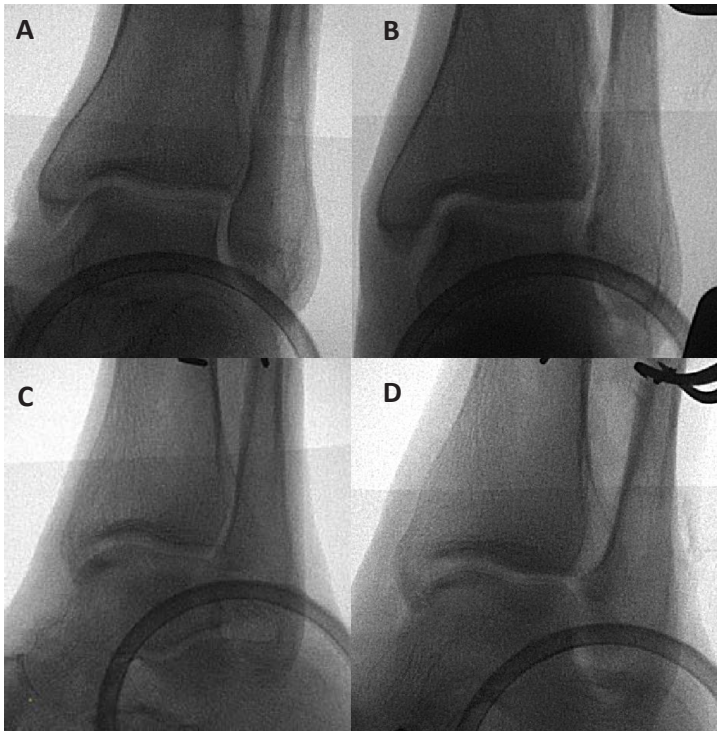


Figure 1. Complete syndesmosis disruption A) Mortise view without stress B) Mortise view with stress C) Syndesmotic view without stress D) Syndesmotic view with stress

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

the intact ligamentous condition and all three different stages of dissection in both views.

Results: For stage one injury, results show no significant TFCS difference between SV and MV with both stress tests. In stage two injury, the mean TFCS difference was 1.2 mm for MV (not significant) and 2 mm for SV (P = 0.01) with the ERST. With the LHST, the mean TFCS was 1.5 mm (P = 0.01) on the MV and 1.1 mm (P = 0.05) with the SV. In stage three injury, all measurements were significantly different. The largest mean TFCS was recorded on the SV with a diastasis of 3.2 mm (P = 0.002).

Conclusion: The new syndesmotic view is more sensitive than the classic true mortise view to detect syndesmotic instability intraoperatively. This view is particularly helpful to uncover instability secondary to an incomplete syndesmosis ligament injury.

See pages 49 - 106 for financial disclosure information.

Reducing the Syndesmosis Under Direct Vision: Where Should I Look?

*Paul Tornetta III, MD[1]; **Mark Yakavonis, MD[1]**; David Veltre, MD[1]; Anjan Shah, MD[2]*
[1]Boston University Medical Center, Boston, Massachusetts, USA;
[2] Florida Orthopaedic Institute, Temple Terrace, Florida, USA

Background/Purpose: Accurate reduction of the syndesmosis is considered critical in obtaining the best functional outcomes for patients with unstable ankle injuries. Many radiographic methods of reduction have been described in recent years; however, little attention has been paid to open techniques. Because the incisural anatomy varies and may be shallow and relatively unconstrained, the evaluation of the reduction at this level may be challenging and lead to anterior or posterior malalignment. We hypothesized that the relationship of the syndesmosis at the articular surfaces of the anterolateral plafond and the anteromedial fibula at the level of the joint may provide a better visual reference than the relationship of the fibula to the incisura above the joint. There were two aims of this anatomic study: (1) to compare the quality of the reduction of the syndesmosis using the relationship of the fibula to the tibia at the articular surface of the joint to that using the relationship at the incisura, and (2) to evaluate the width of the fibula to the corresponding tibial surface at the level of the articular surface to that at the level of the incisura.

Methods: Ten cadaveric ankles were used for this study. The soft tissues were removed to access the ankle and syndesmosis. Prior to sectioning, two 1.6-mm K-wires to be used later as reference points were driven from lateral to medial immediately adjacent to the anterior and posterior edges of the fibula approximately 1 cm above the joint line. These wires were pulled out medially and were not visible from the lateral side, nor were the holes they went through. The syndesmosis was then sectioned to a point 1 cm from the proximal tibiofibular joint as were the lateral ankle ligaments rendering the distal fibula mobile. Seven surgeons were asked to reduce the syndesmosis to the best of their ability and stabilize it in its anatomic position with a Kirschner wire (K-wire) (all K-wires had separate starting points between 1 and 2 cm above the joint). These reductions were done using either the articular surface at the anterolateral joint line or the entire incisura as a visual reference. For each method, green towels were used to mimic the available surgical exposure by covering areas that would not be visible during surgery. Three surgeons used the incisura technique first and four used the articular surface technique first. All surgeons used both methods for each specimen. Measurements were made using digital calipers to the tenth of a mm from either the anterior or posterior reference K-wire after pushing the wire back through the reference hole. The absolute values of the displacements were recorded. Comparisons of the reduction quality were performed using a paired t test with significance set at <0.05. As the final stage of the study, a single investigator measured the anterior to posterior depth of the fibular and tibial articular surfaces at the level of the joint and the AP depth of the fibula and the incisura 1 cm above the joint using the digital calipers.

Results: The malalignment of the syndesmosis using the articular surface as a visual reference was 0.71 ± 0.7 mm and using the incisura was 1.2 ± 1.0 mm ($P = 0.0001$). The range of malalignment using the joint as a reference was 0.0 mm-2.5 mm and using the incisura was 0.1 mm-4.8 mm. All seven reviewers yielded better reductions using the articular surface

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

than using the incisura as a reference. The second part of the study evaluated the width of the fibula versus the incisura at the level of the articular surface and at 1 cm above the joint. The difference in the fibular width and the tibial incisura width was less at the level of the articular surface than at 1 cm above the joint (2 mm vs 6 mm; P = 0.0003).

Conclusion: We sought to evaluate the accuracy of two visual reference methods for open reduction of the syndesmosis in this cadaver study. Our findings indicate that using the articular surface of the anterolateral tibia and the anteromedial fibula at the level of the joint is a more accurate method than using the relationship of the fibula to the incisura above the joint level. Measurements of the difference of the fibula and incisural width at the joint and 1 cm above the joint may provide an explanation for this as there is much closer relationship at the level of the articular surface, which would potentially lead to a better reduction when using this relationship as the visual reference.

See pages 49 - 106 for financial disclosure information.

Location, Location, Location: Does the Distance of Fixation From the Plafond Affect Reduction of the Syndesmosis?

Michael Beebe, MD[1]*; Kyle Stoops, MD*[1]*; Sean Lannon, MD*[1]*; Charles Clark, MD*[2]*; David Watson, MD*[1]*; Paul Tornetta III, MD*[3]*; Roy Sanders, MD*[4]*; Hassan R. Mir, MD*[2]*; Anjan Shah, MD*[2]

[1]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[2]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[3]*Boston Medical Center, Boston, Massachusetts, USA;*
[4]*Orthopaedic Trauma Service, Tampa, Florida, USA*

Purpose: We aimed to determine if the level of fixation with regard to the physeal scar has an effect on malreduction in syndesmoses repaired with a 3.5-mm quadcortical screw or suture tightrope fixation.

Methods: A priori power analysis to detect a 1-mm difference between techniques was based on previous literature describing the normal syndesmosis and exhibited a need for 5 specimens per group. 6 cadaveric specimens, without apparent previous ankle injury or arthritic change, were placed into a nonmetallic ankle-foot orthosis to hold neutral position throughout the study. Specimens underwent initial 1-mm slice CT scans to determine the uninjured relationship of the distal tibiofibular joint (DTFJ). Two pilot holes were then created using a custom jig prior to ligament resection. Pilot hole 1 was placed at the level of the physeal scar, beginning lateral on the fibula and passing parallel to the plafond and parallel to the dissection table with the specimen in position for a mortise radiograph. The second hole was performed utilizing the same technique, but was placed at 2.5 cm proximal to the physeal scar. A radiopaque marker was placed on each tibia between the pilot holes to ensure measurements were made at the same level without revealing fixation methods to the observer. All three ligaments of the syndesmosis and the interosseus membrane were then sharply divided. The fibula was manually reduced into the incisura, with direct visualization of the anterior DTFJ, and each specimen underwent fixation in succession: (1) tightrope fixation 2.5 cm proximal to the physeal scar; (2) tightrope fixation at the physeal scar; (3) screw fixation 2.5 cm proximal to the physeal scar; and (4) screw fixation at the physeal scar. After each technique, specimens underwent CT scanning. The previous implant was then removed and the fibula was again displaced prior to proceeding. Single CT scan slices at the level of the marker were then randomized and all images were reviewed by three fellowship-trained orthopaedic traumatologists. The anterior incisura (AI), posterior incisura (PI), and fibular rotation (R) measurements were performed as described by Warner et al. Interrater reliability was verified using intraclass correlation coefficients (ICCs). Fixation measurements were compared to anatomic measurements using Student's t test for paired samples.

Results: Interobserver repeatability was good for all measures at 0.76, 0.72, and 0.62 for AI, PI, and R, respectively. The proximally placed tightrope device performed best, with no measurement showing a statistically significant difference from anatomic measurements (Table 1). Both screw fixation techniques resulted in posterior translation of the fibula, which increased the AI measurement and decreased the PI measurement. Proximal screw placement

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

performed worst, with all three measurements showing a statistically significant difference from anatomic measurements. While placement at the level of the physeal scar decreased the rotational deformity after positional screw placement, it did not show the same effect on those fixed with tightrope devices.

	Anatomic	Proximal Tightrope	Physeal Tightrope	Proximal Screw	Physeal Screw
Anterior Incisura (mm)	3.5 (1.9)	4.2 (1.8)	3.8 (1.3)	4.5 (1.7)*	4.5 (1.6)*
Posterior Incisura (mm)	4.4 (0.5)	3.2 (1.1)	3.6 (0.6)*	2.8 (1.4)*	3.4 (0.7)*
Rotation (degrees)	5.9 (4.0)	4.4 (3.3)	3.7 (3.5)	-0.2 (2.9)*	3.5 (4.7)

*Indicates $p<0.05$ when compared to anatomic measurements.

Conclusion: Likely the most common method of syndesmotic fixation utilized by traumatologists to date, screw fixation 2.5 cm proximal to the physeal scar performed significantly worse than a tightrope at either level; however, placement of a screw at the level of the physeal scar significantly decreased malrotation of the fibula in the incisura.

See pages 49 - 106 for financial disclosure information.

The Severity of Compartment Syndrome-Associated Microvascular Dysfunction May Be Diminished by the Neutralization of Proinflammatory Cytokines

Erin Donohoe, MB, BCh, BAO[1]*; David Sanders, MD*[2]*; Aurelia Bihari, MS*[3]*; Abdel-Rahman Lawendy, MD, PhD, FRCSC*[3]
[1]*Western University, Ontario, CANADA;*
[2]*Victoria Hospital, Ontario, CANADA;*
[3]*London Health Sciences Centre, London, Ontario, CANADA*

Background/Purpose: Compartment syndrome (CS), one of the most devastating consequences of musculoskeletal trauma, is defined as elevated pressure within a closed osseofascial compartment. The pathophysiology of CS includes elevation of intracompartmental pressure (ICP), resulting in damaged microcirculation, decreased oxygen delivery, tissue anoxia, and cell death. CS is a combined ischemic and inflammatory condition that induces the systemic inflammatory cascade. Within the first hour of reperfusion, a peak in the proinflammatory cytokine, tumor necrosis factor alpha (TNF-α) has been reported in complete ischemia-reperfusion literature. The purpose of our study was to examine the suspected systemic inflammatory cytokine/chemokine release in response to CS, and to evaluate the microvascular dysfunction, tissue injury, and inflammatory response following the neutralization of TNF-α.

Methods: 12 male Wistar rats were randomized into 3 groups: (1) sham (no CS), (2) CS (2-hour CS followed by Intra Vital Video Microscopy [IVVM]), and (3) TNF-α neutralizing (2-hour CS followed by TNF-α neutralizing antibody and IVVM). The 2-hour CS insult was followed by fasciotomy, and then 45 minutes of reperfusion. Serum levels of 24 different cytokines/chemokines were measured and obtained at 10-minute time intervals throughout the experiment, and analyzed using an xMap Luminex assay. IVVM was used to assess microvascular perfusion, inflammation in the postcapillary venules, and tissue injury.

Results: Of the 24 cytokines/chemokines sampled, 6 were significantly elevated from their baseline levels, and included the proinflammatory cytokines TNF-α, interleukin (IL)-1ß, GRO/KC (growth-related oncogene/keratinocyte chemoattractant), monocyte chemoattractant protein (MCP)-1, macrophage inflammatory protein (MIP)-1α, and the anti-inflammatory cytokine IL-10. A CS insult resulted in a significant decrease in microvascular perfusion from 75.1% (standard error of the mean [SEM] 2.3) continuously perfused capillaries in the sham group, to 30.7% (SEM 3.6), and 35.7% (SEM 3.5) in the CS and TNF-α neutralizing groups, respectively, $P < 0.0001$. TNF-α neutralization did not alter the microvascular dysfunction seen in CS. CS-associated tissue injury was significantly decreased with TNF-α neutralization (33% [SEM 4.0]) in CS group versus 21% (SEM 4.0) in TNF-α neutralization group, $P < 0.05$). Additionally, TNF-α neutralization blocked leukocyte rolling and adherence (9.8 [SEM 3.2] leukocytes/30s/1000 μm2) and 14.1 (SEM 1.6) leukocytes/30s/1000 μm2, respectively, in the CS group versus 2.4 (SEM 1.0) leukocytes/30s/1000 μm2 and 0.9 (SEM 0.2) leukocytes/30s/1000 μm2, respectively in TNF-α neutralizing group, $P < 0.05$).

Conclusion: The results of our study have confirmed that CS induces a proinflammatory response. Neutralization of TNF-α led to a significant relative reduction of approximately

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

36% in tissue injury, while having no effect on the microvascular dysfunction associated with CS. TNF-α plays at least some role in the inflammatory response following a CS insult, and may represent a future therapeutic target in order to diminish the parenchymal injury associated with CS.

See pages 49 - 106 for financial disclosure information.

The Dose-Response Effect of Ketotifen Fumarate on Substance P-Containing Nerves, Mast Cells, and Myofibroblasts in Posttraumatic Joint Contractures

Prism Schneider, MD, PhD, FRCSC[1]*; Herman Johal, MD, MPH*[2]*; Mei Zhang, PhD*[1]*; David Hart, PhD*[1]*; A. Befus, PhD*[1]*; Paul Salo, MD, FRCSC*[1]*; Cun-Yi Fan, PhD*[3]*; Xiangdang Liang, PhD*[4]*; Kevin Hildebrand, MD, FRCSC*[1]
[1]*University of Calgary, Alberta, CANADA;*
[2]*McMaster University, Hamilton, Ontario, CANADA;*
[3]*Jiaotong University, Shanghai, CHINA;*
[4]*People's Liberation Army Hospital, Beijing, CHINA*

Purpose: Posttraumatic joint contracture (PTJC) is a debilitating complication following intra-articular injury. Prior research has shown that treatment with ketotifen can significantly reduce PTJC severity in a rabbit model. Prior to clinical testing, knowledge of the dose-response relationship is required. We hypothesize that there will be a dose-response effect between ketotifen and PTJC severity and measures of fibrosis.

Methods: After obtaining IRB approval, an in vivo model of PTJC of the knee was created, using a combination of intra-articular injury and internal immobilization in skeletally mature New Zealand White rabbits. Five groups of animals were studied (n = 10 per group): a nonoperative control group (Non-OP), a group with the operatively created PTJC and no pharmacological treatment (operative contracture group - OP), and 3 groups with the operatively created PTJC treated with a mast cell stabilizer, ketotifen fumarate, at doses of 0.01 mg/kg (KF 0.01), 0.1 mg/kg (KF 0.1), and 5.0 mg/kg (KF 5.0) injected subcutaneously twice daily for 8 weeks. After 8 weeks of immobilization, PTJC was measured using a hydraulic materials testing machine. The posterior knee joint capsules were then harvested for immunohistochemistry (IHC), Western blot gel electrophoresis, and reverse transcription-polymerase chain reaction (RT-PCR) quantification of α-smooth muscle actin (SMA), collagen type 1 (Col 1), and mast cell tryptase. The Western blot and RT-PCR levels were normalized to glyceraldehyde-3-phosphate dehydrogenase (GAPDH). Triple label IHC combined with DAPI nuclear labeling was also completed and cell counts for myofibroblasts (MFs), mast cells (MCs), and Substance P (SP) were calculated as a percentage relative to the total cell count. Statistical analysis consisted of a one-way analysis of variance (ANOVA) with Tukey's post hoc analysis. Statistical significance was $P < 0.05$.

Results: Five rabbits were excluded due to hardware failure or patellar subluxation. Relative to the Non-OP, the OP group had an average flexion contracture of 39° ± 10°, while contracture severity was reduced to 34° ± 7° (P = 0.32), 21° ± 12° (P = 0.016) and 15° ± 11° (P = 0.001) in the KF 0.01, KF 0.1, and KF 5.0 ketotifen groups, respectively. Using IHC analysis, there was a decrease in MFs, MCs, and SP nerve fiber counts with increasing doses of ketotifen (Fig. 1). Expressed as a percentage of total cells, there were statistically significant differences in MF, MC, and SP values between the OP group and the KF 0.1 and KF 5.0 groups ($P < 0.05$). There were no significant differences between the Non-OP and the KF 5.0 groups; KF 0.1 and KF 5.0 groups; and the OP and KF 0.01 groups, for MFs, MCs, and SP ($P > 0.05$). The Western blot gel showed a dose-response effect of ketotifen on SMA, Col 1, and tryptase levels. The trend was for increasing doses of ketotifen to be associated with

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

decreasing levels of all three molecules, the differences statistically different between the OP and the KF 5.0 groups. The Non-OP group was statistically different from the OP group while there was no statistically significant difference between the Non-OP and KF 5.0 groups. The RT-PCR analysis for SMA and Col 1 followed a similar pattern as the Western blot. We did not analyze tryptase mRNA levels, as there is no rabbit specific tryptase PCR primer.

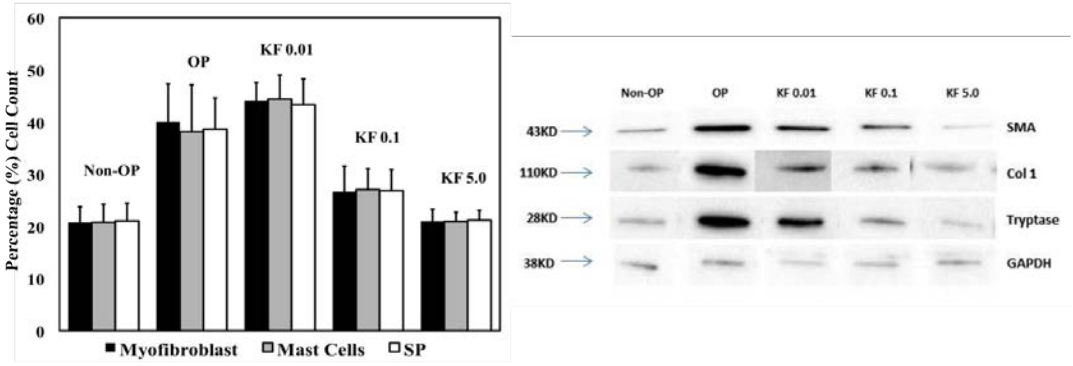


Figure 1: Immunohistochemistry (left) for cell counts for myofibroblasts, mast cells, and Substance P (SP) cell counts, calculated as a percentage relative to the total cell count; and Western blot gel electrophoresis (right) quantification of α-Smooth Muscle Actin (SMA), Collagen type 1 (Col 1), and mast cell tryptase, normalized to glyceraldehyde-3-phosphate dehydrogenase (GAPDH).

Conclusion: Using the rabbit in vivo preclinical model of PTJC, a dose-response of ketotifen treatment was observed. Increasing doses of ketotifen were associated with decreasing biomechanical estimates of PTJC coupled with decreasing numbers of MFs, MCs, and SP containing nerve fibers. Western blot analysis of SMA (myofibroblast marker), tryptase (mast cell marker), and Col 1 protein levels, and RT-PCR analysis of SMA (myofibroblast marker) and Col 1 mRNA levels also decreased with increasing doses of ketotifen. PTJC severity reduced 63% while the IHC, Western blot, and RT-PCR levels were similar to Non-OP controls at the highest dose of ketotifen. A threshold response EC50 ketotifen dose of 0.22 mg/kg was calculated, which has not been previously shown across a narrow range of ketotifen doses.

See pages 49 - 106 for financial disclosure information.

Reamed Intramedullary Nailing Affects Trauma-Induced Coagulopathy Based on Thrombelastography

Prism Schneider, MD[1]*; Elizabeth Davis, BS*[2]*; Matthew Galpin, RC*[3]*; Robert Hudson, BS*[4]*; Patrick Mitcham, BS*[2]*; Mark Prasarn, MD*[4]*; Joshua Gary, MD*[5]
[1]*University of Calgary, Calgary, Alberta, CANADA;*
[2]*University of Texas Health Science Center at Houston, Houston, Texas, USA;*
[3]*UTHSC Orthopaedic Trauma, Houston, Texas, USA;*
[4]*University of Texas at Houston, Houston, Texas, USA;*
[5]*UT Houston Department of Orthopaedic Surgery, Houston, Texas, USA*

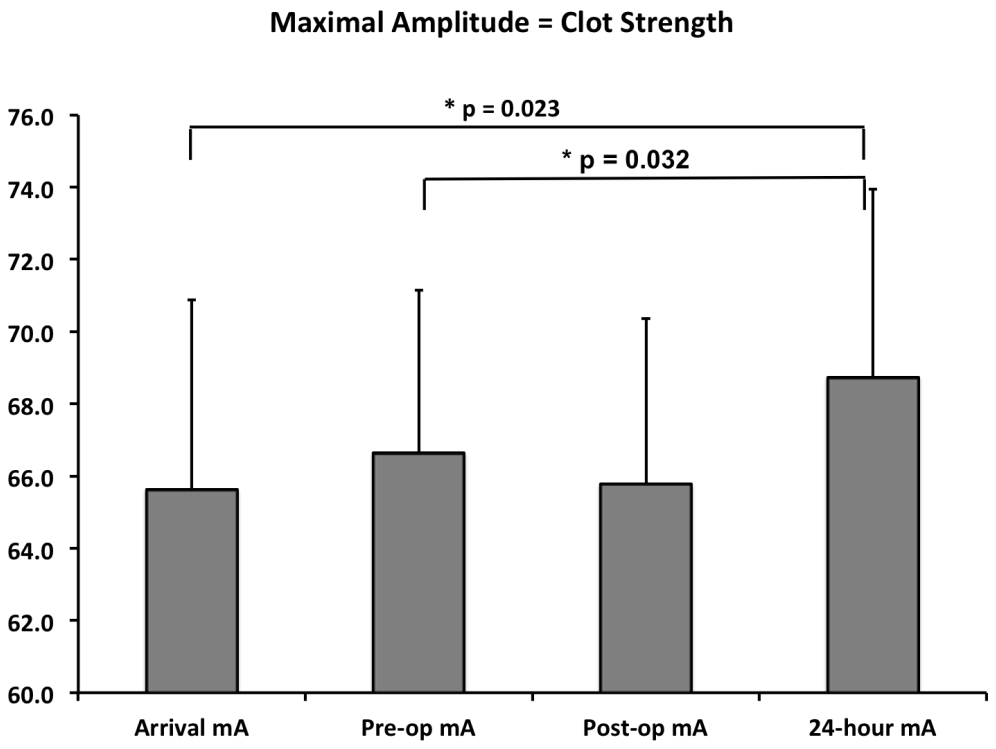
Background/Purpose: Reamed intramedullary nails (rIMNs) are the standard of care for adult diaphyseal tibia and femur fractures. However, reaming stimulates the immune system and raises proinflammatory cytokines. Patients suffering major trauma often experience trauma-induced coagulopathy (TIC), which correlates with morbidity and mortality; however, it is unknown whether intramedullary reaming and the release of inflammatory factors exacerbate TIC in orthopaedic trauma patients. Rapid thrombelastography (r-TEG) is a technology that evaluates the clotting function of whole blood and elevated maximal amplitude (mA) is associated with increased risk for venous thromboembolic events (VTEs). We hypothesized that TIC will be exacerbated in patients treated with rIMN fixation for lower extremity fractures, as demonstrated by increasing mA from r-TEG values following reaming.

Methods: This is a prospective cohort study of patients aged 18-75 years with femur fractures (AO-OTA 31, 32 and 33 A, B, C) or isolated tibia fractures (AO-OTA 41-A, 42-A, B, C, and 43-A) amenable to treatment with rIMN fixation. Exclusion criteria were pathologic fracture, preinjury anticoagulation therapy, previous history of VTEs, active malignancy, burns >20% body surface area, and pregnancy. r-TEG measures were taken on arrival to the emergency department (arrival r-TEG), 1 hour prereaming (pre r-TEG), 1 hour postreaming (post r-TEG), and 24 hours postreaming (24-post r-TEG). The primary outcome measure was the 24-hour postoperative mA values from the r-TEG analysis. Secondary outcome measures included admission r-TEG, 1-hour preoperative r-TEG, 1-hour postoperative r-TEG, and inhospital VTE. All r-TEG specimens were analyzed using a TEG thrombelastograph 5000 (Hemoscope Corporation), using our institutional standardized protocol. Statistical comparisons between groups were performed using the Wilcoxon rank-sum test.

Results: 29 patients were enrolled (n = 19 femur fractures, n = 10 tibia fractures), including 14 females and 15 males, with the most common mechanisms of injury being motor vehicle collisions (n = 14) and motorcycle collisions (n = 5). There were no significant differences between the femur and tibia fracture groups for age (P = 0.61), body mass index (BMI) (P = 0.35), ISS (P = 0.14), arrival pH (P = 0.42), lactate (P = 0.48), heart rate (P = 0.52), or systolic blood pressure (P = 0.55), therefore the data for all patients treated with rIMN were pooled. The mean age was 41.1 (±16.9) years, mean BMI was 28.3 (±8.0), and mean ISS was 14.5 (±9.7). Mean reaming time for femurs was 11.1 (±6.5) minutes and mean tibial reaming time was 27.6 (±11.6) minutes (P = 0.008). All patients underwent definitive rIMN within 72 hours from arrival. The mean mA for the 24-hour postreaming r-TEG analysis of 68.7 (±5.2) was

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

significantly higher when compared with the mean mA from the arrival r-TEG of 65.6 (±5.3) (P = 0.023). Similarly, the mean mA was 66.6 (±4.5) from the pre r-TEG and was significantly increased compared with the mean mA from the 24-post r-TEG (P = 0.032) (Fig. 1).



Conclusion: In this small prospective cohort group, there was an increase from both arrival and prereaming maximal amplitude, using r-TEG analysis, to the 24-hour postreaming mA, indicating increased coagulopathy in patients with diaphyseal femur and tibia fractures requiring treatment with rIMN. Future work will continue to investigate mechanisms and treatments to help prevent of the sequelae of trauma-induced coagulopathy.

See pages 49 - 106 for financial disclosure information.

Compartment Release in Austere Locations (CORAL):
A Pilot Study of Telesurgery for Compartment Syndrome

Max Talbot, MD, FRCSC[1]*; Rudolph Reindl, MD, FRCSC*[2]*; Gregory Berry, MD, FRCSC*[2]*; Homer Tien, MD, FRCSC*[3]*; Gerard P. Slobogean, MD*[4]*; Edward Harvey, MD, MSc, FRCSC*[2]*; CORAL Collaborators*[1]
[1]*Canadian Armed Forces, Quebec, CANADA;*
[2]*McGill University, Quebec, CANADA;*
[3]*University of Toronto, Ontario, CANADA;*
[4]*University of Maryland, Baltimore, Maryland, USA*

Purpose: Telesurgery for compartment release has the potential to improve limb salvage in austere environments. This pilot study was performed to establish the feasibility of this procedure and identify methodological issues relevant for future research.

Methods: Three anesthesiologists and one critical care physician were recruited as operators. The participants were directed to perform a two-incision leg fasciotomy on a Thiel-embalmed cadaver leg under the guidance of a remotely located military orthopaedic surgeon. The operating physician and the surgeon (mentor) were connected through Reacts Lite© software running on iPad Air2©, which allowed for real-time supervision and the use of a virtual reality pointer overlaid onto the surgical field. A critical care nurse without surgical experience performed as first assistant. Two experienced orthopaedic traumatologists independently assessed the adequacy of compartment decompression and the presence of iatrogenic complications. A questionnaire was administered to the physicians before and after the procedure to assess their level of confidence in performing this procedure.

Results: The average surgery lasted 56 min 12 sec (SD 244 sec) and consumed 1.3 GB (SD 0.47) of data. Both evaluators reported that 14 of 16 total compartments were completely released. The first evaluator considered that two deep posterior compartments were incompletely released at the soleus arch. The second evaluator considered that two superficial posterior compartments were incompletely released over the proximal gastrocnemius. There were no injuries to the saphenous nerve, saphenous vein, superficial peroneal nerve, tibial artery, or tibial nerve. The only complication was a large laceration to the soleus that occurred during a period of blurred video signal attributed to a drop in bandwidth. This resulted in the operator straying from the correct tissue plane while attempting to reach the deep posterior compartment. Once the video signal returned to normal, the deep posterior compartment was released adequately. The telementor reported the greatest challenges were visualization of the superficial peroneal nerve and release of the deep posterior compartment. The latter requires balancing full release at the soleus arch with the risk of injury to the popliteal vessels. Three of the four participants stated afterwards that they would feel confident or very confident to perform this procedure under the video guidance of a surgeon. We also observed a significant learning curve for the telementor.

Conclusion: Our results are promising and warrant further research. Both evaluators reported that all compartments were released with 87% of all compartments fully released. There were no iatrogenic neurovascular injuries. We noted interobserver variation in the

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

assessment of compartment release, which should be considered in the design of future research protocols. The deep posterior compartment is the hardest to adequately release during telesurgery. A head lamp would help visualization of deeper structures.

See pages 49 - 106 for financial disclosure information.

Acceleration of Fracture Healing Modulated by Compounds that Stimulate Inducible Nitric Oxide Synthase

Rebecca Rajfer Trueblood, MD*[1]*; *Ayhan Kilic, MD*[2]*; Su Hlaing, BS*[3]*; Leah Schulte, MD*[1]*; Andrew Neviaser, MD*[1]*; Edward Ebramzadeh, PhD*[4]*; Monica Ferrini, PhD*[3]*; Sang Hyun Park, PhD*[4]

[1]*George Washington University, Washington, District of Coumbia, USA;*
[2]*School of Medicine, Bahcesehir University, Istanbul, TURKEY;*
[3]*University of California Los Angeles, Charles R. Drew University of Medicine and Science, Los Angeles, California, USA;*
[4]*University of California Los Angeles, Los Angeles, California, USA*

Purpose: Nitric oxide, synthesized in vivo by nitric oxide synthase (NOS), has been implicated in the fracture healing process. We investigated in the rat the effects on fracture healing of two upregulators of inducible nitric oxide synthase (iNOS): tadalafil, a phosphodiesterase inhibitor, and the recently reported nutraceutical COMB-4 (consisting of L-citrulline, Paullinia cupana, ginger, and muira puama), given orally for either 14 or 42 days following an open femoral fracture.

Methods: Unilateral fractures were created in 58 male rats and fixed with an intramedullary compression nail. Rats were treated daily either with vehicle, tadalafil, or COMB-4. The volume, mineral content, and bone density of the callus were measured by quantitative CT at days 14 and 42. At day 42, biomechanical testing of the healed fracture was also performed. iNOS expression was measured by immunohistochemistry.

Results: At days 14 and 42, there was no significant difference between the three groups with respect to callus volume, mineral content, and bone density. When compared to the control group, biomechanical testing at day 42 demonstrated that the COMB-4 group exhibited higher maximum strength (46%; P = 0.093) and significantly more stiffness (92%; P = 0.016) while there was no change in the tadalafil group (Fig. 1A). iNOS expression at day 14 was highest in the COMB-4 group that, as expected, returned to baseline levels at day 42 (Fig. 1B).

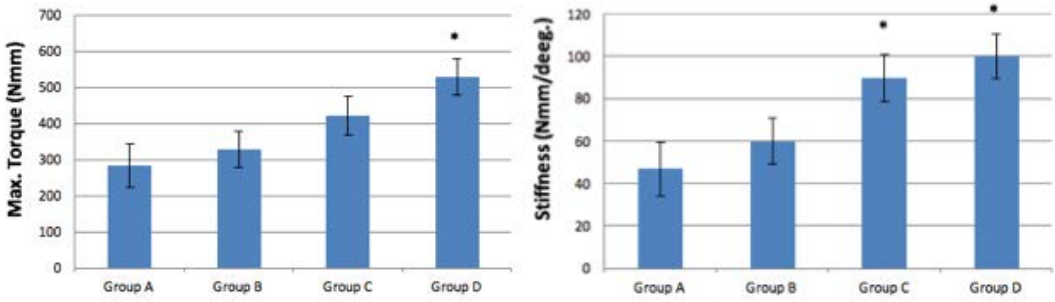


Figure 1A-B. A, Maximum Torque (strength) at 6 weeks. B, Stiffness at 6 weeks. * p<0.05 compare to Group A (bar = SD).

Conclusion: This study demonstrates an enhancement in fracture healing in the rat by an oral natural product known to augment iNOS expression. Clinical studies will be required to determine the suitability of COMB-4 as an adjunctive treatment for fractures in humans.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Doxycycline-Loaded Coaxial Nanofiber Coating Enhances Osseointegration and Inhibits Infection

David Markel, MD[1]; Wei Song, PhD[2]; Shi Tong, MS[2]; Nancy Jackson, PhD[1]; Chris Bergum, MS[1]; Jeffrey Flynn, PhD[3]; ***Weiping Ren, MD[2]***
[1]*Providence Hospital, Southfield, Michigan, USA;*
[2]*Wayne State University, Detroit, Michigan, USA;*
[3]*Providence Hospital and Medical Centers, Southfield, Michigan, USA*

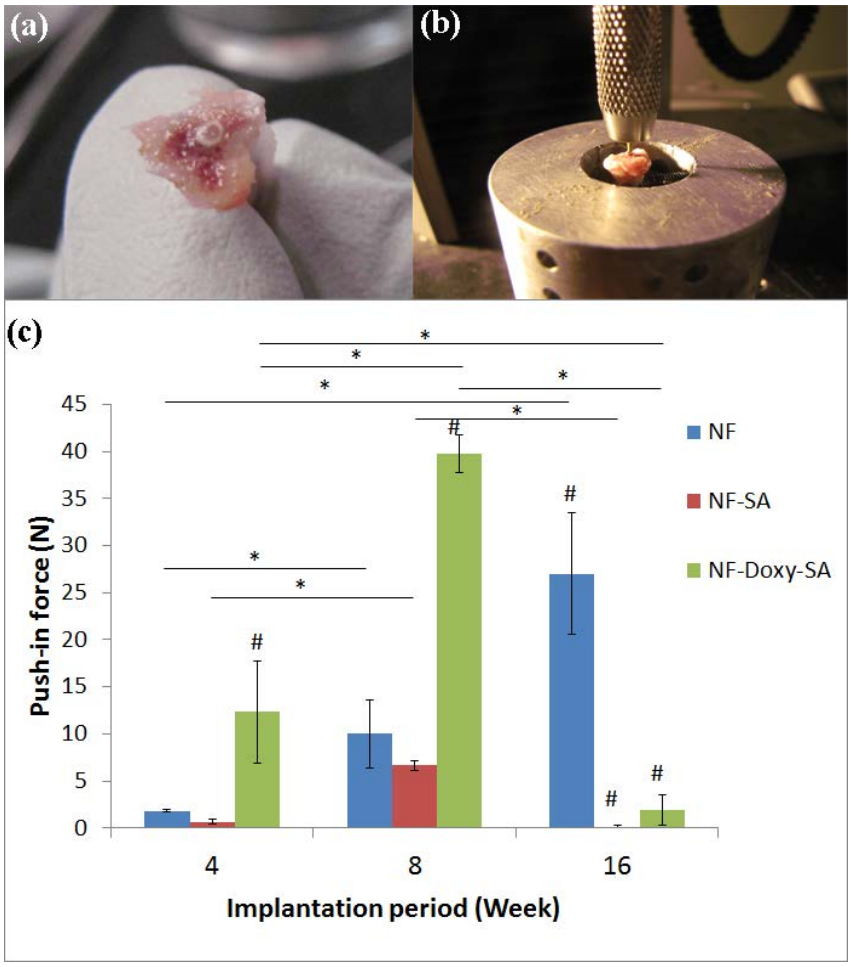
Purpose: Few studies have focused on developing an implant surface nanofiber (NF) coating to prevent infection and enhance osseointegration by local drug release. We presented our preliminary work on coaxial doxycycline (Doxy)-doped polycaprolactone/polyvinyl alcohol (PCL/PVA) NFs that could be directly deposited on titanium (Ti) implant surface during electrospinning at a previous OTA meeting. We found that an NF coating provided sustained antibiotics release, that the bonding strength of NFs to the Ti surface was strong, and no delamination and/or disruption of NF coating was found in ex vivo porcine bone push-in and pullout tests.The aim of this continuing study was to determine the therapeutic efficacy of Doxy-doped PCL/PVA NF coating using a Staphylococcus aureus-infected rat tibia implantation model.

Methods: A Ti pin with coaxial PCL (sheath)/PVA (core) NF coating with Doxy loading (200 μg/mL) was prepared by electrospinning. A total of 72 rats were divided into three groups: (1) control, NF coating; (2) NF coating + S. aureus infection (NF-SA); and (3) Doxy-NF coating + S.aureus infection (Doxy-NF-SA). Rats were sacrificed at 4, 8, and 16 weeks after surgery. Each group included 24 rats (8 rats for each time point). The osseointegration and the inhibition of bacterial growth were evaluated by microbiologic testing, histology, mechanical push-in test, and micro-CT.

Results: We demonstrated that Doxy-doped NF coating effectively inhibited bacterial infection and enhanced osseointegration in this infected (S. aureus) rat tibia implantation model. Doxy released from NF coating inhibited bacterial growth for up to 8 weeks in vivo. The maximal pushin force of Doxy-NF-SA group (38 N) was much higher than that of NF-SA group (6.5 N) 8 weeks after implantation ($P < 0.05$); enhanced osseointegration was further confirmed by quantitative micro-CT. For the NF (control) group, a gradual increase of bone volume around the Ti pin surface was observed up to 16 weeks. Progressive bone loss around the Ti pin was observed in the NF-SA group, forming a visible gap between Ti and the surrounding bone matrix. The incorporation of Doxy (Doxy-NF-SA) successfully prevented bacterial infection and enhanced osseointegration as manifested by continued increase of new bone formation around the Ti pin up to 8 weeks. Finally, the status of osseointegration was carefully evaluated by quantitative histological analysis. More new bone formation was found in the Doxy-NF-SA group than that of the NF-SA group at the 4-week time point. A significant inflammatory tissue response observed in the NF-SA group was not seen in the NF-Doxy-SA group. At the 8-week time point, the local bacterial growth and tissue response are visible in the NF-SA group, which cannot be observed in the NF-Doxy-SA group.

See pages 49 - 106 for financial disclosure information.

Push-in test



Representative image of harvested rat tibia with Ti pin. (b)The photo of push-in test setup. (c) Rat tibia implanted Ti-pin push-in test result. Rat tibias were harvested from different time points (4, 8, 16 weeks). n= 8. $p^*< 0.05$ represents significant difference between different time points within group. $p\#< 0.05$ represents significant difference between different groups within the same time point.

Conclusion: Many strategies have been used to prevent implant infection by either implant surface fabrication or incorporation of antibiotics into/onto the implant devices. A desired implant coating system should deliver antibiotics well above their minimum inhibitory concentration for at least 6 weeks for the treatment of implant infection. In this study, we demonstrated that Doxy was released from the NF coating and stimulated implant osseointegration and inhibited bacterial growth for up to 8 weeks in a rat tibia implantation model. These findings may provide a new implant surface fabrication strategy aimed at reducing the risk of poor osseointegration and/or implant infection, especially in the face of a contaminated trauma situation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Three-Dimensional Printed Scaffolds for Segmental Defects in Long Bones

Sandeep Pandit, MD; *Todd Goldstein, PhD; James Mullen, MD; Mikael Starecki, MD; Lewis Lane, MD; Daniel Grande, PhD; Katy Nellans, MD*
Feinstein Institute for Medical Research, Manhasset, New York, USA

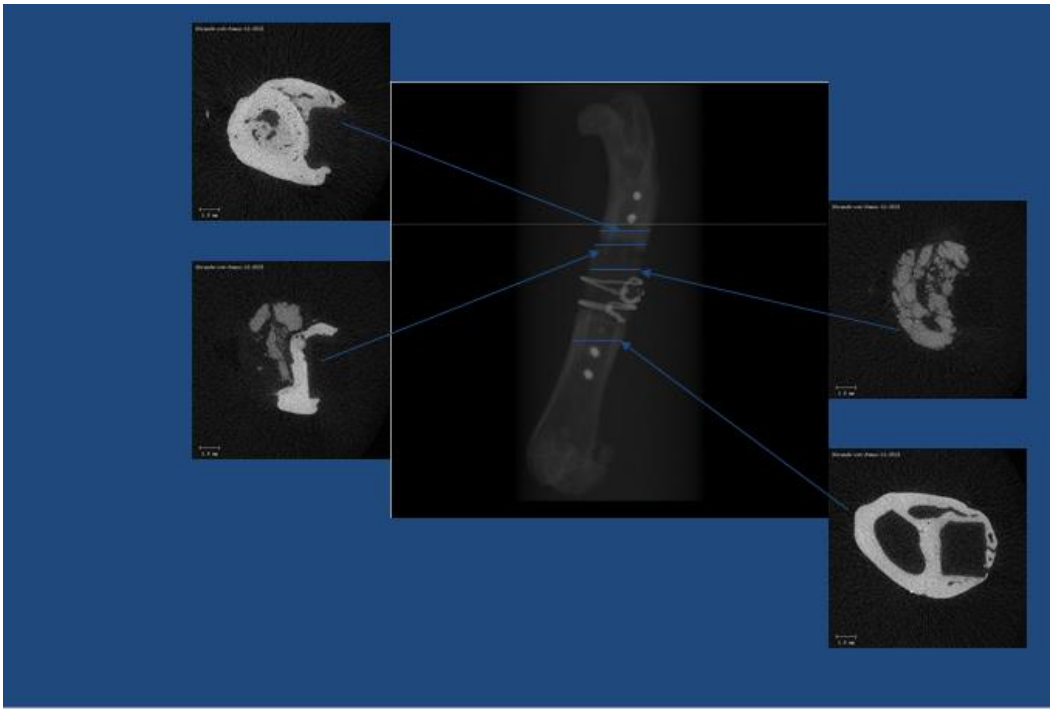
Background/Purpose: Segmental bone loss is a devastating injury that can result from trauma, malignancy, or infection with significant sequelae of disability, psychosocial stress, and financial burden especially in a young, active patient. While working with a multidisciplinary approach has been shown to improve outcomes, many advances have also been made within the orthopaedic discipline to improve time to union and functionality. Despite advances many techniques present challenging limitations, ubiquitous complications, and unpredictable results. The introduction of three-dimensional (3D) printing technology has created a new method of producing bone graft substitutes and has the potential to eliminate many of the problems associated with current management techniques for segmental bone defects. The purpose of the current study is to evaluate a novel 3D printed polylactic acid (PLLA)/calcium carbonate (CaCO3) scaffold as a viable substrate for bone regeneration in an in vivo model.

Methods: Design and printing: A 3D-CAD (computer-assisted design) model was created using the Rhino3d™ Wenatchee-OsX CAD designer. The segment was 8 mm in length and shaped to mimic the native anatomy of the rat femur. The graft was designed with multiple pores to allow for cellular infiltration, growth, and surgical fixation. Grafts were printed on a desktop printer extruding bioink and PLLA / CaCO3 filament concurrently. Bioink production: Type I bovine collagen was combined with 1 mL of 10X RPMI (Sigma-Aldrich). pH was neutralized. Low-viscosity sodium alginate was mixed into the solution at a 1:1 ratio and passed through a 0.22-μm filter. A CaSO4 solution was added to the collagen / alginate gel and set for 45 minutes. Previously harvested mesenchymal stem cells (MSC) are homogenously mixed into the gel and used. In vitro: Sprague Dawley rat bone marrow MSCs were isolated and cultured for 7 days at 1, 3, 5, and 7-day time points in 96-well plates on PLLA / CaCO3 disks. ~10,000 cells are seeded and grown in osteogenic media with 6 wells per time point per group. Three of the groups were analyzed for cell proliferation and histology and three for gene expression compared to a control group grown in monolayer. RT-qPCR (reverse transcription polymerase chain reaction) for genetic markers of osteoinduction and histology using Alizarin red / Alcian blue staining was completed. In vivo: Sprague Dawley rat femora were exposed by longitudinal incision and isolated. A PEEK (polyether ether ketone) fracture fixation plate was attached to the femur by four 0.70 x 5.70-mm screws. After rigid fixation of the plate, an 8-mm transverse middiaphyseal critically sized bone segment was removed by using a rotary osteotomy burr along with the adherent periosteum. The defect was either left empty as a control or a 3D-printed bone graft was inserted and fixed with cerclage wire. Following treatment the muscles, fascia, and skin were opposed in a routine manner with use of 4-0 Vicryl sutures. The animals were not immobilized postoperatively. At 16 and 24 weeks postsurgery, the animals were radiographed. At 24 weeks, the animals were euthanized and the femurs were harvested, formalin-fixed, and processed for histology and biomechanics.

See pages 49 - 106 for financial disclosure information.

Results: In vitro: Over the course of 7 days cells grown on PLLA / CaCO3 in vitro increased at a proliferation rate equivalent to unmanipulated controls, early calcification is present, and genetic markers of osteoinduction increase over time. In vivo: Postsurgery rats were ambulatory, no signs of infection or graft rejection were noted throughout the study. Varying levels of calcification were present. Fluoroscopy at 16 weeks and micro-CT at 24 weeks show bony ingrowth (Figure 1), and the graft did not lose significant strength over the course of the study.

Figure 1



Conclusion: In this in vitro model a novel 3D-printed PLLA / CaCO3 scaffold supports growth of rat bone marrow MSCs. The printed scaffold exhibited osteoinductive and osteoconductive properties. The use of this novel scaffold as a tool in the management of segmental bone defects shows promise. In vivo results suggest that a 3D-printed scaffold could prove to be a viable option for treatment of segmental defects for personalized medicine. Fluoroscopy taken at 16 weeks after implantation suggests bony ingrowth with cortical bridging. Gait analysis did not show any abnormalities, which suggests the implant was well tolerated. All of the above results suggest this concept could potentially be rapidly adopted as a print-on-demand solution in the operating room for various clinical situations.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ Investigating an Endothelial Progenitor Cell Dose Response for the Healing of Critical Size Bone Defects

David Ramnaraign, MSc*[1]*; *Charles Godbout, PhD*[1]*; Emil H. Schemitsch, MD*[2]*; Aaron Nauth, MD, FRCSC*[2]
[1]*University of Toronto, Ontario, CANADA;*
[2]*St. Michael's Hospital, Ontario, CANADA*

Background/Purpose: The management of bone defects and nonhealing fractures remains a considerable challenge for orthopaedic surgeons. To date, the preferred method of treatment still remains the autologous iliac crest bone graft (AICBG). Unfortunately, AICBG is associated with excess patient morbidity, a risk of infection, and a suboptimal rate of success. Researchers have investigated the use of bone cell precursors as well as growth factor therapies in an effort to remedy this situation, but these approaches have had limited success clinically. Within recent years, our group on the other hand has shown consistent success in repairing critical size defects in the femurs of rats using a bone marrow-derived endothelial progenitor cell (EPC). EPCs have been shown to promote and enhance both osteogenesis and angiogenesis—critical components of fracture healing. The purpose of this study is to therefore further explore and optimize this cell therapy by investigating an EPC dose-response relationship for bone healing in a rat model. We hypothesize that the local application of EPCs to a nonhealing defect will improve bone healing in a dose-dependent manner until a plateau of effectiveness is reached.

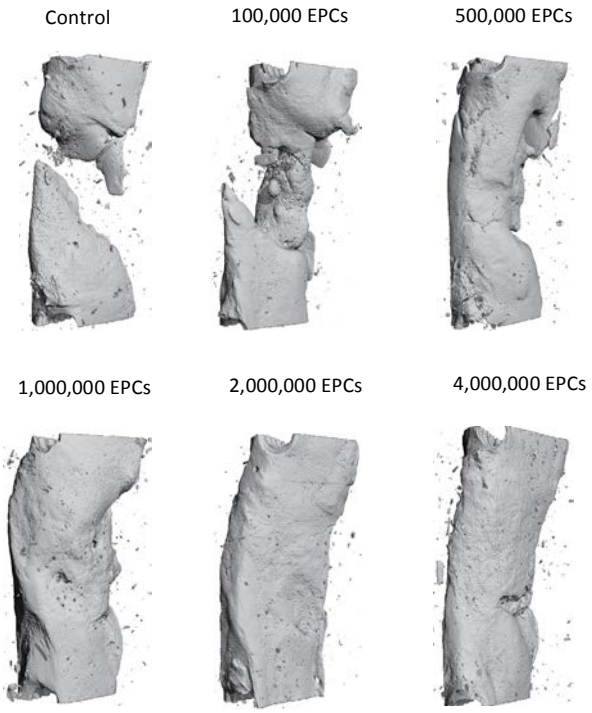
Methods: Male inbred rats underwent a double osteotomy of their right femur to create a 5-mm nonhealing defect, which was subsequently stabilized by a mini-plate and screws. A biodegradable collagen scaffold seeded with varying doses of syngeneic, ex vivo expanded EPCs (100,000, 500,000, 1 million, 2 million, or 4 million cells; n = 6), was then placed into the defect before the wound was carefully sutured. The cells used for implantation were isolated from a separate sacrificed rat whose bone marrow was cultured in endothelial growth media for approximately 7 days prior to surgery. To monitor the progress of bone healing, biweekly radiographs of the operated femur were taken up until our 10-week end point and sacrifice. These radiographs were then scored by blinded assessors according to the proportion of the defect filled with callus and its density. Postsacrifice, micro-CT analysis and biomechanical testing were then used to further evaluate and quantify bone healing. All animal protocols were approved by the St. Michael's Hospital Animal Care Committee.

Results: As evidenced by our scored radiographs, earlier bone healing and union was observed in animals that received our largest dose of EPCs, 4 million. The average time to union in this high-dose treatment group was 4 weeks—2 weeks faster than the next quickest groups (1 and 2 million EPCs). Yet, micro-CT analysis and biomechanical testing revealed that animals that received 2 million EPCs experienced the greatest amount of bone formation, and the greatest biomechanical strength (Fig. 1). Crucially, the femurs of animals that were treated with 2 million EPCs also showcased strengths that were not significantly different than intact, nonoperated femurs ($P < 0.05$).

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

A



B

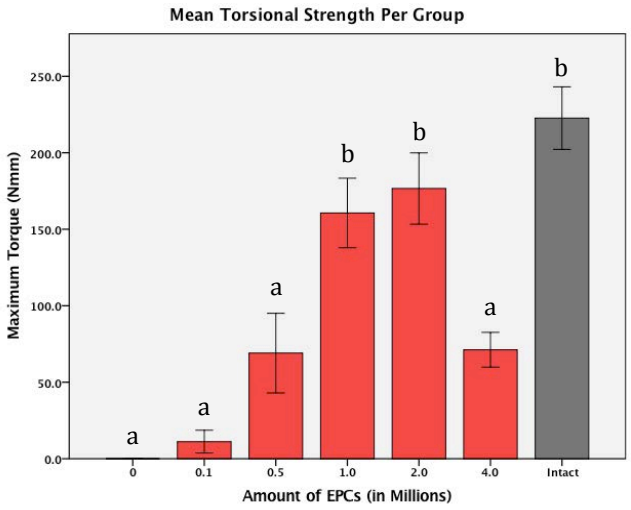


Figure 1. (A) MicroCT 3D reconstructions of the defect area showing differences in bone healing across the various treatment groups. **(B)** Graphical representation of the maximum torque sustained by specimen in each treatment group, including intact femurs. Error bars represent ± SE; different letters denote significance ($p<0.05$).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusion: To date, the optimal concentration of bone marrow-derived EPCs for bone healing has yet to be elucidated. From our results, we conclude that earlier, but not functionally superior, bone healing occurs when 4 million EPCs are applied to a 5-mm bone defect. The greater biomechanical strength and bone volume observed in animals receiving a submaximal dose of cells in this investigation (2 million EPCs) suggests a peak of effectiveness for EPC therapy, contrary to our initial hypothesis. Overall, the results of this study highlight the importance of appropriate cell dosing in tissue repair, while also guiding future investigations in their design of bone regenerating EPC-based therapies.

See pages 49 - 106 for financial disclosure information.

The Impact of Surgical Fixation on Fracture Healing: Radiographic Analysis of a Novel Fracture Model in Rats

Alejandro Marquez-Lara, MD; *Ian Hutchinson, MD; Thomas Smith, PhD; Anna Miller, MD, FACS*
Wake Forest University School of Medicine, Winston Salem, North Carolina, USA

Purpose: The effect of inflammation on fracture healing is well recognized by clinicians. In addition, the inflammatory effect of surgery on the trauma patient is known to induce an additional surge of inflammatory mediators (second hit) with known systemic consequences. Currently, our understanding of the effects of inflammation on fracture callus formation and tissue homeostasis are derived from one hit animal models where the experimental fracture is simultaneously fixed. The purpose of this study was to develop a translational animal model to determine the impact of temporized (24 hours) surgical fixation on local inflammatory shifts, tissue homeostasis, and fracture healing.

Methods: A closed middiaphyseal femur fracture was generated in the right femur of 20 young adult, female Sprague Dawley rats using the method described by Bonnarens and Einhorn. Half (n = 10) underwent conventional fixation with retrograde intramedullary pin placement (0.8 mm) prior to the experimental fracture. The remaining rats (n = 10) underwent fracture fixation 24 hours after the index injury. Under fluoroscopic guidance, a 0.05-mm guide pin was utilized to realign the fracture segments. Hypodermic tubing (0.8 mm) was then placed over the pin in a retrograde fashion for final fixation. Fracture healing rates were measured with weekly radiographs and scored independently by three of the authors based on bone bridging across the healing callus (0-4 points). A score of 4 denoted complete healing. Time to healing was assessed using Kaplan-Meier methods, and a two-way repeated-measures analysis of variance (ANOVA) was utilized to determine the effect of immediate and temporized fracture fixation over time. Four-point bend testing was performed to assess mechanical strength after 6 weeks. A P value of <0.05 was set to denote statistical significance. This study was approved by our institutional animal care and use committee.

Results: All animals tolerated the procedures well without any complications. There were no significant differences on the average time to union between groups (5.7 vs 6.0 weeks, $P = 0.063$). However, average radiographic scores were significantly lower in rats that underwent temporized fixation compared to rats that underwent fixation at the time of injury (1.7 ± 1.3 vs. 2.4 ± 1.3, $P = 0.001$). Analysis of simple main effects demonstrated that these differences were only significant at week 3 (1.4 ± 0.8 vs 2.4 ± 0.5, $P = 0.04$) and week 5 (2.7 ± 0.5 vs 3.6 ± 0.5, $P = 0.015$). Average radiographic scores increased from week 1 to week 6 in both groups ($P < 0.001$). In addition, maximum load was significantly lower in the setting of temporized surgical fixation, compared to simultaneous injury and fixation (115.6 ± 42.4 vs 198.4 ± 34.2 N, $P < 0.001$).

Conclusion: This study demonstrates the feasibility and reproducibility of a novel translational animal fracture model that reflects a more realistic clinical scenario. The impact of surgical fixation, as a major inflammatory event, on fracture healing has not been previously considered in animal models. Although there were no significant differences in time

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

to union, bone bridging across the fracture site was achieved earlier (week 3 and 5) in rats that underwent fixation immediately after injury. In addition, temporized surgical fixation was associated with reduced biomechanical strength at 6 weeks. Given the disparity in radiographic healing and failure load, future studies will focus on the assessment of structural characteristics as well as the longitudinal shifts in inflammatory mediators at the fracture site in this new model. Improving the translation strength of preclinical animal models of fracture healing using delayed fracture fixation may further enhance our ability to derive clinically driven answers from basic science studies. Ultimately, characterizing inflammation at the fracture site will guide the development of biological augmentation strategies and the use of anti-inflammatory medications in the postoperative period with the aim of improving patient outcomes.

Table 1 – Radiographic scores between immediate and delayed fixation

	Immediate Fixation	Radiographic Score (SD)	Delayed (24h) Fixation	Radiographic Score (SD)	p-value
1 wk		0.0±0.0		0.0±0.0	1.0
2 wk		1.6±0.9		0.9±0.7	0.134
3 wk		2.4±0.5		1.4±0.8	**0.040**
4 wk		2.6±0.5		2.0 ±1.3	0.356
5 wk		3.6±0.5		2.7±0.5	**0.015**
6 wk		3.9±.04		3.4±0.9	0.339

See pages 49 - 106 for financial disclosure information.

Assessment of RIA Filtrate Osteoinductive Potential in an Ectopic In Vivo Model

Alexander Wessel, MD[1]*; James Stannard, MD*[3]*; James Cook, DVM, PhD*[3]*; Brett D Crist, MD*[2]*; Gregory Della Rocca, MD, PhD, FACS*[2]
[1]*University of Missouri, Columbia, Missouri, USA;*
[2]*University of Missouri School of Medicine, Columbia, Missouri, USA;*
[3]*Missouri Orthopaedic Institute, Columbia, Missouri, USA*

Purpose: The reamer-irrigator-aspirator (RIA) is a device popularly utilized for harvest of autologous bone graft. RIA filtrate has been noted to contain multiple biologically active mediators that could be important for stimulating bone growth. We aimed to assess the osteoinductive potential of RIA filtrate in a validated in vivo model.

Methods: After IRB and animal care and use committee approvals, the liquid filtrate from patients undergoing medullary reaming of the femur utilizing the RIA system was collected. The RIA filtrate was then processed for protein analysis and implantation into the muscles of mice. Filtrate samples were assayed for the presence of multiple factors known to be associated with bone growth, including but not limited to adrenocorticotrophic hormone (ACTH), fibroblast growth factor (FGF), interleukin (IL) -1, IL-6, parathyroid hormone (PTH), osteocalcin (OC), osteoprotegrin (OPG), and vascular endothelial growth factor (VEGF). Athymic mice (n =16; 32 hindlimbs) were randomly assigned to 1 of 4 test groups (n = 8 limbs per group). Mice were anesthetized for percutaneous intramuscular implantation into the center of each gastrocnemius muscle with either demineralized bone matrix (DBM) (10 mg), powder lyophilized from RIA liquid (10 mg), RIA liquid (10 mg of filtrate in 100 μL phosphat- buffered saline (PBS), or DBM (10 mg) + RIA liquid (10 mg in 100 μL PBS). Radiographs of both hindlimbs were obtained at 2, 4, and 8 weeks after implantation. Mice were euthanized at 8 weeks and the entire gastrocnemius muscle from each hindlimb was collected and processed for histologic examination. Histological samples and radiographs were blindly rated according to a semiquantitative scheme.

Results: RIA filtrates were obtained from 9 subjects (6 females, 3 males; mean age 43.3 years; range, 25-74 years). The protein composition and concentrations of samples was consistent among patients and contained proteins important for bone production. All mice were successfully implanted and survived for the intended duration of study. No complications were noted. For all groups, radiographic scores were significantly ($P < 0.014$) higher (more ossification) at 8 weeks compared to 2 weeks. Radiographic scores were not significantly different among groups at 2 weeks. However, DBM and DBM + RIA groups were significantly higher than RIA liquid and RIA powder at 4 weeks and 8 weeks ($P < 0.019$ and $P < 0.049$, respectively). Histologic scores were significantly ($P = 0.004$) higher in the DBM + RIA group compared to the RIA liquid group at 8 weeks; otherwise, histologic scores were not significantly different between groups. Histologic scores showed strong correlations ($r > 0.77$) to radiographic scores for all groups.

Conclusion: RIA filtrate safely induced new bone formation in the muscles of athymic mice. New bone formation was greatest in muscles injected with a combination of DBM and RIA proteins. RIA filtrate alone did not induce new bone formation to the same degree

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

as DBM in this model. However, both RIA liquid and RIA powder were able to induce new bone formation in muscle, and this significantly increased in amount and maturity over the 8-week study period. RIA filtrate and lyophilized RIA powder appear to be osteoinductive. We recommend validation for clinical use through further testing of the osteoinductive potential of RIA filtrate in a critical-sized defect animal model.

See pages 49 - 106 for financial disclosure information.

Does the Modified RUST Score Correlate with the Biomechanical Properties of Bone? Evaluation in a Murine Model

*Paul Tornetta III, MD[1]; **Margaret Cooke, MD[1];** Amira Hussein, PhD[1]; Jody Litrenta, MD[1]; William M. Ricci, MD[2]; Jason Nascone, MD[3]; Robert V. O'Toole, MD[3]; Louis Gerstenfeld, PhD[1]*
[1]Boston University Medical Center, Boston, Massachusetts, USA;
[2]Washington University in Saint Louis, Saint Louis, Missouri, USA;
[3]University of Maryland, Shock Trauma Orthopaedics, Baltimore, Maryland, USA

Background/Purpose: The modified Radiographic Union Score for Tibial fractures (mRUST score) is a radiographic tool used to evaluate healing of fractures using a cortical scoring system. This system has been shown to have high intraclass correlation coefficients (ICCs) in multiple environments; however, there is little evidence evaluating the score against the physical properties of the bone. The purpose of this study is to compare the mRUST score with biomechanical properties in a murine model using a normal and phosphate-deficient diet. Phosphate deficiency leads to osteomalacia and has been found to affect biomechanical properties of fracture healing in mice.

Methods: Closed stabilized femur fractures were generated in 8- to 12-week-old C3H/HeJ (C3) male mice. Phosphate deficiency (Pi) was initiated 2 days prior to fracture and was maintained for 17 days, after which a normal diet was resumed. Control animals were fed a normal diet throughout. Fracture calluses were harvested from N = 8-12 mice per time point at 14, 21, 35, and 42 days in both Pi and control groups. Micro-CT was used to evaluate the structural and material properties of the callus; additionally 2-dimensional projections were used to create AP and lateral images that were evaluated by 4 senior orthopaedic traumatologists and 1 orthopaedic fellow for mRUST score and whether they felt the bone was or was not healed. Mechanical properties were determined by torsion testing and were normalized to a nonfractured bone at day 0. Data were analyzed using 2-factor analysis of variance (ANOVA), ICC, and Pearson correlations.

Results: The mRUST scores among the 5 reviewers had an ICC of 0.86 (near perfect). Diet was not a significant factor in predicting mRUST score (ANOVA P = 0.15). Regarding the biomechanical properties of the fractured femora, the mRUST score positively correlated (P <0.0001) with bone mineral density (r: 0.87, CI: 0.81-0.91), stiffness (r: 0.49, CI: 0.32-0.63), rigidity (r: 0.45 CI: 0.27-0.60), and strength (r: 0.26, CI: 0.05-0.44, P = 0.01), (see figures). The total callus volume (r: -0.57, CI: -0.69 - -0.42) and ductility (twist to failure) (r: -0.42, CI: -0.58 - -0.24) were negatively correlated with increasing mRUST score (P <0.0001). As expected, RUST scores were higher over time (r: 0.85, CI: 0.78-0.90, P <0.0001). The ICC for union was 0.65, which represents a strong agreement.

Conclusion: The mRUST score correlated statistically with all mechanical properties of bone, although most strongly with bone mineral density (r = 0.87). The correlation was not influenced by a phosphate-deficient diet. These data suggest that mRUST may be a useful surrogate for progression of healing and estimating bone mineral density (BMD) after fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does the Modified RUST Score Correlate with the Biomechanical Properties of Bone? Evaluation in a Murine Model

Fig1: mRUST score positively correlates with % BMD.

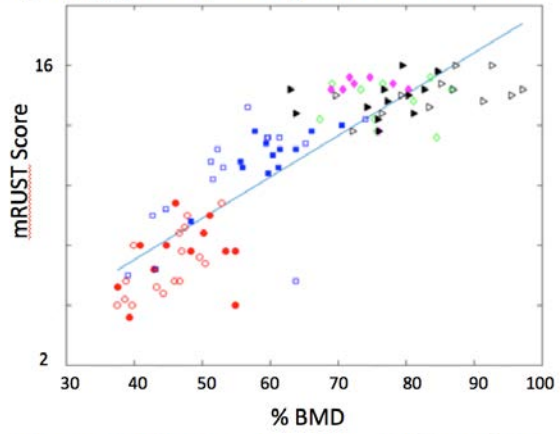


Fig2: % BMD increases over time regardless of diet.

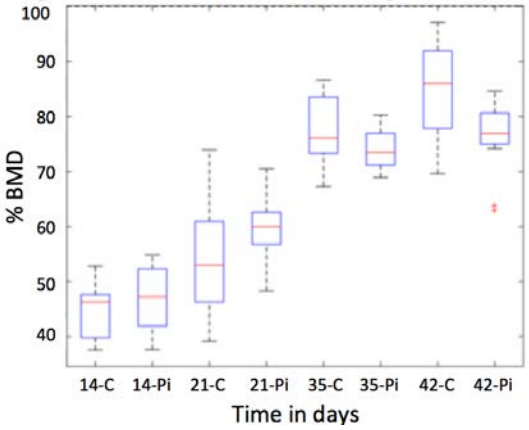
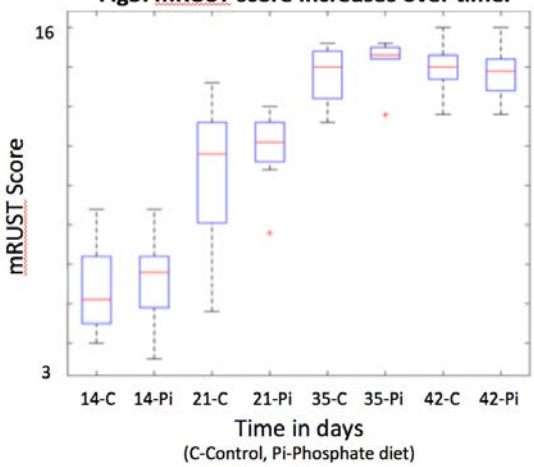


Fig3: mRUST score increases over time.



See pages 49 - 106 for financial disclosure information.

Does a Patient's Self-Reported Ability to Weight-Bear Immediately After Injury Predict Stability for Ankle Fractures?

Bonnie Chien, MD[1]*; Kurt Hofmann, MD*[2]*; Mohammad Ghorbanhoseini, MD*[3]*; David Zurakowski, PhD*[4]*; Edward Rodriguez, MD*[3]*; Paul Appleton, MD*[5]*; John Ellington, MD*[6]*; John Kwon, MD*[5]

[1]*Harvard Combined Orthopaedic Residency Program, Boston, Massachusetts, USA;*
[2]*Tufts Medical Center, Boston, Massachusetts, USA;*
[3]*Beth Israel Deaconess Medical Center / Harvard Medical School, Boston, Massachusetts, USA;*
[4]*Children's Hospital Boston, Boston, Massachusetts, USA;*
[5]*Beth Israel Deaconess Medical Center, Dept of Orthopaedics, Boston, Massachusetts, USA;*
[6]*OrthoCarolina, Foot and Ankle Institute, Charlotte, North Carolina, USA*

Background/Purpose: Determining the stability of ankle fractures, particularly for isolated Weber B fibula fractures, can be challenging. While the ultimate goal remains achieving an anatomic mortise, different techniques to predict ankle stability such as stress and weight-bearing radiographs have been utilized with variable results. History of injury and the ability to walk after sustaining ankle trauma may be predictive of stability. Therefore, this study seeks to determine whether a patient's ability to fully weight-bear immediately after injury is an effective indicator for ankle stability following ankle fracture. We hypothesize that the ability to weight-bear immediately after injury has a high predictive value for a stable mortise whereas the inability to fully weight-bear at the time of injury predicts instability.

Methods: A prospective study was conducted of 121 patients who sustained an isolated unilateral lateral malleolar, bimalleolar, or trimalleolar ankle fracture. Patients' ability to weight-bear after injury was elicited on initial presentation and correlated with ankle radiographs that were deemed stable or unstable based on commonly used indices to assess stability (ie, widening of the medial clear space). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were determined using standard formulas in order to assess a patient's ability to bear weight as a predictor of ankle fracture stability (sensitivity) and a patient's inability to bear weight as a predictor of instability (specificity).

Results: For the entire cohort, patients who were able to weight-bear immediately after injury were over 8 times more likely to have a stable fracture than those who could not (odds ratio [OR] = 8.7, $P < 0.001$). PPV for being able to fully weight-bear as it relates to stability was 73%. Inability to weight-bear was 85% specific among patients with an unstable fracture. When analyzing patients with radiographic isolated fibula fractures (n = 67), PPV = 82%, NPV = 53%, specificity = 79%, while the OR was 5.0 ($P = 0.003$) for those who could weight-bear having a stable fracture. When subanalyzing patients who presented with isolated fibula fractures and an anatomic mortise (n = 43), PPV = 74%, NPV = 52%, specificity = 62%, while the OR was 3.6 ($P = 0.07$) for those who could weight-bear having a stable fracture.

Conclusion: Patients ability to weight-bear immediately after injury is a specific and prognostic indicator for stability across a range of ankle fracture subtypes. Patients with an isolated fibula fracture and anatomic mortise were 3.6 times more likely to have a stable fracture if they were able to fully weight-bear at time of injury. While a patient's history does not preclude the need for appropriate imaging studies and clinical judgment, it may aid in the assessment of ankle stability following fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ Health-Related Quality of Life Following Operative Management of Open Fractures

*Brad Petrisor, MD[1]; **Kyle Jeray, MD[2]**; Sheila Sprague, PhD[3]; Paula McKay, BSc[3]; Gordon Guyatt, MD[3]; Stephen D. Walter, BSc, ARCS, PhD[3]; Emil H. Schemitsch, MD[4]; Susan Liew, MD[5]; Diane Heels-Ansdell, MSc[3]; Sun Makosso-Kallyth, PhD[3]; Mohit Bhandari, MD, FRCSC, PhD[6]; FLOW Investigators*
[1]Hamilton General Hospital, Hamilton, Texas, USA;
[2]Greenville Health System University Medical Center, Greenville, South Carolina, USA;
[3]McMaster University, Hamilton, Ontario, CANADA;
[4]St. Michael's Hospital, Toronto, Ontario, CANADA;
[5]The Alfred Hospital, Melbourne, Victoria, AUSTRALIA;
[6]MacOrtho Research, Hamilton, Ontario, CANADA

Purpose: Open fractures are common and debilitating injuries yet there are little data on the health-related quality of life and function following operative management. The recently completed FLOW (Fluid Lavage of Open Wounds) trial was a multicenter, blinded, randomized controlled trial, using a 2 × 3 factorial design that evaluated irrigation solution (soap vs normal saline) and irrigation pressure (very low vs low vs high) in patients with open fracture wounds. The FLOW primary analysis of 2447 patients found soap to have a significantly higher reoperation rate than saline and found no differences between the irrigation pressures evaluated. Using the FLOW data, we sought to describe health-related quality of life and function for patients in the year following their open fracture.

Methods: Patients enrolled in the FLOW study completed the Short Form-12 (SF-12) and the EuroQol-5 Dimensions (EQ-5D) at baseline (preinjury recall) and at 2 and 6 weeks, and 3, 6, 9, and 12 months postfracture. Using the standardized scoring method, we calculated the Physical Component Score (PCS) and the Mental Component Score (MCS) of the Short Form (SF)-12. The PCS and MCS are expressed on a scale from 0 to 100 with a minimally important difference of 5 points. EQ-5D results are expressed as a utility score on a scale from 0 to 1 with a minimally important difference of 0.03. The mean scores for the SF-12 PCS, SF-12 MCS, and EQ-5D were plotted over time for all patients and separately by treatment group. We conducted a multilevel Cox proportional hazards regression analysis with three levels (center, patient, and time of follow-up).

Results: We did not find any significant differences between soap and saline and between the three irrigation pressure groups on the SF-12 PCS, SF-12 MCS, and EQ-5D ($P > 0.5$). Patients had not returned to their preinjury function at 12 months for any of the three functional outcomes ($P < 0.001$). Patients' SF-12 PCS score at 12 months was 10.15 (95% CI 9.51-10.79) points lower than their preinjury score and their SF-12 MCS score was 2.66 (95% CI 2.01-3.31) points lower than their preinjury score. Patients' utility scores were 0.15 (95% CI 0.14-0.16) lower at 12 months than preinjury.

Conclusion: Similar to the findings of the FLOW primary analysis, there were no differences between irrigation pressures in the SF-12 and EQ-5D. The significant effect of irrigation solutions in our primary analysis was not found in the health-related quality of life and functional outcomes. This may be a result of generic instruments used not being sensitive

Δ OTA Grant
See pages 49 - 106 for financial disclosure information.

enough to capture differences due to reoperation or this may be due to reoperations not having a large impact on general quality of life and physical function. Patients sustaining open fractures had not returned to their pr-injury status at 12 months postfracture, as demonstrated by the clinically significant lower SF-12 PCS and utility scores.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Selective Serotonin Re-Uptake Inhibitors Impair Fracture Healing

Vivian Bradaschia Correa, DDS, PhD[1]; Devan Mehta, BS[2]; Anna Josephson, BS[1]; Jason Huo, BS[1]; Matthew Mizrahi, BS[1]; Kenneth A. Egol, MD[2]; ***Philipp Leucht, MD***[2]
[1]*New York University School of Medicine, New York, New York, USA;*
[2]*New York University Hospital for Joint Diseases, New York, New York, USA;*

Background/Purpose: Selective serotonin re-uptake inhibitors (SSRIs) are one of the most commonly prescribed antidepressants worldwide. Recent studies have linked chronic SSRI use to osteoporosis and an increased fracture risk. To date there are no studies investigating the effect of SSRIs on fracture healing. Here, we first examined the direct effect of SSRIs on osteoprogenitor cells (OPCs) in an in vitro setting followed by an in vivo analysis in a mouse model.

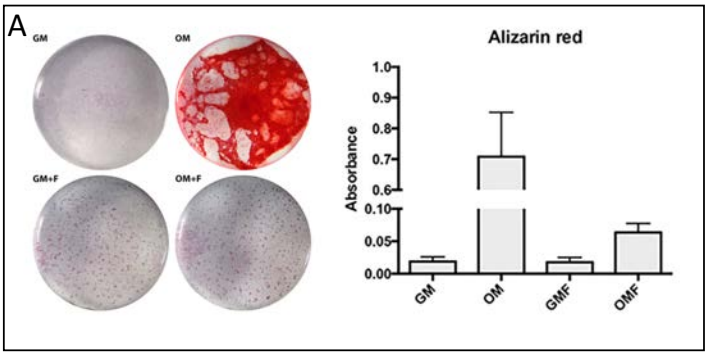
Methods: Bone marrow-derived OPCs were treated with 5, 10, 20, 50, or 100 μM of fluoxetine or control media. Cell proliferation and differentiation were assessed with standard tests including BrdU (bromodeoxyuridine), PCNA (proliferating cell nuclear antigen) staining, qPCR (quantitative polymerase chain reaction) for collagen type 1, runx2, osteocalcin, osteopontin, osterix, alkaline phosphatase (ALP), and Alizarin Red staining. For the in vivo experiments, adult C57/BL6 mice were treated with fluoxetine for 3 weeks prior to surgery. A 1-mm unicortical drill hole model was utilized to assess bone formation rate, callus volume, proliferation, differentiation, and remodeling in vivo. Mice were euthanized at 7 and 14 days postinjury.

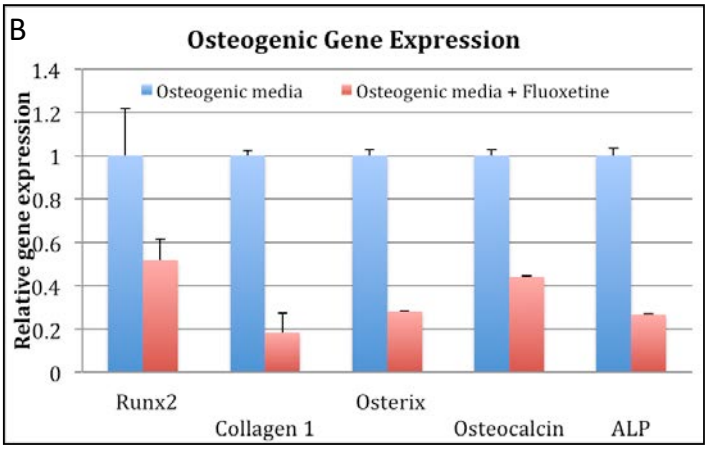
Results: Selective serotonin re-uptake inhibitors decrease osteoprogenitor cells proliferation and differentiation in vitro. In this study we sought to investigate if SSRIs had a direct effect on OPCs and primary osteoblasts. We harvested bone marrow-derived mesenchymal stem cells, using the well-accepted scrape and flush technique. Cells were plated on tissue culture plastic and split for the experiments once they had reached confluence. First, we tested whether treatment with fluoxetine affected the mitotic activity of these primary cell cultures. Treatment with fluoxetine resulted in a significant reduction of the proliferative activity compared to the control cells ($P = 0.032$). Next, we assessed whether differentiation was affected by fluoxetine treatment. We treated cells with osteogenic differentiation media ± fluoxetine for 7 days and then performed an alkaline phosphatase assay (Fig. 1A). After 7 days we found a significant reduction in alkaline phosphatase activity after fluoxetine treatment ($P = 0.009$). Quantitative PCR revealed that osteoblastic markers, such as runx2, collagen type 1, osterix, osteocalcin, and ALP were down-regulated in the fluoxetine-treated cells ($P < 0.002$) (Fig. 1B). Selective serotonin re-uptake inhibitors impede fracture healing in a murine fracture model. Finally, we examined the injured tibiae from control and SSRI-treated mice by microCT. Both at 7 and 14 days, cortical and trabecular BV/TV (bone volume/total volume)was significantly lower in mice treated with fluoxetine, confirming the in vitro findings in an in vivo model (Fig. 1C,D).

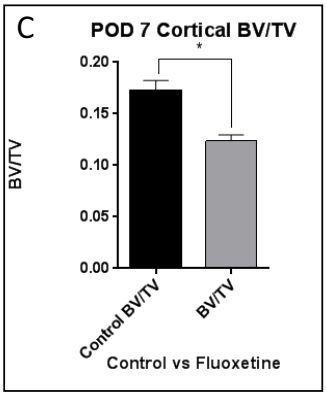
Conclusion: These experiments demonstrate that fluoxetine inhibits osteoprogenitor cell/osteoblast proliferation and impedes osteogenic differentiation both in vitro and in vivo. Animal research and human clinical data have unmistakably shown that chronic SSRI use leads

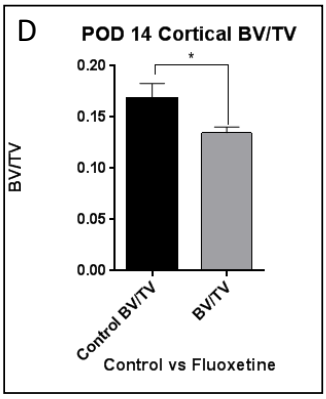
See pages 49 - 106 for financial disclosure information.

to osteoporosis, thus putting patients at risk for fragility fractures. If in fact SSRIs have a negative effect on bone regeneration after a fracture, then this patient cohort will be prone for delayed unions and nonunions. In addition, the discovery of the mechanism of action by which SSRIs inhibit bone formation may identify other, not yet identified therapeutic targets for future biomimetic approaches to enhance fracture healing.









The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Pharmacokinetics of Depot Administered Vancomycin Powder in a Rat Femur Fracture Model: Retention Time is Brief

Zachary Working, MD[1]*; Hunter Frederiksen, BS*[2]*; Alex Drew, BS*[2]*; Catherine Loc Carrillo, PhD*[2]*; Erik Kubiak, MD*[1]
[1]*University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA;*
[2]*University of Utah, Salt Lake City, Utah, USA*

Purpose: Adoption of depot vancomycin for prophylaxis against developing wound and hardware-related infections is increasing. While early data suggest that this technique could reduce infection rates, use of powdered vancomycin is being adopted by surgeons in all subspecialties of Oothopaedics despite an absence of research delineating the mechanism in question. The purpose of this study is to understand the pharmacokinetics of locally administered vancomycin powder in a high-energy, open femur fracture model in a rat.

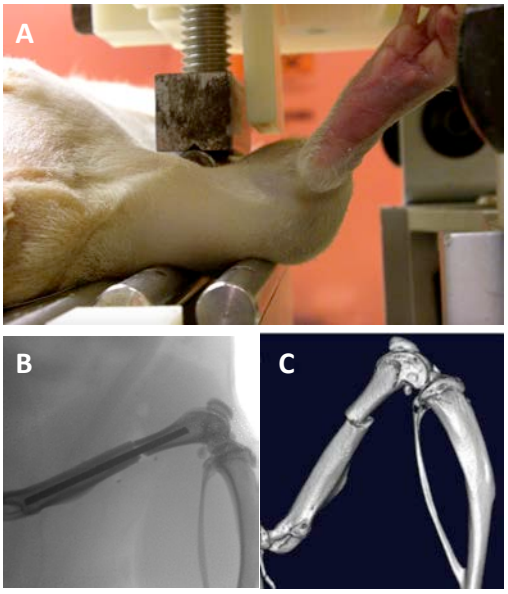
Methods: 24 Sprague Dawley rats sustained a closed, midshaft femoral fracture while under anesthesia (Fig. 1-C). A blunt guillotine apparatus was used to produce a repeatable method where a 750-g metal rod was dropped from a height of 50 cm onto the rat limb (Fig. 1-A). The left hindlimb was then surgically opened at the site of the fracture to simulate an open injury. A .054-in Kirschner wire was inserted into the femur retrograde and anterograde at the site of the fracture (Fig. 1-B). Vancomycin powder was administered using a weight based protocol. Goal dosing was set at 25 mg/kg based on prior studies utilizing vancomycin in a rat model; average total mass of administered vancomycin was 15.2 mg (SD 1.34 mg). The open wound was then closed in a layered fashion. Rats were then sacrificed in groups of 4 at 4, 8, 24, 48, 72, and 96 hours. Blood samples were taken from the rat-tail vein just prior to the time of sacrifice and bone and soft-tissue samples were explanted post mortem. High performance liquid chromatography (HPLC) analysis was performed on the femur, thigh musculature, and plasma to determine the concentration of vancomycin in the samples as a function of time.

Results: All concentration versus time curves shown in Fig. 1-D. The surrounding soft tissue demonstrated the highest maximum concentration, reaching an average of approximately 1.5 mg vancomycin per gram of muscle. Bone reached a maximum average of 199 μg vancomycin per g of femur, approximately 13% of the maximal absorption into soft tissues comparatively. Plasma ultimately reached a maximum concentration of only 1.8 μg per mL of plasma, demonstrating minimal systemic absorption. All maximum concentrations were detected at the first time point postadministration. Removal of the drug from these compartments then proceeded exponentially as a function of time. Within 48 hours, the average muscle vancomycin concentration dropped to 3 μg/g muscle (0.2% of maximum muscle concentration) and the average bone concentration dropped to 1.9 μg/g femur (0.9% of maximum concentration). Vancomycin was undetectable on all samples at 96 hours postadministration.

Conclusion: Depot administered vancomycin is shown to decrease in concentration both at the site of administration and systemically with exponential decay. Within 48 hours, drug decreased to near undetectable levels in bone, plasma, and the surrounding soft tissues in a

See pages 49 - 106 for financial disclosure information.

rat model. Therefore, the act of infection prevention is likely to occur within that time frame. This information is critical in understanding the mechanism of action of locally delivered vancomycin and the difference in pathophysiology between early and late surgical site and trauma-related infections. The rate of removal of the drug and low levels of tissue absorption also brings into question whether depot vancomycin achieves therapeutic dosing or if it is a subtherapeutic treatment modality. Further research will be necessary to answer these questions.



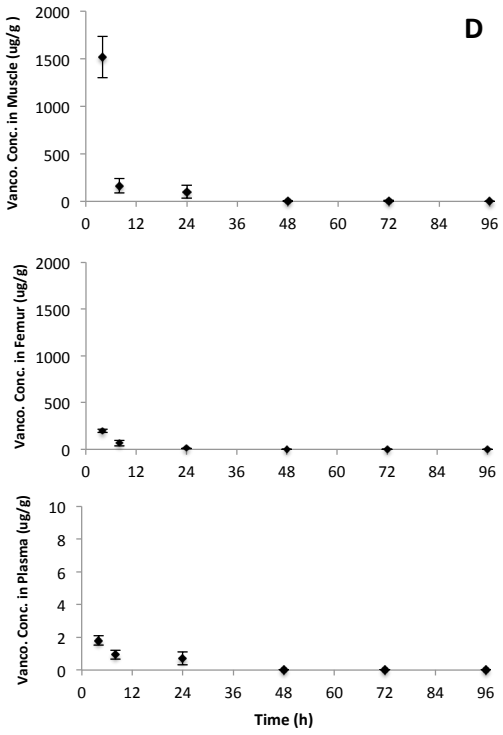


Figure 1. (A) Rat limb positioned on blunt guillotine; (B) X-ray of femur fracture; (C) Micro-CT of femur fracture; (D) Vancomycin concentration in thigh musculature, femur, or plasma over 96 h period after single 25 mg/Kg dose.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ The Effect of Timing of Aminobisphosphonate Therapy on Fracture Healing: A Rabbit Osteoporosis Model

Jesse Otero, MD[1]; Rory Metcalf, BS[1]; Nicole Watson, PhD[1]; Emily Peterson, DVM[1]; Douglas Fredericks, MD[2]; ***Michael Wiley, MD[1]***
[1]University of Iowa, Iowa City, Iowa, USA;
[2]University of Iowa Hospitals and Clinics, Iowa City, Iowa, USA

Purpose: Aminobisphosphonates reduce the rate of fragility fractures, but little is known about the effect of aminobisphosphonates on fracture healing in osteoporotic patients.

Methods: Female New Zealand white rabbits underwent ovariectomy and IV methylprednisolone treatment to induce osteoporosis. Rabbits were divided into 4 groups on the basis of timing of zoledronic acid (ZA) treatment around radius osteotomy. The pretreatment group received 0.1 mg/kg IV ZA 2 weeks prior to osteotomy. The early treatment group began ZA treatment the day of osteotomy. The delayed treatment group received ZA therapy 2 weeks after osteotomy. The control group received no ZA. Bones were analyzed at 5 weeks biomechanically, histologically, and with micro-CT.

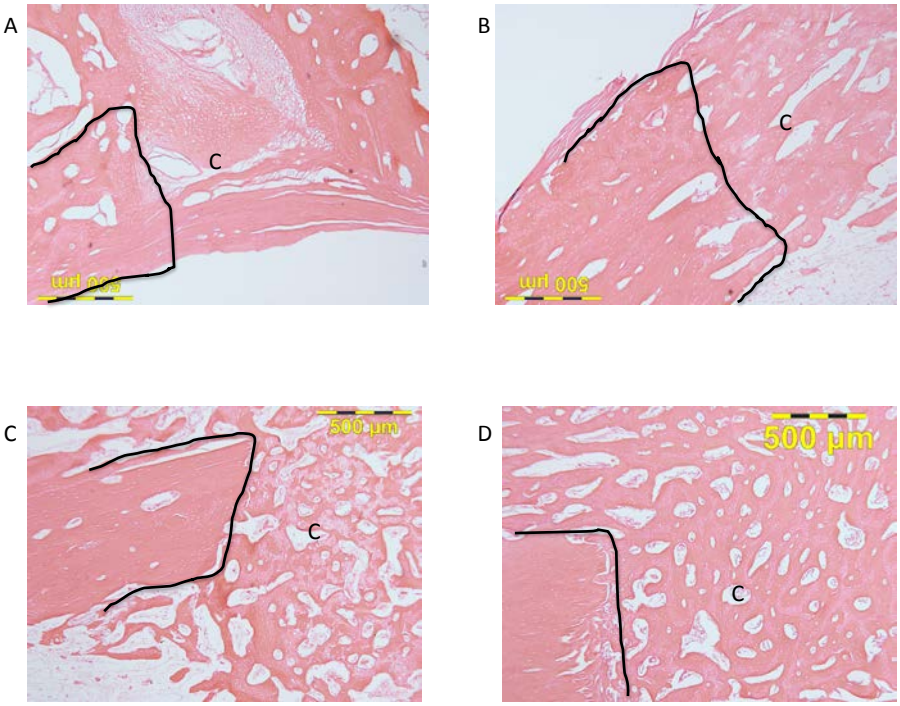


Figure 1. Histology of Fracture Callus. (A) Radius osteotomy callus stained with hematoxylin and eosin at 5 weeks post-osteotomy in rabbits treated with no zoledronic acid (control), and treated with zoledronic acid in (B) delayed, (C) early, and (D) pre-treatment periods. Line contour denotes osteotomized cortex; C denotes bridging fracture callus.

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

Results: Fracture callus volume was greater with ZA pretreatment compared with early treatment (P = 0.02) and control conditions (P = 0.04). There was a trend in increasing cross-sectional area of fracture callus with longer exposure to ZA. Fracture callus mineral density increased with longer exposure to ZA, which achieved statistical significance in pretreatment (P = 0.04) and early treatment (P = 0.008) compared with the control group. Peak torque to failure was higher with ZA pretreatment compared with delayed (P = 0.003) and control (P = 0.04) conditions. Histologically, fracture callus showed an increase in woven bone formation with longer bisphosphonate exposure.

Conclusion: In our osteoporotic rabbit fracture model, aminobisphosphonate treatment allowed a robust fracture healing response, even when administered acutely. Longer exposure resulted in increased strength of fracture callus.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Proprionibacterium Acnes Colonization Impairs Fracture Healing in a Rat Model of an Open Femur Fracture Treated with Intramedullary Fixation

Robert Duerr, MD[1]*; Mark Longwell, BS; Michael Florack, MD*[1]*; Laura Nistico, PhD*[3]*; Daniel Altman, MD*[2]*; Gregory Altman, MD*[2]*; Rachael Kreft*[3]
[1]*Allegheny Health Network, Pittsburgh, Pennsylvania, USA;*
[2]*Allegheny General Hospital, Pittsburgh, Pennsylvania, USA;*
[3]*Allegheny Singer Research Institute, Biofilms Center of Excellence, Pittsburgh, Pennsylvania, USA*

Background/Purpose: Bacterial biofilms play an important role in failed orthopaedic surgeries, notably joint arthroplasty and fracture nonunion. Novel molecular diagnostics have led to multiple studies characterizing biofilms in orthopaedic infections. Such studies suggest these infections are usually polyclonal, and often, but not always, associated with negative outcomes. Furthermore, these studies demonstrate that some species, which are often missed or discarded as lab contaminants, are in fact colonizers of bones or orthopaedic implants. One prominent example is Proprionibacterium acnes, a gram-positive anaerobic bacillus traditionally considered nonpathogenic. It is commonly found colonizing the skin, upper respiratory tract, and/or gastroenteric mucosa. P. acnes is often overlooked in clinical diagnostics as it is an anaerobe and not easily detected in standard culture. Multiple recent studies using highly sensitive molecular diagnostics have detected P. acnes in orthopaedic infections supporting the hypothesis that P. acnes plays a pathogenic role. We hypothesize that P. acnes has a pathogenic role in the formation of biofilms and will impair fracture healing after intramedullary (IM) fixation of a femur fracture in a rat model.

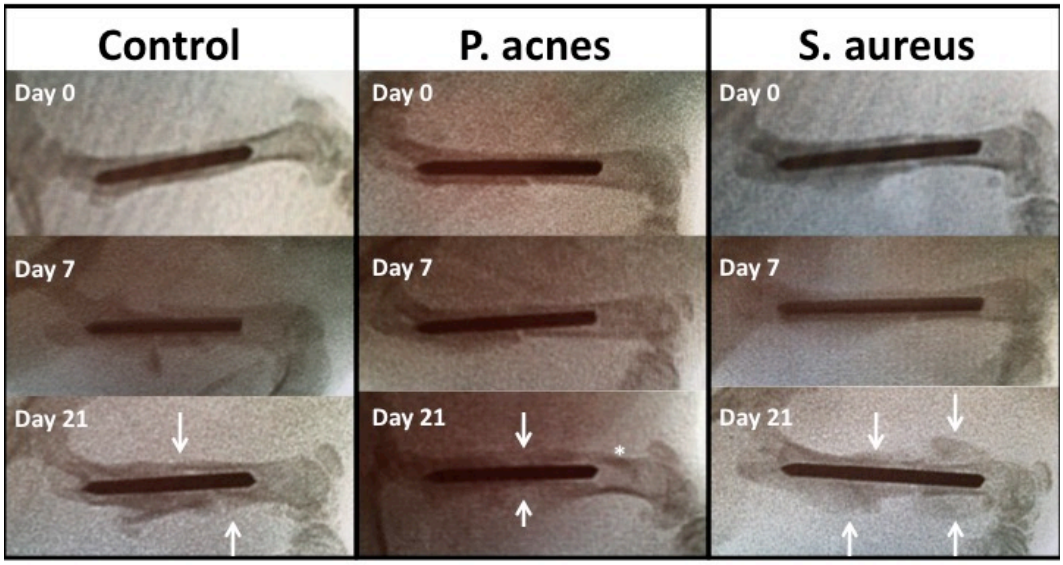
Methods: Once IACUC (Institutional Animal Care and Use Committee) approval was obtained, a pilot study was completed to ensure the efficacy of our novel surgical technique. 84 male Sprague Dawley rats then underwent IM fixation of an open femur fracture created under sterile conditions and were inoculated with (1) sterile saline (control), (2) Staphylococcus aureus, or (3) P. acnes. 24 rats were excluded from the study; 9 did not recover from anesthesia, 9 wounds dehisced, 4 fractures were comminuted and not amenable to IM fixation, and 2 had loss of fixation. The rats were followed for either 7 or 21 days, for a total of 10 rats in each group. At the end point, a lateral radiograph of the hindlimb was obtained, and necropsy was performed to evaluate for signs of infection and fracture healing. The lateral radiograph of the femur was evaluated for osteolysis, soft-tissue swelling, periosteal reaction, general impression, and deformity and scored as (0) absent, (1) mild, (2) moderate, or (3) severe. Also, 1 additional point was added for either sequestra formation, or spontaneous fracture for a maximum score of 17. Radiographs were scored independently by two orthopaedic surgeons. The groups were compared using Student's t test for statistically significant differences ($P < 0.05$).

Results: At 7 days, the average radiographic score was 2.7 ± 1.3, 3.8 ± 1.4, and 5.2 ± 2.7 for the control, S. aureus, and P. acnes groups respectively. At 21 days, the average radiographic score was 4.8 ± 2.4, 7.9 ± 3.2, and 7.2 ± 2.4 for the control, S. aureus, and P. acnes groups respectively. There was a significant difference between the control and P. acnes groups at 7 days ($P = 0.02$) and at 21 days ($P = 0.04$). There was also a significant difference between

See pages 49 - 106 for financial disclosure information.

the control and S. aureus groups at 21 days (P = 0.025). There was no significant difference between the P. acnes and S. aureus groups at 7 (P = 0.16) or 21 days (P = 0.59). At necropsy, the control group showed signs of early callus formation at 7 days and most were healed by 21 days. In several of the P. acnes and S. aureus rats, there were obvious signs of infection with frank purulence at the fracture site and minimal signs of healing.

Figure 1



Control: No loss of fixation, bridging callous across fracture site at 21 days (arrows)
P. acnes: At day 21: loss of fixation in distal fragment, osteolysis at fracture site (arrows) and within distal canal (*)
S. aureus: At day 21: Substantial periosteal reaction (arrows), correlated clinically with sequestra formation

Conclusion: P. acnes inoculation of a rat femur fracture treated with IM fixation impairs fracture healing and leads to radiographic changes similar to those seen with S. aureus inoculation at 7 and 21 days (Fig. 1). The use of a control group and a known pathogenic comparison group enabled a thorough evaluation of the radiographic changes that occur in a rat model of an open femur fracture treated with IM fixation. The possibility of contamination during the surgical procedure is a risk, as with any surgical procedure, although our best efforts to maintain sterility were utilized and the fact that none of our control groups had signs of infection at necropsy is encouraging. Future studies utilizing molecular diagnostics to identify the bacterial species at necropsy and confocal microscopy to evaluate for the formation of biofilms at the fracture sites are planned. The primary limitation of the study is the small number of animals in each group, although we were able to achieve significance.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ Impedance Measurements Correlate to Callus Maturation of Mice Tibia Fractures

Monica Lin, BS[1]*; Frank Yang, BS*[2]*; Safa Herfat, PhD*[2]*; Chelsea Bahney, PhD*[3]*; Michel Maharbiz, PhD*[4]*; Meir Marmor, MD*[2]
[1]*UC Berkeley - University of California San Francisco, San Francisco, California, USA;*
[2]*San Francisco General Hospital, San Francisco, California, USA;*
[3]*University of California San Francisco, San Francisco, California, USA;*
[4]*University of California Berkeley, Berkeley, California, USA*

Background/Purpose: Approximately 15 million fracture injuries occur in the United States each year. Accurate monitoring of fracture healing can determine timing of return to function or the need for early intervention in case of a fracture nonunion. Fracture healing is currently monitored by radiographic methods, which rely on mineralization of tissue that only occurs in the later stages of fracture healing, and other monitoring techniques are either subjective or inaccurate. Electrical impedance spectroscopy (EIS) provides a measure of the dielectric properties of a medium and has been used to differentiate between different tissue types. We hypothesized that EIS can be used to monitor fracture healing by tracking the changing tissue composition of a fracture callus as it progresses through the various stages of healing.

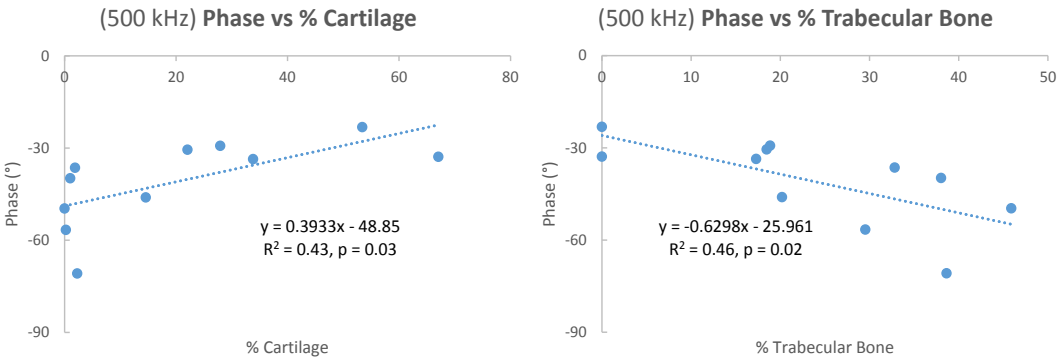
Methods: Standardized, closed fractures were created in the middiaphyses of mice tibia according to an established murine model of endochondral repair. Mice were euthanized and their fracture callus tissues dissected out at days 8, 14, and 21 postfracture for measurement (N = 11). Each intact callus was pressed onto custom-made sensors with a 590-g weight, and 2-point impedance measurements were taken across two gold electrodes (150-μm diameter) over a range of frequencies (20 Hz to 1 MHz). Samples were also fixed in 4% paraformaldehyde overnight, decalcified in 19% EDTA (pH 7.4) for 14 days at 4°C, and embedded in paraffin. Serial 10-μm longitudinal sections throughout the entire callus tissue were collected and stained with modified Milligan's Trichrome. To quantify tissue volume fractions, histomorphometric analyses of total callus, cartilage, trabecular bone, cortical bone, muscle, fibrous tissue, and bone marrow space volumes were performed using an Olympus CAST system and Visiopharm software. The total tissue volumes were calculated in cubic millimeters (mm3) using the equation for a conical frustum and Cavalieri's principle. Univariate linear regression analysis was performed to assess correlative relationships between impedance measurements and volume fraction percentages of the various tissues present in the fracture calluses, and two-tailed t tests were used to determine whether regression slopes were significantly different than 0. Significance was set at $P < 0.05$ and trends were defined as $0.05 < P < 0.1$.

Results: Linear regression analyses indicated negative relationships between impedance magnitude ($|Z|$) and % trabecular bone as well as % marrow space, and positive relationships between $|Z|$ and % cartilage as well as % fibrous tissue. The opposite trends were found when comparing phase angle (θ) to these same volume fractions of tissues. These correlations were as expected; as healing time increases, % cartilage decreases and % trabecular bone increases as the spongy bone replaces the early soft callus. As a result, $|Z|$ rises over the course of healing as more conductive tissue (cartilage) is remodeled into more resistive tissue (bone). % fibrous tissue decreases with healing time as it is replaced by trabecular

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

bone or marrow space, and consequently % marrow space increases. Specifically at 500 kHz, |Z| and phase both showed significant correlation with % cartilage and % trabecular bone (R2 >0.40, P <0.05). At 1 MHz, phase became less negative with greater % cartilage and % fibrous tissue (R2 >0.54, P <0.01) and more negative with greater % trabecular bone (R2 = 0.58, P = 0.007). In addition, phase became less negative significantly with % trabecular bone at 5 kHz (R2 = 0.39, P = 0.04), and this trend was maintained for frequencies less than 5 kHz (P <0.1).



Regression analysis of phase angle (θ) correlated to % volume fractions of cartilage and of trabecular bone for fracture calluses. Significant relationships are shown here for measurements at 500 kHz.

Conclusion: Impedance magnitude and phase angle have significant correlations with volume fractions of cartilage, trabecular bone, fibrous tissue, and marrow space at multiple frequencies, particularly below 5 kHz and above 500 kHz. These findings support use of electrical impedance spectroscopy for monitoring fracture healing.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

See pages 49 - 106 for financial disclosure information.

Gaylord
NATIONAL HARBOR
Maryland

2016 ANNUAL MEETING

Program Chair
Robert V. O'Toole, MD

Program Co-Chair
Michael D. McKee, MD

Local Host
Jean-Claude G. D'Alleyrand, MD

President
Steven A. Olson, MD

OTA ORTHOPAEDIC TRAUMA ASSOCIATION

FINAL PROGRAM

October 5-8, 2016

Gaylord National
National Harbor, Maryland, USA

See pages 49 - 106 for financial disclosure information.

Better Clinical and Radiographic Outcomes with Suture Endobutton Compared to Syndesmotic Screw in Treatment of Syndesmotic Injuries: A Randomized Controlled Trial

Mette Andersen, MD*[1]*; *Frede Frihagen, MD, PhD*[2]*; Johan Hellund, MD, PhD*[3]*; Jan Erik Madsen, MD, PhD*[2]*; Wender Figved, MD, PhD*[1]
[1]*Department of Orthopaedic Surgery, Baerum Hospital, Vestre Viken HF, Drammen, NORWAY*
[2]*Department of Orthopaedic Surgery, Division of Surgery and Clinical Neuroscience, Oslo University Hospital, Oslo, NORWAY*
[3]*Department of Radiology and Nuclear Medicine, Oslo University Hospital, Oslo, NORWAY*

Purpose: Anatomic reduction of the tibiofibular joint is associated with better functional outcome and less posttraumatic arthritis. There is a great variability in methods of fixation, perhaps as a result of the lack of evidence supporting one method over another. The purpose of this study was to compare clinical results after stabilization of the acute injured syndesmosis with suture endobutton (SE) or one quadricortical screw (SS).

Methods: 97 patients between 18 and 70 years of age with syndesmotic injuries were randomized into two groups (SE =48, SS = 49). 95 patients had concomitant OTA / AO ankle fracture type 44-C and 2 patients had an isolated syndesmotic injury. The two groups were similar regarding gender, age, and body mass index (BMI). The syndesmotic screw was removed 10-12 weeks after surgery as a routine. Rehabilitation was standardized for both groups; partial weight bearing was allowed after 2 weeks and full weight bearing was allowed after 6 weeks. Dorsiflexion ad modum Lindsjo and functional outcome scores were obtained after 6 weeks, 6 months, and 1 year. Main outcome measure was the modified American Orthopaedic Foot & Ankle Society ankle hindfoot score (AOFAS). Conventional radiographic examination of the injured ankle was obtained after surgery, 6 weeks, and 6 months. CT scans of both ankles were obtained within 2 weeks after surgery and after 1 year. The examinations were standardized with the ankles in neutral position and legs in 20° internal rotation. The syndesmosis was assessed on axial scans 1 cm proximal to the tibial plafond. The tibiofibular distance (TFD) was measured at three standardized points (Fig. 1), and the difference between the width of the oper-

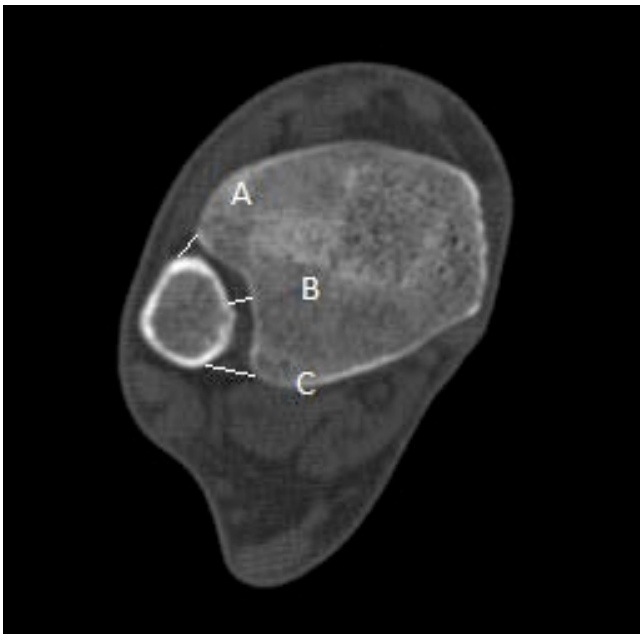


Fig 1: Axial CT scan with measurements (A=anterior, B=central, C=posterior)

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

ated and nonoperated ankle was calculated. Rate of complications and reoperations were recorded. 85 patients (88%) completed 1-year follow-up (SE = 46, SS = 39).

Results: Patients treated with SE presented with better AOFAS after 6 weeks (63 vs 58, P = 0.13), 6 months (88 vs 82, P = 0.02), and 1 year (93 vs 84, P = 0.001). Also Olerud Molander Score was better in the SE group after 6 weeks (35 vs 32, P = 0.41), 6 months (81 vs 68, P = 0.001), and 1 year (90 vs 80, P = 0.02). The difference in maximal dorsiflexion between injured and noninjured side was smaller in the SE group than the SS group after 6 weeks (-17.1 vs -20.9°, P = 0.08), 6 months (-7.6 vs -10.9°, P = 0.04), and 1 year (-4.7 vs -7.6°, P = 0.05). Number of patients with TFD between operated and nonoperated ankle of 2 mm or more were higher in the SS group after 1 year: anterior, 23 (58%) vs 12 (28%) (P = 0.008); central, 18 (45%) vs 10 (23%) (P = 0.04); posterior, 17 (45%) vs 10 (23%) (P = 0.1). Seven patients (15%) in the SS group were diagnosed with recurrent syndesmotic diastasis during the treatment period compared to none in the SE group (P = 0.005). Three patients (6%) in the SE group required suture endobutton removal within the first year after surgery due to discomfort associated with the lateral knot.

Conclusion: Suture endobutton is a better alternative than one quadricortical screw in the treatment of syndesmotic injuries in patients below 70 years of age, because it provides better anatomical restoration and superior clinical results.

See pages 49 - 106 for financial disclosure information.

Single versus Continuous Nerve Block for Extremity Fractures: A Comparative Study

Abhishek Ganta, MD*[1]*; *David Ding, MD*[1]*; Nina Fisher, BS*[1]*; Sudheer Jain, MD*[2]*; Nirmal C. Tejwani, MD*[1]

[1]*New York University Hospital for Joint Diseases, New York, New York, USA*

[2]*New York University Langone Medical Center, New York, New York, USA*

Background/Purpose: Peripheral nerve blocks are frequently used in extremity fracture surgery for controlling intraoperative and postoperative pain. However, patients have reported a rise in rebound pain as the anesthetic wears off. Continuous nerve blocks have been utilized to help decrease the amount of rebound pain and decrease postoperative narcotic analgesia. The purpose of this study was to compare the efficacy of the continuous nerve block as well as the single shot nerve block in distal radius fractures as well as ankle fracture surgeries. Additionally, the continuous nerve block was compared to single nerve block for both fracture types together to assess overall efficacy of the continuous nerve block

Methods: There were 50 patients undergoing operative fixation of ankle fractures and 40 patients undergoing operative fixation of distal radius fractures that were reviewed after being randomized to receive a single nerve block (n = 59) or a continuous nerve block with a pump (n = 41). Patients with distal radius fractures received an infraclavicular block, and ankle fractures received a popliteal-sciatic block. Postoperative pain scores as well as number of pain pills were recorded at 8, 12, 24, 48, and 72 hours postoperatively. Pain scores and number of pain pills taken at each of these time points were compared across extremity fracture groups within the single and continuous nerve block groups. Overall pain scores and number of pain pills were compared across single and continuous block groups for both extremity fracture groups combined.

Results: When comparing the continuous nerve block between ankle fractures and distal radius fractures, the distal radius group had significantly less pain pills at 48 hours postoperatively (median number of pain pills: 3 vs 5, P = 0.019). For the single nerve block groups, the distal radius group was found to have significantly less pain compared to ankles at the 12-hour postoperative period (median pain score: 6.0 vs 8.0, P =0.039) and also fewer pain pills at the 24-hour (median number of pain pills 2 vs 5, P = 0.002) and 48-hour (4 vs 6, P = 0.001) postoperative periods. When comparing the continuous block for upper and lower extremity fractures with the single nerve block, the continuous nerve block group had overall decreased pain at all time points but was statistically significant at the 12-hour postoperative period (median pain score: 4.5 vs 7.0, P = 0.041). Furthermore, the same trend was noted for the amount of pain pills taken postoperatively and was statistically significant at the 24-hour period (median number of pain pills: 3 vs 2, P = 0.014).

Conclusion: The distal radius group required less pain medication and had lower pain scores with both the single nerve block as well as continuous nerve block infusion groups. Furthermore, it was also noted that use of a continuous infusion pump for postoperative pain in ankle and distal radius fracture cases combined has been shown to decrease rebound pain at 24 hours when compared to a single nerve block.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Plate Fixation versus Nonoperative Treatment for Displaced Midshaft Clavicular Fractures: A Multicenter Randomized Controlled Trial

Sarah Woltz, MD*[1]*; *S. Stegeman, MD, PhD*[1]*; P. Krijnen, PhD*[1]*; Bart van Dijkman, MD, PhD*[2]*; Thom van Thiel, MD, PhD*[3]*; N.W.L. Schep, MD, MSc, PhD*[4]*; Piet de Rijcke, MD, PhD*[5]*; Jan Paul Frolke, MD*[6]*; I.B. Schipper, MD, PhD*[1]
[1]*Leiden University Medical Center, NETHERLANDS;*
[2]*Flevoziekenhuis, NETHERLANDS;*
[3]*Koningin Beatrix Ziekenhuis, NETHERLANDS;*
[4]*AMC Amsterdam, Noord-Holland, NETHERLANDS;*
[5]*IJsselland Ziekenhuis, NETHERLANDS;*
[6]*Radboud University Nijmegen Medical Center, NETHERLANDS*

Purpose: Operative treatment for clavicular fractures is now more popular than ever, despite varying results of previous studies. The aim of this study was to compare plate fixation with nonoperative treatment for displaced, midshaft clavicular fractures in terms of nonunion, adverse events, and shoulder function.

Methods: In this multicenter, prospective, randomized controlled trial, patients between 18 and 60 years with a displaced, midshaft clavicular fracture were randomized between nonoperative treatment and open reduction with internal plate fixation. The primary outcome was nonunion at 1 year. Other outcomes were secondary operations, arm function as measured with the Constant shoulder score and DASH (Disabilities of the Arm, Shoulder and Hand) score, pain, cosmetic results, and general health status. Outcomes were recorded at 6 weeks, 3 months, and 1 year following trauma.

Results: 160 patients were randomized. The incidence of nonunion was significantly higher in the nonoperative group (2.4% vs 23.1%, P <0.0001), as was the incidence of nonunion for which secondary plate fixation was performed (1.2% vs 12.9%, P = 0.006). The rate of secondary operations was 10.7% in the operative group and 15.7% in the nonoperative group (P = 0.47). An additional 16.7% of patients in the operative group underwent elective plate removal. 19% of patients in the operative group had persistent loss of sensation around the scar. Constant and DASH scores did not differ between groups at all time points.

Conclusion: Patients with a diaphyseal fracture of the clavicle displaced more than one shaft width can be advised that plate fixation improves the chances the bone will heal, but is more likely to lead to a second operation, and does not improve shoulder function or general symptoms and limitations compared with nonoperative treatment in a sling.

See pages 49 - 106 for financial disclosure information.

Δ Simple Decompression versus Anterior Transposition of the Ulnar Nerve for Distal Humerus Fractures Treated with Plate Fixation:
A Multi Centre Randomized Controlled Trial

Emil H. Schemitsch, MD[1]*; Niloofar Dehghan, MD, MS, FRCSC*[2]*; Milena Vicente, RN*[2]*;*
Aaron Nauth, MD, FRCSC[1]*; Jeremy Hall, MD, FRCS (ORTHO), MEd*[1]*;*
Michael D. McKee, MD[1]*; COTS (Canadian Orthopaedic Trauma Society)*
[1]*St. Michael's Hospital, Toronto, Ontario, CANADA*
[2]*University of Toronto, Toronto, Ontario, CANADA*

Background/Purpose: Isolation, decompression, and protection of the ulnar nerve is required for the fixation of distal humerus fractures performed through a posterior approach. While this fact is widely agreed upon, the management of the ulnar nerve at the conclusion of the surgical procedure is a matter of controversy, focused upon either leaving the nerve in situ versus anterior transposition. There have been advocates of both strategies in the literature, but high-level evidence comparing the two strategies is lacking. Given the high incidence of ulnar nerve dysfunction following the surgical management of distal humerus fractures, and the substantial impact of ulnar nerve symptoms on patient outcomes, this important issue warrants further research. This study sought to address this controversy by comparing simple decompression to anterior transposition of the ulnar nerve following plate fixation of fractures of the distal humerus. The hypothesis was that there would be no difference in ulnar nerve function at 1 year postsurgery between the two groups.

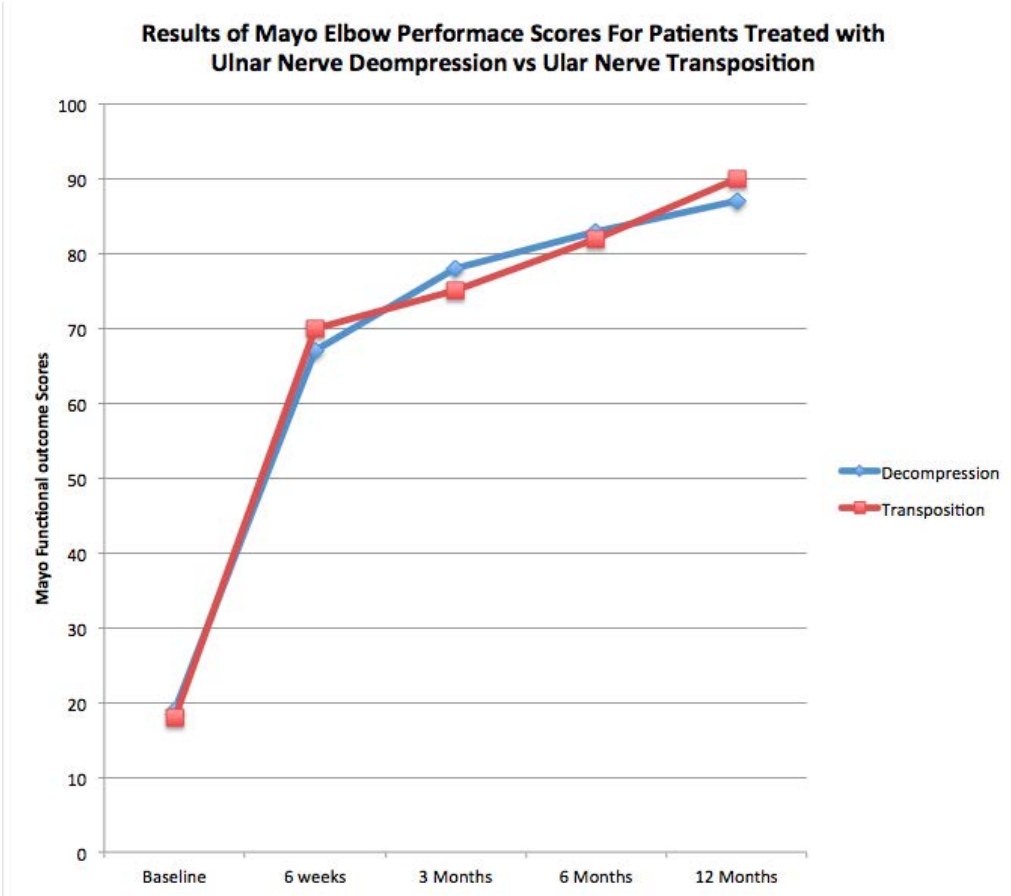
Methods: This multicenter randomized controlled trial was performed across eight trauma centers in North America. All patients underwent dual plate fixation for an acute, displaced fracture of the distal humerus, and were randomized to receive either (1) simple decompression or (2) anterior subcutaneous transposition of the ulnar nerve at the conclusion of the procedure. Inclusion criteria included: patients 16 to 80 years of age, displaced distal humerus fractures (OTA 13A or 13C) ≤28 days postinjury, closed fractures or grade I/II open fractures, and provision of informed consent. Comprehensive neurological, functional, sensory, motor, and electrophysiological outcome assessments were conducted. The primary outcome was the Ulnar Nerve Entrapment Score classification system of Gabel and Amadio. Secondary outcomes included a functional outcome score (MEPS [Mayo Elbow Performance Score]), grip and pinch strength, hand function test of Jebsen, and nerve conduction testing. Patients were followed at 6 weeks, 3 months, 6 months, 1 yea,r and 2 years postoperatively. Complications were also assessed at each visit.

Results: 61 patients were recruited: 30 were randomized to decompression, 28 were randomized to anterior transposition, and 3 patients withdrew from the study. The mean age was 52 years, and 60% were female. There was no difference between the two groups with regard to age, sex, body mass index (BMI), smoking, diabetes, injury characteristics, time to operating room (OR), length of OR, or surgical approach. When comparing simple decompression and anterior transposition of the ulnar nerve, there was no difference in outcome between the two groups at any time point with regard to Ulnar Nerve Entrapment Score, MEPS scores, VAS (visual analog scale), or two-point discrimination. Overall, Ulnar Nerve Entrapment Scores improved in both groups from 6.0 at baseline to 7.8 at 1 year postoperatively (P = 0.005).

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Patients also had significant improvement in MEPS scores at each visit: 19 at baseline, 68 at 6 weeks, 77 at 3 months, 83 at 6 months, and 88 at 1 year postoperatively (Fig. 1, $P < 0.05$). Overall, two-point discrimination in the ulnar nerve distribution improved from 7.2 mm at 6 weeks to 5.0 mm at 1 year postoperatively ($P = 0.003$). There was minimal change in the VAS at any time point. Complications included 4 superficial wound infections, 2 deep infections, 4 nonunions, and 11 revision surgeries, and were equally distributed between the two groups.



Conclusion: This randomized trial demonstrated that the majority of patients with plate fixation of a distal humerus fracture develop symptoms of ulnar nerve irritation postinjury; however, the majority of patients demonstrated improvement by 1 year postsurgery. Functional outcomes also improved significantly in the first year after surgical treatment. There was no difference with regards to ulnar nerve symptoms, functional outcomes, or complications for patients treated with either simple decompression or anterior transposition of the ulnar nerve. This study was unable to demonstrate any significant difference in outcome between these two treatments of the ulnar nerve when performed following dual plate fixation of a distal humerus fracture. Either strategy for managing the ulnar nerve is acceptable and can be used at the discretion of the treating surgeon.

See pages 49 - 106 for financial disclosure information.

EUSOL® versus Antibiotic-Loaded Collagen Granules (Co-Mupimet®) as a Dressing Agentin the Management of Traumatic Wounds

Rajiv Maharjan, MBBS, MD; *Amit Shah, MBBS, MD; Pashupati Chaudhary, MBBS, MS*
BP Koirala Institute of Health Sciences, Koshi, NEPAL

Purpose: Traumatic wounds are one of the common causes of morbidity in orthopaedic patients. To date there is no randomized controlled trial available that compares the healing potential of Edinburgh University Solution of Lime (EUSOL) with mupirocin in collagen granules and Metronidazole (Co-Mupimet®) as a dressing agent. We aim to compare the effectiveness and healing potential of Co-Mupimet® and EUSOL in terms of quantity and quality of granulation tissue formation, pattern of wound discharge, healing potential, or need of secondary procedures like skin grafting or flap coverage.

Methods: This study was approved by the Institutional Ethical Review Board. 130 eligible patients with infected traumatic limb wounds and surgically infected wounds were randomized into the EUSOL group (n = 65) and Co-Mupimet® group (n = 65). Patients with impaired wound healing potential, wound over insensate/avascular limb, and patients not giving consent were excluded. A wound swab for culture was taken for all cases at the presentation. Size of wound after debridement at initial presentation, at 1st, 2nd, 3rd, and 4th week was measured and the quality and quantity of granulation tissue formation was assessed.

Results: The gender distribution (P = 0.323), mode of injury distribution (P = 0.826), spectrum of injury (P = 0.31), and ratio of culture positives at presentation (P = 0.71) among the groups were not significant. The mean age (years), mean wound size at presentation after debridement (cm2), baseline hemoglobin (g/dL), random blood sugar (mg/dL), and serum albumin (g/dL) was 35.11 ± 20.63, 36.08 ± 28.98, 10.78 ± 1.79, 97.76 ± 15.27, and 5.90 ± 0.84 respectively for EUSOL group, while it was 34.56 ± 19.58, 37.77 ± 36.97, 10.88 ± 1.63, 95.52 ± 12.64, and 5.96 ± 0.70 respectively for Co-Mupimet® group with the corresponding P values being 0.71, 0.69, 0.92, 0.33, and 0.82, respectively. The P value for ratio of discharging wounds among the EUSOL group and Co-Mupimet® groups at 1st, 2nd, 3rd, and 4th week was 0.20, 0.62, 0.54, and 0.24, respectively. Lesser amount of discharge was seen among wounds dressed with collagen granules (P >0.05). Similarly, the P value for appearance of healthy granulation tissue among the groups at 1st, 2nd, and 3rd week were 0.02, 0.00, and 0.02, respectively. Probability of complete healing at 1st, 2nd, 3rd, and 4th week were 0.16, 0.29, 0.41, and 0.50, respectively, for EUSOL group while they were 0.26, 0.61, 0.61, and 0.40, respectively, for Co-Mupimet® group with their corresponding odds ratio as 1.62, 2.10, 1.48, and 0.80, respectively.

Conclusion: Co-Mupimet® is a better and cost-effective dressing agent as it showed earlier and higher probability of healing with better quality granulation tissue that is ready for skin grafting much earlier. There was also faster reduction in wound size with Co-Mupimet® dressing.This indirectly reduces the hospital stay / treatment cost and use of hospital resources.

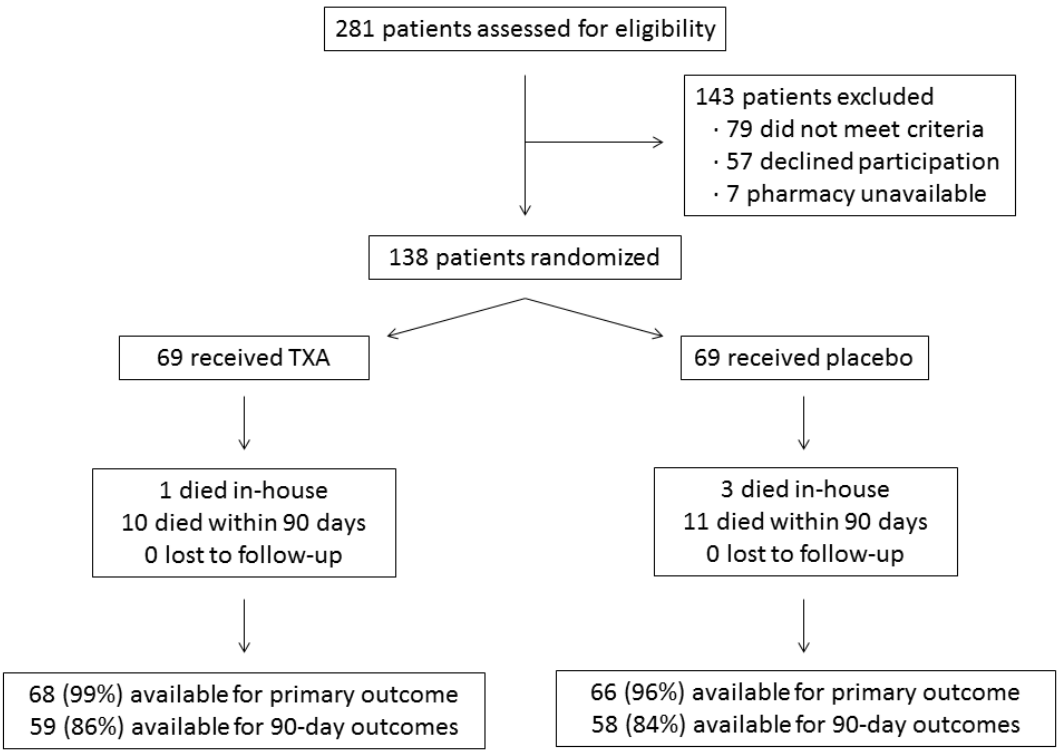
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Tranexamic Acid Safely Reduced Blood Loss in Hip Arthroplasty for Acute Femoral Neck Fracture

Chad Watts, MD; Matthew Houdek, MD; ***Stephen Sems, MD;*** *William Cross, MD; Mark Pagnano, MD*
Mayo Clinic, Rochester, Minnesota, USA

Purpose: Tranexamic acid (TXA) has been shown to limit blood loss and transfusion in elective primary total hip arthroplasty (THA), but there are limited data on its use in patients undergoing arthroplasty for femoral neck fracture (AO 31B). We aimed to determine (1) does TXA reduce calculated blood loss, (2) does TXA reduce the incidence of allogenic blood transfusion, and (3) are there any observable differences in 30- and 90-day complications with TXA administration?

Methods: We performed a prospective, double-blinded, randomized controlled trial wherein 138 patients were randomized to receive either TXA or placebo at the time of surgery. Follow-up was available for all patients through at least 90 days, unless death came earlier. Data collected included calculated blood loss, proportion of patients transfused, number of units transfused, hospital readmission, and 30- and 90-day complications including thromboembolic event, wound complication, reoperation, and mortality.



See pages 49 - 106 for financial disclosure information.

Results: TXA reduced mean calculated blood loss by 305 mL (P = 0.0005). Fewer patients received transfusions in the TXA group (17%) when compared to the placebo group (26%), but this was not statistically significant (P = 0.22). TXA was safe with no differences in adverse events at 30 and 90 days.

Conclusion: This randomized clinical trial found that TXA administration was safe and effective in reducing blood loss, but did not show a significant difference in transfusion for patients undergoing hip arthroplasty for acute femoral neck fracture. More studies are needed to further ascertain the role of TXA in the management of patients with femoral neck fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Fixation Using Alternative Implants for the Treatment of Hip Fractures: A Large, Blinded, International Multicenter Randomized Trial

FAITH Investigators, MD, McMaster University, Hamilton, Ontario, CANADA
Marc F. Swiontkowski, MD

Purpose: Worldwide, 4.5 million persons are disabled from hip fractures yearly with an expected increase to 21 million persons living with disability in the next 40 years. The optimal fracture fixation technique for low-energy femoral neck fractures remains controversial. A lack of consensus regarding the optimal approach for fixation of femoral neck fractures fueled the design and execution of the Fixation Using Alternative Implants for the Treatment of Hip Fractures (FAITH) randomized controlled trial (RCT). This RCT evaluated the impact of cancellous screw fixation versus sliding hip screws on rates of revision surgery at 24 months in individuals with femoral neck fractures.

Methods: This was a large, blinded randomized trial enrolling patients across 81 centers with displaced and undisplaced femoral neck fractures requiring internal fixation. Participants were randomized to one of two fixation strategies. The first strategy involved fixation of the fracture with multiple small diameter cancellous screws (cancellous screw group). The second treatment strategy involved fixation of the fracture with a single larger diameter screw with a sideplate (sliding hip screw group). The primary outcome was revision surgery within 2 years of the initial surgery. Patients and data analysts were blinded to the treatment groups.

Results: 1111 participants were enrolled into the trial over a 6-year period from 2008 to 2014 at 81 clinical sites in the United States, Canada, Australia, the Netherlands, Norway, and India. Baseline characteristics are presented in Table 1. The results will be released in a symposium presentation at the OTA annual meeting

Conclusion: This study represents major international efforts to definitively resolve the treatment of low-energy femoral neck fractures. The rigor of the FAITH trial, and its size, ensures that, given the current variability in use of internal fixation methods of femoral neck fracture, the results will change practice in the management of these challenging fractures.

Table 1. Baseline Characteristics

Age (mean ± SD)	72.0±12.2
Male	435 (39.7%)
Ethnicity	
Caucasian	891 (81.4%)
South Asian	145 (13.2%)
Black	40 (3.7%)
East Asian	10 (0.9%)
Hispanic of Latino	5 (0.5%)
Native or Aboriginal	4 (0.4%)
Mechanism of Injury	
Fall	1060 (96.9%)
Spontaneous	20 (1.8%)
Other	14 (1.3%)
Fracture Displacement	
Undisplaced	747 (68.1%)
Displaced	350 (31.9%)
Level of the Fracture Line	
Subcapital	627 (57.2%)
Midcervical	376 (34.3%)
Basal	94 (8.6%)
Pauwel's Classification	
Type I	203 (18.5%)
Type II	675 (61.5%)
Type III	219 (20.0%)

SD=Standard deviation

See pages 49 - 106 for financial disclosure information.

Parapatellar Semi-Extended and Flexed Knee Tibial Nailing Technique are Equivalent in Regards to Knee Pain: A Randomized Controlled Trial

David Rothberg, MD; *Ami Stuart, PhD; Angela Presson, PhD; Thomas Higgins, MD; Erik Kubiak, MD*
University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA

Purpose: Knee pain is a common complication of intramedullary tibial nailing with a reported incidence of 10-86% at 2-year follow-up. Four reasons are commonly offered for knee pain after tibial nailing: skin incision location, approach in reference to the patellar tendon, nail insertion site, and nail prominence. Semi-extended nailing techniques have been gaining popularity outside of traditional indications (proximal third tibial shaft fractures) due to ease in imaging, fracture reduction, and leg positioning. The purpose of this study was to determine if the semi-extended, parapatellar tibial nailing technique (SEK) imparts any undue risk of knee pain compared to the traditional flexed knee, parapatellar tibial nailing technique (FK).

Methods: A single-center randomized controlled trial (RCT) was conducted at an academic Level I regional trauma center comparing the SEK technique to the FK technique. 60 patients with OTA 42A-C tibial shaft fractures were consented and enrolled. Exclusion criteria included prior operations around the knee, neurovascular compromise, a nonambulatory status, ipsilateral femur fractures, other tibia fractures not allowing tibial nailing, age <18, and non-English speakers. We collected age, sex, and injury-related variables including mechanism of injury, OTA fracture, Henley, Tscherne, Gustilo-Anderson, and Kellgren-Lawrence classifications; and surgery-related variables including additional fixation (such as fixation of ipsilateral rotational ankle fracture), nonunion, malunion, hardware prominence, need for hardware removal, and additional complications. The primary outcome was the symptoms subset of the International Knee Documentation Committee score (SS-IKDC) at 1-year follow-up as this focused on knee pain. An a priori power analysis to test equivalence as defined by a ±5-point margin was performed assuming a standard deviation of 5 points or a 13% change in the SS-IKDC. With 23 evaluable patients per group we would have 80% power at a 0.05 significance level. Statistical analysis was performed using linear regression to estimate a 90% confidence interval (CI) for the group differences to ensure a 0.05 level of statistical significance using a two one-sided tests (TOST) procedure. Equivalence was defined if the 90% CI was within a ±5 points window.

Results: 60 patients were enrolled, and final follow-up collected at 1 year for 24 SEK and 23 FK patients. No significant differences were found between the groups in regards to demographics, injury, or surgery-related variables except for the need for additional fixation (12% in SEK and 43% in FK, P = 0.02). All additional fixation was for rotational ankle fractures in the ipsilateral tibia. The two techniques did not have equivalent SS-IKDCs when adjusting for additional fixation (90% CI: 1.89 [-2.8, 6.6]) but did have equivalent scores when not adjusting for additional fixation (90% CI: 0.3 [-4.2, 4.8]). The adjusted mean SEK subset score was 27.2 (standard error [SE] = 2.2) and the adjusted mean FK subset score was 25.3 (SE = 1.9, P = 0.12). The nonadjusted mean SEK subset score was 25.3 (SE = 1.9) and the mean FK subset score was 26.0 (SE = 1.9, P = 0.50). When comparing demographic and injury-related

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

variables to the SS-IKDC, only age was statistically significant (P = 0.05) where increasing age was associated with lower scores.

Conclusion: The results of this single-center RCT show that SEK and FK techniques for tibial nailing are equivalent in regards to knee pain (defined as ±5 points on the SS-IKDC) when not adjusting for additional fixation in the ankle. While rotational ankle fractures in association with tibial shaft fractures may indicate increasing energy of injury or differing mechanism they are unlikely to affect knee pain in the context of understood causes. SS-IKDCs have a slightly higher but nonsignificant mean for the SEK technique when adjusting for fixation differences between the techniques. This study demonstrates that the use of the semi-extended technique for tibial nailing should not be associated with any higher likelihood of knee pain than the flexed knee technique.

See pages 49 - 106 for financial disclosure information.

Is Septic Knee Arthritis a Realistic Concern Following Suprapatellar Nailing of Open Tibia Fractures?

Frances Broghammer, BS[1]*; John Scolaro, MD*[1]*; Caroline Tougas, MD*[2]*; Luke Nicholson, MD*[2]*; Geoffrey Marecek, MD*[3]
[1]*UC Irvine Medical Center, Orange, California, USA;*
[2]*University of Southern California, Los Angeles, California, USA;*
[3]*University of Southern California, Department of Orthopaedic Surgery, Los Angeles, California, USA*

Background/Purpose: The use of an intra-articular suprapatellar entry portal has been proposed as an alternative approach for tibial nail placement. The suprapatellar portal requires a knee arthrotomy and passage of surgical instrumentation within the knee joint. In the setting of an open fracture, the knee is potentially exposed to tissue and fluid that have been in contact with the open fracture site. This exposure may increase the risk of postoperative knee sepsis. An intra-articular approach through the knee has been reported as safe for retrograde nailing of open femur fractures. Compared to open femur fractures, open tibia fractures have a higher rate of postoperative infection, yet no study has evaluated the safety of the suprapatellar approach in open tibia fractures. We sought to determine if suprapatellar nailing of open tibia fractures placed the knee at risk for septic arthritis.

Methods: We identified all open tibia fractures (OTA/AO 42) at two Level I trauma centers treated with a medullary nail through a suprapatellar entry portal from 2009 to 2015 via CPT code and chart review. We included all fractures in patients aged 18 or older and excluded any treatment of pathologic fractures and those patients with less than 12 weeks of clinical follow-up. Patient demographic, injury, and initial management information was recorded. The primary outcome measure was evidence of culture positive infection from a knee aspiration or surgical arthrotomy and the need for a secondary procedure(s) to clear the septic arthritis. Secondary outcome measures were entry portal cellulitis/superficial infection, later infection of the open fracture site or medullary canal, and need for reoperation for any reason.

Results: We identified 162 patients with 165 fractures. After exclusion criteria, 84 patients with 87 fractures remained for analysis. There were 15 women and 69 men with a median age of 38 years (range, 18-84). There were 2 cases of septic arthritis (2.2%). There were 11 total infections (12.6%), of which 3 (3.4%) were deep. 29 fractures (33.3%) required reoperation for any reason. One case of septic arthritis occurred after a deep infection. In the other, the patient fell and sustained a new wound that later developed an infection.

Conclusion: The intra-articular suprapatellar entry portal for tibial nail placement theoretically exposes the knee joint to contamination from the open fracture site during tibial canal preparation and nail insertion. In this large consecutive series of eligible patients from two

	Number
Gender (male)	**69 (82%)**
Median Age (years)	**38 (18 – 84)**
Gustilo-Anderson	
Type I	**21 (24%)**
Type II	**24 (28%)**
Type IIIa	**25 (29%)**
Type IIIb	**8 (9%)**
Type IIIc	**2 (2%)**

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

urban Level I trauma centers, we found that the risk of associated knee sepsis from this technique is rare. However, when an infection develops at the open fracture site or within the medullary canal, the risk of knee sepsis is real. Based on the information presented, we believe that the suprapatellar approach can be used safely for treatment of most open tibia fractures following a thorough debridement and irrigation of the open fracture site. In the setting of grossly contaminated open fractures, consideration should be given to the small, but present, risk of iatrogenic septic arthritis.

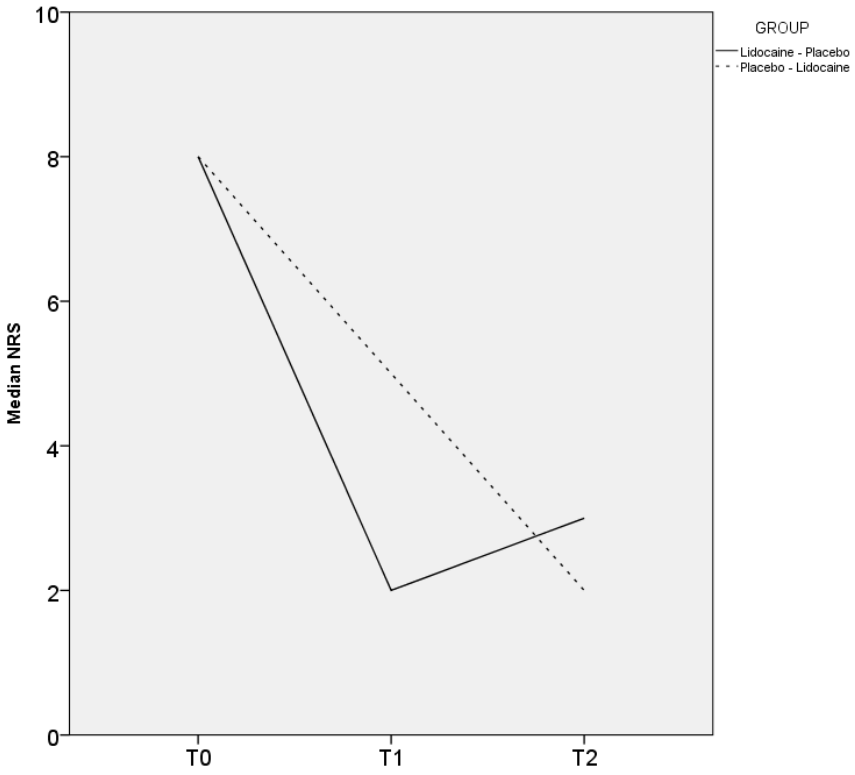
See pages 49 - 106 for financial disclosure information.

Effect of Infrapatellar Nerve Block on Chronic Anterior Knee Pain After Tibial Nailing: A Randomized Double-Blind Placebo-Controlled Study (INCOP)

M.S. Leliveld, MD, MsC; *S.J. M. Kamphuis, MD; M.H.J. Verhofstad, MD, PhD*
Erasmus MC, University Medical Center Rotterdam, Zuid-Holland, NETHERLANDS

Purpose: Chronic knee pain is a common complaint after intramedullary nailing of tibia shaft fractures. Injury or entrapment of the infrapatellar nerve is a possible cause of this persisting postoperative knee pain. The purpose of this randomized, placebo-controlled, double-blind crossover trial was to compare changes in knee pain after an infrapatellar nerve block with lidocaine or placebo in patients with persistent knee pain after tibial nailing.

Methods: Between June 2000 and December 2013, 380 patients (age, 18-65 years) were treated with an intramedullary nail. These patients were sent a questionnaire regarding knee pain during eight activities (rest, walk, run, jump, kneel, squat, walk stairs, prolonged sitting with bent knees). Pain was rated using a numeric rating scale (NRS; 0 - 10). Criteria for inclusion in the trial were an NRS of 4-6 (moderate pain) during at least 3 out of 8 activities or an NRS of 7 or higher (severe pain) during 1 or more activities. 64 patients met these criteria, of whom 28 agreed to participate in the study and signed an informed consent. These patients were randomized to an infrapatellar nerve block with a subcutaneous injection of lidocaine or placebo after which they were supervised in performing the eight activities. Before and



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

after these activities, pain was recorded using an NRS. Hereafter patients crossed over to the alternate group and pain scores were again recorded. Randomization of the treatment sequence was performed with use of a random-number generator. The allocated sequence was kept in sealed envelopes. Envelopes were prepared by a secretary who had no involvement in the trial. Upon each patient's enrollment into the study, the next consecutively numbered envelope was opened by an outpatient nurse. Two syringes were prepared, marked with number one or two according to the allocation, and checked by a doctor not involved in the trial. As both fluids were colorless and odorless, both patient and examiner remained unaware of which treatment was administered. The primary end point was the change in pain intensity during kneeling after each infrapatellar nerve block. Secondary outcomes were changes in pain intensity after each nerve block during rest, walking, running, jumping, squatting, climbing stairs, and sitting with flexed knees. Effects of lidocaine and placebo on NRS of all activities were analyzed using Mann-Whitney U.

Results: 28 patients aged 18-62 years (mean, 41 years ± 13) signed an informed consent and were equally randomized. Mean follow-up was 89 (± 52) months. A significant reduction of the NRS for kneeling pain with an infrapatellar nerve block with lidocaine was found compared with placebo (median [range], -4 [-10 – +1] vs -1 [-11 – +8]; P = 0.022. There were no differences between the treatments for the NRS values for rest, walk, run, jump, squat, and prolonged sitting with bent knees.

Conclusion: Compared with placebo, an infrapatellar nerve block with lidocaine was more effective in reducing pain during kneeling in patients with chronic knee pain after tibial nailing. Data from the present study therefore support the contention that kneeling pain after tibial nailing is a peripheral nerve-related problem.

See pages 49 - 106 for financial disclosure information.

Δ LIPUS Health Utility and Economic Analysis

*Paul Tornetta III, MD[1]; **Jason Busse, DC, PhD**[2]; Mohit Bhandari, MD, FRCSC, PhD[3]; Gordon Guyatt, MD[2]; Thomas Einhorn, MD[1]; James Heckman, MD[4]; Kwok-Sui Leung, MD[5]; Emil H. Schemitsch, MD[6]; Stephen D. Walter, BSc, ARCS, PhD[2]; Natasha Burke, MSc[2]; Rob Hopkins, BA, BSc, MBA, PhD[2]*
[1]Boston Medical Center, Boston, Massachusetts, USA;
[2]McMaster University, Hamilton, Ontario, CANADA;
[3]MacOrtho Research, Ontario, CANADA;
[4]Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA;
[5]The Chinese University of Hong Kong, HONG KONG;
[6]St. Michael's Hospital, Toronto, Ontario, CANADA

Background/Purpose: Tibial fractures are common and costly injuries that disproportionally affect young men in the prime of their working lives. Low-intensity, pulsed ultrasound (LIPUS) is a form of bone stimulation that is often used to augment fracture healing. Despite this high rate of use, the evidence to support the widespread adoption of LIPUS is limited and inconclusive, with most trials having focused on surrogate outcomes of recovery (radiographic healing). Our group recently completed a 501-patient, multicenter, randomized controlled trial to establish the effect of LIPUS on tibial shaft fractures managed with intramedullary nailing. We conducted an economic evaluation as part of this trial.

Methods: For each arm of the trial we calculated resource use and estimated costs of hospitalization and other components of treatment. We collected and converted Health Utilities Index version III (HUI-III) scores (a health status classification system that yields a mean score per group on the interval from death [=0] to perfect health [=1]) at baseline and follow-up into Quality-Adjusted Life Years (QALYs). Finally, we evaluated the cost-effectiveness of LIPUS from 2 perspectives: (1) the perspective of the payer, which will include direct health-care costs only, and (2) the societal perspective, which included both direct costs and indirect costs (eg, time lost from work).

Results: We acquired HUI-III data from 481 of 501 (96%) patients, which showed no difference between treatment and control groups (mean difference = 0.032; 95% CI: -0.004, 0.068). The incremental cost effectiveness ration (ICER) was $61,530/QALY from a payer perspective, and $63,646/QALY from a societal perspective.

Conclusion: LIPUS is costlier and no more effective than care as usual, and the ICER per QALY exceeds the range acceptable to payers and decision-makers for adoption (ie, less than $50,000 per QALY).

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

The Trajectory of Short- and Long-Term Functional Recovery of Tibial Shaft Fractures Following Intramedullary Nail Fixation

Sebastian Ko, MD*[1]*; *Peter O'Brien, MD, FRCSC*[2]*; Pierre Guy, MD*[2]*; Henry Broekhuyse, MD*[2]*; Piotr Blachut, MD, FRCSC*[2]*; Kelly Lefaivre, MD*[1]
[1]*Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia, CANADA;*
[2]*University of British Columbia, Vancouver, British Columbia, CANADA*

Background/Purpose: Tibia shaft fractures are the most common long bone fracture. Intramedullary nail fixation (IMN) of displaced tibial shaft fractures is a well-studied operation performed frequently in community hospitals and tertiary trauma centers. Multiple studies have demonstrated that IMN results in superior functional outcomes when compared with other fixation methods. Typically, this injury is seen in relatively young patients; the course of postoperative recovery thus deserves thorough investigation. There are many studies that separately describe both the short- and long-term outcomes of these injuries. However, studies describing the trajectory of recovery, or the relative functional change between multiple time points, are lacking in the literature. This information is very important for prognosticating function and planning return to work and activity. The purpose of this study is to describe the trajectory of recovery between specified time points (0-6 months, 6-12 months, and 1-5 years) after tibial shaft fracture treated with IMN.

Methods: 132 patients with tibial shaft fracture (OTA 42-A,B,C) treated with IMN were enrolled at a Level I trauma center between 2005 and 2010. Functional recovery (Short Form [SF]-36 Physical Composite Score and Short Musculoskeletal Function Assessment [SMFA] Functional Composite Score) at baseline, 6 months, 1 year, and 5 years were prospectively collected. The proportion of patients that achieved MCID (minimal clinically important difference) between time points was calculated. Statistical significance was set at a P value <0.05.

Results: Mean SF-36 scores improved between 6-12 months ($P = 0.0008$) and between 1-5 years ($P = 0.0029$). Similiarly, mean SMFA scores improved between 6-12 months ($P = 0.0254$) and between 1-5 years ($P = 0.0106$). In both scores, the slope of this improvement is flatter between 1-5 years than it is between 6-12 months. Furthermore, SF-36 and SMFA scores did not reach baseline at 5 years. SF-36 detected a greater proportion of patients achieving MCID than the SMFA at all time points, including 52% of patients still achieving MCID change in the 1-5 year interval.

Conclusion: This study demonstrates that the trajectory of functional recovery after tibial shaft fracture is characterized by an initial decline in function, followed by improvement between 6-12 months. There is still further improvement beyond 1 year, but this is of flatter trajectory. Regardless, the data show that function does not yet improve to baseline by 5 years. The SF-36 was found to be a more sensitive test for detecting functional recovery.

See pages 49 - 106 for financial disclosure information.

Progression of Healing Using RUST:
Can We Eliminate The Cost of Early Radiographs?

Robert Wojahn, MD[1]; *Torgom Abraamyan, BS[2]; Amanda Spraggs-Hughes, BS, MA[2]; Michael J. Gardner, MD[3]; William M. Ricci, MD[2]; Christopher McAndrew, MD, MSc[2]*
[1]Washington University Orthopaedics, Kirkwood, Missouri, USA;
[2]Washington University in Saint Louis, St. Louis, Missouri, USA;
[3]Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA

Background/Purpose: Assessment of radiographic healing for patients with tibial shaft fractures treated with intramedullary nailing remains a challenge and the ideal timing of postoperative radiographs is unknown. The Radiographic Union Score for Tibial fractures (RUST) has been popularized and demonstrates a higher intra- and interobserver reliability than prior radiographic grading systems for evaluation of union. Furthermore, studies have shown a correlation between RUST score and clinical outcome measures during healing. The purpose of this study was to report the progression of RUST scores after tibial nailing in a large sample of patients. We hypothesized that few patients would show signs of radiographic healing before 8 weeks after surgery and few would be healed (defined as RUST score of 9 based on recent studies) within 3 months after surgery. Therefore, routine postBoperative radiographs may be unnecessary during the early follow-up period.

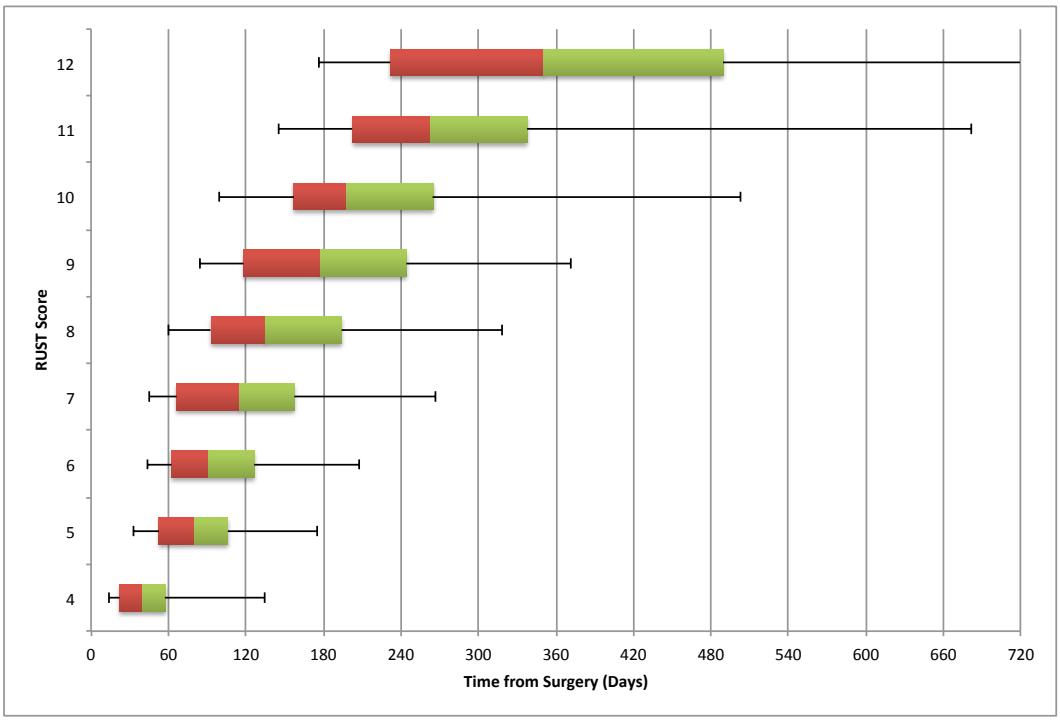
Methods: A retrospective review was performed of all tibial shaft fractures treated with intramedullary nailing at our institution from 2006-2013, a total of 604 fractures in 598 patients. Exclusion criteria were inaccessible imaging, age <18 years, definitive treatment delay >7 days, pathologic or stress fracture, or nonunion repair. Of the 480 remaining fractures, 185 had at least 6 months of radiographic follow-up and were included in the study. Baseline demographic, injury, and surgical data were collected for each patient. RUST scores were then determined for each set of follow-up radiographs. Descriptive statistics were utilized to analyze the median and variability of postoperative RUST scores.

Results: The average age was 43.7 years (range, 18-87), 47% were open fractures, and 6% were associated with compartment syndrome. Five patients in our series underwent early reoperation, three for infection and two for malalignment. In all cases the indication for reoperation was apparent on physical examination or immediate postoperative radiographs. No hardware failure was identified on follow-up radiographs within the first 3 months. The graph shows the 5th percentile, lower quartile, median, upper quartile, and 95th percentile of time from surgery for each RUST score. The 5th percentile for "any healing" (RUST = 5) was 33 days and the median time for "any healing" was 78 days. The 5th percentile and median for "healed" (RUST = 9) were 84 days and 182 days, respectively. The median time to "complete healing" (RUST = 12) was 355 days.

Conclusion: Based on RUST scores, very little radiographic healing was observed within the first 3 months after nailing and the median time to radiographic healing was approximately 6 months. Complete radiographic healing took approximately 1 year. Based on these results we are reconsidering the utility of postoperative radiographs within the first 3 months in the absence of clinical concerns such as new trauma, clinical malalignment, or infection. Little

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

radiographic fracture healing occurred in this time frame, no hardware failure was identified, and all early reoperations in our series were based on data from a physical examination or immediate postoperative imaging. At a list price of $306 per study at our institution (technical and professional fees), eliminating these unnecessary radiographs would have saved an average of $500 per patient.



See pages 49 - 106 for financial disclosure information.

Percutaneous or Open Reduction of Closed Tibial Shaft Fractures During Intramedullary Nailing Does Not Increase Wound Complications, Infection, or Nonunion Rates

Darryl Auston, MD, PhD[1]*; Jordan Meiss, MD*[1]*; Rafa Serrano, MD*[2]*; Brian Kistler, MD*[1]*; Thomas Sellers, MD*[3]*; Michael Beebe, MD*[2]*; Jonathan Quade, MD*[4]*; Timothy Hoggard, BS*[3]*; Benjamin Maxson, DO*[5]*; Anthony Infante, DO*[4]*; David Watson, MD*[2]*; Anjan Shah, MD*[4]*; Hassan R. Mir, MD*[4]

[1]*SUNY Upstate Medical University, Syracuse, New York, USA;*
[2]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[3]*University of Southern Florida Medical School, Tampa, Florida, USA;*
[4]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[5]*Tampa General Hospital, Tampa, Florida, USA*

Purpose: Diaphyseal tibia fractures are commonly treated with intramedullary devices. This technique is often performed with closed reduction maneuvers. Surgeons faced with difficulty can use percutaneous techniques to manipulate the fracture fragments, or formally open the fracture site for direct reduction. Concerns with percutaneous and open techniques include superficial and deep wound complications, an increased risk of infection secondary to fracture exposure, and an increase in the rate of nonunion. Our purpose was to compare the incidence of complications (wound, infection, nonunion) among those patients treated with closed, percutaneous, and open intramedullary nailing for closed tibial shaft fractures.

Methods: Closed diaphyseal tibia fractures (OTA type 42) treated with intramedullary fixation at three trauma centers over a 6-year period were retrospectively reviewed. All injuries were treated by fellowship-trained traumatologists and the reduction method was classified as closed, percutaneous, or open. Patient demographics, fracture classification, and associated injuries were recorded. Charts and radiographs were reviewed to determine union, postoperative wound complications, and return to the operating room within 1 year for an infection requiring surgical debridement. A Fisher exact test using a Monte Carlo method of approximation was utilized due to small observations per cells. The P value was set at 0.05 for two-tailed test.

Results: 322 (OTA type 42) tibial shaft fractures in 321 patients met inclusion criteria. 205 patients were treated with closed reduction, 61 patients were treated with percutaneous reduction, and 56 patients were treated with formal open reduction. Patients were followed for a minimum of 12 months or to union. The nonunion rate was 4.9% (10/205) for the closed group, 4.9% (3/61) for the percutaneous group, and 7.1% (4/56) for the open group, with no statistically significant difference (P = 0.492). The deep infection rate was 2% (4/205) for the closed group, 1.6% (1/61) for the percutaneous group, and 7.1% (4/56) for the open group, with no significant difference (P = 0.133). The superficial wound complication rate was 1% (2/205) for the closed group, 1.6% (1/61) for the percutaneous group, and 3.6% (2/56) for the open group, with no significant difference (P = 0.179).

Conclusion: This is the largest reported series of closed tibial shaft fractures nailed with percutaneous and open reduction. We found that percutaneous or open reduction of closed

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

tibial shaft fractures did not result in increased wound complications, infection, or nonunion rates. As a result, we feel that carefully performed percutaneous or open approaches may be useful in obtaining reduction of difficult tibial shaft fractures treated with intramedullary devices.

See pages 49 - 106 for financial disclosure information.

Radiographic Investigation of the Distal Extension of Fractures into the Articular Surface of the Tibia (The RIDE FAST Study)

Lucas Marchand, MD[1]; *Ajinkya Rane, MD[1]; Zachary Working, MD[1]; Lance Jacobson, MD[1]; Erik Kubiak, MD[1]; Thomas Higgins, MD[2]; David Rothberg, MD[1]*
[1]University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA;
[2]University Orthopaedic Center, Salt Lake City, Utah, USA

Purpose: Distal third tibial shaft fractures are known to have a high rate of associated posterior malleolar fractures, and this phenomenon is well documented in the literature. Occult intra-articular fracture involvement can be difficult to diagnose on plain film radiographs. This may lead to CT evaluation of many tibial shaft fractures, at the cost of additional radiation and financial burden. No studies have previously investigated whether specific plain radiograph fracture characteristics in the tibia are predictive of distal intra-articular involvement (DII). The purpose of this study is to determine whether the geometry of the fracture plane in the tibial shaft is predictive of involvement of the distal tibial articular surface.

Methods: All patients presenting to our academic Level I regional trauma center between January 2010 and December 2015 with a distal tibial shaft fracture were captured using an IRB-approved university database. Patients with fractures proximal to the tibial isthmus were excluded. Plain radiographs and CT scans obtained at the time of clinical evaluation were examined to determine the location of the fracture, intra-articular involvement, and measure predetermined geometric parameters. On both the AP and lateral radiographs the following parameters were measured: (1) angle between the predominant fracture line and the plane of the tibial plafond (α-angle), (2) length of the fracture, (3) distance from the most inferior extent of the fracture to the tibial plafond (DTP), (4) width of the tibial plafond, and (5) width of the tibial isthmus. Finally, the ratio of fracture length to DTP (fracture to plafond ratio [FTP]) was calculated to produce a single, dimensionless number, independent of the effects of radiograph magnification or tibial size (Fig. 2). Measurements for established cohorts of patients with and without DII were compared. Simple logistic regression was utilized to examine the relationship between the above measurements and DII. Receiver operating characteristic (ROC) curves were created for variables significantly associated with DII. Backwards stepwise multivariable logistic regression was performed to identify measurement independently associated with DII with a leave criteria of $P > 0.05$.

Results: 217 patients with distal tibial shaft fractures were identified via retrospective review. There were 56 (25.8%) patients with DII. Advanced statistics ultimately proved that the FTP ratio can be used as an effective screening tool to rule out DII in distal tibia fractures. Simple logistic regression reveals that several radiographic measurements including fracture obliquity, length, distance from the plafond, and the FTP ratio were significantly associated with DII (Table 1). However, many of these measurements are inter-related and, therefore, multivariable logistic regression was performed to reveal that DTP measured in the AP plane (odds ratio [OR] 0.97, 95% CI 0.96, 0.99) and fracture length measured in the AP plane (OR 1.04, 95% CI 1.02, 1.06) were independently associated with DII ($P < 0.0001$ for both). The FTP ratio was the most effective screening measurement for DII with ROC area under the curve of 0.83 (Fig. 1). A threshold FTP ratio of 0.61 produced a sensitivity of

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

0.88 and, most significantly, a negative predictive value (NPV) of 94% (Table 2). This testing characteristic highlights the utility of the FTP ratio as a rule-out test for DII in distal tibia fractures. Finally, patients with proximal-lateral to distal-medial fracture obliquity were associated with a 138% greater odds of DII (OR 2.38, 95% CI 1.02, 5.30).

Table 1. Simple logistic regression of radiographic measurements associated with DII

Variable	*Odds Ratio	Lower 95%	Upper 95%	P-value
AP DTP	0.96	0.95	0.98	<0.0001
AP α-angle	1.05	1.02	1.07	<0.0001
AP fracture length	1.05	1.04	1.07	<0.0001
AP FTP	8.20	4.26	17.22	<0.0001
AP fracture obliquity	2.33	1.02	5.31	0.04
LAT DTP	0.96	0.95	0.97	<0.0001
LAT fracture length	1.03	1.02	1.05	<0.0001
LAT FTP	10.00	4.78	23.23	<0.0001
LAT α-angle	1.03	1.01	1.05	0.006

*Odds ratio of having distal intra-articular extension of the tibia

Table 2 Evaluation of AP Fracture to Plafond ratio as a diagnostic test measure.

Cutoff	Sensitivity	Specificity	PPV	NPV	TP	TN	FP	FN
< 0.61**	0.88	0.6584	0.47	**0.94**	49	106	55	7
> 1.62*	0.27	0.9752	**0.79**	0.79	15	157	4	41

TP: true positive, TN: true negative, FP: false positive, FN, false negative, PPV: positive predictive value, NPV: negative predictive value

* A cut-off of < 0.61 will rule out DII with a NPV of 94%,

** A cut-off of > 1.62 will rule in DII with a PPV of 79%

Figure 1 Receiver operating characteristic curve of AP Fracture to Plafond ratio

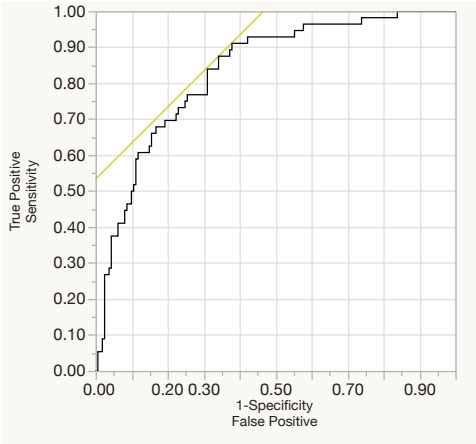
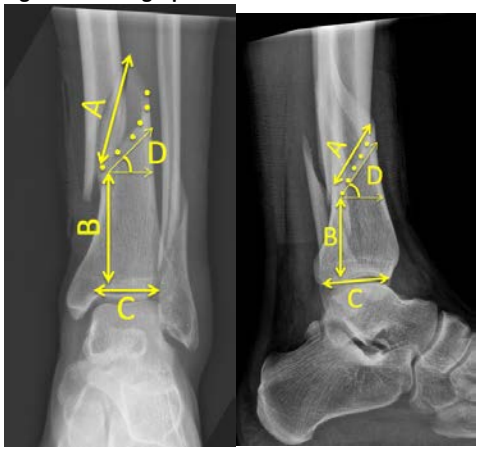


Figure 2: Radiographic Measurements



A: Fracture length
B: Distance to Plafond (DTP)
C: Width of tibial plafond
D: α-angle
●●●Fracture line

See pages 49 - 106 for financial disclosure information.

Conclusion: Involvement of the distal articular surface in patients with distal tibial shaft fractures is significantly associated with fracture geometry. Our results suggest that patients with an FTP ratio (simply the length of the fracture divided by the distance from the fracture to the plafond on an AP radiograph) of less than 0.61 likely do not have distal intra-articular extension of their fracture. With an NPV of 94%, the FTP ratio may be used as an effective screening tool for ruling out intra-articular involvement of distal tibia shaft fractures. Employment of this instrument clinically may significantly reduce radiation and expense due to CT examination in the preoperative workup of patients being evaluated for tibial shaft fractures.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Extreme Nailing: Is It Safe to Allow Immediate Weight Bearing of Extra-Articular Distal Tibia Fractures (OTA 43-A) Treated with Intramedullary Fixation?

Michael Beebe, MD*[1]*; *Rafael Serrano-Riera, MD*[2]*; Jonathan Quade, MD*[3]*; Darryl Auston, MD, PhD*[4]*; Anthony Infante, DO*[3]*; Anjan Shah, MD*[3]*; Benjamin Maxson, DO*[5]*; David Watson, MD*[1]*; Roy Sanders, MD*[6]*; Hassan R. Mir, MD*[3]

[1]*Florida Orthopaedic Institute, Tampa, Florida, USA*
[2]*Florida Orthopedic Institute, University of South Florida, Tampa, Florida, USA*
[3]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[4]*SUNY Upstate Medical University, Syracuse, New York, USA*
[5]*Tampa General Hospital, Tampa, Florida, USA*
[6]*Orthopaedic Trauma Service, Tampa, Florida, USA*

Purpose: This study was conducted to evaluate whether immediate weight bearing after intramedullary (IM) fixation of extra-articular distal tibia fractures (OTA 43-A) resulted in loss of fixation or change in alignment at union.

Methods: After IRB approval, our prospectively collected database was retrospectively reviewed for all isolated extra-articular distal tibia fractures within 7.5 cm (<3 in) of the distal tibial articular surface (OTA 43-A) treated by IM fixation and distal locking with 5-mm screws between July 1, 2005 and June 30, 2015. 98 fractures in 94 consecutive patients were identified. 18 were excluded for follow-up <6 months and 26 for concurrent lower extremity injuries that prevented or limited immediate weight bearing. 51 fractures in 50 patients were included in the final analysis. All patients were allowed to bear weight immediately with full body weight in an off-the-shelf boot. The age, sex, comorbidities, injury pattern, fixation construct, follow-up length, subsequent procedures, complications, initial anterior distal tibial angle (aDTA), initial lateral distal tibial angle (lDTA), final aDTA, and final lDTA were recorded. All fractures, including those with implant revision for complications, were included in the final analysis.

Results: 44.4% of patients were female and the average age was 47.0 ± 16.4 years. Average follow-up was 26.2 months (range, 12.0-114.5). Fractures were classified as OTA 43-A1 for 17, OTA 43-A2 for 18, and OTA 43-A3 for 16. 37% of fractures were open and 18.5% were placed into an external fixator, on average 6.6 ± 4.5 days before definitive fixation. All fractures were fixed with at least one anteroposterior (AP) and one mediolateral (ML) screw and 94% underwent distal fixation with 3 interlocking screws (2 ML, 1 AP). 48% (n = 26) of fractures had lateral column support (16 fibula plated, 2 fibula IM rod, 8 intact fibula). Average initial lDTA and aDTA were 88.7° ± 2.8° and 84.7° ± 3.5°, respectively. Average change from initial angulation at final follow-up was 0.5° ± 1.5° of varus and 0.4° ± 2.8° of extension. 3.7% required free flap coverage and 7.4% underwent staged grafting secondary to bone loss. 18.5% had an unplanned return to the operating room (9.3% for infected nonunion requiring hardware exchange, 5.5% for infection requiring debridement without hardware revision, and 3.7% for aseptic nonunion).

Conclusion: Immediate weight bearing following IM fixation of extra-articular distal tibia fractures (OTA 43-A) did not lead to loss of fixation or change in alignment at union. Regard-

See pages 49 - 106 for financial disclosure information.

less of the typical complications surgeons may encounter in the management of distal tibia fractures, based on our data, we believe that immediate full weight bearing after IM nail insertion can be reliably employed for distal tibia fractures where a minimum of 3 locking screws may be employed.

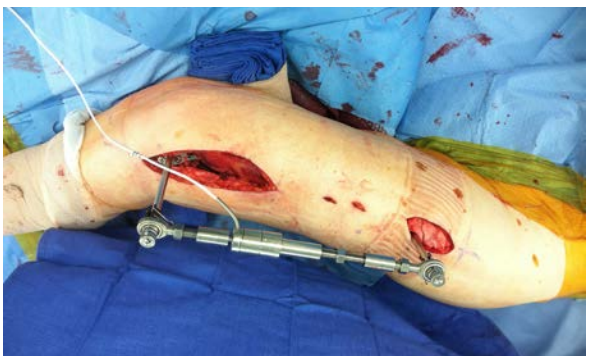
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

In-vivo Stiffness Measurements for Distal Femur Fractures Fixed with Locked Plating

Christopher Parks, MD[1]; *Michael J. Gardner, MD[2]; William M. Ricci, MD[1]; Christopher McAndrew, MD, MSc[1]*
[1]Washington University in Saint Louis, St. Louis, Missouri, USA;
[2]Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA

Purpose: Correlations between fixation stiffness and fracture healing outcomes have been the subject of much recent investigation in both clinical series and animal models. Clinical studies have been limited by a lack of a quantitative evaluation of construct stiffness. A novel device measuring intraoperative construct stiffness after the application of a distal femur locking plate was designed and validated for use in this study. The purpose of this study was to measure and correlate in vivo construct stiffness to clinical outcomes using this device. We hypothesized that a correlation would exist between stiffness and callus formation.

Methods: Patients who sustained a distal femur fracture (OTA 33) who underwent locked plating were prospectively enrolled. Average age was 63 years (range, 29-98) and average body mass index was 32.7 kg/m2 (range, 18-45.9). Four patients sustained injuries from a high-energy mechanism and the rest were ground level falls. Two fractures were open. 12 of the fractures were classified as OTA 33A, 1 as OTA 33B, and 5 as OTA 33C. Four fractures were above total knee arthroplasty. Construct design, plate length, number of screws, screw type, and points of fixation were at the discretion of the operating surgeon (1 of 3 orthopaedic traumatologists participating in the study). Constructs were designed purposely to produce either relative stability via bridging (to induce secondary bone healing) or absolute stability (to induce primary healing). Absolute stability was defined as an anatomic reduction with lag screw(s) or compression across the major metadiaphyseal fracture fragment, while relative stability was defined as any plate construct that was placed in a bridging fashion. Intraoperative stiffness was measured using the custom device following final fixation (Fig. 1). Data regarding the construct, including working length (WL), plate length (PL), WL/PL ratio, and number of proximal and distal screws were collected. Patients were followed clinically and data were collected including standard demographics, LEM (lower extremity measure) scores, radiographic union, clinical union, and complications (delayed union, nonunion, fixation failure, deep and superficial infection). Using 3-month follow-up radiographs, a callus score (0, no; 1, minimal; 2, moderate; 3, robust) and a modified RUST (Radiographic Union Score for Tibial fractures) score were determined by 3 orthopaedic trauma surgeons blinded to intraoperative stiffness measurements.



Results: 18 of the 28 enrolled patients completed the study. There was no difference in stiffness between 3 constructs designed to have absolute stability (mean stiffness of 4.79 N/

See pages 49 - 106 for financial disclosure information.

mm [range: 1.07-7.67]) and 15 designed for relative stability (mean stiffness of 4.79 N/mm [1.76-8.20]), P = 0.99. The mean WL for the absolute and relative stability constructs were 78.7 mm and 90.3 mm respectively and they were not statistically significantly different (P = 0.57). One patient had a delayed union, one had a deep infection with loss of fixation, and one patient had a nonunion. There was no difference in the stiffness measurements when comparing patients with a complication to patients without a complication, P = 0.52. Mean LEM score for patients who had a complication (38.7) compared to no complication (64.1) was significantly different, P = 0.019. A scatterplot with callus score as a function of stiffness and modified RUST score as a function of stiffness did not reveal any correlation (R2 = 0.016 and 0.009, respectively). There was no correlation between stiffness and WL or stiffness and WL/PL ratio (R2 = 0.16 and 0.15 respectively). When stratified for the number of distal screws (4, 5, or 6), stiffness was not significantly different (P = 0.926).

Conclusion: This is the first time the stiffness of a construct has been measured in vivo and correlated to clinical outcomes. In this study, we did not find correlations between callus formation or healing, and construct stiffness. We also did not find correlations between callus formation and WL or WL/PL. This may have been due to the mechanical properties of the plate itself and its large contribution to the overall stiffness of the construct. A power analysis was unable to be performed due to the lack of knowledge of clinically relevant stiffness, although this study may provide future studies with stiffness estimates. This methodology and these preliminary findings may lay the groundwork for further investigations into this prevalent clinical problem.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ The Effect of Coronal Plane Angulation on the Outcomes of Operatively Treated Distal Femur Fractures

*Paul Tornetta III, MD[1]; **Margaret Cooke, MD[1];** Kenneth A. Egol, MD[2]; Clifford Jones, MD, FACS[3]; Janos Ertl, MD[4]; Brian Mullis, MD[5]; Ed Perez, MD[6]; Cory A. Collinge, MD[7]; Robert Ostrum, MD[8]; Catherine Humphrey, MD[9]; Robert Dunbar, MD[10]; William M. Ricci, MD[11]; Laura Phieffer, MD[12]; David Teague, MD[13]; Christopher Born, MD[14]; Alan Zonno, MD[15]; Judith Siegel, MD[16]; Henry Sagi, MD[10]; Andrew Schmidt, MD[17]; Stephen Sems, MD[18]; Darin Friess, MD[19]*
[1]*Boston Medical Center, Boston, Massachusetts, USA;*
[2]*New York University Hospital for Joint Diseases, New York, New York, USA;*
[3]*Orthopaedic Associates of Michigan, Grand Rapids, Michigan, USA;*
[4]*Indiana University, Carmel, Indiana, USA;*
[5]*Eskenazi Health, Indianapolis, Indiana, USA;*
[6]*Campbell Clinic, Memphis ,Tennessee, USA;*
[7]*Harris Methodist Fort Worth Hospital Fort Worth, Texas, USA;*
[8]*UNC Department of Orthopaedics, Chapel Hill, North Carolina, USA;*
[9]*University of Rochester Medical Center, Rochester, New York, USA;*
[10]*Harborview Medical Center, Seattle, Washington, USA;*
[11]*Washington University in Saint Louis, St. Louis, Missouri, USA;*
[12]*Ohio State University Med, Columbus, Ohio, USA*
[13]*University of Oklahoma Medicine, Oklahoma City, Oklahoma, USA*
[14]*University Orthopedics, Providence, Rhode Island, USA;*
[15]*Brown University, Providence, Rhode Island, USA;*
[16]*UMass Memorial Med Ctr, Worcester, Massachusetts, USA;*
[17]*Hennepin Medical Center, Minneapolis, Minnesota, USA;*
[18]*Mayo Clinic, Rochester, Minnesota, USA;*
[19]*Oregon Health & Science University, Portland, Oregon, USA*

Purpose: Coronal plane malalignment is common after distal femur fracture fixation, particularly valgus deformity after plating. While varus deformity is known to be problematic in tibial plateau fractures, the influence of coronal plane angulation on outcomes in distal femur fractures is not well documented. The purpose of this study is to compare validated functional outcome and mobility scores of patients with neutral alignment with patients having >5° of varus or valgus angulation after operative treatment for distal femur fractures.

Methods: As part of a prospective multicenter trial of adult patients with A1-3 or C1 distal femur fractures, data on angulation were gathered. Patients were treated by intramedullary nail or locked plate. In addition to demographic and fracture data, mobility scores for (1) stair climbing, (2) walking distance, and (3) ambulatory device use, and validated patient-based outcomes including Short Musculoskeletal Function Assessment (SMFA), Bother Index, and EQ (EuroQol) health index were obtained at 3, 6, and 12 months postoperatively. Angulation was documented in degrees of varus or valgus alignment at each interval as compared with anatomic. For the purpose of this analysis, varus and valgus malalignment were defined as = 5°. Comparisons were made using Fisher's exact test for categorical variables and t tests for continuous variables.

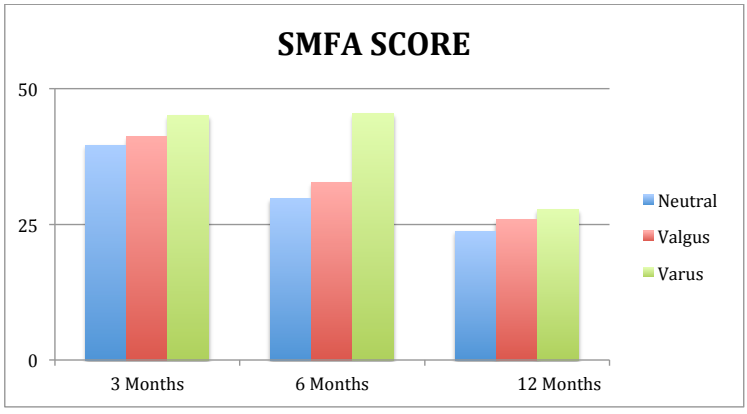
Δ OTA Grant

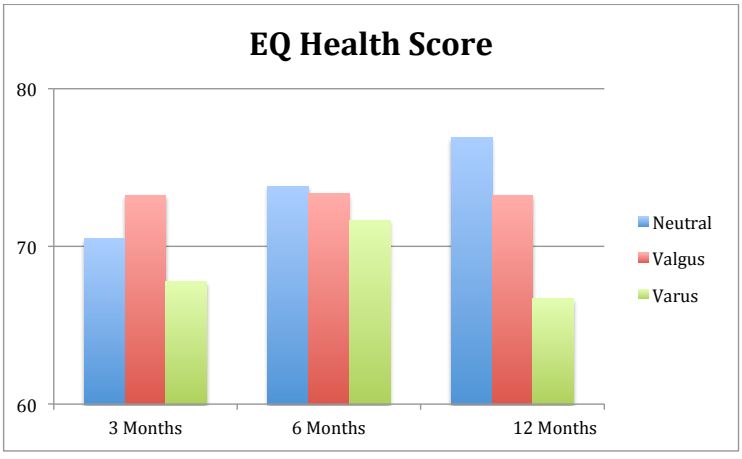
See pages 49 - 106 for financial disclosure information.

Results: Of 123 patients who had initial postoperative coronal plane angulation documented, clinical outcome data were available for 105 at 3 months, 95 at 6 months, and 81 at 1 year. There were 59% men and 41% women, aged 17-91 years (average 50), of whom 47% were treated with an intramedullary nail and 53% were treated with a locked plate. Immediately postoperative radiographs demonstrated valgus alignment = 5° in 24% (avg = 8°; range, 5°-18°) and a varus alignment = 5° in 2% (average = 8°; range, 7°-10°). This distribution remained stable over time with 25% valgus and 4% varus at 1 year. At 3 months, there was no difference between the groups in any of the clinical or functional outcome scores measured. With regard to the mobility scores, patients with varus angulation had a worse stair climbing score at 6 months (P = 0.05) and required more ambulatory support at 12 months (P = 0.06) than those patients with neutral alignment. At 1 year, the average patient with neutral or valgus alignment needed at most a cane whereas the average patient in varus needed at least a cane and at times a walker. There were no differences at any time point between those with valgus alignment and those with neutral alignment. With respect to the validated patient-based outcome scores, we found no statistical difference in in the SMFA, Bother, or EQ-5D between patients with valgus or varus malalignment and those with neutral alignment at any time point (see figure of SMFA and EQ-5D).

Conclusion: Valgus malalignment is common after distal femoral fixation; however in this prospective trial, valgus of 5°- 8° was well tolerated as it did not affect validated outcome scores or mobility scores. Patients with varus malalignment had worse mobility scores, but SMFA, Bother, and EQ-5D were unaffected. Validated outcome scores may not be sensitive enough to pick up subtle differences in mobility in this population.

The Effect of Coronal Plane Angulation on the Outcomes of Distal Femur Fractures





The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Should We Throw Away the External Fixator for Knee Dislocations?

Robert Corey, MD; *Nathan Park, BS; Scott Kaar, MD; Lisa K. Cannada, MD*
Saint Louis University, St. Louis, Missouri, USA

Purpose: Knee dislocations are limb-threatening injuries and may present as pure knee dislocations, fracture dislocations, or periarticular knee fractures. There are limited data to guide optimal management strategies for these dislocations. Many authors have reported improved outcomes with early surgical reconstruction of all ligamentous structures. Some advocate for the role of initial external fixation in the management of the dislocated knee, especially with neurovascular compromise. There are currently no articles in the literature that describe the patient reported outcomes of multiligamentous knee dislocations treated with nonarticulated external fixation. The purpose of this study is (1) to describe the demographic and injury characteristics of a series of patients with multiligamentous knee dislocations and (2) to report patient outcome data (SANE [Single Assessment Numeric Evaluation] and PROMIS [Patient-Reported Outcomes Measurement Information System] scores) following the use of nonarticulated external fixation.

Methods: Between 2008 and 2013, 41 patients with multiligamentous knee dislocations presented to our emergency department. All patients were treated with application of nonarticulated external fixation placed by orthopaedic trauma surgeons. Indications for spanning external fixation included gross instability on examination with failure to maintain joint reduction, open injuries, and those with neurovascular compromise. Their medical records were retrospectively reviewed for injury characteristics and patient demographics. All patients underwent MRI scan following application of external fixation. All patients underwent manipulation under anesthesia at time of removal of external fixation. Patient-reported outcome data was quantified using SANE and PROMIS scores.

Results: 33 patients were identified, with 22 males and 11 females. The mean age was 39 years (range, 17-70) and the mean body mass index was 32 kg/m2 (range, 21-66). Three patients (9%) had isolated knee dislocations. The most common mechanism for injury was motor vehicle collision (42%), followed by a fall from height (30%), pedestrian versus auto (18%), and fall from standing (9%). MRI results revealed a torn anterior cruciate ligament in all patients (100%). The other most commonly injured structures were posterior cruciate ligament (91%), lateral collateral ligament (48%), medial collateral ligament (44%), medial meniscus (18%), lateral meniscus (15%), and posterolateral corner (12%). Thus, all were multiligamentous knee injuries. 82% of patients were treated definitively with external fixation, while 18% underwent ligamentous repair/reconstruction. The mean time to removal of external fixation was 48 days (range, 4-82). 86% of patients underwent formal physical therapy. The average follow-up was 44 months (range, 9-62). At time of follow-up, 26 patients (79%) maintained normal radiographic alignment of the knee, while 7 patients (21%) were in varus alignment. Four of these 7 patients underwent high tibial osteotomy. The mean range of motion of the knee was 101° (range, 55-138). The patient-reported outcomes were obtained using SANE and PROMIS scores, with a mean SANE score of 49 (range, 5-90) and mean PROMIS score of 38 (range, 32-46). SANE is a subjective measure of patient's perceived function and our results indicated decreased function. The PROMIS score indicates that the

See pages 49 - 106 for financial disclosure information.

patient's average level of physical function is higher than 38% percent of people in the general population. Additionally, not a single patient scored above 50% of their age-matched peers.

Conclusion: To our knowledge, this series represents the first dedicated patient-reported outcome data using SANE and PROMIS scores in patients sustaining multiligamentous knee injuries treated with nonarticulated external fixation. While use of this method might be thought of as leading to stiff knee, the patient's final range of motion in this study is higher than previous reports. Our protocol of manipulation under anesthesia at the time of external fixator removal and importance of outpatient physical therapy most likely contributed to these results. Over 20% of patients had a varus deformity at follow-up. Multiligamentous knee dislocations are serious injuries as the overall patient-reported outcomes indicated decreased function. However, the use of a nonarticulated external fixator is a viable treatment alternative for traumatic knee dislocations.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Fixed Angle Locking Plate Fixation of Complex Comminuted Patellar Fractures

Tyler Moore, MD*[1]*; *Bharat Sampathi, BA*[2]*; Martin Tynan, MD*[1]*; David Zamorano, MD*[1]*; John Scolaro, MD*[3]
[1]*University of California, Irvine, Orange, California, USA;*
[2]*University of California, Irvine School of Medicine, Irvine, California, USA*
[3]*UC Irvine Medical Center, Orange, California, USA*

Background/Purpose: Comminuted patella fractures are difficult orthopaedic injuries and commonly result in persistent functional impairment. Goals of patellar fracture treatment include restoration of the extensor mechanism and congruent reduction of the articular surface. Hardware irritation and loss of fixation are the most common complications related to fixation. When complex patella fractures are encountered, standard tension band fixation techniques may not be able to provide stable fixation; alternative means of fixation are then required. Methods such as fracture fragment excision, wire cerclage, and plate fixation have all been described. Multiple studies have evaluated the biomechanical performance of patellar plate fixation, yet clinical series are limited. The purpose of this study is to evaluate the radiographic and measured functional outcome of patients with comminuted patellar body fractures treated with fixed angle plate and screw implants. Our hypothesis is that fixed angle plate fixation can be employed successfully for comminuted patellar fractures.

Methods: A retrospective study was performed at a single Level I trauma center of all patients with comminuted patellar fractures (OTA/AO 34C2 and C3) treated with a fixed angle locking plate between 2010 and 2015. Patients were identified by ICD-9, CPT code, and chart review. Patient demographic, fracture, and surgical fixation information was recorded. Follow-up data specifically evaluated the presence of bothersome hardware, need for reoperation, and fracture union. Functional data including the Knee Outcome Survey (KOS), Lower Extremity Functional Scale (LEFS), and goniometer measured knee range of motion were evaluated in patients available for follow-up.

Results: A total of 33 patients with comminuted patellar fractures underwent fixed angle plate fixation. Eighteen 34C2 fractures and fifteen 34C3 fractures were identified; 11 fractures were open. Locking minifragment implants were used in all cases. Supplemental screws outside of the plate were used in 16 cases and additional nonabsorbable suture fixation was used in 2 cases. One case of fracture fixation failure occurred and required revision surgery. 15 patients were available for clinical re-evaluation and functional outcome scoring. Follow-up averaged 142 weeks (range, 19-240 weeks). The average KOS score was 60.67 (max 75) and the average LEFS score was 62.26 (max 80). Average range of motion was 1-132° at latest follow-up. Four patients noted hardware irritation; no patient underwent elective hardware removal. One postoperative infection occurred and removal of hardware was performed following fracture union.

Conclusion: Fixed angle minifragment plates provide reliable fixation for complex patellar body fractures. We report the largest clinical series of comminuted patellar fractures treated with a fixed angle plate and screw devices. Complications of the technique, including fracture fixation failure, infection, and bothersome hardware necessitating removal were

See pages 49 - 106 for financial disclosure information.

rare. Knee range of motion and patient-reported functional outcome scores demonstrated excellent clinical results following these difficult injuries. Fixed angle plating is a promising and viable option for the fixation of complex patellar fractures and should be considered when standard fixation or fragment excision cannot be performed.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

ORIF versus Arthroplasty of Geriatric Acetabular Fractures: Results of a Prospective Randomized Controlled Trial

Theodore Manson, MD[1]*; Robert V. O'Toole, MD*[2]
[1]*R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA*
[2]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA*

Purpose: Geriatric acetabular fractures are a growing clinical challenge that poses important unanswered questions including the relative performance of open reduction and internal fixation (ORIF) to total hip arthroplasty with concomitant ORIF (THA). Our hypotheses were 1. THA would have a higher short term complication rate, but would result in better validated outcome scores and 2. A clinical trial on this issue would be feasible.

Methods: The study design was a prospective randomized controlled trial with a prospective observational arm for patients who refused randomization. From 2011 to 2016 all patients admitted with an acetabular fracture to a single statewide referral trauma center were screened. Inclusion criteria were patients over age 60 with a *displaced* acetabular fracture that had at least one of three characteristics previously identified with poor outcomes after ORIF in geriatric patients: 1. Dome impaction, *or* 2. Posterior wall component *or* 3. Femoral head impaction. Exclusion criteria included physiologic inability to undergo surgery, clinical contraindication for either treatment arm, or severe dementia. Patients who declined randomization were treated with the patients' preferred method and included in the observational arm of the study.

Patients in the ORIF group had standard plate and screw fixation through standard surgical approaches. Patients in the THA group underwent plate and screw fixation and then subsequent THA through the same approach and prep. All surgeries were performed by fellowship trained surgeons. The primary outcome measures were validated outcome scores (satisfaction (PS18), WOMAC, Harris Hip Score, SF36). Secondary outcome was unplanned reoperations.

Results: The study group consisted of 39 patients (18 ORIF, 21 THA, 16/39 randomized (41%), no differences in demographics between treatment groups). No patients were lost to follow-up (0%) and 24 patients have at least one year follow-up to date. In the ORIF group, 5/18 (28%) have been converted to THA for subsequent post traumatic osteoarthritis. There was one femoral nerve palsy and two deep infections in the ORIF group. One patient in the ORIF group underwent heterotopic ossification removal in preparation for THA. No dislocations or infections have occurred in the THA group. One patient in the THA group returned to the OR for a superficial wound dehiscence without infection.

In contrast to our hypothesis, there were no important clinical or statistical differences in any mean validated outcome scores at one year [(WOMAC: ORIF:15, THA: 18, p= 0.79.; Patient Satisfaction (PS18): ORIF:58,THA: 57, p=0.46; SF 36 mental, SF36 physical , and Harris Hip Scores all also p>0.20]. A post hoc power analysis revealed 80% power to detect a difference of 15 in the WOMAC score and 3 in the patient satisfaction score.

See pages 49 - 106 for financial disclosure information.

Fewer patients in the ORIF + THA group (1/21, 4.7%) required reoperation than those in the ORIF group (7/18, 38.8%) (p=0.015, Fischer's Exact).

Conclusions: In contrast to our expectation, patient satisfaction and functional scores were similar in the two treatment groups at one year and we did not observe increased complications in the THA group. Patient's treated with ORIF + THA required fewer reoperations than those treated with ORIF alone in this selected group of patients over the age of 60 with displaced acetabular fractures involving a posterior wall component *or* dome impaction *or* femoral head impaction.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Risk Factors for Early Reoperation Following Operative Treatment of Acetabular Fractures

Anthony Ding, MD[1]*; Robert V. O'Toole, MD*[1]*; Renan Castillo, PhD*[2]*; George Reahl, BS*[3]*; Ryan Montalvo, BS*[4]*; Marcus Sciadini, MD*[5]*; Jason Nascone, MD*[6]*; Theodore Manson, MD*[4]
[1]*University of Maryland Shock Trauma Center, Baltimore, Maryland, USA;*
[2]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA;*
[3]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[4]*R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;*
[5]*Department of Orthopedics, RA Cowley STC, University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[6]*Shock Trauma Orthopaedics, Baltimore, Maryland, USA*

Purpose: Despite the widespread use of open reduction and internal fixation (ORIF) to treat displaced acetabular fractures, there are limited data on the risk factors that drive early treatment failure and return to the operating room. The purpose of this study is to evaluate the rates and risk factors for early reoperation following operative fixation of acetabular fractures.

Methods: This retrospective case-control study evaluated early reoperation following acetabular ORIF. All patients admitted with a displaced acetabular fracture from 2006-2015 who underwent acetabular ORIF were screened for inclusion. 806 patients met inclusion and exclusion criteria. Early reoperation was defined as a secondary procedure within 3 years of the initial operative treatment, including irrigation and debridement for infection, conversion to total hip arthroplasty (THA), revision ORIF, and implant removal. We evaluated risk factors hypothesized to be associated with early reoperation including patient demographics, comorbidities, fracture patterns, associated injuries ,and descriptors of surgical treatment. Bivariate statistical analysis, comparing patients who underwent early reoperation against those who did not, identified significant variables associated with reoperation, which were then evaluated in a multivariate regression analysis. Significance was set at a P value <0.05.

Results: Of the 806 included patients, 14% (n = 105) underwent early reoperation. 59 (7.3%) underwent irrigation and debridement for infection and wound complications. Risk factors associated with infection and wound complications included pelvic embolization (odds ratio [OR] 5.53, 95% confidence interval 2.04-15.0), body mass index (BMI) (OR 1.04, 1.01-1.08), and time between injury and surgical fixation (OR 1.12, 1.06-1.18). For BMI, a 10-point increase results in a 50% increase in infection rate. For time, a 1-day surgical delay leads to a 12% increase in infection rate. 57 (7.1%) underwent early reoperation for failure, including 39 conversions to THA, 8 revision ORIF, and 9 hardware removals. Risk factors associated with early failure and reoperation included hip dislocation (OR 3.71, 1.95-7.05), ipsilateral injury to the femoral head or neck (OR 2.44, 1.26-4.71), age (OR 1.02, 1.01-1.04), and articular comminution (OR 2.12, 1.15-3.91). For age, odds of failure increase by 30% for every 10 years. Interestingly, combined injuries to the pelvic ring and acetabulum, marginal impaction, and BMI had no significant effect on early failure.

Conclusion: The main drivers of early reoperation and treatment failure following acetabular ORIF differed based on the reason for the return to the operating room. Cases of infection

See pages 49 - 106 for financial disclosure information.

were more likely in patients who were embolized, were obese, or had delay in time to fixation (likely indicating more severe overall injury burden preventing earlier operative treatment). Return to the operating room for arthroplasty or fixation failure was more likely with hip dislocation, femoral head or neck fracture, advancing age, and articular comminution ($P < 0.05$). These factors may be useful for patients and clinicians as they evaluate the risks and benefits of operative treatment of acetabular fractures.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does Prehospital Spinal Immobilization Influence Inhospital Decision to Obtain Imaging after Trauma?

Joseph Drain, BS*; Timothy Moore, MD; Heather Vallier, MD*
MetroHealth System, Cleveland, Ohio, USA

Purpose: Emergency Medical Services providers perform cervical spinal immobilization when transporting trauma patients to the emergency department (ED), with variable indications for applying a cervical collar. In many Level I trauma centers initial imaging of the cervical spine injury is CT, which incurs financial cost, radiation exposure, and longer stay in the ED. Our purpose was to determine if patients who arrived with a collar were more likely to receive cervical spine imaging than were patients with similar trauma who arrived without a collar. We hypothesized that patients presenting with a cervical collar would be more likely to undergo advanced imaging.

Methods: All trauma patients seen at an urban, Level I trauma center during 4 months in 2013 were reviewed (n = 1438). Demographic and injury data were collected. Patients were stratified by trauma category (designation made at time of injury based on acuity), mechanism of injury, known injury cephalad to clavicles, and placement of a cervical collar. Known injury cephalad to the clavicles was defined as physical signs and/or symptoms of trauma, such as pain, wounds, or hematomas of the head, face, or neck on initial presentation. Cervical spine imaging findings were recorded.

Results: Cervical spine CT was performed for 975 patients (67.8%). 26 (1.81%) sustained a fracture or ligamentous injury, and all had presented with known injury cephalad to clavicles. 161 patients (11.2%)with no known injury cephalad to clavicles had a C-spine CT, but no cervical injury was diagnosed in any of these patients. Category 1 patients with gunshot wounds with injury cephalad to clavicles were more likely to have CT C-spine imaging if they arrived wearing a collar than those without a collar (66.7% vs 14.3%, P = 0.027). Category 2 and 3 patients with injury cephalad to clavicles after motor vehicle collisions (MVCs) (88.2% vs 69.6%, P = 0.011), low-energy falls (88.3% vs 59.4%, P <0.0001), and assault (86.0% vs 37.1%, P <0.0001) also underwent CT C-spine imaging more frequently if they arrived wearing a collar. Category 2 and 3 trauma patients without injury cephalad to clavicles were also more likely to undergo CT when wearing a collar after MVC (66.3% vs 21.4%, P = 0.001), low-energy fall (81.8% vs 35.3%, P = 0.016), and pedestrian versus MVC (55.6% vs 12.5%, P = 0.04).

Conclusion: Certain trauma patients were more likely to undergo cervical CT if they arrived to the ED wearing a cervical collar. This suggests that in some instances, a prehospital decision to place a collar ultimately impacted inhospital decision making. We conclude that the visual cue of a patient arriving with cervical spine immobilization may heighten suspicion for cervical injury in a manner independent from the injury itself; this bias, coupled with a low overall incidence of cervical spine injury, argues for usage of consistent guidelines to select patients at acceptably low risk for cervical spine injury and to clear them without advanced imaging.

See pages 49 - 106 for financial disclosure information.

A Randomized Controlled Clinical Trial of Indigenized Innovative Negative Pressure Device for the Management of Stage 3 and 4 Pressure Ulcer in Traumatic Paraplegia Patients

Rajeshwar Srivastava, MS*; Mukesh Dwivedi, MSc, PhD Scholar; Amit Bhagat, MSc, PhD Scholar; Saloni Raj, MBBS*
King George's Medical Medical University, Lucknow, Uttar Pradesh, INDIA

Purpose: A randomized controlled clinical trial was conducted to compare negative pressure wound therapy (NPWT) by our innovative negative pressure device (NPD) to conventional wound dressing of pressure ulcer (PU) in traumatic paraplegia patients.

Methods: This study was conducted in the Department of Orthopaedic Surgery at King George's Medical University, Lucknow, India. 44 traumatic paraplegia patients with sacral pressure ulcers of stage 3 and 4 were randomized into two groups: one (n = 23) received conventional wound dressing and the other (n = 21) received NPWT with innovative NPD. The outcomes variable were length, width (surface area), depth of PU, exudates, discharge, tissue type (necrotic, slough, and red granulating tissue), and cost-effectiveness during 0 to 9 weeks follow-up.

Results: Length and width were significantly ($P < 0.01$) decreased in NPWT group as compared to conventional group at week 9. At weeks 1, 2, and 3, depth was significantly ($P < 0.05$) higher in NPWT group, whereas at week 9 significant reduction ($P = 0.01$) was observed. Exudates were significantly ($P = 0.001$) less in NPWT group at weeks 4-9. Conversion of slough into red granulation tissue was significantly higher in NPWT group ($P = 0.001$). Discharge became significantly ($P = 0.001$) lower in NPWT at week 2 and no discharge after week 6. In all parameters, decrease was higher in NPWT group compared to conventional, which was significant for exudates type ($P = 0.03$) and tissue type ($P = 0.004$).

Conclusion: NPWT by our NPD is a better wound care procedure and cost-effective for management of PU.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Indications for CT Angiography of the Vertebral Arteries after Trauma

Joseph Drain, BS[1,2]*; Douglas Weinberg, MD*[2]*; James Ramey, BS*[1,2]*; Timothy Moore, MD*[1]*; Heather Vallier, MD*[1]
[1]*MetroHealth System, Cleveland, Ohio, USA;*
[2]*University Hospitals/Case Medical Center, Cleveland, Ohio, USA*

Purpose: Vertebral artery injury (VAI) occurs infrequently with trauma to the neck and cervical spine. With increasing frequency, trauma providers are using CT angiography (CTA) to visualize vessels of the head and neck, including the vertebral arteries. However, CTA has associated risks of increased radiation exposure, renal injury from contrast dye, as well as higher cost and longer emergency department stay. The purpose of this project was to assess risks and benefits of CTA of the neck in the trauma setting. We propose to develop guidelines for providers to differentiate patients at medium/high risk of VAI from those who are at low risk.

Methods: We retrospectively analyzed all trauma patients seen at an urban, Level I trauma center over 4 months in 2013 (n = 1872). Mean age was 42.0 years, and 63% were male. Mechanisms of injury included motor vehicle collision (n = 533, 29%), motorcycle crash (n = 100, 5.3%), high-energy fall (n=233, 12.5%), low-energy fall (n = 356, 19%), pedestrian versus motor vehicle (n = 91, 4.9%), gunshot wound (n = 166, 8.9%), assault (n = 189, 10%), stabbing (n = 71, 3.7%), sports (n = 51, 2.7%), and other (n = 83, 4.4%). CTA of the neck was done in 144 (7.3%). Presence of VAI and other findings were noted. The presence or absence of subjective complaint of neck pain, physical examination findings, the number and type of cervical spine fracture/soft-tissue/vascular injuries were recorded. A two-proportion Z-test statistical analysis was performed for each category comparing those with VAI versus those without VAI.

Results: Patients without VAI included 138 of 144 patients with CTA (96%), or 1866 of the 1872 entire population (99.7%). All patients without CTA were assessed clinically for 2 years and no undetected VAI was noted. Six patients had VAI: 5 suspected dissections and 1 thrombosis. Three of them had no anticoagulation and died as a result of brain injury (n = 2) and exsanguination (n = 1); in one case VAI and brain injury were contributing factors. The 3 others were treated with aspirin, and 1 experienced transient hemiparesis, which resolved with heparin. One other died from head injury. Patients with VAI were older (56.3 years vs 42.0, P = 0.04), more likely to have subjective neck pain (67% vs 21%, P <0.001), more likely to have a positive finding on physical examination of the cervical spine such as laceration, step-off, subluxation, crepitus, tenderness to palpation (100% vs 29%, P <0.001), and more likely to have a cervical fracture (100% vs 4.3%, P <0.001). Of the 144 patients who had CTA of the neck, n = 82 (57%) had a negative diagnostic CT previous to the CTA; all were ultimately found to be without VAI.

Conclusion: CTA is performed frequently, but less than 5% of scans identified an injury. VAI is very uncommon (<1% of trauma patients), and adverse consequences of VAI are infrequent, occurring in 14%. Multivariate regression analysis identified factors associated with VAI as diagnosed by CTA: older age, neck pain, physical findings, or cervical fracture. We posit

See pages 49 - 106 for financial disclosure information.

that CTA is not routinely indicated for those without cervical fracture. This work highlights the importance of identifying patients who are at a higher risk for VAI and require CTA of the neck versus those who are at low risk and can be evaluated without CTA. The avoidance of unnecessary scanning would decrease radiation exposure, renal toxicity, and costs.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Randomized Controlled Trial Using Neuromuscular Electrical Stimulation with Pelvic Fracture Rehabilitation: An Interim Analysis

Jessica Rich, MRes, MSc, BSc; *Peter Bates, FRCS (Tr & Orth), BSc;*
Paul Culpan, BSc, MBChB, FRCS (Tr & Orth)
Barts Health NHS Trust, London, UNITED KINGDOM

Purpose: The acute management of pelvic fractures has seen significant improvements in recent years; however, there remain no formal guidelines or evidence for rehabilitation. Patients will often suffer from muscle atrophy following long periods of non-weight-bearing. Neuromuscular electrical stimulation (NMES) has been proven to minimize muscle loss and enhance recovery; however, it has not yet been investigated after pelvic fracture. The aim of the study was to investigate the efficacy of NMES in postoperative rehabilitation within pelvic fractures.

Methods: 41 participants with surgically fixed pelvic fractures were randomly allocated into two groups postfixation. The intervention group completed 10 weeks of NMES. The placebo group used transcutaneous electrical nerve stimulation (TENS). Muscle strength was measured using the Cybex HUMAC machine and peak torque was calculated in the operated limb at 12 weeks using the nonoperated limb as a baseline. A EuroQol (EQ)-5D questionnaire was given to patients at 6 weeks and 12 weeks postfracture to assess the participant's quality of life. Gait analysis was performed on all participants at 12 weeks postfracture using a CODA motion analysis system (Charnwood Dynamics) at a sampling rate of 200 Hz. A customized MATLAB (MathWorks)-based algorithm was used to extract joint movements of the ankle, knee, hip joints, and the pelvis during patients' gait cycles. Compliance data were obtained from prerecorded sessions on the NMES machines and from a compliance diary the participants completed.

Results: The first 26 participants' data were available to analyze for preliminary findings in which a Mann Whitney U test was performed on peak torque and EQ-5D results. Within the intervention group there was minimal difference in muscle strength between operated and nonoperated limbs, which was not of clinical significance for abduction (2 Nm) and adduction (8 Nm) 12 weeks postfracture ($P < 0.5706$ and $P < 0.3642$, respectively). Within the placebo group there was a large difference in muscle strength between operated and nonoperated limbs for both abduction (25 Nm) and adduction (36 Nm) with a significant difference ($P < 0.0164$ and $P < 0.0191$, respectively). A clinical and

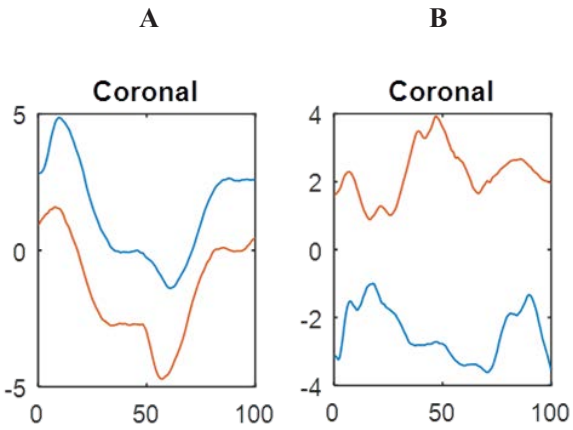


Figure 1.
Pelvic Rotation in the intervention group (A) and placebo group (B)
(blue non-operated and red operated side).

See pages 49 - 106 for financial disclosure information.

significant difference was found between the intervention and placebo group with regards to EQ-5D scores at 6 weeks postoperation. Participants scored higher and more independent scores within the intervention group compared to the placebo group which was of significant difference ($P < 0.0498$). Gait analysis results show a decrease in pelvic rotation within the coronal plane for the intervention group between operated and nonoperated limbs when compared to the placebo group.

Conclusion: This investigation is the first randomized controlled trial to investigate the effects of NMES following a traumatic pelvic fracture. NMES has been shown to be a useful adjunct to standard bed exercise rehabilitation in an under-researched population. This study indicates that within the intervention group, participants have maintained their muscle strength using NMES despite the long periods of non-weight-bearing, compared to the placebo group. The EQ-5D results indicate participants could potentially feel better and more independent as early as 6 weeks postoperation compared to the placebo group. The participants' gait was analyzed with a small population for the interim analysis. This demonstrates minimal pelvic coronal rotation within the intervention group indicating less of a Trendelenburg gait. This is potentially due to stronger hip abductor strength compared to the placebo group. Although a small sample size was analyzed for the interim results, the clinical and significant differences achieved at this early stage indicate promising results that require further investigation with more participants in which recruitment is ongoing.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Relationship of Sacral Fractures to Nerve Injury:
Is the Denis Classification Still Accurate?

Jannat Khan, BS[1]; Alejandro Marquez-Lara, MD[1]; ***Anna Miller, MD, FACS***[2]
[1]*Wake Forest University School of Medicine, Winston-Salem, North Carolina, USA;*
[2]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA*

Background/Purpose: Sacral fractures were largely undiagnosed until 1988, when Denis et al published a groundbreaking paper that classified sacral fractures in accordance with location and symptoms by analyzing radiographs and a limited number of computed tomography (CT) scans from a study population of 236 patients. The Denis classification identifies risk of neurologic injury correlated with sacral fractures by using a progressive severity scale divided into 3 anatomical zones: Zone I (sacral ala; 61-C1.3, c, a1), Zone II (transforaminal; 61-C1.3, c, a2), and Zone III (central sacral canal; 61-C1.3, c, a3). However, recent studies have shown that radiographs have limited power in assessing fractures. Alternatively, modern advances in imaging increase diagnostic sensitivity for determining the classification of these fractures and their corresponding neurologic injuries. Thus, it is hypothesized that the identified neurologic injury risks associated with specific sacral fractures are lower than reported in the original Denis et al paper.

Methods: A retrospective study of 683 consecutive patients with sacral fractures in a series of 1507 patients with pelvic fractures was conducted by analyzing fine-cut CT scans using the Denis classification. Chart review was used to evaluate for associated nerve injuries. Patients were stratified based on the diagnosis of acute nerve injury at presentation. Fisher's exact test was used to determine statistical significance between the frequency of nerve injuries associated with each zone in our study population and in the population in the original Denis paper.

Results: Overall neurologic injury associated with sacral fracture was low at 3.5% as compared with 21.6% in the original Denis paper. Of the sacral fractures evaluated, 66% were Zone I fractures, 25% were Zone II fractures, and 9% were Zone III fractures. These are approximately equivalent to the original Denis paper. Within these subpopulations, 1.9% of nerve injuries were associated with Zone I fractures, 5.8% were associated with Zone II fractures, and 8.6% were associated with Zone III fractures. The frequency of neurologic injuries associated with each specific fracture type was significantly lower in our patient population than published in the original paper ($P = 0.046$). Patients with nerve injuries were significantly correlated with spinopelvic dissociation ($P = 0.048$; 61-A3.3) and comminuted fracture patterns ($P = 0.001$) compared to those without nerve injury. In addition, Zone III injuries were significantly more frequent in patients with associated nerve injury ($P = 0.006$). Patients with nerve injury more often underwent surgical intervention ($P = 0.037$).

Conclusion: The significantly lower frequency of neurologic injuries associated with specific sacral fractures in our study population confirms our hypothesis that nerve injuries associated with each Denis classification are much less common than reported in the original paper. These findings indicate that, in comparison to radiographs, CT scans allow for more accurate diagnosis of sacral fractures and their associated neurologic injuries due to an increased level of detail that helps to limit misdiagnosis. Hence, it may be recommended

See pages 49 - 106 for financial disclosure information.

that all patients with pelvic and/or sacral injuries receive CT scans, preferably with 0.6 mm cut. In addition, patients with nerve injury more often presented with Zone III fracture or spinopelvic dissociation. As such, we encourage physicians treating sacral fractures to have a very high index of suspicion for Zone III fracture or spinopelvic dissociation whenever a nerve injury is present. Further research is warranted to evaluate short- and long-term nerve function in patients who present with these complex fracture patterns, due to persistence of neurologic deficit.

Table 1 – Patient demographics, injury characteristics, and post-operative outcomes based upon the presence of nerve injury

	Associated Nerve Injury (n=24)	No Nerve Injury (n=659)	p-value
Age	46.6±19.1	43.4±19.3	0.425
% Female	45.8%	45.2%	0.953
Body mass index	27.9±9.9	27.6±6.9	0.843
Bilateral Fracture	20.8%	9.7%	0.076
Spinopelvic dissociation	16.7%	6.4%	**0.048**
Displacement - Non-displaced - Minimally displaced - Displaced - Comminuted	 37.5% 8.3% 8.3% 45.8%	 62.1% 18.5% 3.2% 16.2%	**0.001**
Mechanism of Injury* - Fall - High energy - Other	 12.5% 75.0% 12.5%	 24.0% 70.7% 5.3%	0.173
Zone of injury** - Zone 1 - Zone 2 - Zone 3	 37.5% 41.7% 20.8%	 67.4% 24.6% 8.0%	**0.006**
% Surgery	20.8%	8.5%	**0.037**
Post-operative management			
Weight bearing status - Non-weight bearing - As tolerated	 62.5% 37.5%	 51.0% 49.0%	0.268
DVT Prophylaxis	58.3%	44.9%	0.195
Pain medication - Narcotics - Acetaminophen	 100% 0.0%	 96.5% 3.5%	0.352
Physical therapy	79.2%	62.5%	0.097
Abnormal nerve function at follow up***	29.2%	2.4%	**<0.001**

* High energy include: motor vehicle accident, pedestrian vs vehicle, or motorcycle accident. Other include: Tractor accident, bicycle accident, or ATV
** Based on Denis classification
***3-6 weeks

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does Operative Intervention Provide Early Pain Relief for Patients with Undisplaced Unilateral Sacral Fractures?

Paul Tornetta III, MD[1]*; Julie Agel, ATC*[2]*; Anna Miller, MD, FACS*[3]*; Joshua Gary, MD*[4]*; Clifford Jones, MD*[5]*; Jason Lowe, MD*[6]*; Darin Friess, MD*[7]*; Ross Leighton, MD, FRCSC, FACS*[8]*; William M. Ricci, MD*[9]*; Erik Kubiak, MD*[10]*; Laurence Kempton, MD*[11]*; Heather Vallier, MD*[12]*; Brian Mullis, MD*[13]*; Sean Nork, MD*[2]*; Zachary Roberts, MD*[14]

[1]*Boston Medical Center, Boston, Massachusetts, USA;*
[2]*Harborview Med Center, Seattle, Washington, USA;*
[3]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA;*
[4]*UT Houston Department of Orthopaedic Surgery, Houston, Texas, USA;*
[5]*The CORE Institute, Phoenix, Arizona, USA;*
[6]*University of Alabama – Birmingham, Homewood, Alabama, USA;*
[7]*Oregon Health & Science University, Portland, Oregon, USA;*
[8]*Queen Elizabeth II, Nova Scotia, CANADA*
[9]*Washington University in Saint Louis, St. Louis, Missouri, USA;*
[10]*University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA;*
[11]*Indiana University Health Methodist Hospital, Indianapolis, Indiana, USA;*
[12]*MetroHealth Medical Center, Cleveland, Ohio, USA;*
[13]*Eskenazi Health, Indianapolis, Indiana, USA;*
[14]*University of Oklahoma Medical Center, Oklahoma City, Oklahoma, USA*

Purpose: Sacral fractures comprise approximately 75% of pelvic fractures. The most common type is a unilateral sacral injury with anterior impaction of the sacrum. Operative indications are unclear even in undisplaced fractures. One of the drivers of operative management is the belief that fixation will diminish early pain, potentially leading to faster recovery. We designed a multicenter prospective trial to evaluate unilateral sacral fractures that is funded by the OTA. The purpose of this report is to compare the early pain experienced by patients with undisplaced unilateral sacral fractures treated operatively versus those treated nonoperatively.

Methods: Over a 7-year period we offered enrollment to all patients with unilateral sacral fractures in 15 centers. Exclusion criteria were: AP compression injuries as demonstrated by symphyseal dislocation, pregnant patients or prisoners, and those who would not be able to follow up. All fractures were evaluated for location by zone and displacement (in mm) on the standard three views of the pelvis and CT scan. For the purpose of this report, undisplaced fractures demonstrated no displacement on the AP and inlet views. Pain was assessed using a standard visual analog scale (VAS) score of 0-10. Pain "over the last day" in the anterior pelvis and the posterior pelvis were documented at baseline (prior to injury), 24 hours posttreatment (first 48 hours for nonoperative), and 1, 3, 6, and 12 weeks posttreatment or postinjury. We compared the VAS pain at each time point for all patients with data at that visit using group t tests with significance set at $P < 0.05$.

Results: We enrolled 298 patients with undisplaced fractures (average age = 40, average ISS = 13.7) of whom 53% were female. The average body mass index (BMI) was 25.9. The most common mechanisms of injury were motor vehicle accident (51%) followed by fall

See pages 49 - 106 for financial disclosure information.

from a height (20%). 136 patients were treated nonoperatively and 63 operatively. There were no differences in age, gender, BMI, or mechanism of injury between the groups. ISS was statistically higher in the operative group (16.6 vs 12.8; P <0.02). Nonoperative patients reported 1.6-point average higher pain in the posterior pelvis and 1 point in the anterior pelvis at 24 hours pos-treatment or postinjury and 1 point in the anterior pelvis at 1 week. There was no further difference in VAS reported at 3, 6, or 12 weeks.

Conclusion: We sought to evaluate whether operative intervention resulted in early pain relief for patients with undisplaced unilateral sacral fractures from a prospective cohort of patients treated in 16 trauma centers. There was a 1-point increase in anterior pain and a 1.6-point difference in posterior pain reported at 24 hours by the nonoperative group. By 3 weeks there was no difference between the 2 groups that continued through union at 3 months. Internal fixation of undisplaced unilateral sacral fractures does not provide substantial pain relief during union.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

INFIX versus Plating for Pelvic Fractures with Symphyseal Disruption

*Rahul Vaidya, MD[1]; **Adam Martin, MS[2];** Matthew Roth, MS[3]; Frederick Tonnos, DO[4]; Kerellos Nasr, MD[2]*
[1]Detroit Medical Center, Wayne State University, Ann Arbor, Michigan, USA;
[2]Detroit Medical Center, Wayne State University, Detroit, Michigan, USA;
[3]Wayne State School of Medicine, Detroit, Michigan, USA;
[4]Detroit Medical Center, Michigan State University, Novi, Michigan, USA

Purpose: Unstable pelvic injuries with disruption of the symphysis pubis (SP) are traditionally fixed with anterior plates in conjunction with posterior fixation. The anterior subcutaneous internal fixator (INFIX) is a biomechanically sound method of fixation that is implanted using small incisions, even in obese patients. The purpose of this study is to compare INFIX to traditional symphyseal plating by assessing reductions, complications, and functional outcomes.

Methods: An IRB-approved retrospective cohort study was performed using our hospital's trauma database including 52 patients with unstable pelvic injuries who had SP disruptions. 24 patients who underwent implantation of INFIX with posterior fixation were compared to 28 patients who underwent SP plating with posterior fixation. INFIX: There were 13 AO/OTA type B and 11 C-type injuries. The fracture patterns seen were 13 (54%) APC (AP compression), 7 (29%) VS (vertical shear), and 4 (17%) LC (lateral compression. The average age of patients was 43.38 years (range, 21-86), 18 males and 6 females with an average ISS of 21.53 ± 8.71. The average length of follow-up was 40 ± 26 months. Plates: There were 14 B and 14 C-type AO/OTA injuries. Fracture patterns seen were 17 (61%) APC type, 7 (25%) LC type, and 4 (14%) VS. The average age of patients was 39.6 years (range, 21-62), 25 males and 3 females with an average ISS of 22.48 ± 8.45. The average length of follow-up was 51 ± 39 months. Reductions of the SP were measured using AP pelvis radiographs of the original injuries and the most recent AP Pelvis radiograph on file. The pelvic ring reduction was also measured using the Keshishyan cross method and reported as the pelvic deformity index (PDI). Functional outcomes were assessed using the score developed by Majeed. Complications were recorded, and heterotopic ossification (HO) was graded. Statistical analysis was completed in Excel using the Student t test.

Results: INFIX: Average reduction of the SP was 63.48% (range, 19.70-85.09%) of the original diastasis. Average reduction of the pelvic ring was 14.96% based on the PDI values. Five (21%) of the patients developed complications. We experienced 2 (8%) improper implantations, 1 (4%) case of pain associated with the device, 1 (4%) irritation to the lateral femoral cutaneous nerve, and 1 (4%) surgical site infection. The improper implantations occurred in the early cases and consisted of improper fixation of the caps and screws resulting in loss of reduction and in 1 case the construct was placed too deep requiring revision. 11 cases of HO (52.38%) were seen in our patients but had no sequelae. The average Majeed score was 84 (median, 89; range, 51-100). Plates: The average reduction in the SP injury was 75.25% (range, 9.68-90.00%) of the original diastasis. Average reduction of the pelvic ring was 54.15% based upon the PDI. Complications included 4 (14%) surgical site infections and 3 (11%) implant failures. The types of hardware failure seen were 1 broken plate and 2 cases of screw loosening. The average Majeed score was 73.77 (median, 79; range, 48-100).

See pages 49 - 106 for financial disclosure information.

	Patient	AO/OTA Fracture Classification	ISS	SP Reduction	PDI Reduction	Complications
INFIX	1	61-C1.2a2c5	18	66.22%	-	
	2	61-B2.2(1)c1	14	61.74%	68.77%	
	3	61C2.3a1,b1	34	50.68%	27.62%	LCFN irritation
	4	61B3.1c4	14	63.72%	-9.64%	Improper rod and cap fixation with loss of reduction
	5	61B3.2a4b1c8	22	80.95%	72.09%	Pain
	6	61C3.1a4b4c9	21	51.22%	7.04%	Infix bar placed too deep
	7	61C3.1a2b2c4	45	61.79%	86.48%	Expired
	8	61C3.1a2c4	18	70.10%	49.73%	
	9	61B3.1(1)c4	27	26.07%	-174.97%	Expired
	10	61B1(1)C4	13	53.94%	82.95%	
	11	61C3.1c4	21	72.43%	36.38%	
	12	61-B3.2(3)a3b1.1c7	41	32.30%	-42.10%	
	13	61-C1.2a3c1	9	74.47%	-63.90%	
	14	61-C1.2a2c9	9	58.51%	74.38%	
	15	61-B2.1(1)c8	27	69.74%	50.50%	
	16	61-C1.3a2c8	20	81.52%	-5.88%	
	17	61-B1.1(1)c5	20	85.09%	-589.48%	
	18	61-B1.1(1)4	21	31.86%	-44.25%	
	19	61-B3.1(1)a1b1.1c5	9	49.77%	-59.88%	
	20	61-B1.1c5	24	60.86%	56.83%	Expired
	21	61-C1.3a1c9	27	19.70%	-141.11%	
	22	61-C2.2a2b1.1c5	24	75.80%	-335.90%	
	23	61-B1.1(1)a1c7	34	66.44%	69.14%	
	24	61-B1.1(1)c5	18	65.70%	100.00%	Infection
Plates	1	61-C1.2a2c3	29	34.59%	51.14%	
	2	61-B3.2(2)a2b3c3	43	90.00%	396.70%	
	3	61-B1.1(1)c5	24	48.08%	87.24%	
	4	61-B1.1(1)c4	18	69.11%	77.80%	
	5	61-C1.3a1c5	24	75.89%	62.16%	
	6	61-C1.2a1c4	18	51.81%	88.22%	
	7	61-C2.1b1.1c5	18	80.52%	87.16%	
	8	61-B1.2c5	34	69.89%	62.37%	Hardware Loosening
	9	61-C1.2a3c4	20	72.65%	77.07%	
	10	61-C1.2a2c5	22	86.70%	27.60%	
	11	61-C1.3a2c2	33	46.03%	71.58%	
	12	61-C1.2(a2)c4	24	88.51%	36.54%	Infection
	13	61-C2.2a2b1.1c5	36	88.79%	270.30%	Infection
	14	61-C1.2a2c4	9	85.66%	76.82%	
	15	61-B1.1(1)c1	19	57.57%	771.52%	
	16	61-B1.1(1)c5	34	86.20%	1122.14%	
	17	61-B2.3(1)c5	18	62.67%	42.87%	
	18	61-B1.1(1)c1	27	71.06%	76.66%	
	19	61-C1.2a2c8	18	74.71%	378.63%	
	20	61-C1.2a3c5	14	56.19%	57.35%	
	21	61-C1.3a1c4	10	60.99%	75.46%	Plate failed resulting in loss of reduction, Infection
	22	61-B1.1(1)c4 OOP CT	9	9.68%	285.34%	
	23	61-B1.1(1)c5	29	79.05%	10.04%	
	24	61-B1.1c5	21	88.30%	197.33%	
	25	61-B1.1c8	21	89.29%	83.10%	
	26	61-B2.2(1)c5	17	83.46%	4.96%	Hardware Loosening, Infection
	27	61-C1.2a2c5	18	81.32%	94.64%	
	28	61-B3.2(3)a1b3c0	27	26.34%	97.30%	

Conclusion: Plates provide superior reduction of the SP when compared to INFIX (P = 0.036). Plating also requires only 1 surgery compared to the 2 of INFIX. Complication rates were not significantly different between the methods (P = 0.37). There was no statistically significant difference in the Majeed outcomes scores (P = 0.0774). Fixation using INFIX may be preferred in obese patients due to ease of application and in young women of child-bearing age as there is no retained hardware.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Predictors of Unplanned Reoperation after Operative Treatment of Pelvic Ring Injuries

George Ochenjele, MD[1]; *Kristoff Reid, MD[2]; Renan Castillo, MD[3]; Carrie Schoonover, BS[1]; Ryan Montalvo, BS[1]; Theodore Manson, MD[1]; Marcus Sciadini, MD[4]; Jason Nascone, MD[5]; Robert V. O'Toole, MD[6]*

[1]R. Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA;

[2]Medical University of South Carolina, Mt Pleasant, South Carolina, USA;

[3]John Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA;

[4]Department of Orthopedics, RA Cowley STC, University of Maryland School of Medicine, Baltimore, Maryland, USA;

[5]Shock Trauma Orthopaedics, Baltimore, Maryland, USA;

[6]University of Maryland, Shock Trauma, Baltimore, Maryland, USA

Purpose: Pelvic ring injuries are associated with relatively high rates of mortality and morbidity, but little is known regarding the risk factors for complication and unplanned reoperation. The goal of this study is to evaluate the incidence of unplanned reoperation after pelvic ring injuries and to develop a risk prediction model. Our hypothesis is that unplanned reoperation will be relatively common, occurring early, and that strong predictors for reoperation will be identified.

Methods: We reviewed the medical records of 913 patients with operatively treated pelvic ring injuries at our Level I trauma center from 2003 to 2015. The primary outcome measure was unplanned index reoperation for the following indications: infection, fixation failure, heterotopic ossification (HO), or bleeding complication. Multiple logistic regression analysis was performed to evaluate for the relative contribution of associated clinical parameters to unplanned reoperation. A risk prediction model was then developed using logistic regression analyses, which enabled us to assess the effect of multiple covariates. The mean age was 35 ± 13 years (range, 14-89). There were 644 males, 269 females. The inhospital mortality rate was 4.1% (n = 37). Combined pelvic ring and acetabulum injuries were relatively common (17.6%, n = 161), 8.0 % (n = 73) were open injuries, 27.3% (n = 249) sustained head injuries, 19.9% (n = 154) had urogenital injuries, and 31% (n = 283) had abdominal viscera injuries.

Results: The overall rate of unplanned reoperation was 14.6% for the following indications: infection (8.1%, n = 74), fixation failure (5.7%, n = 52), HO (<1%, n = 6), and bleeding complication (<1%, n = 1). Reoperation for infection and failure typically occurred within the first month of the index procedure (mean occurrence of 19 and 22 days, respectively). We identified four independent predictors of reoperation: open fractures (odds ratio [OR] 2.74, P = 0.001), combined pelvic ring and acetabular injuries (OR 2.46, P <0.001), abdominal viscera injuries (OR 2.56, P <0.001), and increasing Young-Burgess pelvic fracture grade (AP compression [APC] II/lateral compression [LC] II OR 3.31, P = 0.013; APC III/LC III fractures OR 6.90, P <0.001; and vertical shear [VS]/combined mechanism injury [CMI]/sacral fractures OR 8.69, P <0.001). There was no independent association between reoperation and patient, treatment or any other injury factors that were evaluated (P >0.20).

See pages 49 - 106 for financial disclosure information.

Conclusion: As we hypothesized, unplanned reoperation was relatively common (15%) in this large series of operatively treated pelvic fractures. Infection and fixation failure were the most common indication for unplanned reoperation. We did identify factors that were associated with reoperation. These factors are related to the severity of the injury to the local pelvis and abdominal viscera (open fracture, Young-Burgess fracture class, combined pelvic and acetabular fractures, and abdominal viscera injury). These data should be useful for clinicians in discussing the risks of surgery with patients as well as helping them to direct their efforts to reduce the reoperation rate.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

The Post-Sarmiento Era: Is It Time to Rethink Expectations of Functional Bracing for Humeral Shaft Fractures?

Rafael Serrano-Riera, MD[1]; *Benjamin Maxson, DO[2]; Anthony Infante, DO[3]; David Watson, MD[4]; Roy Sanders, MD[5]; Hassan R. Mir, MD[3]; Anjan Shah, MD[3]*
[1]*Florida Orthopaedic Institute - University of South Florida, Tampa, Florida, USA;*
[2]*Tampa General Hospital, Tampa, Florida, USA;*
[3]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[4]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[5]*Orthopaedic Trauma Service, Tampa, Florida, USA*

Purpose: The current belief is that the majority of humeral shaft fractures can be treated nonoperatively with predictable outcomes, and early operative management is taboo other than for very limited indications. Sarmiento reported good success and a relatively low rate of malunion and nonunion in patients who tolerated fracture bracing. However, not all patients accept fracture bracing. Often, patients in whom closed treatment was acutely initiated are later subacutely having to be converted to operative treatment. The purpose of this study is to review our rate of failure of closed treatment of humeral shaft fractures with fracture bracing, requiring conversion to surgical intervention.

Methods: 222 patients with a closed humeral shaft fracture managed nonoperatively with a functional brace between 2005 and 2014 were identified in our prospective database and reviewed retrospectively. Patients <18 years old, pathologic and periprosthetic fractures, fractures extending beyond the diaphysis, and patients lost to follow-up (FUP) or with a FUP <12 months were excluded. Data analysis included: demographics, mechanism of injury, fracture characteristics (pattern and location), neurovascular injuries, fracture union, and time to healing. In the event of failure of conservative treatment, time from injury to surgery and reason for surgery was recorded.

Results: 60 patients were excluded, leaving 162 fractures (162 patients). The cohort followed a bimodal distribution (young male, elderly female). Overall mean age was 48 years old (range, 18-92) with 49% males. 28% (n = 46) of the fractures occurred in the proximal diaphysis, 50% (n = 82) in the midshaft, and 22% (n = 34) in the distal diaphysis (P <0.001). Fracture patterns included: 33% (n = 54) transverse, 30% (n = 49) spiral, 15% (n = 25) oblique, 11% (n = 18) comminuted, 9% (n = 14) butterfly, and 2% (n = 3) were segmental (P = 0.3). 12 closed fractures (7%) presented with symptoms of radial nerve palsy before application of the brace. Union occurred at an average of 17 weeks (range, 12-36). 60 fractures (37%) required surgical intervention after failure of nonoperative treatment. Time between injury and failure of nonoperative treatment averaged 9.4 weeks (range, 2-24 weeks). Of those, 29 patients (48%) lost their initial reduction beyond the acceptable parameters, 8 (13%) were noncompliant to functional bracing, 4 (6%) had persistent signs of radial nerve palsy (average 15 weeks of observation), and 19 (38%) developed a nonunion (after average 20 weeks of bracing). No patient undergoing surgery for a failure of conservative treatment required a subsequent intervention. All patients with radial nerve palsy fully recovered except one. The failure of functional bracing was analyzed by fracture pattern with the following association found: 44% (n = 8) of comminuted fractures required surgery, 42% (n = 20) of spiral fractures, 35%

See pages 49 - 106 for financial disclosure information.

(n = 5) of butterfly fragments, 33% (n = 8) of oblique fractures, 33% (n = 1) of segmental fractures, and 32% (n = 17) of transverse fractures (P = 0.88). Comminution (OTA 20/12C3-1/12C3-3) and spiral fracture (OTA 12A-1) patterns were associated with the lowest success rate using conservative treatment.

Conclusion: We report a failure rate of nonoperative treatment of 37% with fracture bracing of humeral shaft fractures. These results are markedly higher than previously reported, upon which the current recommendations of bracing are based. The current data call into question what the conservative standard of care should be for comminuted or spiral humeral shaft fractures. Early surgical intervention aiming for a quicker rehabilitation, pain relief, and avoidance of high failure rates with nonoperative management should be considered.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Firm Shake Leads to a Strong Union: Stability Six Weeks following Humeral Shaft Fracture Predicts Healing

Adam Driesman, BA, *Nina Fisher, BS; Sanjit Konda, MD; Kenneth A. Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: While the majority of humeral shaft fractures go on to heal with nonoperative treatment, fracture nonunion can be a significant complication. The purpose of this study is to assess the ability of fracture site gross motion on physical examination to predict humeral shaft progression to healing or nonunion in patients managed nonoperatively using a functional brace.

Methods: 84 patients undergoing nonoperative treatment of a diaphyseal humeral shaft fracture at our institution were identified. Clinical examination for fracture stability was performed on all patients by the treating physician at each postinjury follow-up. 328 visits were examined to assess for radiographic and clinical healing. All patients included had complete follow-up through bony union or intervention. Significance was assessed via Pearson's $\chi 2$ analysis and logistic regression, with level of significance set at $P < 0.05$.

Results: 73 of the 84 patients (87%) healed their fracture within our study cohort by 6 months postoperatively. The physical examination test for humeral shaft stability at 6 weeks follow-up identified fracture healing with 98% sensitivity, with 72 of 73 unions correctly identified. Testing at the 6-week mark also had 82% specificity with a false positive rate of 18.2%. Positive predictive value and negative predictive values were 97% and 90%, respectively. Pearson's $\chi 2$ test demonstrated a statistically significant association between gross motion at 6 weeks and nonunion formation, $\chi 2(1) = 58.99$, $P < 0.001$. When fracture morphology and patient age were controlled for, gross fracture motion on physical examination at 6 weeks retained significant association with development of nonunion using multivariate logistic regression.

Conclusion: Clinical examination of fracture site stability at 6 weeks is an accurate and reliable tool for identifying those individuals with humeral shaft fractures that will likely heal to union. Those with gross motion at this time point should be educated in and evaluated for early surgical intervention to speed time to healing. With a high positive predictive value, fracture stability at 6 weeks should be assessed in every patient to predict which patients will most likely result in fracture healing.

See pages 49 - 106 for financial disclosure information.

A Prospective Randomized Trial of Nonoperative versus Operative Management of Olecranon Fractures in the Elderly

***Andrew Duckworth, MBChB; BSc, MRCSEd, MSc, PhD*[1];**
Nicholas Clement, MRCSEd, PhD[1]*; Jane McEachan, FRCSEd; Timothy White, MD, FRCSEd*[1]*;*
Charles Court-Brown, MD, FRCSEd[1]*; Margaret McQueen, MD, FRCS*[1]
[1]*Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh, UNITED KINGDOM;*
[2]*Department of Orthopaedic Surgery, Queen Margaret Hospital, Dunfermline,*
UNITED KINGDOM

Purpose: Recent retrospective studies have advocated primary nonoperative treatment for isolated displaced olecranon fractures in elderly lower-demand patients. The aim of this multicenter, prospective randomized controlled trial was to compare patient-reported and functional outcomes, complications, and economic costs for displaced olecranon fractures in patients 75 years or older who were managed with either primary open reduction and internal fixation (ORIF) or nonoperative treatment. The null hypothesis was that there is no difference between groups in the patient-reported outcome at 1 year postinjury.

Methods: We performed a registered prospective randomized two-center trial in elderly patients (≥75 years of age) with an acute displaced fracture of the olecranon. Patients were randomized to either operative (tension band wire or plate fixation) or nonoperative (2 weeks immobilization followed by early active motion) management. The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 1 year post injury. Secondary outcome measures included surgeon-reported outcome measures, complications, pain, and cost. Power analysis determined a total sample size of 50 patients (25 per arm) was required to provide 80% power to detect significant difference (0.05) in the DASH at 1 year (effect size 0.8).

Results: There were 19 patients randomized to receive nonoperative (n = 8) or operative (n = 11) management. Two patients died in the year following surgery, with the follow-up rate in those available 100%. There was a significant improvement in elbow function in both groups over the 1-year period following injury (P = 0.001). There was no difference in the DASH between groups at all time points over the 1 year following injury, with the mean DASH at 1 year 22 (range, 2.5-57.8) in the operative group and 23 (range, 0-59.6) in the nonoperative group (P = 0.763). At 1 year following injury, the elbow flexion arc was just significantly better in the operative group (129 vs 106; P = 0.049). There was no other significant difference between groups in terms of elbow flexion arc, forearm rotation arc, Broberg and Morrey Score, or the Mayo Elbow Score at all the assessment points over the 1 year following injury (all P = 0.05). There was a significantly higher rate of complications (81.8% vs 14.3%; P = 0.013) and cost ($15,295 vs $4947; P = 0.008) following surgical intervention.

Conclusion: In older lower-demand patients, these data provide further evidence to support the primary nonoperative management of isolated displaced olecranon fractures. This trial was stopped early due to the high rate of complications found in the operative treatment arm on interim analysis and safety monitoring.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Comparison of the Henry versus Thompson Approaches for Fixation of Proximal Radial Shaft Fractures: A Multicenter Study

Jesse Dashe, MD*[1]*; *Brett Murray, BS, MA*[2]*; Paul Tornetta III, MD*[3]*; Kelly Grott, BS*[4]*; Brian Mullis, MD*[5]*; Kate D. Bellevue, MD*[6]*; Reza Firoozabadi, MD, MA*[6]*; Harish Kempegowda, MD*[7]*; Daniel S. Horwitz, MD*[7]*; Philip Fontenot, MD*[8]*; Shaan Patel, MD*[8]*; Hassan R. Mir, MD*[9]*; John Ruder, MD*[10]*; CAPT (ret) Michael Bosse, MD*[10]*; Jerald Westberg, BA*[11]*; Benjamin Sandberg, MD*[12]*; Kasey J. Bramlett, PA-C*[13]*; Andrew J. Marcantonio, DO, MBA*[13]*; Alex J. Sadauskas, BS*[14]*; Lisa K. Cannada, MD*[14]*; Alexandra Goodwin, MD*[15]*; Anna N. Miller, MD, FACS*[15]*; Samuel Klatman, MD*[16]*; Mary P. George, MD*[16]*; Peter Krause, MD*[17]

[1]*Boston University Medical Center, Boston, Massachusetts, USA;*
[2]*Boston University, Boston, Massachusetts, USA*
[3]*Boston Medical Center, Boston, Massachusetts, USA;*
[4]*Indiana University, Indianapolis, Indiana, USA;*
[5]*Eskenazi Health, Indianapolis, Indiana, USA;*
[6]*Harborview / University of Washington, Seattle, Washington, USA;*
[7]*Geisinger Medical Center, Danville, Pennsylvania, USA*
[8]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[9]*Florida Orthopaedic Institute, Temple Terrace, Florida*
[10]*Carolinas Medical Center, Charlotte, North Carolina, USA*
[11]*Hennepin County Medical Center, Minneapolis, Minnesota;*
[12]*University of Minnesota, Dept of Orthopaedic Surgery, Minneapolis, Minnesota, USA*
[13]*Lahey Hospital and Medical Center, Burlington, Massachusetts, USA;*
[14]*Saint Louis University, St. Louis, Missouri, USA;*
[15]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA*
[16]*Louisiana State University, New Orleans, Louisiana, USA;*
[17]*Louisiana State University Health Sciences Center, New Orleans, Louisiana, USA*

Background/Purpose: The standard of care for radial shaft fractures is compression plating. A volar Henry approach is recommended for the distal 2/3 of the radius. In contradistinction, many sources recommend a dorsal Thompson approach for proximal 1/3 fractures to allow for more proximal fixation points and to identify and protect the posterior interosseous nerve (PIN). Other surgeons are comfortable using the extensile volar Henry for proximal fractures, with fixation up to the biceps insertion, which avoids dissection of the PIN and uses a medial release of the supinator to protect the nerve in the supinated position. There are no clinical series describing the use of the volar Henry approach for proximal 1/3 radial shaft fractures. The purpose of this study was to compare these two approaches in a large series of proximal 1/3 radial shaft fractures with respect to complications and resultant range of motion.

Methods: All patients with a proximal 1/3 radial shaft fracture (with or without associated ulna fracture) treated operatively in 8 trauma centers were included. Demographic patient, injury, fracture, and surgical data were recorded. Final range of motion and complications of infection, wound dehiscence, neurologic injury, compartment syndrome, malunion/nonunion, pain, hardware irritation, contracture, and severe restriction of range of motion

See pages 49 - 106 for financial disclosure information.

(<90° arc) were gathered and compared for volar versus dorsal approaches using t tests for continuous variables and Fisher's exact test for categorical variables.

Results: 172 patients (119 M, 53 F) aged 18-84 years (average 35.9) with 63 transverse, 32 oblique, 57 comminuted, and 20 segmental fractures of the proximal 1/3 of the radius were evaluated. Patients were followed an average of 347 days and all patients were followed through union or the diagnosis of nonunion. 60 fractures were open (51 I-IIIA; 9 IIIBC), 121 patients had an associated ulna fracture, and 85 patients had associated injuries. 131 were fixed through a volar and 41 via a dorsal approach. There were no differences in the patient factors between the groups. Patients treated with a dorsal approach had fractures that were slightly more proximal (71 mm vs 86 mm from the radiocapitellar joint) (P = 0.0006). This did not translate to more fixation proximal to the fracture with the mean number of screws being 4 for both approaches. No other patient or fracture factor correlated with the chosen approach. 52% of the volar and 53% of the dorsal plates ended distal to the bicipital tuberosity and the remainder engaged or were proximal to the tuberosity. Double plating was used in 14% of the volar and 10% of the dorsal approaches. Complications occurred in 32% of dorsal and 23% of volar approaches (P = 0.3). Complications were more common in open fractures approached dorsally (P = 0.005) but not in those approached volarly (P = 0.51). There were only 3 neurologic injuries (1.7%) in the series, 2 in the volar and 1 in the dorsal group. Three patients had a deep infection, all in the volar group. Nine (5%) nonunions occurred, 5 volar and 4 dorsal. Nine patients had significant restrictions in their rotation (<90° arc). After removing these outliers, the average arc of pronosupination in the volar and dorsal groups was 160° and 159° and elbow range of motion was 5°-132° and 6°-128°, respectively. The presence of an ulna fracture did not influence pronosupination in either group or the combined series (P = 0.58).

Conclusion: This multicenter series demonstrates no difference in the complication rates between a volar and dorsal approach for proximal 1/3 radius fractures. Specifically, fixation to the level of the tuberosity is safely accomplished via the volar approach without an increase in risk to the PIN. Nonunion was more common in the dorsal approach, but no other differences were seen in the complication rates between the groups. 5% of patients had significant restrictions in their arc of motion (<90°), but all others in both groups had a final average arc of 160°. This series demonstrates the safety of the volar Henry approach for proximal 1/3 radial shaft fractures with a trend toward a lower complication rate than the dorsal approach. Surgeons may employ the volar approach with greater confidence despite the general recommendations to use a dorsal approach for neurologic safety.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Prospective Randomized Trial of Plate Fixation versus Tension Band Wire for Olecranon Fractures

Andrew Duckworth, MBChB, BSc, MRCSEd, MSc, PhD;
Nicholas Clement, MRCSEd, PhD; Timothy White, MD, FRCSEd;
Charles Court-Brown, MD, FRCSEd; Margaret McQueen, MD, FRCS
Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh, UNITED KINGDOM

Purpose: Tension band wire (TBW) fixation is the most commonly employed technique for isolated displaced fractures of the olecranon, with plate fixation a noted alternative. A recent Cochrane review concluded that further work is needed in this area to determine the optimal surgical management of simple isolated fracture of the olecranon. The aim of this single-center, single-blind, randomized controlled trial was to compare patient-reported and functional outcomes, complications, and economic costs for displaced olecranon fractures managed with either TBW or plate fixation. The null hypothesis was that there is no difference between groups in the patient-reported outcome at 1 year postinjury.

Methods: We performed a registered prospective randomized, single-blind, single-center trial in 67 patients aged between 16 and 74 years with an acute isolated displaced fracture of the olecranon. Patients were randomized to either TBW (n = 34) or plate fixation (n = 33). The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 1 year postinjury. Secondary outcome measures included surgeon-reported outcome measures, complications, pain, and cost. A power analysis determined a total sample size of 50 patients (25 per group) was required to provide 80% statistical power to detect significant differences (0.05) in the DASH score at 1 year, assuming an effect size of 0.8. Intention to treat analysis was performed.

Results: The baseline demographic and fracture characteristics of the two groups were comparable. The mean age of patients was younger in the TBW group (43 vs 52 years). The 1-year follow-up was 85%. There was a significant improvement in elbow function over the 12 months following injury in both groups ($P < 0.001$). At 1 year following surgery the DASH score for the TBW group was not statistically different from the plate fixation group (12.8 vs 8.5; $P = 0.315$). There was no significant difference between groups in terms of elbow flexion arc, forearm rotation arc, Broberg and Morrey Score, the Mayo Elbow Score, or the DASH at all the assessment points over the 1 year following injury (all $P = 0.05$). Complication rates were significantly higher in the TBW group (63% vs 38%; $P = 0.042$), predominantly due to a significantly higher rate of symptomatic metalwork removal (50.0% vs 22%; $P = 0.021$). Overall, the mean cost per patient was not significantly different between the two groups ($P = 0.131$).

Conclusion: In active patients with an isolated displaced fracture of the olecranon, no difference was found in the patient-reported outcome between TBW and plate fixation at 1 year following surgery. The complication rate is higher following TBW fixation due to a high rate of symptomatic metalwork removal.

See pages 49 - 106 for financial disclosure information.

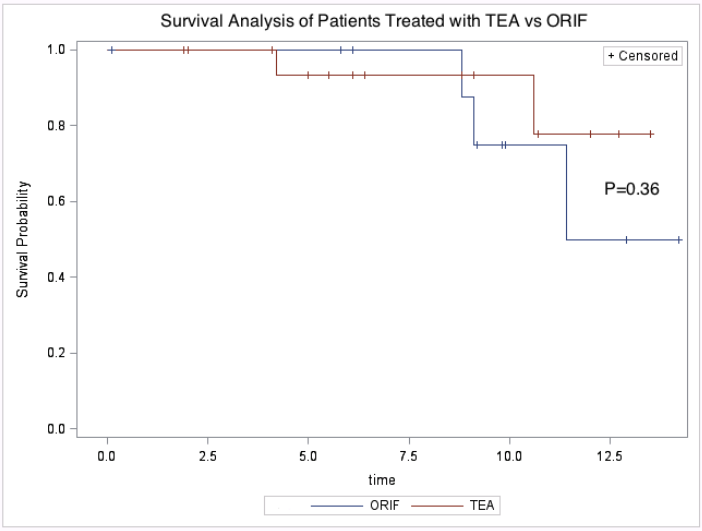
Δ Long-Term Outcomes of Total Elbow Arthroplasty for Distal Humeral Fracture: Results from a Prior Randomized Clinical Trial

Niloofar Dehghan, MD, MS, FRCSC[1]; *Matthew Furey, MD[2]; Emil H. Schemitsch, MD[3]; Christine Schemitsch, BS[1]; Michael D. McKee, MD[3]*
[1]*University of Toronto, Ontario, CANADA;*
[2]*University of Calgary, Alberta, CANADA;*
[3]*St. Michael's Hospital, Toronto, Ontario, CANADA*

Purpose: The use of total elbow arthroplasty (TEA) has become an increasingly popular treatment option in the setting of acute trauma for elderly patients with comminuted intra-articular distal humeral fractures. Multiple retrospective studies have documented good to excellent clinical outcome following TEA for trauma at short- to moderate-term follow-up. However, the longevity and long-term complications associated with this procedure are unknown. The objective of the present study was to examine long-term outcomes and implant survival in patients from a randomized clinical trial (RCT) comparing TEA to open reduction and internal fixation (ORIF).

Methods: We followed patients from a previously reported RCT comparing TEA and ORIF in patients over 65 years of age with comminuted, intra-articular distal humeral fractures conducted between 2000 and 2006. 42 patients were originally randomized. Patients and/or family members were contacted to obtain the required information. Outcomes included patient-reported grading of function and pain, revision surgical procedures, and implant survival.

Results: 11 patients were lost to follow-up, and we were able to obtain follow-up on 31 patients (7 men and 24 women, mean age 78 years). There were 2 early postoperative deaths, and 17 late deaths (19/42, 45%) and the mean follow-up was 8.3 years (range, 1.9-14.2 years). Three patients in the ORIF group underwent a second surgical procedure, at a mean of 1.7 years postoperatively, all for hardware removal. Two patients underwent a secondary procedure in the TEA group at a mean of 1.1 years postoperatively, one for irrigation and debridement for a deep infection, and a second for elbow release. There were no differences between the two groups with regard to rates of revision surgery (P = 0.36) (Fig. 1). Of the 18 patients with a TEA who were followed, none required revision of



Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

the TEA, and this group included 8 who were living with their original arthroplasty, and 10 who died with a well-functioning implant in situ.

Conclusion: Total elbow arthroplasty is an effective and reliable procedure for comminuted fractures of the distal humerus in elderly patients. Our study revealed that long-term survival of the implant is excellent, with no patient requiring a late revision. This finding, combined with the better functional results and rapid rehabilitation compared to ORIF we have previously reported, confirms the utility of TEA in this elderly, low-demand, and frail population. For the overwhelming majority of these patients, a well-performed TEA will give them a well-functioning elbow for life and be the last elbow procedure they require.

See pages 49 - 106 for financial disclosure information.

Intraoperative O-Arm Imaging of AO/OTA C2 and C3 Distal Radius Fractures Identifies Malreduced Final Reductions in up to 30% of Cases

Brian Vickaryous, MD*; J. Dean Cole, MD; Bob Meuret, MD*
Florida Hospital Orlando, Orlando, Florida, USA

Background/Purpose: Fractures of the distal radius are one of the most common orthopaedic injuries and account for over 600,000 emergency room visits per year. Severity of injury has been correlated with need for surgical fixation and restoration of articular congruity has been noted to correlate with posttraumatic degenerative changes. Current standard of care utilizes intraoperative evaluation with two-dimensional (2D) C-arm imaging techniques, whereas 3D O-arm imaging techniques are now available and feasibly should improve the diagnostic and management abilities of the operating surgeon. The purpose of this study is to assess the quality of intraoperative definitive provisional reduction of AO/OTA C2 and C3 fractures of the distal radius through 3D O-arm visualization and its effects on intraoperative management and short-term radiologic outcomes.

Methods: This is a prospective nonrandomized trial evaluating 48 consecutive AO/OTA C2 and C3 distal radius fractures comparing intraoperative intention to treat based on standard 2D C-arm radiography assessment after provisional reduction versus the same reduction adequacy after O-arm 3D visualization. From June 2015 to January 2016, a consecutive series of 48 patients were enrolled in the study, and underwent pre- and postreduction radiographs and CT to evaluate severity of injury. Inclusion criteria were displaced (2 mm or more) intra-articular distal radius fractures in skeletally mature, mentally competent individuals. Eligible patients had the following parameters recorded on a prospectively maintained database: age, duration of surgery, duration of O-arm imaging, intent to treat based on adequacy of reduction via C-arm imaging, and adequacy of initial reduction. Patient records and radiographs were reviewed for accuracy and any additional findings recorded that were pertinent to the O-arm intervention that are pertinent to the study outcome.

Results: There were 48 patients enrolled (30 female, 18 male) with 46 AO/OTA type C3 and 2 AO/OTA C2 intra-articular fractures. There were 12 patients whose initial reduction was noted as anatomically reduced via C-arm fluoroscopy and were found by subsequent O-arm to be inadequately reduced. In total, 25% of all fractures were found to be malreduced and would have been deemed erroneously fixed by the operating surgeon. Of note on further review, 2 patient O-arm studies showed findings that should have been addressed intraoperatively, one loose body in the joint and residual articular displacement of 2 mm (4.2%). There was a total of 14 patients or 29.2% of all treated distal radius fractures in this series that would have been or were erroneously fixated in a malreduced position or had other findings that may interfere with outcomes. The average O-arm imaging time was 6 minutes (range, 3-13 minutes) and did not significantly affect operative length.

Conclusion: Current standard 2D fluoroscopic imaging and subsequent surgical treatment of AO/OTA type C2 and C3 fractures allows for up to 30% of all fractures to be fixed in a malreduced position, particularly at the articular surface. With long-term posttraumatic degenerative joint changes correlating with degree of articular displacement, future fixa-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

tion efforts in these fractures might benefit from the routine use of advanced intraoperative imaging modalities such as the 3D O-arm.

See pages 49 - 106 for financial disclosure information.

Digital Edema Predicts Early Progression to Functional Plateau Following Volar Locked Plating for Distal Radius Fractures

Michael Maceroli, MD[1]*; Edward Shields, MD*[1]*; John Ketz, MD*[2]*; John Elfar, MD*[3]*; Jonathan Gross, MD*[4]*; Warren Hammert, MD, DDS*[1]
[1]*University of Rochester, Rochester, New York, USA;*
[2]*University of Rochester Medical Center, Pittsford, New York, USA;*
[3]*University of Rochester Department of Orthopaedics, Rochester, New York, USA;*
[4]*Healthcare Associates, Department of Orthopaedics, Staten Island, New York, USA*

Purpose: The majority of operatively treated distal radius fractures will achieve good or excellent functional outcomes at 1-2 years postinjury followed by plateau. There is a paucity of data suggesting clinical predictors for rapid or delayed achievement of functional plateau. The purpose of the present study is to identify early clinical examination findings, including digital edema and finger range of motion (ROM), that predict postoperative recovery following distal radius fractures treated by open reduction and internal fixation with locked volar plating.

Methods: Patients treated for unstable distal radius fractures with locked volar plating from 2012-2014 were prospectively recruited and followed for 12 months postoperatively. Patients were excluded if they were less than 18 years of age, had distal radius fractures treated with any method other than locked volar plating, history of prior fracture or deformity to either upper extremity, or had medical conditions that compromise the ability to maximize functional recovery. Specific clinical examination findings were recorded at 1 week, 4-6 weeks, 12 weeks, 6 months, and 1 year postoperative including digital edema (defined as circumference at the proximal interphalangeal [PIP] joint level of index through small finger), wrist and forearm ROM, pinch and grip strength, and finger ROM (measured as middle finger nail distance to the distal palmar crease). The primary outcome measure was the validated Patient Reported Wrist Evaluation (PRWE). Secondary outcomes were the Disabilities of the Arm, Shoulder and Hand (DASH) and the Pain Catastrophizing Scale (PCS). Patients were classified as functionally plateaued if the PRWE score differed by ≤10 points, the minimal clinically important difference.

Results: 58 patients were successfully recruited as study participants, 23 of whom were followed for a minimum of 12 months postoperative. At the first postoperative visit, 26% of patients had a 0-mm fingernail to palm distance and 61% had digital edema ≤0.5 mm difference compared to the contralateral side. The mean PRWE score at last follow-up was 12.6 ± 15.3, while the mean DASH score was 15 ± 16.7 and PCS 2.3 ± 5.3. 69% of the patients reached a PRWE plateau prior to the 12-month postoperative visit. Digital edema difference ≤0.5 mm was 75% sensitive and 57% specific as a test to predict early functional plateau while fingernail to palm distance demonstrated no correlation as a predictive test. Linear regression analysis demonstrated a trend between 1 week postoperative digital edema and final follow-up PRWE score but this did not reach significance (P = 0.12). No relationship was appreciated between digital edema and DASH score (P = 0.48). There was no association of digital edema or finger ROM with the PCS score at final follow-up.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusion: The present study introduces digital edema measured at the first postoperative visit following locked volar plating of displaced distal radius fracture as a predictor for early functional plateau. Measuring digital edema as the circumference around the PIP joints of the operative hand and comparing to the noninjured contralateral is a safe, reproducible physical examination technique. Furthermore, increased digital edema at the first postoperative visit trended toward worse PRWE functional outcome scores at final follow-up. This information can help guide postoperative care and set patient expectations for rapidity of functional recovery.

See pages 49 - 106 for financial disclosure information.

Taylor Spatial Frame Stacked Transport for Tibial Infected Nonunions with Bone Loss: Long-Term Functional Outcomes

Joshua Napora, MD[1]*; Douglas Weinberg, MD*[1]*; Blake Eagle*[2]*; Bram Kaufman, MD*[2]*; John Sontich, MD*[3]
[1]*University Hospitals/Case Medical Center, Cleveland, Ohio, USA;*
[2]*MetroHealth System, Cleveland, Ohio, USA;*
[3]*University Hospitals, Cleveland, Ohio, USA*

Purpose: Infected nonunions with bones loss are a limb-threatening problem. The purpose of this study was to analyze the long-term functional outcomes in patients with posttraumatic infected tibial nonunions undergoing bone transport using a Taylor Spatial Frame (TSF). Additionally, we analyzed patients' functional outcomes over time.

Methods: Seventy patients were treated for infected nonunions with bone loss using stacked TSF transport by a single surgeon at a Level I trauma center. All patients who were identified as candidates for the study were mailed a Short Musculoskeletal Function Assessment (SMFA) survey. At a mean follow-up of 59 months, 38 patients completed the SMFA questionnaire. The SMFA is a functional outcome instrument with scores ranging from 0 to 100, with lower scores indicating better function. Parameters measured included age, gender, diabetes, smoking, use of a free flap, bone defect size, length in frame, external fixation index, direction of lengthening, and use of adjunctive stabilization. We defined adjunctive stabilization as use of intramedullary nail, plate fixation, or reapplication of TSF to aid in healing of docking or regenerate site. SMFA scores from a previous study of the same patient population allowed for a comparison of functional outcomes over time.

Results: The mean SMFA score for the entire group was 27.1.The average patient age was 46.8 ± 12.7 years, 28 patients (74%) were male, 3 (8%) were diabetic, and 11 (29%) were smokers. 17 patients (45%) had soft-tissue defects that required a free flap performed by plastic surgery. The mean size of the defect was 5.1 cm. The mean length in frame was 9.3 months and mean external fixator index was 1.9 month/cm. Age, gender, and presence of diabetes demonstrated no effect on functional outcomes. Smoking had higher degrees of

	SMFA score
Men	27 ± 16
Women	27 ± 17
Free Flap	29 ± 17
No Free Flap	25 ± 15
Smoker *	39 ± 16
Non-Smoker *	22 ± 14
Diabetic	27 ± 13
Non-Diabetic	27 ± 17
Adjunctive Stability $^{\infty}$	33 ± 17
Absence of Adjunctive Stability $^{\infty}$	22 ± 15
$p<0.05$: *smokers vs non-smokers; $^{\infty}$adjunctive stability vs absence of adjunctive stability	

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

disability, as measured by the MFA, compared to nonsmokers (39 ± 16 vs 22 ± 14, P = 0.011). Patients who were managed with adjutant stabilization after removal of the external fixator reported higher degrees of disability, as measured by the MFA, compared to those who did not receive adjunctive stabilization (33 ± 17 versus 22 ± 15, P = 0.049). We also assessed functional outcome scores over time. 16 patients returned two SMFA surveys at different time points after completion of bone transport. Initial average SMFA score was 26.5 at a mean of 25.3 months after frame removal, while the second average MFA score was 19.4 at a mean of 98.8 months after frame removal.

Conclusion: The SMFA scores suggest that TSF is a good technique for bone transport for infected nonunion of the tibia with bone loss. However, the most important finding in this population was the improved outcome of SMFA scores from 2 years to 8 years, indicating that over time, these patients are approaching levels of the normal population allowing for integration back into society. Limb salvage with TSF transport appears to be justified but may take years before the beneficial results are fully appreciated.

See pages 49 - 106 for financial disclosure information.

Can a Tibia Shaft Nonunion Be Predicted at Initial Fixation? Applying the Nonunion Risk Determination (NURD) Score to the SPRINT Trial Database

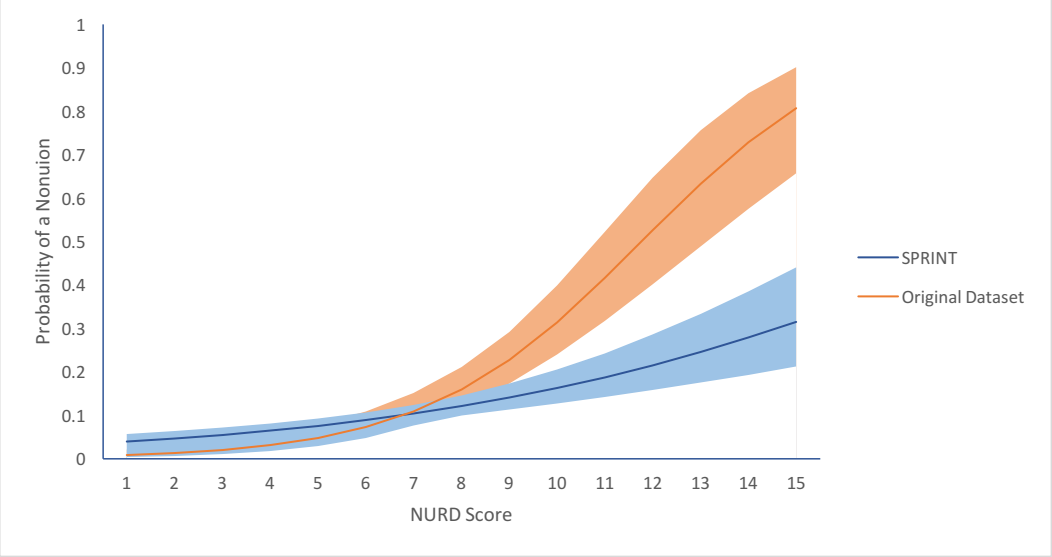
Gerard P. Slobogean, MD[1]*; Kevin O'Halloran, MD*[2]*; Nathan O'Hara, MHA*[3]*; Renan Castillo, PhD*[4]*; Sheila Sprague, PhD*[5]*; Mohit Bhandari, MD, FRCSC, PhD*[6]*; Robert V. O'Toole, MD*[2]*; SPRINT Investigators*[7]

[1]*University of Maryland, Baltimore, Maryland, USA;*
[2]*University of Maryland, Shock Trauma Center, Baltimore, Maryland, USA;*
[3]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[4]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA;*
[5]*McMaster University, Ontario, CANADA;*
[6]*MacOrtho Research, Ontario, CANADA;*
[7]*Shock Trauma Baltimore, Maryland, USA*

Background/Purpose: The Nonunion Risk Determination (NURD) score was developed using a cohort of 376 patients to reliably predict tibia shaft nonunions at the time of initial intramedullary nail fixation. The scoring system was developed in a single Level I trauma center and assigns points based on seven commonly collected variables: American Society of Anesthesiologists (ASA) score, percent cortical contact, male gender, open fractures, chronic disease status, compartment syndrome, and use of flap. Points are subtracted for spiral fractures and low-energy fractures. The purpose of this study was to compare NURD scores of patients in the original cohort to the 1226 patients included in the SPRINT (Study to Prospectively Evaluate Reamed Intramedullary Nails in Tibial Fractures) multicenter trial to determine the predictive accuracy of the tool.

Methods: Patients with no cortical contact were excluded from both data sets. The charac-

Figure 1 Probability of a tibia shaft nonunion for a given NURD score. A 95% confidence interval is indicated by the shaded area.



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

teristics of patients in the two data sets were compared using X2 tests. Receiver operating characteristic (ROC) curves were used to calculate the probability with confidence intervals of a nonunion as predicted by a NURD score in each of the two data sets. The mean difference of the probabilities was compared at each scoring increment using t tests.

Results: Despite the patient characteristics differing ($P < 0.05$) in almost every scoring variable including ASA score, cortical contact of 100% and 25%, open fractures, chronic disease status, the use of flaps, spiral fractures, and low energy, the NURD score has similar predictive probability in the two data sets. 83% of the original sample population and 88% of the SPRINT data set had NURD scores of 8 or less. The difference in the probability of a nonunion remained less than 4% within that range (Fig. 1). In NURD scores of 9 or greater, patients in the original data set had a substantially higher probability of a nonunion ($P < 0.001$).

Conclusion: The NURD score demonstrates high predictability in the majority of the SPRINT cohort. Overall the SPRINT data set had a much lower nonunion rate (8.6% vs 14.6%, $P = 0.001$) and a smaller proportion of their sample in the higher ranges of the NURD score (12% vs 17%, $P = 0.02$). Comparisons at the upper ranges of the NURD score highlights the increased variability in predicting nonunions when a multitude of risk factors are present in tibia shaft fracture patients.

See pages 49 - 106 for financial disclosure information.

Patient Reported Pain Following Successful Nonunion Surgery: Can We Completely Eliminate It?

Nina Fisher, BS*; Adam S. Driesman, BA; Sanjit Konda, MD; Kenneth A. Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: Many patients undergo surgical revision for fracture nonunion in order to regain their pre-injury functional status and to relieve themselves of continued pain. However, there is little evidence that reveals if patients are truly relieved of painful symptoms in the long-term. The purpose of this study was to investigate which types of patients experience continual long-term pain following surgical revision for fracture nonunion.

Methods: Three hundred and twenty-eight patients surgically treated for fracture nonunion were prospectively followed at one institution. Demographics, radiographic evaluations, VAS pain scores, and Short Musculoskeletal Functional Assessment (SMFA) scores were collected at routine intervals. Only patients who had a minimum of one-year follow-up and complete healing were included this analysis. The average follow-up interval was 25 months. Patients were assigned to either a high-pain or low pain cohort. The high-pain cohort was defined as any patient who had a long-term pain score of 4 or higher. Based on the VAS pain scale, a score of 4 can interfere with tasks, so this cut-off was deemed reasonable. Univariate analysis was performed using Student's t-test for normally distributed continuous variables and Mann Whitney U test for non-normally distributed continuous variables. Pearson's chi-squared analysis was used for categorical variables.

Results: Two hundred and forty-five patients were included in this analysis, with 149 patients in the low-pain cohort and 96 patients in the high-pain cohort. Thirty-two (35.6%) patients in the high-pain cohort experienced a net increase of pain, compared to only 8 (5.7%) patients in the low-pain cohort ($p < .0005$). The mean long-term pain score for the low-pain cohort was 0.83 and was 5.77 for the high-pain cohort. Within the high-pain cohort, 32 (33.3%) patients experienced continuous pain and 64 (66.7%) experienced intermittent pain, while in the low-pain group 88 (59.1%) experienced no pain, 5 (3.4%) experienced continuous pain, and 56 (37.6%) experienced intermittent pain. There were no significant differences between the groups in terms of Charlson Comorbidity Index (CCI), age at injury, age at nonunion surgery, time to nonunion surgery, gender, life activity status, education level, presence of additional injuries, or energy of initial injury. The mean baseline (preoperative) pain score was 4.80±2.60 for the low-pain group and 5.91±2.41 for the high-pain group ($p=.001$), yet the baseline quality of pain was not significantly different between the groups ($p = .229$). There was small correlation between baseline pain and long-term pain ($r = .214$), suggesting that there are other factors that contribute to long-term pain. Lower extremity nonunion ($p = .018$), current smoker ($p = .004$), lower income level ($p = .007$), and worker's compensation case ($p = .004$) were found to be significantly more prevalent in the high-pain cohort.

Conclusions: Patients with lower extremity nonunions, higher baseline pain scores, history of smoking, lower income and worker's compensation case are at a higher risk of reporting significant and potentially debilitating long-term pain following nonunion surgery. While

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

patients may expect complete relieve of pain, orthopaedic surgeons must inform patients of the possibility of experiencing pain 1 year or more post-operatively. Additionally, other factors not accounted for in this study such as neuropathic pain may be need to further investigated prior to nonunion surgery to accurately counsel patients about their expected postoperative pain relief.

See pages 49 - 106 for financial disclosure information.

Intertrochanteric Osteotomy for Femoral Neck Nonunion:
Does "Undercorrection" Result in an Acceptable Rate of Femoral Neck Union?

Brandon Yuan, MD[1]*; David Shearer, MD, MPH*[2]*; David Barei, MD, FRCS(C)*[3]*; Sean Nork, MD*[3]
[1]*Mayo Clinic, Rochester, Minnesota, USA;*
[2]*University of California, San Francisco, California, USA;*
[3]*Harborview Med Center, Seattle, Washington, USA*

Purpose: Femoral neck nonunions in young patients present multiple treatment challenges. The valgus-producing intertrochanteric osteotomy improves the biomechanical environment for union through reduction of shear forces across the nonunion. Prior descriptions of this procedure have advocated adjusting the degree of correction based on the verticality of the femoral neck fracture, with the goal of completely neutralizing the shear forces across the fracture (Pauwels angle ~25°). However, this degree of correction often results in significant deformity of the proximal femur; as the neck is brought into more valgus, the femoral shaft is medialized and the greater trochanter is distalized. The use of a smaller closing wedge osteotomy of 20° or 30° allows for neutralization of most of the shear forces across the femoral neck nonunion without the severe alteration of the proximal femoral anatomy. The purpose of this study was to analyze the radiographic outcomes of valgus-producing intertrochanteric osteotomy for the treatment of femoral neck nonunion with "undercorrection" of the Pauwels angle and relative preservation of the proximal femoral anatomy.

Methods: 32 consecutive patients with established femoral neck nonunion treated with an intertrochanteric osteotomy were identified. Seven patients were treated with a 30° closing wedge osteotomy and 25 with a 20° or smaller osteotomy. All patients were treated with a valgus-producing intertrochanteric osteotomy with a blade plate. Demographic data were collected and pre- and postoperative radiographs were reviewed. All patients were followed for at least 6 months after osteotomy.

Results: 31 of 32 patients (97%) proceeded to osseous union of the femoral neck, and all intertrochanteric osteotomies healed. There was no significant difference in the rate of union between those patients treated with a 30° versus a 20° (or less) osteotomy. The mean Pauwels angle decreased from 71° (range, 52°-95°) to 47° (range, 23°-67°) and the mean proximal femoral offset decreased by 11 mm (range, 0-23 mm). Seven patients developed radiographic signs of osteonecrosis after osteotomy (22%), three of whom developed femoral head collapse and were treated with total hip arthroplasty (9%). Patients treated with a 30° osteotomy were more likely to develop osteonecrosis than those treated with a 20° or less osteotomy (67% vs 12%, P = 0.014).

Conclusion: A valgus-producing intertrochanteric osteotomy for nonunion of the femoral neck that results in a smaller degree of correction than has been traditionally described leads to an excellent rate of radiographic union while preserving more of the native proximal femoral anatomy.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

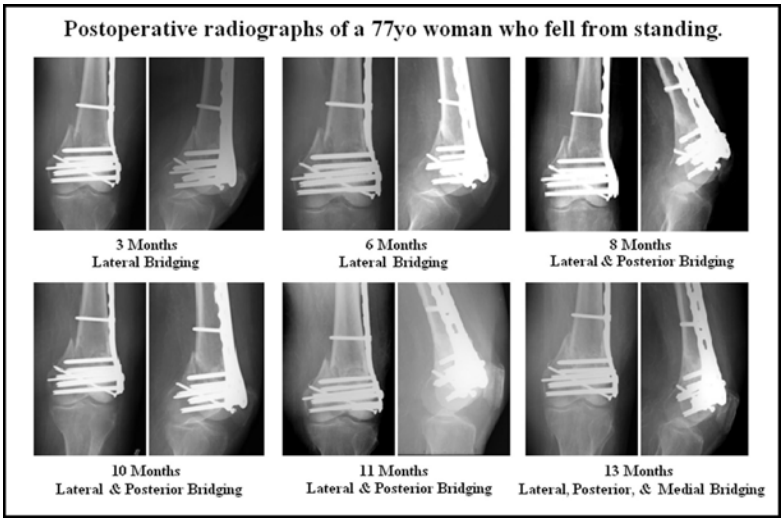
Any Cortical Bridging Predicts Healing of Supracondylar Femur Fractures

Patrick Strotman, MD[1]*; Madhav Karunakar, MD*[2]*; Tammy Rhoda, MPH*[1]**;**
Rachel Seymour, PhD[2]*; William Lack, MD*[1]
[1]*Loyola University Medical Center, Maywood, Illinois, USA;*
[2]*Carolinas Medical Center, Charlotte, North Carolina, USA*

Purpose: Locking plates are frequently used for fixation of supracondylar femur fractures, particularly in the setting of osteoporosis. This treatment has been increasingly associated with reports of deficient callus, nonunion, and need for secondary procedures with bone grafting. Outside of implant failure, there is no consensus regarding the radiographic and clinical criteria used to assess fracture healing. Ideally, a discriminating tool could accurately identify fractures bound for union versus nonunion based on information available in the first few months after injury. The aim of this study is to determine the accuracy and reliability of radiographic cortical bridging criteria in predicting the final healing of supracondylar femur fractures.

Methods: We retrospectively reviewed the records at two Level I trauma centers for patients who presented with supracondylar femur fractures (AO/OTA 33A, C) and were treated with locking plate fixation between 1/1/2004 and 1/1/2011. The final study population included 82 fractures after excluding patients with open physes (n = 4), nondisplaced fractures (n = 4), early revision for technical failure (n = 4), or inadequate follow-up (n = 42). Postoperative radiographs until final follow-up were assessed for cortical bridging at each cortex on AP and lateral views. Analysis by three orthopaedic traumatologists allowed assessment of reliability. Final determination of union required both radiographic and clinical confirmation. Receiver operator characteristic (ROC) curve and X2 analyses were performed to determine the predictive accuracy of each criterion throughout the postoperative period.

Results: Assessment for any cortical bridging was the earliest accurate predictor of final union (95.1% accuracy at 4 months postoperatively), relative to criteria requiring bicortical bridging (93.9% accuracy at 6 months) and tricortical bridging (78% accuracy at 21 months). Any cortical bridging demonstrated a higher interobserver reliability (K = 0.73) relative to bicortical (K = 0.27) or tricortical bridging (K = 0.5).



See pages 49 - 106 for financial disclosure information.

Conclusion: Our results for plate fixation of supracondylar femur fractures mirror those previously described for tibia shaft fractures following intramedullary nailing. Any radiographic cortical bridging by 4 months postoperatively is an accurate and reliable predictor of final healing outcome following locking plate fixation of supracondylar femur fractures. Assessment for bicortical or tricortical bridging is less reliable and inaccurate during the first postoperative year.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ Are Large Clinical Trials in Orthopaedic Trauma Justified?

*Sheila Sprague, PhD[1]; Paul Tornetta III, MD[2]; **Gerard P. Slobogean, MD[3];***
Nathan O'Hara, MHA[4]; Paula McKay, BSc[1]; Diane Heels-Ansdell, MSc[1];
Brad Petrisor, MD[5]; Kyle Jeray, MD[6]; Emil H. Schemitsch, MD[7]; David Sanders, MD[8];
Mohit Bhandari, MD, FRCSC, PhD[9]; FLOW Investigators
[1]McMaster University, Ontario, CANADA;
[2]Boston Medical Center, Boston, Massachusetts, USA;
[3]University of Maryland, Baltimore, Maryland, USA;
[4]University of Maryland School of Medicine, Baltimore, Maryland, USA;
[5]Hamilton General Hospital, Ontario, CANADA;
[6]Greenville Health System University Medical Center, Greenville, South Carolina, USA;
[7]St. Michael's Hospital, Toronto, Ontario, CANADA;
[8]Victoria Hospital, Ontario, CANADA;
[9]MacOrtho Research, Ontario, CANADA

Purpose: Large definitive clinical trials in orthopaedic trauma are expensive, challenging, and time-consuming to conduct. In times of limited research funding, their value is questioned as it costs several million dollars to answer one or two clinical questions and results may not be translated into practice for 5 to 8 years following initiation of the trial. The objective of this study is to evaluate the necessity of one such large clinical trial using data from the FLOW (Fluid Lavage of Open Wounds) trial.

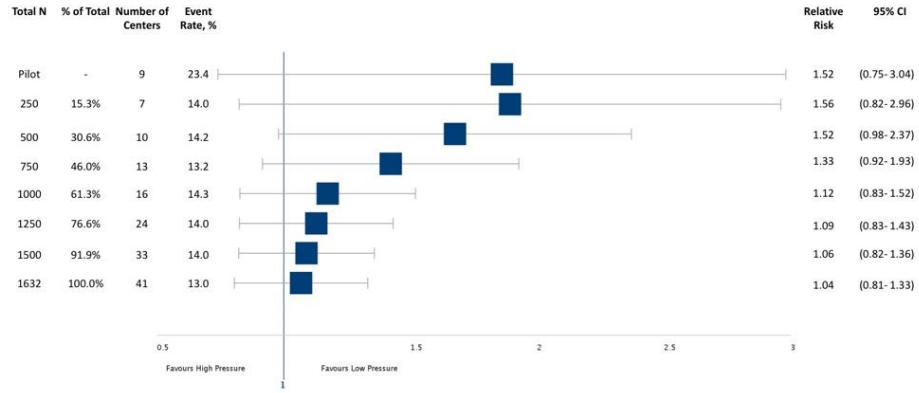
Methods: The FLOW pilot study and trial were factorial randomized controlled trials that evaluated the effect of different irrigation solutions and pressures on reoperation within 12 months for infection, wound healing, or bone healing. To evaluate the usefulness of this large trial, we analyzed the data from the pilot study and then the definitive trial in increments of 250 patients until the final sample size was reached. At each increment we calculated the relative risk (RR) and associated 95% confidence interval (CI) for the treatment effect. We then compared the results that would have been reported at the smaller enrollments with those seen in the final, adequately powered study.

Results: The pilot study analysis of 89 patients and the initial incremental enrollments in the definitive trial favored high pressure compared to low pressure (RR: 1.52 95% CI: 0.75-3.04; RR: 1.56 95% CI: 0.82-2.96 respectively), which is in contradistinction to the final enrollment, which found no difference between high and low pressure (RR: 1.03 95% CI 0.81-1.33) (Fig. 1a). In the soap versus saline comparison, the pilot study suggested that the reoperation rate was higher in the saline group (RR: 0.98 95% CI: 0.50-1.92), whereas the definitive trial found the opposite, that the reoperation rate was higher in the soap treatment arm (RR: 1.28 95% CI: 1.04-1.57) (Fig. 1b).

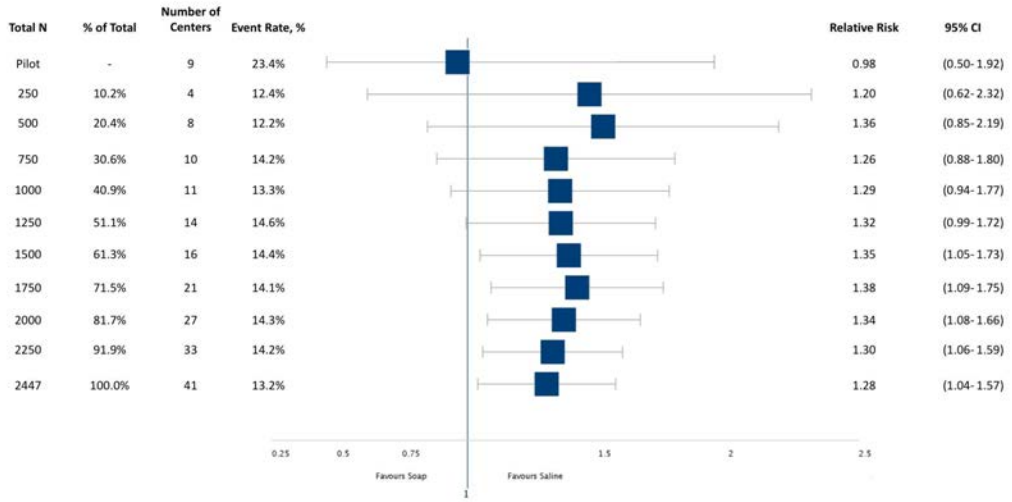
Conclusion: Our findings suggest that the FLOW pilot study and early stopping of the trial would have led to erroneous conclusions in the management of open fracture wounds. One of the major questions (irrigation pressure) changed from a substantial difference to a finding of no difference. More importantly, the results of the second major question, namely whether soap reduced the risk of event, changed from suggesting an advantage to using

Δ OTA Grant
See pages 49 - 106 for financial disclosure information.

soap to a significant finding of soap increasing the risk of reoperation. While many readers understand that trials may be underpowered, few realize that truly erroneous conclusions may come from smaller studies, including a reversal of the initial findings. These data highlight the need for large clinical trials in the field of orthopaedic trauma.



A.



B.

Figure 1: The effect of high vs. low pressure (A) and soap vs. saline (B) on patients enrolled in the [BLINDED] trial at different sample sizes

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

An Evaluation of the Relationship between 6-week Post-Discharge Risk Classification and 6-Month Outcomes Following Orthopaedic Trauma

Renan Castillo, MD[1]*; Kristin Archer, PhD*[2]*; CAPT (ret) Michael Bosse, MD*[3]*; Robert Hymes, MD*[4]*; Andrew Pollak, MD*[5]*; Heather Vallier, MD*[7]*; Anna Bradford, PhD, MSW*[6]*; Susan Collins, MSc*[1]*; Katherine Frey, RN, MPH*[1]*; Yanjie Huang, ScM*[1]*; Daniel Scharfstein, ScD*[1]*; Elizabeth Wysocki, MS*[1]*; Stephen Wegener, PhD*[1]*; Ellen MacKenzie, PhD*[1]*; (Consortium) METRC*[1]

[1]*Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA;*
[2]*Vanderbilt University Medical Center, Nashville, Tennessee, USA;*
[3]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[4]*Inova Fairfax Hospital, Falls Church, Virginia, USA;*
[5]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[6]*Inova Fairfax Hospital, Fairfax, Virginia, USA;*
[7]*MetroHealth Medical Center, Cleveland, Ohio, USA*

Purpose: Numerous studies have demonstrated that long-term outcomes following orthopaedic trauma are related to psychosocial and behavioral health factors evident early in the patient's recovery. The goal of this project is to examine whether clusters (sets of patients who are more similar to each other than to members of other clusters) based on risk and protective factors measured at 6-week postinjury predict outcomes at 6 months following trauma.

Methods: Among 420 participants with AIS (Abbreviated Injury Scale) 3 orthopaedic injuries, 333 (79.3%) with both 6-week assessment and 6-month follow-up data were included in this analysis. At 6 weeks postdischarge, patients completed standardized measures for five risk factors: pain intensity, depression measured using the Patient Health Questionnaire (PHQ)-9, posttraumatic stress disorder measued using the PTSD Check List (PCL), and alcohol and tobacco use. Five protective factors were also measured: resilience (Connor-Davidson Resilience Scale), social support (Behavioral Risk Factor Surveillance System), and self-efficacy for return to usual activity and managing the financial demands of recovery, adapted from the Arthritis Self Efficacy Scale. Latent class analyses were used to classify participants into three clusters (low risk, high protection; medium risk, low protection; and high risk, low protection). Clusters were evaluated against the Short Musculoskeletal Function Assessment (SMFA) bother and dysfunction index, the overall health scale from the Veterans Rand 12 (VR-12), the PCL, and PHQ-9, all measured at 6 months. Regression models (linear for continuous outcomes, proportional odds for ordinal outcomes) were used to adjust for age, gender, race, education, injury severity, and length of stay, as well as additional adjustment for site level effects.

Results: As shown in the table, the three clusters were powerful predictors of 6-month outcomes. The unadjusted trends in outcomes across clusters (columns 3-5 of the table were statistically confirmed by regression analyses shown in the last two columns of the table. These results show that outcomes worsen as risk increases, with none of the 97.5% confidence intervals for the differences between clusters including 0 for any outcome tested. Sensitivity analyses showed similar results with a 4-cluster solution for the risk and protective factor data.

See pages 49 - 106 for financial disclosure information.

Results presented as mean (standard deviation), except for the VR-1, which is presented as count (percent).		Cluster 1 - Low Risk, High Protection (n = 164)	Cluster 2 - Medium Risk, Low Protection (n = 115)	Cluster 3 - High Risk, Low Protection (n = 54)	Difference Between Clusters (97.5% C.I.)	
					2 vs 1	3 vs 2
SMFA Dysfunction		23.8 (15.9)	38.3 (18.2)	53.2 (19.0)	13.8 (9, 19)	15.0 (9, 21)
SMFA Bother *15 patients had missing data		22.2 (18.5)	39.1 (20.4)	63.8 (23.2)	15.9 (10, 22)	23.5 (16, 31)
VR-1 (Excellent, Very good, Good, Fair, Poor)	E, VG, G	145 (88%)	86 (75%)	23 (43%)	2.2 (1, 5)	4.0 (2, 9)
	F	17 (10%)	23 (20%)	18 (33%)		
	P	2 (1%)	6 (5%)	13 (24%)		
Depression (PHQ-9)		4.3 (4.9)	8.7 (5.8)	16.2 (6.4)	4.1 (3, 6)	7.3 (5, 9)
PTSD (PCL)		8.8 (10.6)	19.8 (12.8)	40.4 (15.6)	11.1 (8, 15)	19.7 (15, 24)

Conclusion: The study demonstrates trauma patients can be classified, early in the recovery process, into risk/protective clusters that result in very strong prediction for a wide range of 6-month functional and health outcomes. Identification of an individual's risk and protective factors may have important implications for the potential benefits for psychosocial interventions and referral. Individuals falling into cluster 1 (low risk, high protection) are likely to achieve full recovery barring clinical complications. Individuals falling into cluster 2 (medium risk, low protection) may have subclinical conditions that could be contributors to poor outcomes. Collaborative care programs that emphasize peer support and self-management may help patients in this cluster by improving resilience, self-efficacy, and social support. Those in cluster 3 (high risk, low protection) may benefit from early and aggressive referral to an appropriate mental health specialist. Further research is necessary to define the role and efficacy of psychosocial interventions within these individual clusters.

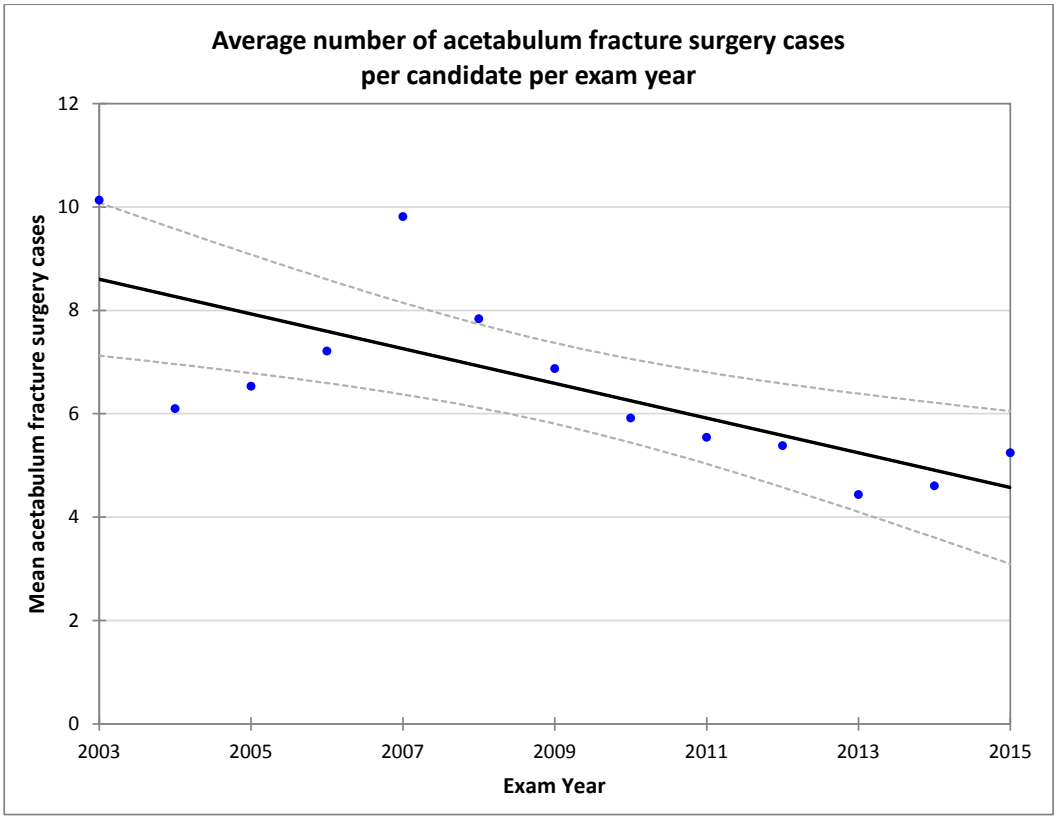
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Are Early Career Orthopaedic Trauma Surgeons Performing Enough Complex Trauma Surgery?

Jacob Gire, MD; *Michael J. Gardner, MD; Alex Harris, PhD; Julius Bishop, MD*
Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA

Purpose: There has recently been a sharp increase in the number of fellowship-trained orthopaedic trauma surgeons, raising concerns that the surgical experience of early career surgeons may be diluted, particularly of less common but more complex and technically demanding fracture cases. The purpose of this study was to evaluate the change in complex trauma case volume of orthopaedic trauma surgeons sitting for Part II of the American Board of Orthopaedic Surgery (ABOS) certification examination for years 2003 through 2015.

Methods: The case log data from all surgeons taking Part II of the ABOS examination over a 13-year period (2003-2015) were evaluated. Any surgeon who examined in the trauma subspecialty was included and Current Procedural Terminology (CPT) codes were used to identify surgical procedures. We defined pelvis, acetabulum, and periarticular fracture surgeries as complex trauma procedures and evaluated changes in case volume over time using mixed-effects linear regression analysis.



See pages 49 - 106 for financial disclosure information.

Results: 8911 ABOS candidates reported 1,116,811 procedures during the data collection period. From this group we included 468 candidates who examined in the trauma subspecialty and performed 90,261 procedures. The number of candidates testing in trauma ranged from 15 to 65 and increased significantly over time (ß = 4.05 (.37), P <.0001). Trauma candidates reported on average 193 cases during their collection period and this case volume was stable over time (ß =-1.7 (1.1), P = 0.16). The number of acetabulum fracture surgeries performed per candidate per year decreased significantly over time from a mean of 10.1 cases in 2003 to 5.2 cases in 2015 (ß = -0.34 (0.08), P = 0.0015, Fig. 1). There was no significant change in the number of pelvic fracture surgery cases per candidate per test year (ß = -0.1 (0.1), P = 0.285). There was a trend toward less periarticular fracture surgery cases per candidate per test year (ß = -0.3 (0.1), P = 0.072).

Conclusion: The number of orthopaedic trauma candidates taking Part II of the ABOS examination has increased significantly over time. Although pelvic ring and periarticular fracture surgery volume has remained steady, these early career surgeons have experienced a significant decrease in acetabular fracture case volume. The implications of this decreased surgical experience warrants careful consideration as the orthopaedic trauma workforce continues to evolve.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Management of Complex Orthopaedic Trauma:
Is the Balance Shifting Away from Level I Trauma Centers?

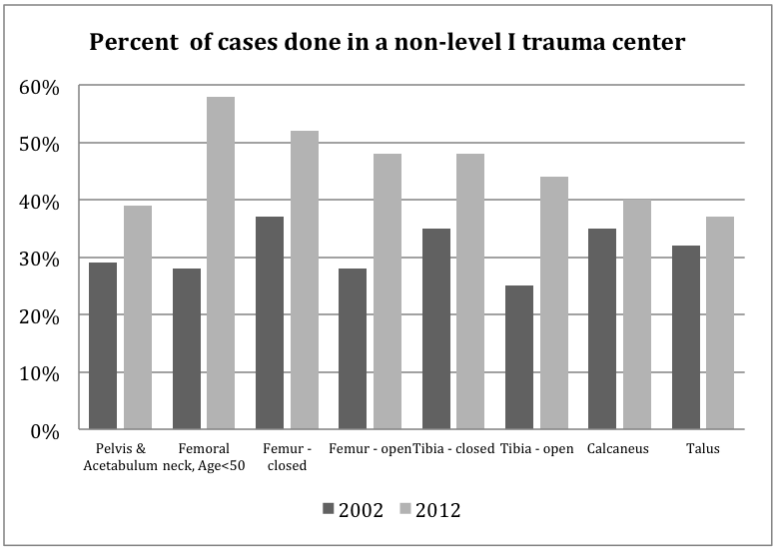
Meir Marmor, MD*[1]*; *Saam Morshed, MD*[2]*; Arash Rezaei, MD Candidate*[3]
[1]*University of California San Francisco, San Francisco, California, USA;*
[2]*UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA;*
[3]*Orlando, Florida*

Purpose: Recent years have shown an increase in the amount of fellowship-trained orthopaedic trauma surgeons. Many of these surgeons practice in Level II and III hospitals. The benefit of Level I centers to patient care is well recognized. However, we hypothesized that in the past decade the treatment of complex trauma and fracture care has shifted from Level I trauma centers to community Level II and III centers, reflecting, perhaps, the increase in fracture management expertise in these centers.

Methods: Data from the National Trauma Data Bank (NTDB) collected between 2002-2012 was analyzed. Level I, II, and III trauma center admission rates for complex fractures were recorded. A total of 250,912 fractures were included in the analysis.

Results: Between 2002 and 2012 Level I hospitals trended to treat less femoral neck fractures, femoral, and tibia shaft fractures, open fractures, and pelvis and acetabulum fractures. This trend was smaller for open, calcaneus, and talus fractures. Rate of complications for non-Level I trauma centers has decreased since 2002. Compared to 2002, in 2012 complication rates at non-Level I trauma centers decreased by 40% for pelvis and acetabulum fractures, 22% for femur fractures, 80% for tibia fractures, and 76% for femoral neck fractures in patients <50 years old. The percent of cases treated in non-Level I centers in 2012 versus 2002 is shown in the figure.

Conclusion: The trauma systems that are shaping in recent years are showing a shift of treatment of some complex fractures from Level I to Level II and III centers. This trend may influence the optimal training environment for residents, and the optimal practice environment for orthopaedic traumatologists.



See pages 49 - 106 for financial disclosure information.

Surgical Management and Reconstruction Training (SMART) Course for International Orthopedic Surgeons: Saving Limbs after Traumatic Injury

Hao-Hua Wu, BA*[1]*; *Kushal Patel, MD*[2]*; Amber Caldwell, BA*[3]*; Richard Coughlin, MD*[1]*; Scott Hansen, MD*[4]*; Joseph Carey, MD*[5]
[1]*Institute for Global Orthopaedics and Traumatology, University of California San Francisco, Orthopaedic Trauma Institute, San Francisco, California, USA;*
[2]*University of Illinois Chicago, Department of Orthopaedic Surgery, Chicago, Illinois, USA;*
[3]*Department of Orthopaedic Surgery, University of California San Francisco, Orthopaedic Trauma Institute, San Francisco, California, USA;*
[4]*University of California, San Francisco Department of Plastic Surgery, San Francisco, California, USA;*
[5]*University of Southern California, Division of Plastic Surgery, Los Angeles, California, USA*

Purpose: The burden of complex orthopaedic trauma in low-income and middle-income countries (LMICs) is exacerbated by soft-tissue injuries, which can often lead to amputation. The purpose of this study was to create and evaluate the Surgical Management and Reconstruction Training (SMART) Course to help orthopaedic surgeons from LMICs manage soft-tissue defects and reduce the rate of amputation.

Methods: In this prospective observational study, orthopaedic surgeons from LMICs were recruited to attend a 2-day SMART Course. Prior to the course, participants were asked to assess the burden of soft-tissue injury and amputation encountered at their respective sites of practice. A survey was then given immediately and 1-year postcourse to evaluate the quality of instructional materials and impact of the course in reducing the burden of amputation, respectively.

Results: 51 practicing orthopaedic surgeons representing 25 different countries attended the course. None of the participants (0%) reported previously attempting a flap reconstruction procedure to treat a soft-tissue defect. Prior to the course, participants cumulatively reported a range of 580-970 amputations performed each year as a result of soft-tissue defects. Immediately after the course, participants rated the quality and effectiveness of training materials to be a mean of 4.4 or greater on a Likert scale of 5 (excellent) in 14 of 14 instructional criteria. Of the 34 (66.7%) orthopaedic surgeons who completed the 1-year postcourse survey, 34 (100%, $P < 0.01$) reported performing flaps learned at the course to treat soft-tissue defects. Flap procedures saved 116 patients from amputation. 554 (93.3%) of the cumulative 594 flaps performed by participants 1 year after the course were reported to be successful. 97% of course participants taught flap reconstruction techniques to either colleagues or residents, and a self-reported estimate of 28 other surgeons undertook flap reconstruction as a result of information dissemination by 1-year postcourse.

Conclusion: The SMART Course can give orthopaedic surgeons practicing in LMICs the skills and knowledge to successfully perform flaps and reduce the self-reported incidence of amputation. Course participants were able to disseminate flap reconstructive techniques to colleagues at their home institution. While this course offers a collaborative, sustainable

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Total Flaps Performed, Total Successful and Total Amputations Averted One Year Post-Course

Flaps	*Total Attempts (n=34)*	*Total Successful (n=34)*	*Success Rate*	*Total Amputations Averted (n=34)*
Soleus	72	67	93.10%	23
Gastrocnemius	107	99	92.50%	20
Cross Finger	69	62	89.90%	15
V-Y Hand	93	89	95.70%	14
Sural	31	29	93.50%	10
Thenar	35	35	100%	5
Latissimus	13	12	92.30%	5
Gluteus	12	11	91.70%	4
Groin	16	13	81.30%	4
Axial	32	32	100%	3
Radial Forearm	9	9	100%	3
Reverse Sural	40	32	80%	3
VY Sacrum	27	26	96.30%	3
Tensor Fascia Latae	5	5	100%	2
Kite	11	11	100%	1
Anconeus	2	2	100%	1
Flexor Carpi Ulnaris	11	11	100%	0
Brachioradialis	1	1	100%	0
Flexor Carpi Radialis	1	1	100%	0
Reverse Radial Forearm	4	4	100%	0
Posterior Thigh	2	2	100%	0
Gracilis	1	1	100%	0
Totals	**594**	**554**	**93.30%**	**116**

approach to reduce global surgery disparities in amputation, future investigation into the viability of teaching the SMART Course in low-resource settings is warranted.

See pages 49 - 106 for financial disclosure information.

"Red-Yellow-Green": Effect of an Initiative to Guide Surgeon Choice of Orthopaedic Trauma Implants

Kanu Okike, MD, MPH[1]***;*** *Rachael Pollak, BA*[2]*; Robert V. O'Toole, MD*[3]*; Andrew Pollak, MD*[4]
[1]*University of Maryland Medical Center, Honolulu, Hawaii, USA;*
[2]*Case Western Reserve University, Cleveland, Ohio, USA;*
[3]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA;*
[4]*Univ of Maryland School of Medicine, Baltimore, Maryland, USA*

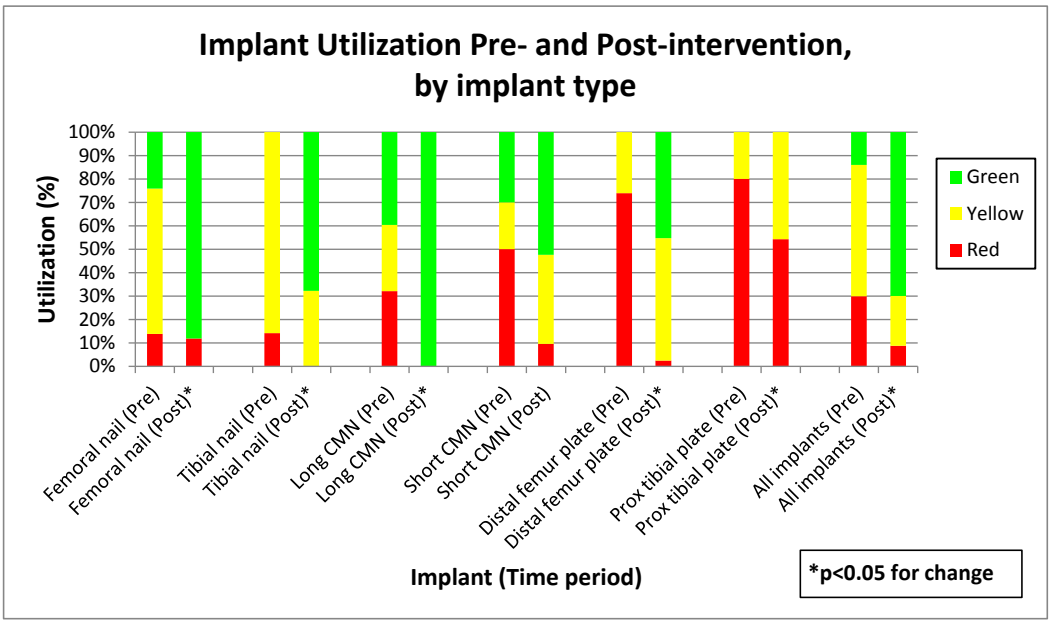
Purpose: Orthopaedic procedures are expensive, and devices account for a large proportion of the costs. While there is little evidence for the clinical superiority of one vendor's product over another, the prices for these items often differ substantially. Hospitals have employed a variety of strategies to decrease implant costs, but many of them center on restricting surgeons' choice of implants. At our institution, we developed and implemented an implant selection tool ("Red-Yellow-Green") that guides surgeons toward more cost-effective implants, while minimally restricting choice. The purpose of this study was to assess the effect of this tool on preferred implant usage rates, vendor attitudes towards pricing structure, and hospital implant expenditures.

Methods: Six orthopaedic trauma devices in common use at our hospital were selected (femoral intramedullary nail, tibial intramedullary nail, short cephalomedullary nail, long cephalomedullary nail, distal femoral plate, and proximal tibial plate). For each type of device, the product offered by each of the 4 vendors in use at our hospital (Smith & Nephew, Stryker, Synthes, and Zimmer) was analyzed. For each device type, similar constructs were created for each of the 4 vendors' products, and the costs determined. On the basis of these costs, the available options for each device type were categorized as Green (preferred vendor), Yellow (mid-range), or Red (use for patient-specific requirements). The result was "Red-Yellow-Green," a chart which was posted on the wall of each orthopaedic trauma operating room in April 2013. Following the initial posting of the chart, the 4 vendors supplying implants to our hospital indicated a desire to renegotiate their contracts with the institution. After finalization of the new contract prices, the "Red-Yellow-Green" chart was revised and reposted in the operating rooms in August 2013. To assess the effect of the implant guidance tool, we compared implant usage patterns in the 12 months preceding the initial posting (Period 1; 3/2012-3/2013) and the 12 months following the revised posting (Period 2; 9/2013-9/2014). We also assessed changes in vendor contract prices, as well as overall savings to our institution. All elements of the study were approved by the University of Maryland Institutional Review Board.

Results: Patient demographics and the types of procedures performed were similar between Period 1 (preintervention) and Period 2 (postintervention). Overall implant usage patterns changed significantly from 30% Red, 56% Yellow, and 14% Green prior to the intervention to 9% Red, 21% Yellow, and 70% Green following the intervention ($P < 0.0001$; Figure). As a result of price renegotiation with vendors following implementation of "Red-Yellow-Green," we observed average price decreases ranging from 1.1% to 22.4% for the 4 vendors in question. Due to increases in preferred vendor usage by the surgeons and decreases in implant prices by the vendors, hospital expenditures on the 6 implants decreased 20% from

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Period 1 to Period 2, which represented a savings of $216,495 per year to our institution on these implants alone.



Conclusion: At our institution, we designed and implemented "Red-Yellow-Green," a simple tool that guides surgeons toward the selection of lower cost implants without violating vendor confidentiality clauses, limiting the implants from which surgeons can choose, or requiring surgeons to discern the prices of complex constructs. Following implementation, hospital expenditures for these implants decreased due to a combination of increased preferred vendor usage by surgeons, who were guided by the cost information presented in this simple tool, as well as increased competition among vendors, which resulted in lower overall prices.

See pages 49 - 106 for financial disclosure information.

Failure Patterns of Young Femoral Neck Fractures:
Which Complication Should We Choose?

David Stockton, MD[1]; Karan Dua, MD[2]; Peter O'Brien, MD, FRCSC[1]; Andrew Pollak, MD[2];
Gerard P. Slobogean, MD[3]
[1]*University of British Columbia, British Columbia, CANADA;*
[2]*University of Maryland School of Medicine, Baltimore, Maryland, USA*
[3]*University of Maryland Baltimore, Maryland, USA*

Purpose: The higher functional demands of nongeriatric patients with femoral neck fractures often necessitate surgical fixation instead of arthroplasty management. While it is unclear if implant selection can improve fracture healing outcomes, it is also unknown if the fixation failure patterns in adult patients resemble osteoporotic failures or if the patterns are associated with the surgical implant selected. The purpose of this study was to describe the failure patterns of young femoral neck fracture fixation, and secondarily to determine if the pattern of failure varies by implant type.

Methods: Adult patients (ages 18-55 years) that experienced a "fixation failure" following internal fixation of a femoral neck fracture were identified from five trauma centers. Failure was defined by screw cutout, implant breakage, varus collapse (<120° neck-shaft angle), or severe fracture shortening (≥1 cm). When multiple complications were identified, mechanical failures were preferentially noted for the analysis. The X2 statistic and Fisher's exact test were used to compare the failure patterns between patients that received multiple cancellous screws versus a sliding hip screw derotation screw (SHS).

Results: 44 patients with treatment failures were identified from the overall cohort of 215 patients. 28 patients with fixation failures were treated with multiple cancellous screws, while the remaining patients received an SHS construct. The failure rate for cancellous screws was 24%, while SHS fixation failed 19% of the time. Severe fracture shortening was the most common complication identified (61%), followed by screw cutout (18%), varus collapse (16%), and implant breakage (5%). A significant difference in the distribution of failure patterns was identified between the treatment groups (P = 0.024). No differences in the incidence of severe shortening (P = 0.750) or implant breakage (P = 1.000) were detected between the fixation groups; however, fixation method was associated with varus collapse and screw cutout. Among the failures with an SHS construct, a greater portion were related to screw cutout (SHS 38% vs screws 7%, P = 0.019); whereas, failures from multiple screws were more commonly associated with varus collapse (screws 25% vs SHS 0%, P = 0.037).

Conclusion: Severe shortening is the most common fixation failure and neither implant appears to prevent this complication. Our results confirm that femoral neck fracture fixation in younger adults fails in a similar pattern as elderly patients: SHS constructs are associated with screw cutout, and multiple cancellous screws typically fail by varus collapse. While neither fixation technique has demonstrated improved fracture healing outcomes, selecting a surgical implant based on its likely failure pattern may allow surgeons to minimize the severity of the failure or its need for secondary conversion to hip arthroplasty.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Open Reduction Internal Fixation versus Closed Reduction Internal Fixation in Treatment of Young Adults with Femoral Neck Fractures: A Multicenter Retrospective Cohort Study

Keisuke Ishii, MD[1]*; Hao-Hua Wu, BA*[2]*; Paul Tornetta III, MD*[3]*; Darin Friess, MD*[4]*; Clifford Jones, MD*[5]*; Ross Leighton, MD, FRCSC, FACS*[6]*; Ari Levine, MD*[7]*; Jeff Maclean, MD*[8]*; Brian Mullis, MD*[9]*; William T. Obremskey, MD, MPH*[8]*; Robert Ostrum, MD*[10]*; Anas Saleh, MD*[11]*; Andrew Schmidt, MD*[12]*; David Teague, MD*[13]*; Antonios Tsismenakis, MD*[3]*; Theodore Miclau, MD*[1]*; Saam Morshed, MD*[1]

[1]*UCSF/SFGH, Orthopaedic Trauma Institute, San Francisco, California, USA;*
[2]*Institute for Global Orthopaedics and Traumatology, UCSF OTI, San Francisco, California, USA;*
[3]*Boston Medical Center, Boston, Massachusetts, USA;*
[4]*Oregon Health & Science University, Portland, Oregon, USA;*
[5]*The CORE Institute, Phoenix, Arizona, USA;*
[6]*Queen Elizabeth II, Nova Scotia, CANADA;*
[7]*MetroHealth Medical Center, Cleveland, Ohio, USA;*
[8]*Vanderbilt Orthopaedic Institute, Nashville, Tennessee, USA*
[9]*Eskenazi Health, Indianapolis, Indiana, USA;*
[10]*UNC Department of Orthopaedics, Chapel Hill, North Carolina, USA;*
[11]*MetroHealth Hospital, Wyoming, Michigan, USA;*
[12]*Hennepin Medical Center, Minneapolis, Minnesota, USA;*
[13]*University of Oklahoma Medicine, Oklahoma City, Oklahoma, USA*

Background/Purpose: Femoral neck fractures in young adult patients often result from high-energy trauma and are associated with a high risk of complications, such as nonunion and osteonecrosis of the femoral head. There is controversy as to whether open reduction and internal fixation (ORIF) or closed reduction and internal fixation (CRIF) leads to better clinical outcomes for this nonelderly age group. The purpose of this study is to compare clinical outcomes and surgical complications between ORIF and CRIF for treatment of nonelderly adult patients with displaced femoral neck fractures.

Methods: In this IRB-approved, multicenter retrospective cohort study, young adult patients (18-65 years) with OTA 31-B2 or 31-B3 fractures with minimum 6-month follow-up or with postoperative complication within 6 months were included. Patients with pathologic or nondisplaced fractures, ipsilateral head or neck fractures, or who underwent arthroplasty as primary treatment were excluded. Patients treated by ORIF were compared to those undergoing CRIF. The primary outcome was reoperation. Secondary outcomes included nonunion, malunion, osteonecrosis, infection, osteoarthritis, heterotopic ossification, and fracture fixation failure. Injury and demographic characteristics were compared between treatment groups and those with bivariable association with outcomes ($P < 0.2$) were used to fit a multivariable logistic regression to adjust for and identify predictors of reoperation.

Results: Of 239 patients enrolled from 13 academic institutions, 126 were treated with ORIF and 113 with CRIF. CRIF patients were older, had more comorbidities (diabetes mellitus, osteopenia) and more likely to have sustained OTA type B3 (displaced subcapital) injuries, while ORIF patients were more likely to have Pauwels Type III injuries and coincident femoral

See pages 49 - 106 for financial disclosure information.

shaft fractures. There was no signficant difference in total reoperation rate between ORIF (47 [37.3%]) and CRIF (31 [27.4%], P = 0.14), although ORIF patients had a significantly higher incidence of reoperation due to nonunion than CRIF patients (16.7% vs 5.3%, P = 0.010) (Table 1). A multivariable logistic model that best fit the data included ORIF versus CRIF, age, Pauwels classification, coincidental femoral shaft fractures, and time to surgery(Table 2). Adjusting for other variables in the model, ORIF was associated with a 2-fold increase in the odds of reoperation versus CRIF (odds ratio [OR] 2.13, 95% CI 1.07 to 4.23, P = 0.02), while coincident femoral shaft fracture was associated with a decreased odds of reoperation (OR 0.29, 95% CI 0.11 to 0.76, P = 0.01).

Table 1. Bivariate analyses of reoperation and complications for non-elderly adult patients with displaced femoral neck fractures treated by ORIF vs. CRIF.

	ORIF (n=104)	CRIF (n=108)	P-value
Total Reoperations	35 (33.7%)	31 (28.7%)	0.23
Etiology [number (%)]			
AVN	7 (6.7%)	12 (11.1%)	0.21
Failure	1 (1.0%)	2 (1.9%)	0.89
Malunion	3 (2.9%)	5 (4.6%)	0.53
Nonunion	16 (15.4%)	7 (6.5%)	**0.039**
OA	2 (1.9%)	3 (2.8%)	0.71
SSI	6 (5.8%)	2 (1.9%)	0.12
Total Complications	45 (43.3%)	58 (53.7%)	0.17
Etiology [number (%)]			
Fracture nonunion	17 (16.3%)	10 (9.3 %)	0.13
AVN of femoral head	9 (8.7%)	20 (18.5%)	**0.034**
Surgical Site Infection	6 (5.8%)	3 (2.8%)	0.29
Heterotopic ossification	3 (2.9%)	2 (1.9%)	0.63
Osteoarthritis	4 (3.8%)	13 (12.0%)	**0.027**
Malunion	5 (4.8%)	7 (6.4%)	0.43
Fracture fixation failure	1 (1.0%)	2 (1.9%)	0.87
Death	0 (0%)	1 (0.9%)	0.32

Conclusion: In this multicenter retrospective study of open versus closed reduction for repair of femoral neck fractures in nonelderly adults with 6-month follow-up, patients treated with ORIF had significantly higher rates of reoperation after adjustment for patient characteristics and injury severity. A prospective randomized controlled trial is indicated to test whether there is a causal association between open approach to reduction and outcomes.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Immediate Weight Bearing as Tolerated has Improved Outcomes Without an Increased Risk of Reoperation after Intramedullary Fixation for Subtrochanteric Fractures Compared to Modified Weight Bearing

Brian P. Cunningham, MD[1]*; Ashley Ali, MD*[2]*; Saif Zaman, MD*[3]*; Ryan Montalvo, BS*[4]*; Bradley Reahl, MD*[4]*; Guiliana Rotuno, BS*[4]*; John Kark, BS*[5]*; Mark Bender, BS*[6]*; Brian Miller, MD*[7]*; Hrayr Basmajian, MD*[3]*; Ryan McLemore, PhD*[8]*; David Shearer, MD, MPH*[9]*; Robert V. O'Toole, MD*[4]*; William T. Obremskey, MD, MPH*[10]*; H. Claude Sagi, MD*[11]*;*
[1]*Regions Hospital, Saint Paul, Minnesota, USA;*
[2]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[3]*Loma Linda University Medical Center, Loma Linda, California, USA*
[4]*R Cowley Shock Trauma Hospital, Baltimore, Maryland, USA*
[5]*University of Washington School of Medicine, Seattle, Washington, USA*
[6]*University of South Florida College of Medicine, Tampa, Florida, USA*
[7]*Sonoran Orthopaedic Trauma Surgeons, Scottsdale, Arizona, USA*
[8]*Clinical Outcomes and Data Engineering Technology, Phoenix, Arizona, USA*
[9]*UCSF/SFGH, San Francisco, California, USA*
[10]*Vanderbilt University, Nashville, Tennessee, USA*
[11]*Harborview Medical Center, Seattle, Washington, USA*

Background/Purpose: Subtrochanteric femur fractures are commonly managed with operative fixation and restricted weight bearing because of a high complication rate resulting from cortical comminution and stress concentration during stance. Intramedullary nailing has become the primary fixation method primarily because of the improved biomechanical profile that has previously been demonstrated. The literature has established improved outcomes from early weight bearing for hip fractures and the safety has been demonstrated previously in comminuted femoral shaft fractures. Pilot data has previously been presented to suggest that early weightbearing may decrease overall length of stay, however no study to date has been adequately powered to evaluate the safety of this protocol. Our hypothesis was that immediate post-operative weight bearing as tolerated (WBAT) for subtrochanteric femur fractures would result in decrease length of stay (LOS) compared to non-weight bearing (NWB) without resulting in an increased risk of re-operation.

Methods: After IRB approval a retrospective cohort study was conducted from August 2008 to November 2015 at six level-1 trauma centres. Inclusion criteria were skeletal mature patients with a subtrochanteric femur fracture, defined as with in 5cm of the lesser trochanter (OTA Classification 31A.3 and 32A-32C.). Exclusion criteria was presentation GCS below 8, spinal cord injury with motor deficits, periprosthetic fracture and bisphosphonate-related atypical subtrochanteric femoral fractures. A total of 437 patients met the inclusion criteria and underwent intramedullary fixation with 299 patients who completed follow up until union. These cohorts were compared using univariate and multivariate regression analysis for statistical significance as well as to evaluate the potential for confounding. Patients were also evaluated regarding age, sex, mechanism of injury, implant type, implant size, degree of comminution and fracture type. Primary outcome was total length of stay (LOS), with secondary analysis of risk of re-operation.

See pages 49 - 106 for financial disclosure information.

Results: Of 437 patients met the inclusion criteria the majority of the patients were male (284, 61%) with the mean patient age was 51.4 years (range 17-98) with a bimodal distribution of 39.6 and 71.4 for high and low energy, respectively. Implant choice was predominantly cephalomedullary nail (63.2%, n=289), followed by reconstruction nail (26.5%, n=116) and standard piriformis entry (7.1%, n=31). The nail diameter was predominantly 10mm (30.9%, n=135) followed by 11mm (25.6%, n=112), 11.5mm (13.3%, n=58) and 12mm (12.6%, n=55). The majority of patients were treated with immediate WBAT (62.9%, n=275) compared to limited weight bearing (37.1%, n=162). Overall the WBAT group had a decreased LOS compared to the NWB group (5.7 vs 8.1, p=0.002). Utilizing multivariate regression high and low energy fracture patterns were analysed for the affect of weight bearing status, age, gender, Winquist-Hansen grade. For low energy fractures the strongest affect on length of stay was immediate weight bearing as tolerated (p=0.0106). For high energy fractures the strongest affect on length of stay was immediate weight bearing as tolerated (p=0.0227) with age also significant (p= 0.0485). In the 299 patients followed to union the overall complication rate was defined as reoperation for any reason related to the subtrochanteric fracture (9.7%, n=29) with nonunion the most common reason for reoperation (5.4%, n=16), followed by symptomatic hardware removal (3.3%, n=10) and infections (1.6%, n=5, 3 deep and 2 superficial). The risk of reoperation was lower in the WB group (8.8%, n=16) compared to the limited WB group (11.1%, n=13), however this did reach statistical significance (p=0.5083).

Conclusion: This study that demonstrates a decreased length of stay using a protocol of immediate post-operative weight bearing as tolerated for subtrochanteric femur fractures in a large multi-center cohort design. Additionally this is the first study adequately powered to demonstrate that this protocol does not increase in the risk of reoperation. Our data suggests that cephalomedullary implants continue to be the preferred nail. We plan to continue studying early weight bearing for subtrochanteric fractures with specific attention on the impact of post-operative coronal and sagittal alignment on the rate of nonunion.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Is Vitamin D Associated with Improved Physical Function and Reduced Re-Operation Rates in Elderly Patients with Femoral Neck Fractures Treated with Internal Fixation?

*Sheila Sprague, PhD[1]; **Gerard P. Slobogean, MD[2]**; Earl Bogoch, MD[3]; Brad Petrisor, MD[4]; Alisha Garibaldi, MSc[1]; Nathan O'Hara, MHA[5]; Mohit Bhandari, MD, FRCSC, PhD[6]; FAITH Investigators[1]*
[1]*McMaster University, Ontario, CANADA*
[2]*University of Maryland, Baltimore, Maryland, USA*
[3]*University of Toronto, Ontario, CANADA*
[4]*Hamilton General Hosp, Ontario, CANADA*
[5]*University of Maryland School of Medicine, Baltimore, Maryland, USA*
[6]*MacOrtho Research, Ontario, CANADA*

Purpose: Daily vitamin D supplementation is recommended for individuals over the age of 50, as vitamin D is necessary for general bone health. There has been increased interest within the orthopaedic community on the potential for vitamin D to improve outcomes in fracture patients. The recently completed FAITH (Fixation using Alternative Implants for the Treatment of Hip Fractures) trial (cancellous screws versus sliding hips screws in femoral neck fracture patients over the age of 50) provides a unique opportunity to investigate this further. The objectives of this study are: (1) to determine the proportion of patients who consistently take vitamin D following their fracture and (2) to determine if vitamin D supplementation is associated with improved postinjury physical function and reduces rates of reoperation within 2 years of the fracture.

Methods: The FAITH trial is a multicenter randomized controlled trial of 1111 femoral neck fracture patients treated with cancellous screws or sliding hip screws. A subset of 625 patients included within this study were asked about vitamin D supplementation at each of the follow-up visits over a 2-year period. Based on their frequency of vitamin D supplementation in the first 6 months of follow-up, patients were categorized as either consistent (3-4 visits), inconsistent (1-2 visits), or noncompliant in their vitamin D supplementation. Patients with one or fewer follow-up visits in the first 6 months were excluded from the analysis. Multivariate regression was used to compare the effect of vitamin D supplementation on physical function (defined as the physical component score of the Short Form-12 [SF-12]) at 12 months postfracture and reoperation, adjusting for baseline SF-12 score, gender, and fracture displacement.

Results: 575 patients were included in the final analysis. The mean age was 74.5, the majority were female (65.8%), and had undisplaced fractures (72.6%). 18.7% reported never taking vitamin D, 35.6% reported taking vitamin D inconsistently, and 45.7% reported taking vitamin D consistently. Our adjusted analysis found that consistent vitamin D supplementation postfracture was associated with a 2.29 increase in the physical component of the 12-month SF-12 score ($P = 0.045$). Vitamin D supplementation was not associated with reoperation rates.

Conclusion: Despite highly publicized vitamin D supplementation guidelines we found that a surprisingly low proportion of elderly hip fracture patients are consistently taking vitamin D, which suggests a need for additional strategies to promote compliance with

See pages 49 - 106 for financial disclosure information.

vitamin D supplementation in this population. Our research also found that vitamin D may be associated with improved physical function following a hip fracture. Further research is needed to confirm these findings given the observational nature of this study.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Predictors of Cephalomedullary Nail Failure in the Treatment of Pertrochanteric and Intertrochanteric Hip Fractures

David Ciufo, MD[1]; *Douglas Zaruta, MD[1]; Jason Lipof, MD[1]; John Gorczyca, MD[1]; Catherine Humphrey, MD[2]; Gillian Soles, MD[3]; Kyle Judd, MS, MD[1]; John Ketz, MD[3]*
[1]University of Rochester, Rochester, New York, USA;
[2]University of Rochester Medical Center, Rochester, New York, USA;
[3]University of Rochester Medical Center, Pittsford, New York, USA

Purpose: Intertrochanteric and pertrochanteric hip fractures are common injuries that affect elderly patients. Failure of fixation for these fractures leads to devastating complications with significant effects on the patient. The current study evaluates radiographic parameters that may be predictive of cephalomedullary nailing failure in pertrochanteric and intertrochanteric hip fractures.

Methods: A retrospective review was performed of all pertrochanteric and intertrochanteric femur fractures (AO/OTA 31-A1,2,3) treated with a trochanteric entry cephalomedullary nail from January 2007 through January 2014 at our institution. Inclusion criteria were patients 55 years or older, low-energy fracture mechanism, and a minimum of 3 months radiographic follow-up. Pathologic and periprosthetic fractures were excluded. Injury radiographs were assessed for greater trochanter comminution, unstable posteromedial fragment, gapping at the basicervical component after fixation, malreduction of the femoral neck-shaft angle defined as >5 ° varus or >15 ° valgus compared to contralateral, tip-apex distance (TAD) >25 mm, and surgeon fellowship training. Each parameter was assessed for failure, and multivariate regression analysis and odds ratios (ORs) were performed among variables.

Results: Of 932 charts reviewed, 362 met inclusion criteria. Average patient age was 83 years and 95.9% were from a low-mechanism injury. The average length of follow-up was 11.5 months. A total of 22 (6%) cutouts occurred. Cutout was significantly more frequent in patients presenting with comminution of the greater trochanter ($P < 0.01$), loss of the medial calcar ($P = 0.01$), gapping at basicervical component after fixation ($P < 0.01$), malreduction in varus >5° or valgus >15 ° of contralateral ($P = 0.01$), and screw above mid-neck ($P = 0.01$). There was no significant difference in failure rate with TAD >25 mm ($P = 0.46$). Multivariate regression analysis was performed to isolate the effect of individual risk factors. Presence of greater trochanter comminution was associated with the greatest risk of fixation failure (OR = 8.7, $P > 0.01$). Angular malreduction was the next most predictive (OR = 4.9, $P < 0.01$) followed by residual gapping at a basicervical component (OR = 3.8, $P = 0.04$). Lag screw placement above mid-neck (OR = 2.9, $P = 0.08$), presence of a posteromedial fragment (OR = 1.8, $P = 0.49$), and fixation performed by non-trauma fellowship-trained surgeons (OR = 1.8, $P = 0.21$) trended towards increased cutout but were not statistically significant.

Conclusion: Preoperative assessment of intertrochanteric femur fractures can help provide further prognostic information based on fracture pattern. Preoperative presence of greater trochanteric comminution or involvement of posteromedial fragment was shown to be of significant risk to lag screw/helical blade cutout. Postoperative parameters of basicervical gapping, malreduction, and superior screw placement were also associated with hardware

See pages 49 - 106 for financial disclosure information.

failure. This suggests that fracture pattern, reduction, and hardware placement are each associated with postoperative patient prognosis. The presence of multiple radiographic predictors further compounds the chances of lag screw/helical blade cutout. The use of a cephalomedullary nail did not have an increased failure rate based on a TAD >25 mm. This information could be useful in the surgical planning/technique and preoperative counseling of patients with this fracture presentation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Frailty is a Better Marker than Age in Predicting Postoperative Mortality and Complications Following Pelvis and Lower Extremity Trauma

Cathy (CatPhuong) Vu, BS*; Robert Runner, MD; William Reisman, MD; Mara Schenker, MD*
Emory University, Atlanta, Georgia, USA

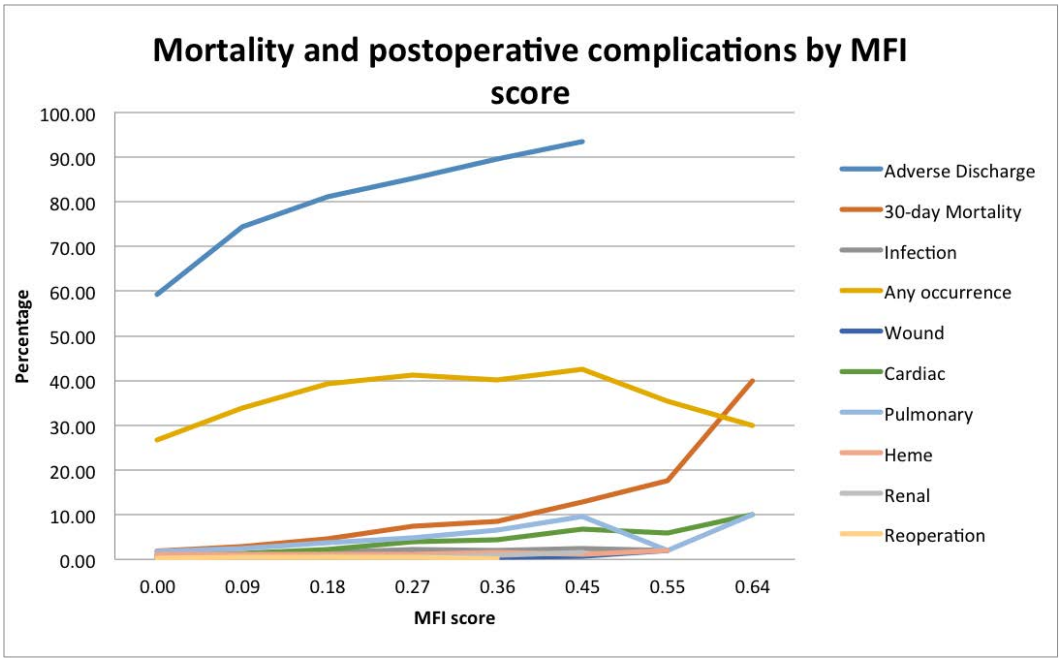
Purpose: "Frailty" has been described as a physiologic marker of decline of multiple organ systems and identifies patients who are more susceptible to complications following the external stress of trauma. Multiple medical and surgical specialties have shown higher complication rates in frail patients, including increased mortality and need for long-term care. This purpose of this study was to evaluate frailty as an independent predictor of postoperative complications in elderly patients with pelvis and lower extremity trauma.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2005-2014 was queried for patients 60 years and older who underwent surgery for pelvis, acetabular, and lower extremity trauma. A previously described modified frailty index (MFI) was utilized. In this, the presence of 11 variables are summated, including diabetes, congestive heart failure, hypertension, myocardial infarction, cerebrovascular accident with and without neurological deficit, peripheral vascular disease, functional status, COPD (chronic obstructive pulmonary disease) or pneumonia, prior percutaneous coronary intervention, cardiac surgery or angina, and history of impaired sensorium. The MFI score was then calculated for each patient, resulting in a fractional index. From prior studies, the threshold between fit and frail has been reported at 0.25, with 0.4 as the threshold for dependence on activities of daily living. We classified patients into non-frail (0-0.24), moderately frail (0.25-0.4), and severely frail (>0.4). Multivariate logistic regression was performed to determine the primary outcome of association between MFI score and age with 30-day mortality, and univariate analysis was performed for secondary outcome measures (all occurrence of adverse events, cardiac, pulmonary, hematologic, renal, reoperation, adverse discharge disposition) with odds ratios and P values reported. Linear regressions were performed to analyze lengths of hospital and ICU stays relative to MFI scores. Significance was established at $P < 0.05$.

Results: This study included 32,535 patients over age 60, with injuries of the pelvis and acetabulum (0.9%), hip (73.2%), femur (4.1%), knee (7.4%), tibia (1.8%), and ankle (12.5%). Based on the MFI thresholds, 86.5% were non-frail, 11.4% were moderately frail, and 0.93% were severely frail. There was a stronger association between MFI score and 30-day mortality (odds ratio [OR] for MFI: 10.45, 95% CI: 5.98-18.28) as compared to age and 30-day mortality (OR for age: 1.05, 95% CI: 1.04-1.06; $P < 0.001$). As MFI score increased, 30-day mortality increased from 1.9% in an MFI score of 0 to 40.0% for MFI score 0.64 and above ($P < 0.001$) (Figure 1). Higher rates of postoperative complications were observed as MFI scores increased, including any occurrence excluding mortality (OR: 1.21, 95% CI: 1.18-1.23, $P < 0.001$), cardiac (OR: 1.61, 95% CI: 1.51-1.72, $P < 0.001$), pulmonary (OR: 1.4, 95% CI: 1.33-1.48, $P < 0.001$), and renal complications (OR: 1.609, 95% CI: 1.39-1.87, $P < 0.001$). Frail patients also had increasing odds of adverse hospital discharge disposition with increasing MFI score (OR: 1.64, 95% CI: 1.59-1.70, $P < 0.001$). Length of hospital stay increased from 5.38 days (±6.0 days) to 16 days (±9.0 days; $P < 0.001$) while length of ICU stay increased

See pages 49 - 106 for financial disclosure information.

from 4.0 days (±4.3 days) to 10.14 days (±6.2 days; P = 0.0035) between MFI score 0 and 0.64. Hematologic complications (OR: 1.06, 95% CI: 0.97-1.17, P = 0.23) and reoperations (OR: 1.10, 95% CI: 0.93-1.29, P = 0.28) were not associated with frailty.



Conclusion: Frailty is a stronger predictor of 30-day mortality than age in elderly patients with pelvis, acetabular, and lower extremity trauma. Given the strength of association between frailty and postoperative complications, evaluation of patients based on a modified frailty index can provide an effective and robust risk assessment tool to more appropriately counsel patients and direct interdisciplinary care.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Hip Fracture Patient on Warfarin: Is Delay of Surgery Necessary?

Matthew Cohn, BS[1]*; Ashley Levack, MD, MAS*[1]*; Nikunj Trivedi, BS*[2]*; Jordan Villa, MD*[1]*; Joseph Koressel, BS*[3]*; David Wellman, MD*[1]*; John Lyden, MD*[1]*; Dean Lorich, MD*[4]*; Joseph Lane, MD*[1]
[1]*Hospital for Special Surgery, New York, New York, USA;*
[2]*Weill Cornell Medical College, New York, New York, USA;*
[3]*Cornell, New York, New York, USA;*
[4]*New York Presbysterian Hospital, New York, New York, USA*

Background/Purpose: Hip fractures account for more hospital days than any other musculoskeletal injury. Delay from hospital admission to surgery has been shown to result in poorer functional outcomes and increased hospital costs. Guidelines suggest that surgery be delayed until a patient's international normalized ratio (INR) is reduced to 1.5 or lower to avoid excessive blood loss and to allow the use of regional anesthesia. However, there is a paucity of published data that suggests worse operative outcomes in patients undergoing surgery with INR above this threshold. The purpose of this study was to compare transfusion rates, blood loss, delay of surgery, and short-term adverse events in (1) patients admitted on warfarin versus non-anticoagulated controls and (2) patients on warfarin with day of surgery (DOS) INR ≥1.5 versus <1.5.

Methods: This retrospective case-control study included all patients over 55 years of age undergoing hip fracture surgery at a tertiary care hospital from 2012 to 2015. Patients with pathologic fractures, periprosthetic fractures, polytrauma, closed reduction and percutaneous pinning, and use of anticoagulants other than warfarin were excluded. All eligible patients on warfarin were included in the study and matched in a 1 to 1 ratio with controls for age, gender, year of surgery, and type of surgery. Outcome measurements included transfusion rate, calculated blood loss, hours from emergency department presentation to surgery, length of stay (LOS), and complication rate. Operative characteristics and outcomes were compared between groups using X2, Fisher's exact, Mann-Whitney U, and Student t tests. Multivariable logistic regression was used to identify factors associated with need for transfusion.

Results: Our study included 128 patients (64 patients admitted on warfarin and 64 matched controls). The total cohort included 74 female and 54 male patients. The mean age of patients admitted on warfarin was 84.3 years (SD, 8.2) and the mean age for controls was 84.2 (SD, 8.6). There were 64 intracapsular fractures (58 hemiarthroplasty, 6 total hip arthroplasty) and 64 extracapsular fractures (64 cephalomedullary nails). The mean INR at admission was 2.6 (standard error of the mean [SEM], 0.1) and 1.0 (SEM, 0.1) for the warfarin and control groups, respectively. Mean DOS INR was 1.5 (SEM, 0.1) and 1.0 (SEM, 0.0) for the warfarin and control groups, respectively. At least one blood transfusion was required in 58% of patients in the warfarin group compared to 56% of controls (P = 0.86). There were no significant differences in calculated blood loss between the warfarin group (1212 mL, SEM 82) and control group (1189 mL, SEM 72, P = 0.71) or in complication rates (P = 0.69). Patients on warfarin had significantly longer time to surgery (P <0.01) and LOS (P <0.01). Subanalysis of the warfarin group showed that 24 patients underwent surgery with INR ≥1.5 (range, 1.5-3.3). Patients with DOS INR at or above 1.5 had similar transfusion rates and

See pages 49 - 106 for financial disclosure information.

blood loss compared to patients with INR below 1.5 (P = 0.65 and P = 0.69, respectively). Those with DOS INR <1.5 had longer time to surgery (P = 0.01) and LOS (P = 0.02), but no difference in complication rates (P = 0.23). Multivariate regression including DOS INR, anti-platelet use, and type of surgery indicated that only cephalomedullary nailing was associated with need for transfusion in comparison to arthroplasty procedures (odds ratio 3.1, 95% confidence interval 1.02-9.68, P = 0.047).

Conclusion: In this study, patients with hip fractures admitted on warfarin were at no higher risk for transfusion or adverse events compared to non-anticoagulated patients. Awaiting normalization of INR delayed surgery and increased LOS, without reducing bleeding or preventing complications. Within reason, surgeons may consider proceeding with surgery in patients with INR>1.5 if patients are otherwise medically optimized. The upper limit above which surgery causes increased blood loss is currently unknown. The need for general anesthesia must also be weighed against the impact of surgical delay in these patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Can Evidence-Based Guidelines Decrease Unnecessary Echocardiograms for Preoperative Evaluation of Hip Fracture Patients?

Chris Adair, MD; *Eric Swart, MD; Rachel Seymour, PhD; Joshua Patt, MD, MPH; Madhav Karunakar, MD*
Carolinas Medical Center, Charlotte, North Carolina, USA

Background/Purpose: Hip fractures are common in the geriatric population and cardiac complications are a significant cause of morbidity and mortality after operative treatment. Preoperative risk assessment is performed to aid clinicians in pre- and postoperative medical management and may include echocardiography (TTE). However, urgent preoperative TTE requires additional resource utilization, increases cost, and may delay time to operating room in some circumstances. Several clinical practice guidelines (CPGs) have been created to provide recommendations on indications for preoperative TTE. The purpose of this study was to evaluate preoperative TTE utilization at a single institution in order to determine (1) how often TTEs are obtained in accordance with current CPGs, (2) how frequently TTEs reveal cardiac disease pathology that may alter medical or anesthesia management, and (3) whether the use of CPGs to indicate preoperative TTE could reduce unnecessary utilization without potentially missing significant pathology.

Methods: A retrospective review of 100 consecutive patients age 55 years and older who sustained a hip fracture between May 2009 to November 2012 and received a preoperative TTE was performed. The percent compliance with published CPGs was recorded, evaluating adherence to guidelines from the American College of Cardiology / American Heart Association (ACC / AHH), the British Society of Echocardiography (BSE), the European Society of Cardiology (ESC), and the Association of Anesthesia of Great Britain and Ireland (AAGBI) (Table 1). TTE reports were reviewed for the presence of significant pathology, which was defined as results that could modify anesthesia or perioperative management, including new left ventricular systolic or diastolic dysfunction, moderate or severe valvular disease, and pulmonary hypertension. Finally, the performance of the individual CPGs as screening protocols were evaluated by testing their sensitivity and specificity for predicting which patients would have TTEs that identified significant pathology.

Results: Adherence to published CPGs varied from 32% to 66% (Table 1). In 14% of cases TTE revealed pathology with potential to modify anesthesia or medical management. In all of those cases, TTE was indicated according to ACC guidelines (ie, the guidelines were 100% sensitive, and no patients with pathology would have been missed if ACC guidelines were followed). Additionally, if the ACC guidelines were followed, 34 of the 86 remaining patients who had TTEs showing no pathology could have been screened out (40% specificity). None of the other guidelines were as sensitive as the ACC guidelines.

Conclusion: Preoperative TTEs in patients with hip fractures are frequently obtained outside the recommendations of established CPGs. In our series, TTEs revealed pathology likely to change management 14% of the time, but following published CPGs could reduce unnecessary TTE utilization without increased risk of missed pathology. When developing care pathways, utilization of CPGs such as the ACC guidelines to determine which patients need

See pages 49 - 106 for financial disclosure information.

TTEs should be considered, as it may decrease variability in care and reduce unnecessary resource utilization without adversely affecting patient outcomes.

Guideline	ACC/AHH	BSE	ESC	AAGBI
Indications for TTE	• Dyspnea of unknown origin • Worsening of known heart failure (HF) signs or symptoms • Known history of valvular dysfunction or HF without Echo in last year or worsened symptoms • Suspicion of moderate or greater valvular stenosis or regurgitation	• Documented ischemic heart disease • Unexplained dyspnea • Murmur with concomitant cardiac or respiratory symptoms • Murmur in asymptomatic patient where structural heart disease is suspect	• Presumed or confirmed severe valvular disease	• Dyspnea at rest or low level of exertion • Murmur suggestive of significant aortic stenosis
% TTEs in accordance with guidelines	66	65	32	50
Sensitivity	100.0%	78.6%	71.4%	71.4%
Specificity	39.5%	37.2%	74.4%	53.5%

Table 1: ACC/AHH American College of Cardiology; BSE British Society of Echocardiography; ESC European Society of Echocardiography; AAGBI Association of Anesthesia of Great Britain and Ireland

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Hip Arthroplasty for Fracture versus Elective Patients: One Bundle Does Not Fit All

Siddharth Mahure, MD; *Richard Yoon, MD; Lorraine Hutzler, MS; Nirmal C. Tejwani, MD; Frank Liporace, MD; Joseph Bosco, MD; Kenneth A. Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: The bundled payment model places a greater responsibility on hospitals to provide optimal care by directly tying reimbursements with the ability to improve outcomes across a variety of quality metrics. Currently, all hip arthroplasty patients fall within a single bundle, regardless of whether treatment is provided on an elective or fracture basis. As fracture care must often be provided on an emergent basis, there may be insufficient time to appropriately optimize these patients prior to surgery, thus leading to significantly worse outcomes that ultimately place significant financial burden on hospital systems. We sought to determine how baseline characteristics may be different between patients undergoing hip arthroplasty for fracture care versus elective treatment, and how this may affect subsequent outcomes.

Methods: The New York Statewide Planning and Research Cooperative System (SPARCS) database was queried to identify patients 18 and older who underwent inpatient total hip arthroplasty (THA) or hemiarthroplasty (HA) between 2010 and 2014. Demographic information, hospital teaching status, bed size, urban/rural location, along with concomitant medical comorbidities were identified. Primary ICD-9 diagnosis code at time of admission was used to characterize patients into either elective or fracture cohorts. Differences between groups regarding inhospital mortality, postoperative complications, length of stay (LOS), total charges, discharge disposition, and hospital readmission were examined.

Results: 76,654 patients underwent THA or HA between 2010 and 2014. 82.8% of the sample was for elective care, 17.2% for fracture-related etiology. Fracture patients were significantly older (81.1 ± 10.20 vs 65.0 ± 11.3, P <0.001), more likely to be female (70.5% vs 29.5%, P <0.001), Caucasian (89.9% vs 84.8%, P <0.001), reimbursed by Medicare (87.9%, P <0.001), and receive general anesthesia (76.6% vs 23.4%, P <0.001). Comorbidity burden and postoperative complications were significantly higher in the fracture group (Figures I and II). Mean LOS (7.3 ± 5.7 vs 3.3 ± 1.7, P <0.001) and hospital charges ($54,087.0 ± 44,384.0 vs $46,441.0 ± 22960.0, P <0.001) were significantly greater for fracture patients as compared to elective cohort. Results from multivariate analysis showed that compared to elective THA, undergoing arthroplasty for fracture-related care was an independent risk factor for: LOS in 75th percentile (odds ratio [OR] 8.91, 7.66-10.36, P <0.001), hospital charges in the 75th percentile (OR 2.28, 2.00-2.59, P <0.001), nonhomebound discharge disposition (OR 3.92, 3.65-4.21, P <0.001), inhospital mortality (OR 6.70, 4.67-10.28, P <0.001), and 90-day readmission (OR 2.53, 2.34-2.74, P <0.001).

Conclusion: Patients undergoing hip arthroplasty for fracture care are significantly older and have more medical comorbidities than patients treated on an elective basis, leading to more inhospital complications, greater LOS, increased hospital costs, and significantly more hospital readmissions. The present bundled payment system unfairly penalizes hospitals who manage fracture patients, and has the potential to incentivize hospitals to defer providing definitive surgical management for these patients. Future amendments to the bundled

See pages 49 - 106 for financial disclosure information.

payment system should consider separating hip arthroplasty patients based upon etiology, allowing for a more accurate reflection of these two distinct patient groups.

Figure I

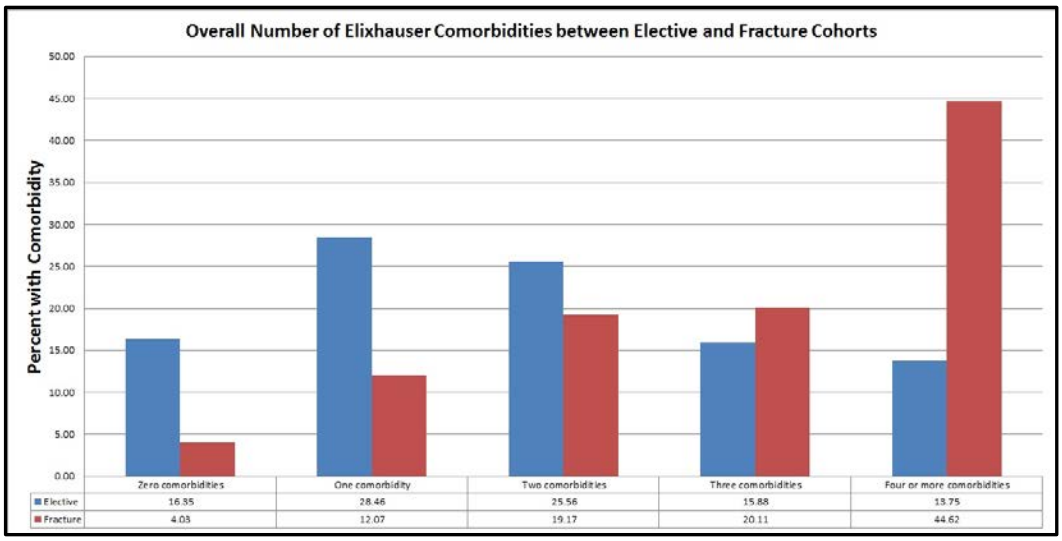
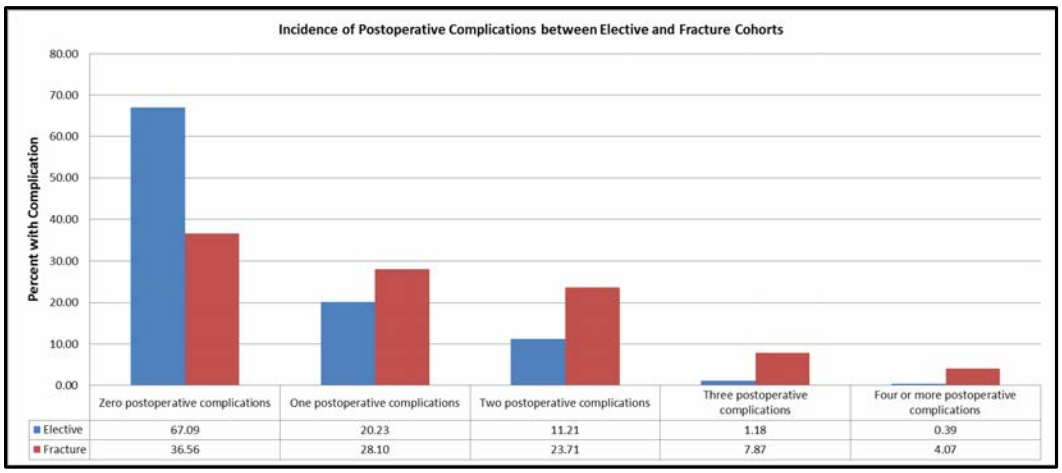


Figure II



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Effect of Hospital and Surgeon Volume on Mortality After Hip Fracture

Kanu Okike, MD, MPH[1]***;*** *Priscilla Chan, BS, MS*[2]*; Liz Paxton, MA*[2]
[1]*University of Maryland Medical Center, Honolulu, Hawaii, USA;*
[2]*Kaiser Permanente Surgical Outcomes and Analysis, San Diego, California, USA*

Purpose: Several studies have documented a positive relationship between procedure volume and clinical outcomes. A few studies have examined the relationship between volume and outcome among hip fracture surgeries, but the results have been inconclusive. The purpose of this study was to assess the hip fracture volume-outcome relationship by analyzing data from a large managed care registry.

Methods: Using an integrated health-care system's hip fracture registry, we identified all surgically treated hip fractures in patients over age 60. Data were recorded on characteristics of the patient (age, gender, race/ethnicity, body mass index, ASA [American Society of Anesthesiologists] score, medical comorbidities) as well as the procedure (surgeon, hospital, procedure, anesthesia type, time from admission to surgery) and outcomes (complications, mortality). To allow for minimum 1-year follow-up, we included all hip fractures sustained between 2010 and 2013. To determine surgical case volume, the registry was used to determine the number of hip fracture surgeries performed in the preceding 12 months. Surgeon volume was divided into terciles and classified as low (0-13 cases/year), medium (14-20 cases/year), or high (21 or more cases/year). Similarly, hospital volume was divided into terciles and classified as low (0-124 cases/year), medium (125-186 cases/year), or high (187 or more cases/year). The primary outcome was mortality at 1 year postoperative. Secondary outcomes were mortality at 30 and 90 days postoperative as well as reoperation (lifetime), medical complications (90-day), and unplanned readmission (30-day). To determine the relationship between volume and these outcome measures, multivariate logistic and Cox proportional hazards regression were performed controlling for the covariates listed above. The study was approved by the organization's institutional review board.

Results: Of the 14,294 patients in the study sample, the majority were female (71%) and white (79%), and the average age was 81 years. The procedures performed included internal fixation (63%), hemiarthroplasty (34%), and total hip arthroplasty (2%), while the anesthesia was general (57%), spinal/epidural (36%) or mixed (3%). The overall mortality rate was 6% at 30 days, 11% at 90 days, and 21% at 1 year. There was no association between surgeon or hospital volume and mortality at 30 days, 90 days, or 1 year (Table 1). There was also no association between surgeon or hospital volume and reoperation, medical complications, or unplanned readmission ($P > 0.05$).

Conclusion: In this analysis of hip fractures in a large integrated health-care system, the observed rates of mortality, reoperation, medical complications, and unplanned readmission did not differ by surgeon or hospital volume. The mortality rates observed at the hospitals in our study (including those with low volume) were lower than reported in the literature. The standardized policies and protocols of the integrated health-care system may contribute to these lower rates.

See pages 49 - 106 for financial disclosure information.

Table: One-Year Mortality, by Surgeon and Hospital Volume

	Multivariate Odds Ratio of Mortality by 1 year** (95% Confidence Interval)	p-value
Surgeon volume		
Low *(0-10 cases/year)*	0.92 (0.81 – 1.03)	0.16
Medium *(11-15 cases/year)*	1.09 (0.97 – 1.22)	0.16
High *(16-23 cases/year)*	0.99 (0.89 – 1.10)	0.85
Very high *(24+ cases/year)**	1.00	---
Hospital volume		
Low *(0-111 cases/year)*	**1.14 (1.03 – 1.28)**	**0.015**
Medium *(112-152 cases/year)*	**1.19 (1.06 – 1.34)**	**0.004**
High *(153-204 cases/year)*	1.03 (0.89 – 1.10)	0.63
Very high *(205+ cases/year)**	1.00	---

*Reference category

**Odds ratios were adjusted for potentially confounding variables including age, gender, race/ethnicity, body mass index (BMI), American Society of Anesthesia (ASA) score, chronic pulmonary disease, liver disease, renal failure, alcohol abuse, anesthesia type, time from admission to surgery, and procedure performed (internal fixation, hemiarthroplasty, or total hip arthroplasty).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Efficacy of Peri-Incisional Multimodal Drug Injection Following Operative Management of Femur Fractures

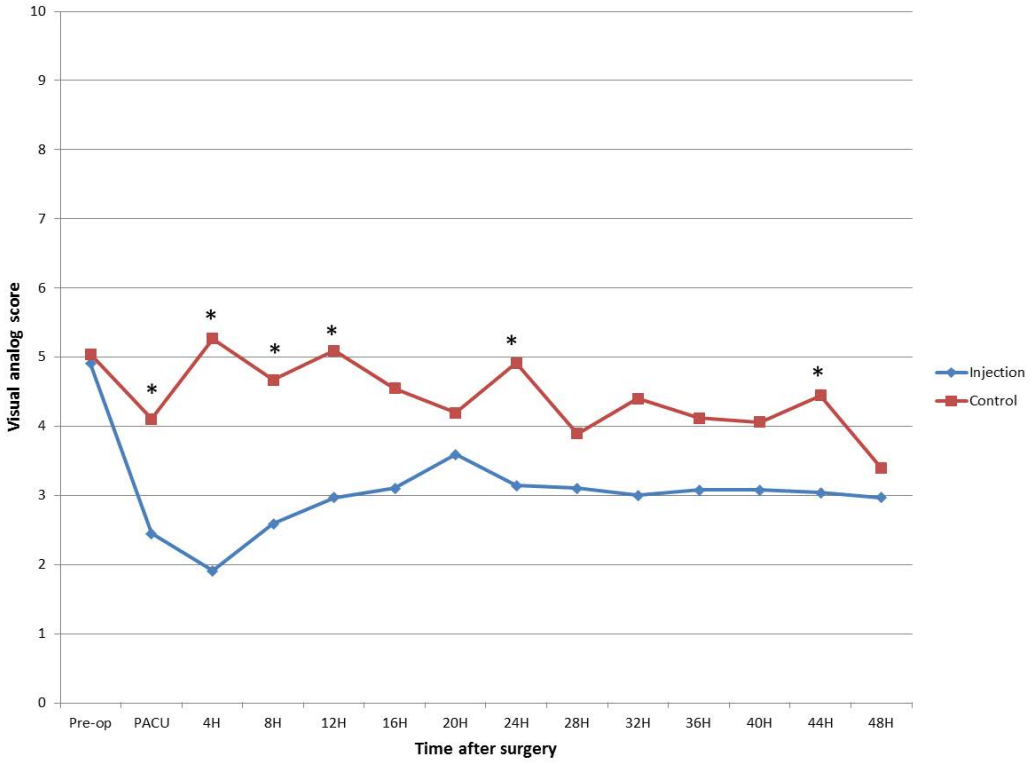
Daniel Koehler, MD[1]*; Larry Marsh, MD*[2]*; Matthew Karam, MD*[3]*; Catherine Fruehling, BA*[1]*; Michael Willey, MD*[2]
[1]*University of Iowa Hospitals and Clinics, Iowa City, Iowa, USA;*
[2]*University of Iowa, Iowa City, Iowa, USA;*
[3]*University of Iowa Hospitals and Clinics, Dept of Orthopaedics, Iowa City, Iowa, USA*

Background/Purpose: Parenteral narcotics are currently a mainstay for perioperative pain control following operative management of femur fractures despite notable side effects including nausea, emesis, pruritus, constipation, urinary retention, confusion, sedation, and respiratory depression. Optimally, an analgesic regimen should limit adverse effects, block pain at its site of origin, and maintain muscle control to allow for early postoperative mobilization. Recently, periarticular injection with employment of local anesthetics has been introduced into the elective lower extremity arthroplasty literature as a means of achieving these goals with promising results. If this simple intervention were found to be effective it could easily be widely adopted to improve pain management for patients with femur fractures.This study was designed to evaluate the efficacy and safety of a peri-incisional multimodal drug injection for postoperative pain control following operative management of femur fractures.

Methods: 102 patients aged ≥18 years (range, 29-97) undergoing surgery (open reduction and internal fixation, intramedullary device, or arthroplasty) for an acute femur fracture were prospectively randomized to receive an intraoperative, peri-incisional injection (400 mg ropivacaine, 0.6 mg epinephrine, 5 mg morphine) into the superficial and deep tissues or to receive no injection. Spinal anesthesia, regional anesthesia, and protocoled preoperative analgesic regimens were not permitted in the study protocol. Exclusion criteria included: revision procedures, regular narcotic use, psychiatric illness, dementia, neuromuscular deficit, allergies to cocktail ingredients, and clinical status that precluded verbal pain assessment. The primary outcome measure was visual analog pain scores assessed at 4-hour intervals for the first 2 postoperative days. Total narcotic consumption in morphine equivalents was recorded over 8-hour intervals as well as medication-related side effects. Patients and nurses performing the postoperative assessments were blinded to the treatment. Surgeons were not blinded and were not involved in recording outcome measures. Intention-to-treat statistical analysis was employed.

Results: The peri-incisional injection (n = 45) and control (n = 50) groups as randomized were similar across all demographic parameters including the distribution of surgical interventions. The injection cohort demonstrated significantly lower visual analog pain scores compared to the control cohort in the recovery room and at the 4, 8, and 12-hour postoperative time points (Fig. 1). Additionally, narcotic consumption was significantly lower in the injection group than the control group (6.5 ± 7.5 mg vs 10.8 ± 9.3 mg) over the first 8 hours following surgery. No cardiac or central nervous system toxicity was observed secondary to infiltration of the local anesthetic.

See pages 49 - 106 for financial disclosure information.



Conclusion: Peri-incisional injection with a multimodal analgesic cocktail offered improved pain control and decreased narcotic utilization over the first postoperative day, with no apparent risks, for patients undergoing operative intervention for acute femur fractures. Decreased narcotic consumption may limit medication-related adverse effects in a predominantly elderly population.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

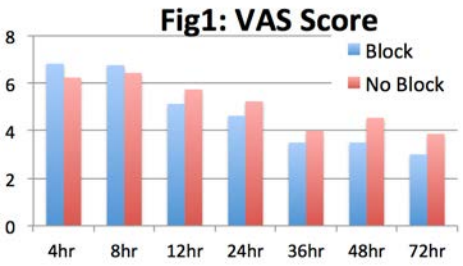
Are Continuous Femoral Nerve Catheters Beneficial for Pain Management After Operative Fixation of Tibial Plateau Fractures? A Randomized Trial

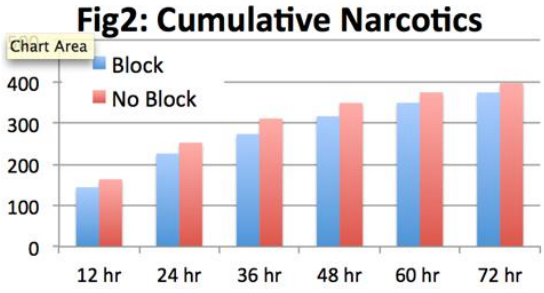
*Paul Tornetta III, MD[1]; **Margaret Cooke, MD[2]**; Tyler Welch, MD[3]; Oleg Gusakov, MD[1]*
[1]Boston Medical Center, Boston, Massachusetts, USA
[2]Boston University Medical Center, Boston, Massachusetts, USA;
[3]Atlantic Orthopaedics & Sports Medicine, York, Maine, USA

Purpose: Continuous femoral and sciatic nerve blocks diminish pain and narcotic requirements after total knee arthroplasty. While sciatic block is contraindicated after plateau fractures in order to allow clinical evaluation of compartment syndrome, femoral nerve blocks may help in pain management as this block affects the anterior part of the knee. The purpose of this study was to determine whether a continuous femoral nerve block after open reduction and internal fixation of tibial plateau fractures would diminish visual analog scale (VAS) scores and/or systemic narcotic intake.

Methods: Adult patients with operatively treated tibial plateau fractures were randomized to either a control group (standard of care using an IV morphine patient-controlled analgesia [PCA]) or to the experimental group (a continuous infusion femoral nerve block [bupivacaine] in addition to the same PCA pump). The primary outcomes were pain and narcotic use. VAS pain scores were obtained at 4, 8, 12, 24, 36, 48, and 72 hours postoperatively and narcotic use was evaluated as morphine equivalents. Statistical analysis included Fisher's exact test for categorical variables and t tests for continuous variables.

Results: 42 patients were enrolled in this study. There were 21 women and 21 men aged 21-70 years (average, 49) with operatively treated tibial plateau fractures. 21 patients were randomized to receive a femoral nerve block with 5 crossovers for technical reasons. Accordingly, we analyzed 16 patients with femoral nerve blocks and 26 with standard care. There were no significant differences between the study groups regarding age, gender, or fracture type. There was no significant difference in VAS scores between the control and experimental group at any time point (Fig. 1). The total systemic morphine equivalent for the femoral block group and the control group was 375 and 397, respectively (P = 0.76, Fig. 2). Across groups, patients with bicondylar fractures tended to have higher VAS scores than those with unicondylar fractures and to use more narcotics although neither was statistically significant.





See pages 49 - 106 for financial disclosure information.

Conclusion: Femoral nerve blocks for postoperative pain management in tibial plateau fractures did not demonstrate an improvement in pain relief or narcotic use.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ Patient Coping and Expectations About Recovery Predict Development of Chronic Post-Surgical Pain Pain Interference and Reduced Quality of Life After Traumatic Open Extremity Fracture

Jason Busse, DC, PhD, Assistant Professor*[1]*; *Sun Makosso-Kallyth, PhD*[1]*; Brad Petrisor, MD*[2]*; Kyle Jeray, MD*[3]*; Ted Tufescu, MD*[4]*; Georges-Yves Laflamme, MD, FRCSC*[5]*; Paula McKay, BSc*[1]*; Randi McCabe, PhD, MA*[1]*; Yannick Le Manach, MD, MSc, PhD*[1]*; Mohit Bhandari, MD, FRCSC, PhD*[6]*; FLOW Investigators*

[1]*McMaster University, Ontario, CANADA;*
[2]*Hamilton General Hospital, Ontario, CANADA;*
[3]*Greenville Health System University Medical Center, Greenville, South Carolina, USA;*
[4]*University of Manitoba, Manitoba, CANADA;*
[5]*Université de Montréal, Hôpital du Sacré-Cœur de Montréal, Quebec, CANADA;*
[6]*MacOrtho Research, Ontario, CANADA*

Purpose: Within the orthopaedic community, there has been an increasing interest in the role that psychological factors, including patients' beliefs and attitudes regarding their medical condition, play in their recovery from severe physical trauma. The purpose of this study is to explore the role of patients' beliefs regarding their recovery on persistent pain, quality of life, and pain interference after traumatic open extremity fracture.

Methods: We previously developed and validated an instrument designed to capture the impact of patients' beliefs on functional recovery from injury; the Somatic Pre-occupation and Coping (SPOC) questionnaire. At both 1 and 6 weeks after surgical fixation, we administered the SPOC questionnaire to a separate population of 1360 patients with operatively managed open extremity fractures. We constructed multivariable regression models to explore the association between SPOC scores and pain and functional outcome at 1 year, as measured by the Short Form-12 (SF-12) and the EuroQol-5D.

Results: Of 1111 open fracture patients with data available for analysis, 725 (65%) reported pain at 1 year. Addition of SPOC scores to an adjusted regression model to predict persistent pain improved the c-statistic from 0.66 to 0.73 ($P < 0.001$ for the difference) and found the greatest risk was associated with high (≥78) SPOC scores (OR [odds ratio] 5.29, 95% CI 3.75-7.46). 36% (406) reported pain interference at 1 year. Addition of SPOC scores to an adjusted regression model to predict pain interference improved the c-statistic from 0.66 to 0.74 ($P < 0.001$ for the difference) and found the greatest risk was associated with high SPOC scores (OR 5.83, 95% CI 4.12-8.26). In our adjusted multivariable regression models, SPOC scores at 6 weeks postsurgery accounted for 11% of the variation in SF-12 physical component summary scores and 13% of SF-12 mental component summary scores at 1 year. All associations were conserved with 1-week SPOC scores, but the magnitude of associations for SPOC scores at 6 weeks was significantly larger across all models.

Conclusion: Patients' coping and expectations of recovery, as measured by the SPOC questionnaire, is a strong predictor of persistent pain, quality of life, and pain interference after traumatic open extremity fracture. Future studies should explore whether these beliefs can be modified, and if doing so improves prognosis.

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

Is Scheduled Perioperative Intravenous Acetaminophen Use In Geriatric Hip Fractures Cost-Effective?

Alan Edwards, MD[1]; *Alexander Bollinge, MD[1]; Thomas Wenzlick, BS[2]; Terrence Endres, MD[3]*
[1]Grand Rapids Medical Education Partners/ Michigan State University, Grand Rapids, Michigan, USA;
[2]Michigan State University, Grand Rapids, Michigan, USA;
[3]Orthopaedic Associates of Michigan, Grand Rapids, Michigan, USA

Purpose: The elderly population of the United States continues to rise, resulting in a concordant expected increase in the number of hip fractures in this population. This has substantial impact on the health-care system, and it is important that steps are taken to make medical treatment decisions that both benefit the patient and are economically responsible. Scheduled intravenous (IV) acetaminophen has been shown to be beneficial in managing pain in orthopaedic surgery and improving outcomes in geriatric hip fracture patients. The purpose of this study was to evaluate the cost-effectiveness of scheduled IV acetaminophen use in geriatric patients with a hip fracture.

Methods: A retrospective review was performed of all patients 65 years and older admitted to a Level I trauma center who received operative treatment for a hip fracture (AO/OTA 31-A, 31-B) over a 2-year period. Demographic data, inhospital variables, outcome measures, and hospital billing data (broken down by department) were analyzed. 330 consecutive fractures in 326 patients met inclusion criteria. These patients were divided into two cohorts. Group 1 (165 fractures) consisted of patients treated before the initiation of a standardized IV acetaminophen perioperative pain-control protocol, and Group 2 (165 fractures) consisted of those treated after the protocol was initiated.

Results: Group 2 had significantly lower mean length of hospital stay (3.8 vs 4.4 days, P <0.001), visual analog scale pain score (4.2 vs 2.8, P <0.001), and narcotic use (41.3 vs 28.3 mg, P <0.001). With billing data broken down by department, group 2 had lower mean total cost of hospital bed (-24.7%, $5758 vs $7181, P <0.001), decreased pharmacy expense (-21.1%, $2104 vs $2549, P = 0.05), and decreased total cost of hospitalization (-8.0%, $27,171 vs. $29,345, P = 0.05). Group 2 had an increase in cost of supplies and implants (14.8%, $4509 vs $3843, P <0.001) and operating room services (7.0%, $5472 vs $5090, P = 0.03). When accounting for these increased supply costs, the overall cost of hospitalization was decreased 20.2% for group 2 (-20.2%, $16,967 vs $20,386, P <0.001). There was positive correlation between length of stay and cost of bed (r = 0.61, P <0.001) and length of stay and total cost of hospitalization (r = 0.53, P <0.001). There was no significant correlation between use of IV acetaminophen and total cost (r = -0.06, P = 0.28) or use of IV acetaminophen and pharmacy cost (r = -0.02, P = 0.72).

Conclusion: The utilization of scheduled IV acetaminophen as part of a standardized pain management protocol for geriatric hip fractures resulted in decreased length of hospital stay, which was correlated with decreased cost of hospitalization, and its use resulted in improved pain control and lower narcotic use without any increase in pharmacy cost. IV acetaminophen use can improve outcomes in geriatric hip fractures in a cost-effective manner.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Continuous Infraclavicular Brachial Plexus Block Versus Single Shot Nerve Block for Distal Radius Surgery: A Prospective Randomized Comparative Trial

Abhishek Ganta, MD*[1]*; *David Ding, MD*[1]*; Nina Fisher, BS*[1]*;*
Sudheer Jain, MD[2]*; Nirmal C. Tejwani, MD*[1]
[1]*New York University Hospital for Joint Diseases, New York, New York, USA;*
[2]*New York University Langone Medical Center, New York, New York, USA*

Purpose: Postoperative pain control after fracture surgery has been closely associated with improved patient outcomes. While peripheral nerve blocks provide excellent anesthesia, patients experience rebound pain as the blocks wear off around 12-24 hours postoperatively. The purpose of this study is to determine whether a continuous infusion of anesthetic with a pump compared to single shot peripheral nerve block will reduce rebound pain and decrease the intake of narcotic analgesia after operatively treated wrist fractures.

Methods: After IRB approval, 43 patients undergoing operative fixation of distal radius fractures were prospectively randomized to receive either an infraclavicular brachial plexus block as a single nerve block (n = 24) or as a continuous infusion with a pump (n = 19). Postoperative pain scores (measured using a visual analog scale) and number of pain pills were recorded at 8, 12, 24, 48, and 72 hours postoperatively. These outcomes were compared for the continuous versus single nerve block anesthetics. Patients were followed for at least 1 year postoperatively.

Results: At the 12-hour postoperative time period, the median single nerve block group pain scores were 6.0 as compared to 5.0 in the continuous infusion group (P = 0.920). However, at the 24-hour postoperative period, the single nerve block group had lower median pain scores as compared to the continuous infusion pump (4.5 vs 5.0, P = 0.814). While either did not reach statistical significance, the 24-hour postoperative pain scores deviated from what was expected. At the 12- and 24-hour postoperative periods, the median number of pain pills with the continuous infusion pump was equivalent to the single nerve block. There was no statistically significant difference median in pain scores as well as pain pills taken from the 48 to 72-hour period as well. However, it should be noted that 6 of 24 did not work as expected with 5 requiring early removal and 1 that was kinked and nonfunctional.

Conclusion: This randomized study of a single shot nerve block versus continuous infusion with the pump for postoperative analgesia in distal radius fractures showed no statistically significant differences in terms of postoperative pain requirements and pain levels at 8, 12, 24, 48, and 72 hours.

See pages 49 - 106 for financial disclosure information.

Best Trauma Paper of the 2016 POSNA Annual Meeting

Functional Bracing for Treatment of Pediatric Diaphyseal Femur Fractures: An Alternative to Spica Casting

Andrea S. Kramer, MD*; Colin Woon, MD; David Speers, CPO, LPO*
Advocate Children's Hospital, Park Ridge, Illinois

Purpose: Closed Reduction and Spica casting (SC) is the traditional treatment of diaphyseal femoral fractures in pediatric patients ages 0 to 5years. However, there are many disadvantages to SC. SC requires general anesthesia, is cumbersome for parents/patients, and difficult to clean and maintain. Additionally, a second cast application is at times necessary when there is progressive malalignment or significant soilage. We hypothesized that diaphyseal femur fractures in this age range could be more easily managed with immediate application of functional fracture bracing (FFB). FFB allows for consistent compression of the fractured limb, is more comfortable, easier to clean, and more cost effective than SC.

Methods: Using case-control design, we compared the clinical, economic and functional outcomes of pediatric patients aged 0 to 5years with displaced and non displaced femoral shaft fractures treated with FFB versus those treated with SC. We evaluated subjective clinical outcomes retrospectively using the Pediatric Outcomes Data Collection Instrument (PODCI) and objective clinical outcomes by assessing post-treatment radiographs in orthogonal planes for angular malalignment and shortening. We evaluated economic outcomes by comparing procedural and equipment costs. Statistical comparisons between groups were performed using the Wilcoxon Mann-Whitney test and Student's T-test.

Results: There were 41 patients and 43 patients in the FFB and SC groups respectively. All patients had minimum of 2 years follow-up. The PODCI questionnaire revealed very high patient satisfaction with FBB. None of the patients had a limp or subjective leg length discrepancy at their most recent follow-up. All fractures went on to union with 6 weeks of immobilization. Comparison of fracture site angulation revealed significant correction of angulation between pre-treatment and most recent post-treatment orthogonal radiographs . There were no significant differences in magnitude of angular correction between groups ($p>0.05$). Economic comparison revealed that FB was significantly less costly overall compared with SC ($P<0.05$).FFB eliminates the need for general anesthesia, surgical and anesthesia charges.

Conclusion: FFB is equally effective to SC in correction and maintenance of fracture alignment, time to union, and functional outcomes but is better tolerated by patients and their parents. Its open design improves hygiene, skin surveillance, and eases transport / lifting as it weighs substantially less than SC. The overall cost of FFB is lower and can be applied immediately without need for general anesthesia and operating room time.

Significance: This study suggests that FFB should be considered a viable alternative to SC in isolated pediatric femoral shaft fractures age 0-5.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Randomized Controlled Trial Comparing the Outcome of Titanium Elastic Nailing versus Stainless Steel Nailing in the Management of Pediatric Diaphyseal Femur Fractures

Rajiv Maharjan, MBBS, MD; *Kumud Limbu, MBBS, MD; Raju Rijal, MBBS, MD*
BP Koirala Institute of Health Sciences, Koshi, NEPAL

Purpose: Pediatric femoral fracture mostly occurs in the middle shaft. The treatment method is basically guided by the age/weight of the child, fracture personality, and level of fracture as well as surgeons preferences. Flexible intramedullary nailing is a reliable method of diaphyseal fracture fixation in children between 6-11 years old, fracture fixation being done either with titanium or stainless steel intramedullary nail. Systematic review and biomechanical analysis provides little evidence to support one over another. Thus this prospective randomized controlled trial aims to compare the functional outcome between titanium and stainless steel nail as a fixation device for pediatric femoral shaft fractures and to study the fracture and surgery/technique-related complications.

Methods: Children between 6 and 11 years with recent closed traumatic isolated femoral shaft fracture were treated randomly either by titanium or stainless steel nail fixation under C-arm control. 30 children were included in each group. Children with abnormal bowing or deformed femur, pathological fractures, and polytrauma were excluded. Study included 22 transverse, 17 short oblique, 12 spiral, and 9 comminuted fractures. Similar group, type, strength, and duration of perioperative antibiotics were given. 8 cases required open reduction. Clinicoradiological evaluation was done for fracture healing at 2 weeks, 6 weeks, 12 weeks, 24 weeks, and 52 weeks.

Results: Mean age (years), duration of surgery (min), hospital stay (days), and blood loss (mL) were 9.727 ± 2.2, 54.55 ±14.3, 6.14 ± 2.66, and 59.55 ± 37.09 for titanium and 9.22 ± 1.8, 55.0 ± 13.39, 5.18 ± 5.83, and 55.28 ± 22.19 for stainless steel nailing (all with $P > 0.01$). Overall, all fractures united in 16 to 22 weeks, 12 cases had limb-length discrepancy (<1.5 cm), maximum angulation seen was 8° varus and 14° anterior angulation, 5 skin irritation/bursitis at entry point, opposite cortex penetration and trochanter/neck perforation 1 patient each, with results being comparable between the two groups ($P > 0.01$). The treatment cost in titanium nailing group was significantly different than the stainless steel group ($P < 0.05$) owing to the much higher cost of the titanium implants.

Conclusion: There is no statistically significant difference between the functional outcome of titanium elastic nailing and stainless steel nailing for fixation of pediatric diaphyseal femur fracture. However, the stainless steel nailing is cost-effective, and equally good results can be obtained at much lower cost by using stainless steel nails instead of titanium ones.

See pages 49 - 106 for financial disclosure information.

Comparison of the Outcome of Above-Knee and Below-Knee Cast for Isolated Tibial Shaft Fractures in Children: A Randomized Trial

Rajiv Maharjan, MBBS, MD; *Amit Limbu, MBBS, MD; Shiva Paneru, MBBS, MD*
BP Koirala Institute of Health Sciences, Koshi, NEPAL

Purpose: Conventionally, pediatric closed isolated tibial shaft fractures were immobilized in an above-knee cast with or without manipulation. We evaluated the effectiveness of application of a below-knee plaster of Paris (POP) cast (BKC) comparing with above-knee POP cast (AKC) for isolated tibial shaft fractures in terms of union time, residual malunion and disability, range of motion, associated complications, and cost of treatment by prospective randomized controlled trial.

Methods: 60 children age 6 months to 15 years with closed and Gustilo grade one/two isolated traumatic extra-articular middle-third and distal-third tibial shaft fracture were randomized (30 in each group) into AKC and BKC groups, who were followed weekly for 3 weeks then each at 6 weeks, 3 months, and 6 months and were compared. Total of 5 children (3 torus, 1 undisplaced, 1 displaced fracture) were lost to follow-up during 6 months and were analyzed with missing value data analysis.

Results: Out of 60 children, 48 were boys and 12 were girls; Right leg was injured more commonly. All fracture united (8.30 ± 2.693 weeks in AKC group, 7.70 ± 2.54 weeks in BKC group). The average prereduction angulations were varus (2°-8°), valgus (4°-8°), anterior angulation (4°-9°), posterior angulation (2°-10°), internal rotation (3°-6°), external rotation (3°-6°), and shortening (6.46 mm). Residual angulation at 6 months were varus (2.83° ± 0.85° in AKC group, 2.60° ± 0.84° in BKC group), valgus (3.20° ± 0.44° in AKC group, 2.50° ± 0.52° in BKC group), anterior angulation (2.83° ± 1.32° in AKC group, 3.00° ± 1.00° in BKC group), posterior angulation (2.67° ± 0.84° in AKC group, 2.93° ± 1.32° in BKC group), internal rotation (3.40° ± 0.54° in AKC group, 3.00° ± 1.41° in BKC group), external rotation (2.83° ± 0.75° in AKC group, 2.33° ± 0.57° in BKC group), and shortening (2.67 ± 1.15 mm in AKC group, 2.00 ± 0.00 mm in BKC group). Reinforcement of plaster was higher in BKC group ($P = 0.014$) as these children were eager to bear weight on plaster earlier. Range of motion at knee was significantly higher in BKC group ($P < 0.001$). There were no refractures, residual disabling pain, and plaster-related complications in either group.

Conclusion: BKC was as effective as AKC for treatment of middle and distal-third isolated tibial shaft fractures in children. In terms of cost and range of motion of knee, BKC was superior ($P < 0.05$).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Pediatric Supracondylar Humerus Fractures: Does After-hours Treatment Influence Outcomes?

Gabrielle Paci, MD[1]; Kali Tileston, MD[2]; John Vorhies, MD[1]; ***Julius Bishop, MD***[3]
[1]*Stanford Hospital and Clinics, Stanford, California, USA;*
[2]*Stanford School of Medicine Department of Orthopaedic Surgery, Stanford, California, USA;*
[3]*Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA*

Purpose: Pediatric supracondylar humerus fractures are common and, when displaced, require surgical reduction and fixation. Surgery frequently occurs outside of normal operating hours. This may be suboptimal due to factors such as surgeon fatigue, limited hospital resources, and variation in surgeon comfort with pediatric fracture care. This study compared the outcomes of pediatric supracondylar humerus fractures treated during daytime operating room hours to those treated after hours.

Methods: We retrospectively reviewed the charts of 195 pediatric patients treated with surgical reduction and pinning of closed supracondylar fractures at one institution. Patients were divided into two groups. 59 patients underwent surgery during daytime hours, defined as a surgery start between 06:00 and 15:59 on weekdays. 136 patients underwent surgery after hours, defined as surgery start between 16:00 and 05:59 on weekdays or any surgery on weekends. Demographics, surgeon subspecialty, operative time, complications, and clinical outcomes were extracted from the patient medical records. Radiographs were assessed for injury classification and quality of reduction. Statistical analysis was performed using $\chi 2$, Fisher exact test, Student t test and logistic regression.

Results: There were no significant differences in demographics between the daytime hours and after-hours patient groups. Surgery performed during daytime hours was more likely to be performed by a pediatric orthopaedic surgeon than after-hours surgery (93% vs 49%, $P < 0.001$). Fractures treated with after-hours surgery had more severe injury patterns with 74% classified as Gartland Type III compared to 54% in the daytime hours group ($P = 0.007$). After controlling for injury pattern and surgeon fellowship training, after-hours operations were not independently associated with increased operative times (odds ratio 1.2, 95% CI 0.5-2.7, $P = 0.48$). There were no significant differences between groups in terms of need for open reduction, complications, range of motion, or radiographic alignment at final follow-up.

Conclusion: After-hours surgical treatment of pediatric supracondylar humerus fractures is more likely to involve Gartland Type III fracture patterns, but is less likely to be performed by a fellowship-trained pediatric orthopaedic surgeon when compared to daytime surgery. There is no difference in operative times or outcomes following surgical treatment of pediatric supracondylar humerus fractures performed outside of normal operating room hours when compared to surgery performed during daytime hours. Supracondylar humerus fractures can be treated after hours without increased risk. These data can better inform surgeons who must decide how and when to treat these fractures.

See pages 49 - 106 for financial disclosure information.

Pulseless Supracondylar Humerus Fracture with AIN or Median Nerve Injury – An Absolute Indication for Open Reduction?

Paul Choi, MD*[1]*; *Liam Harris, BS*[1]*; Alexander Broom, BA*[1]*; Joseph Yellin, BA*[2]*; Ashley Miller, BS*[3]*; John Roaten, MD; Jeffrey Sawyer, MD*[4]*; Patrick Whitlock, MD*[3]*; Alexandre Arkader, MD*[2]*; John Flynn, MD*[2]*; David Skaggs, MD, MMM*[1]
[1]*Children's Hospital Los Angeles, Los Angeles, California, USA;*
[2]*Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA;*
[3]*Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA;*
[4]*University of Tennessee-Campbell Clinic, Memphis, Tennessee, USA*

Purpose: Management of the pulseless supracondylar humerus fracture remains controversial. In particular, the combination of pulseless supracondylar humerus fracture and anterior interosseous nerve (AIN) or median nerve injury may have increased overall risk. The purpose of this study was to assess the necessity for open versus closed surgical management of pulseless supracondylar humerus fractures with concomitant AIN or median nerve injury in children.

Methods: A retrospective review was performed at three pediatric trauma hospitals on all children age 5-15 years who sustained a Gartland type III or type IV supracondylar humerus fracture (OTA 13-M/3 1.III, 13-M/3 2.III, 13-M/3 1.IV, 13-M/3 2.IV) with the combination of absent distal palpable pulses and AIN or median nerve injury between 2000 and 2014. In addition to choice of treatment, details regarding preoperative and postoperative examination findings, follow-up course, and outcome were also recorded.

Results: 78 patients with displaced Gartland type III or type IV supracondylar humerus fractures presented with the combination of absent distal pulses and AIN or median nerve injury and met inclusion criteria. 21 of 78 cases (26.9%) underwent open reduction, antecubital fossa exploration (OR) versus 57 (73.1%) that were treated with closed reduction and percutaneous fixation (CR). Indications for opening included concern for artery entrapment (n = 11), inadequate closed reduction (n = 9), and concern for nerve entrapment (n = 6). The risk of compartment syndrome was higher in open cases (5/20, 25.0%) than closed cases (1/57, 1.8%) (P = 0.001). The incidence of reoperation was also higher with open cases (4/20, 20%) than closed cases (2/57, 3.5%) (P = 0.018). Open reduction was also significantly associated with increased time to surgery (18.7 hours ±31.1 vs 9.0 hours ±4.7, P = 0.024) and length

Table 1 – Clinical course outcome measures by treatment type

	CRPP (n=55)	ORIF (n=21)	P-Value
Average time from injury to surgery (hours)	9.0± 4.7	18.7±31.1	0.024
Patients initially seen at outside hospital (%)	73.7% (42/57)	90.5% (19/21)	0.111
Duration of Hospital Stay (days)	2.0±1.6	4.0±4.2	0.004
Mean pin duration (days)	26.9±5.1	25.6±5.5	0.337
Mean cast duration (days)	27.8±6.6	29.8±11.3	0.347
Patients requiring reoperation (%)	3.5% (2/57)	20.0% (4/20)	0.018
Compartment Syndrome	1.8% (1/57)	25.0% (5/20)	0.001
Infection rate (%)	5.3% (3/57)	10.0% (2/20)	0.460
Patients with resolution of nerve palsy (%)	91.2% (50/57)	95.2% (20/21)	0.538

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

of hospitalization (4.0 days ±4.2 vs 2.0 days ±1.6, P = 0.004) compared to closed reduction. Overall, all but six (of 78, 7.7%) patients ultimately had complete resolution of preoperative nerve palsy with no significant difference in rate of clinical nerve recovery between the treatment groups (20/21 [95.2%] in OR, 52/57 [91.2%] in CR) (P = 0.538).

Conclusion: Outcomes following open and closed surgical management of pulseless grade III or IV supracondylar humerus fracture with AIN or median nerve injury are ultimately both favorable and may suggest that open reduction is not always necessary.

See pages 49 - 106 for financial disclosure information.

Clinical Validation of a Novel ELISA Serum Assay Test for Detection of Staphylococcus aureus Biofilm Antibodies in Serum of Orthopedic Trauma Patients

Janet Harro, PhD[1]; Ryan Montalvo, BS[2]; Theodore Manson, MD[2]; Robert V. O'Toole, MD[3]; Manjari Joshi, MD[4]; Timothy Zerhusen, BS[5]; Roman Natoli, MD[6]; ***Mark Shirtliff, PhD[7]***
[1]Department of Microbial Pathogenesis, University of Maryland School of Dentistry, Baltimore, Maryland, USA;
[2]R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;
[3]University of Maryland, Shock Trauma, Baltimore, Maryland, USA;
[4]Division of Infectious Diseases, R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA;
[5]R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;
[6]Loyola University Medical Center, Maywood, Illinois, USA;
[7]Department of Microbiology and Immunology, University of Maryland School of Medicine, Baltimore, Maryland, USA

Purpose: Postoperative wound infections are common after high-energy orthopaedic trauma and cause additional surgeries, increased length of hospital stay, escalated cost of care, and are associated with increased morbidity and even mortality. The most common pathogens for these infections are known to be Staphylococcus aureus (methicillin-resistant S. aureus [MRSA] and methicillin-sensitive S. aureus [MSSA]); however there is typically a lag time of many weeks between the index surgery and the development of clinical symptoms. This delay allows for biofilm growth and spread of infection and makes treatment with surgery necessary in an attempt to clear the infection. We have developed a novel blood test to detect infection early before it become clinically apparent and have validated this test in animal sera and human joint fluid. Our hypothesis was that our novel test could differentiate between orthopaedic trauma patients who were positive for S. aureus surgical site infection and those who were not.

Methods: As part of a prospective trial to validate our novel serum test, patients (n = 72) were enrolled in a prospective study who had fractures treated operatively that were deemed to be at high risk of infection (open fractures, periprosthetic fractures, calcaneus, tibial plateau, and pilon fractures) or had known diagnosis of surgical site infection. 10-mL blood samples were collected from patients at 3 time points. From the larger sample of patients we selected a smaller subset of patients who were clinically determined to be infected and had blood samples that were drawn at or near the time of deep bone biopsies (<14 days). Biopsies were sent to Clinical Microbiology for culture and microbial identification. Sera samples were obtained from blood specimens by centrifugation (200g, 15 min) and then frozen at -20°C until use. Samples were blinded as to diagnosis of S. aureus infection (n = 7) versus controls that had no history of infection (n = 4) and tested. All samples were tested blindly and in duplicate to verify accuracy. The novel test utilizes ELISA (enzyme-linked immunosorbent assay) to detect host antibodies in clinical sera samples against biofilm-specific antigens produced by S. aureus during biofilm-mediated infection. SACOL0688, a biofilm in vivo-expressed antigen, was used to capture host antibodies via ELISA.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Results: Our novel ELISA based test was able to differentiate with accuracy between patients with and without S. aureus infections up to 30 days preclinical and 30 days postclinical positive culture and determination of infection. Patients that expressed antibodies above 1.0 OD (optical density) were determined to be S. aureus infected and patients below 1.0 were considered negative. All patients with S. aureus culture positive infection (7/7) were positive, while all patients that were culture negative for S. aureus (0/4) were negative (Fisher's exact, P <0.003).

Conclusion: The results of our clinical validation test are very encouraging and it appears that we have developed a novel serum-based test that can detect antigens to S. aureus biofilm in patients' serum at the time of infection. This test may allow detection of infection prior to the infection becoming clinically apparent, perhaps allowing infections to be treated earlier before infection spreads more and even perhaps avoid surgery if antibiotics can be started before biofilms become so established that they must be treated surgically. The SACOL0688 antigen is presently being used to capture host IgG (immunoglobulin G) in a simple lateral flow assay that is fast (<10 min), inexpensive (<$10), and, based on animal studies and our validation data, very accurate. This appears to hold great promise and may have profound effects on the treatment of orthopaedic trauma patients.

See pages 49 - 106 for financial disclosure information.

Intraoperative Temperature in Hip Fractures: Effect on Complications and Outcome

Andrew Pepper, MD; *Nicholas Frisch, MD, MBA; Stuart Guthrie, MD; Craig Silverton, DO*
Henry Ford Hospital, Detroit, Michigan, USA

Purpose: Hip fractures are common orthopaedic injuries and are associated with high morbidity and mortality. Not unlike other orthopaedic procedures, intraoperative normothermia is a goal recommended by national guidelines to minimize additional morbidity / mortality, but limited evidence exists regarding the effect of intraoperative hypothermia on patients with hip fractures. The purpose of this study is to determine the incidence of intraoperative hypothermia in patients with hip fractures and evaluate the impact of hypothermia on complications and outcomes.

Methods: A retrospective chart review was performed of clinical records from 1541 consecutive patients who sustained an intertrochanteric (IT) or femoral neck (FN) fracture and underwent operative fixation at our institution from January 2005 to October 2013. Ultimately 1525 patients were included for analysis, excluding those with multiple injuries requiring additional surgical intervention. Chart review recorded patient demographic data, surgery-specific data, postoperative complications, length of stay, and 30-day readmission. Statistical analysis included univariate tests carried out using independent two-group t tests and X2 tests. A multivariable logistic regression model was built using clinically relevant variables to identify possible independent predictors of hypothermia. Statistical significance was set at $P < 0.05$. All analyses were performed using SAS 9.4.

Results: Overall incidence of mean intraoperative hypothermia (mean body temperature <36.0°C) in hip fracture was 17.0%. Increasing age and lower body mass index (BMI) were associated with mean intraoperative hypothermia (normothermic 77.2 years ± 14.6 vs hypothermic 79.6 years ± 11.9, $P = 0.005$; and normothermic BMI 24.3 ± 6.2 vs hypothermic BMI 23.2 ± 5.3, $P = 0.004$, respectively). In multivariate logistic regression analysis, hypothermia was associated with an increase in the rate of deep surgical site infection (DSSI) (adjusted odds ratio [OR] 3.30 [1.19, 9.14], $P = 0.022$). No other significant findings were observed in regard to complications, length of stay, or 30-day readmission.

Conclusion: The incidence of intraoperative hypothermia in hip fractures was 17.0%. In patients with hip fractures, low BMI and increasing age may be a risk factor for intraoperative hypothermia, and mean intraoperative hypothermia may be associated with increased risk of DSSI. This is the first study to our knowledge that specifically addresses intraoperative temperature monitoring in hip fracture patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Patient Characteristic		All (N = 1525)	Normothermic (N = 1265)	Hypothermic (N = 260)	p-value
Age (years ± SD)		77.6 ± 14.2 (1522)	77.2 ± 14.6 (1263)	79.6 ± 11.9 (259)	**0.005**
Gender					
	Male	36% (549)	37% (463)	33% (86)	0.296
	Female	64% (974)	63% (801)	67% (173)	
Side					
	Right	49% (746)	48% (604)	55% (142)	0.111
	Left	51% (777)	52% (659)	45% (118)	
	Bilateral	0% (2)	0% (2)	0% (0)	
Race					
	Caucasian	58% (884)	58% (733)	58% (151)	0.758
	Black	32% (488)	32% (402)	33% (86)	
	Other	10% (153)	10% (130)	9% (23)	
BMI		24.1 ± 6.1 (1370)	24.3 ± 6.2 (1135)	23.2 ± 5.3 (235)	**0.004**
Smoking Status					
	Nonsmoker	70% (1066)	70% (887)	69% (179)	0.068
	Smoker	27% (410)	27% (342)	26% (68)	
	Former Smoker	0% (1)	0% (0)	0% (1)	
	Unknown	3% (48)	3% (36)	5% (12)	

Table 1: Demographic Data for Hip Fracture Patients
Age and BMI are mean values with included standard deviation. BMI = body mass index. $P < 0.05$ is statistically significant.

See pages 49 - 106 for financial disclosure information.

Characteristic		All (N=1525)	Normothermic (N=1265)	Hypothermic (N = 260)	p-value
Pre-op Hb		11.4 ± 1.9 (1505)	11.4 ± 1.9 (1251)	11.4 ± 2.0 (254)	0.621
ASA					
	1	1% (17)	1% (16)	0% (1)	0.299
	2	12% (176)	11% (142)	14% (34)	
	3	66% (984)	65% (814)	69% (170)	
	4	21% (309)	22% (269)	16% (40)	
	5	0% (4)	0% (3)	0% (1)	
Re-warmer					
	No	27% (405)	26% (330)	30% (75)	0.220
	Yes	73% (1109)	74% (933)	70% (176)	
OR time (min)		153.4 ± 46.3 (1520)	154.3 ± 46.6 (1263)	149.4 ± 44.5 (257)	0.122
Surgical Time (min)		86.2 ± 37.2 (1517)	87.1 ± 37.4 (1261)	81.8 ± 35.7 (256)	**0.039**
EBL (mL)		203.9 ± 175.7 (1511)	207.2 ± 176.8 (1262)	187.1 ± 169.2 (249)	0.099
IVF (mL)		1422.9 ± 801.9 (1498)	1425.7 ± 797.9 (1252)	1408.6 ± 823.3 (246)	0.761
Transfusion (units PRBC)		1.6 ± 1.7 (1525)	1.6 ± 1.8 (1265)	1.4 ± 1.6 (260)	0.101

Table 2: Perioperative Data and Association with Hypothermia
Pre-op Hb = preoperative hemoglobin, ASA = American Society of Anesthesiologists class, re-warmer = use of intraoperative active re-warming device, OR time = operating room time in minutes, EBL = estimated blood loss in milliliters, IVF = intraoperative intravenous fluid administration in milliliters, PRBC = packed red blood cells.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Complication		All (N=1525)	Normothermic (N=1265)	Hypothermic (N = 260)	p-value
DSSI					
	No	99% (1501)	99% (1251)	98% (250)	0.084
	Yes	1% (19)	1% (13)	2% (6)	
SSSI					
	No	98% (1497)	99% (1248)	97% (249)	0.079
	Yes	2% (23)	1% (16)	3% (7)	
NSSI					
	No	95% (1450)	95% (1203)	96% (247)	0.549
	Yes	5% (70)	5% (60)	4% (10)	
MI					
	No	94% (1427)	93% (1179)	96% (248)	0.099
	Yes	6% (93)	7% (83)	4% (10)	
Stroke					
	No	97% (1468)	97% (1221)	96% (247)	0.827
	Yes	3% (50)	3% (41)	4% (9)	
DVT					
	No	96% (1461)	96% (1212)	97% (249)	0.321
	Yes	4% (58)	4% (51)	3% (7)	
PE					
	No	97% (1475)	97% (1223)	98% (252)	0.148
	Yes	3% (45)	3% (41)	2% (4)	
LOS		7.5 ± 6.9 (1525)	7.6 ± 6.9 (1265)	7.1 ± 6.6 (260)	0.317
30day Readmission					
	No	82% (1248)	82% (1031)	83% (217)	0.455
	Yes	18% (277)	18% (234)	17% (43)	

Table 3: Complications Associated with Hypothermia
DSSI = deep surgical site infection, SSSI = superficial surgical site infection, NSSI = non-surgical site infection, MI = myocardial infarction, DVT = deep venous thrombosis, PE = pulmonary embolism, LOS = length of stay in days.

See pages 49 - 106 for financial disclosure information.

Characteristic	Description	Adjusted OR (95% CI)	p-value
DSSI	**Yes vs. No**	3.30 (1.19, 9.14)	**0.022**
Smoking	**Smoker vs. Nonsmoker**	0.96 (0.70, 1.32)	0.881
	Unknown vs. Nonsmoker	0.80 (0.30, 2.09)	
HTN	**Yes vs. No**	1.15 (0.82, 1.62)	0.416
DM	**Yes vs. No**	0.87 (0.61, 1.22)	0.411
CKD	**Yes vs. No**	1.23 (0.87, 1.74)	0.235
Arrhythmia	**Yes vs. No**	0.60 (0.41, 0.87)	**0.007**
ASA	**1v2**	3.46 (0.44, 27.28)	0.481
	1v3	3.10 (0.40, 24.01)	
	1v4	2.30 (0.29, 18.32)	
	1v5	6.35 (0.30, 136.46)	
	1v6	<0.01 (<0.01, >999.9)	
OR time (min)		1.00 (0.99, 1.00)	0.077
Transfusion	**Yes vs. No**	0.90 (0.67, 1.19)	0.455

Table 4: Multivariable Logistic Regression Analysis
DSSI = deep surgical site infection, HTN =hypertension, DM = diabetes mellitus, CKD = chronic kidney disease, ASA = American Society of Anesthesiologists class, OR time = operating room time in minutes

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Nasal Decolonization with Povidone-Iodine Decreases Surgical Site Infection in the Elderly with Intracapsular Femur Fractures

Rafael Serrano-Riera, MD[1]; *Anthony Infante, DO[2]; Benjamin Maxson, DO; Anjan Shah, MD[2]; Roy Sanders, MD[3]; Hassan R. Mir, MD[2]; David Watson, MD[1]*
[1]Florida Orthopedic Institute, University of South Florida, Tampa, Florida, USA;
[2]Florida Orthopaedic Institute, Temple Terrace, Florida, USA;
[3]Orthopaedic Trauma Service, Tampa, Florida, USA

Purpose: We undertook to assess the efficacy of povidone-iodine nasal decolonization to prevent surgical site infection (SSI) by Staphylococcus aureus (SA) in elderly patients with displaced intracapsular femur fractures (OTA 31-B) initially admitted through the Emergency Department (ED).

Methods: After IRB approval, 267 patients undergoing hip replacement (total or hemiarthroplasty) for a displaced femoral neck fracture between January 2012 and December 2015 were retrospectively reviewed. Patients were treated in two different hospitals with two different protocols for SSI prophylaxis. All patients in the study were screened preoperatively for methicillin-resistant S. aureus (MRSA) through a nasal swab test performed by a trained nursing team in the ED. MRSA-carriers in Hospital A (Group A) received preoperatively prophylaxis with vancomycin 1-2 g IV (depending on body mass index [BMI]), whereas MRSA carriers in Hospital B (Group B) received povidone-iodine nasal swab (3M-NSP) with the standard dose of cefazolin 1-2 g IV. Patients were excluded if younger than 60 years old, follow-up (FU) <3 months, pathologic fractures, periprosthetic fractures, and revision arthroplasty. Data analysis included demographics, preoperative risk factors for infection (diabetes mellitus [DM], BMI>35, immunosuppressive states, tobacco, ASA [American Society for Anesthesiologists]>3, anemia, dementia, anticoagulation medication, non-Hispanic race, surgical time), MRSA carrier status, SSI prophylaxis regimen, and development of SSI (superficial/deep). Fisher's exact test was used for statistical analysis.

Results: 231 patients met the inclusion criteria. Group A had 96 patients with a mean age of 79 years (range, 60-95), with 64% of females. Group B included 135 patients with an average of 79 years (range, 60-97), with 57% being females. There were no differences between groups for demographics, preoperative risk factors, and implant selection (Group A: 70% hemiarthroplasty/30% total hip replacement vs Group B: 75% hemiarthroplasty/25% total hip replacement, P = 0.37). 19 patients (16%) in Group A were found to be MRSA carriers for 21 patients (15%) in Group B (P = 0.48). Nine patients (9.3%) in Group A developed an SSI whereas one patient (0.7%) in Group B was noted to have an SSI (P = 0.001; ß = 0.86). Four SSIs (44%) in Group A had positive cultures for S. aureus (2MRSA/2MSSA [methicillin-sensitive S. aureus), with two being MRSA carriers. The only SSI in Group B did not have positive cultures for S. aureus (P = 0.02). Eight of the 9 SSIs in Group A were deep tissue infections requiring irrigation and debridement. The SSI in Group B was deemed superficial and was successfully treated with a course of antibiotics.

Conclusion: Nasal decolonization with povidone-iodine appears to be a more effective infection prophylactic agent than vancomycin when treating femoral neck fractures in the

See pages 49 - 106 for financial disclosure information.

elderly. Moreover, povidone-iodine may not only reduce the risks of additional surgery and financial burden with longer hospitalization, but could potentially prevent S. aureus strains to become resistant to vancomycin.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Should Displaced Scapular Body Fractures Be Operatively Treated? A Randomized Controlled Trial

Clifford Jones, MD*[1]*; *Debra Sietsema, PhD*[1]*; James Ringler, MD*[1]*; Terrence Endres, MD*[2]
[1]*The CORE Institute, Phoenix, Arizona, USA;*
[2]*Orthopaedic Associates of Michigan, Grand Rapids, Michigan, USA*

Purpose: Scapular body fractures are uncommon and usually result from high-energy trauma with associated injuries. Increasing debate exists as to the best treatment for displaced scapular body fractures. The primary purpose of this study was to compare radiographic and functional outcome in operative versus nonoperative treatment of displaced scapular body fractures.

Methods: Over a 6-year period of time, 39 displaced, defined as >2-cm displacement or medialization, >45° angulation, or glenopolar angle (GPA) difference >10°, patients with scapular body fractures were consented, randomized, and treated. 18 were treated nonoperatively (NonOp) and 21 were operatively (Op) treated with a modified Judet approach and 2.7-mm plates and screws. If an associated double shoulder suspensory instability (DSSI) injury was present, the nonscapular injury was treated operatively and the scapular injury treatment was randomized. Regular clinical and radiographic follow-up occurred at determined intervals up to 2 years. Functional outcome measurements were performed with SMFA (Short Musculoskeletal Function Assessment) and DASH (Disabilities of the Arm, Shoulder and Hand). Muscle strength testing was performed with Cybex® equipment.

Results: More males (27) than females (12) were consented but had equal distribution between groups. Average age was 45 years (range, 18-75) with an older age in the NonOp (51) than the Op (40) group. An associated DSSI was present in 22% of NonOp and 24% of Op. Associated injuries were glenoid (2), humeral (1), and rib (22). OTA Classification was A3 (5), B1 (17), and B2 (17). Average initial injury measurements were translation (15 mm), medialization (17 mm), shortening (29 mm), angulation (26°), and GPA 30°. Op had anatomic reconstruction in all patients. At 6 weeks postop, forward flexion (155° vs 113°, P = 0.03) and adduction (105° vs 69°, P = 0.03) were better in the Op than NonOp. At 1 year, abduction was better (P = 0.03) in the Op (172°) than the NonOp (145°). Cybex® muscle testing measurements were statistically similar at all data points except Op External Rotation Total Work was better than NonOp (P <0.05) at 6 weeks. Functional outcome measurements with SMFA and DASH were statistically similar at all data intervals. No complications occurred in the Op group, but two complications in the NonOp (both with associated displaced rib fractures) required operative intervention (exostectomy) for prominent lateral scapular border. One clavicle plate required hardware removal for prominence.

Conclusion: Operative fixation of displaced scapular body fractures perform well clinically and with minimal complications. Despite having poor radiographic parameters and reduced range of motion with abduction and forward flexion, nonoperative intervention of displaced scapular body fractures have similar functional measurements of SMFA and DASH. Nonoperative treatment of displaced scapular body fractures with associated ipsilateral displaced rib fractures may benefit from scapular body operative intervention.

See pages 49 - 106 for financial disclosure information.

5-10 Year Outcomes of Operatively Treated Scapula Fractures

Jeffrey Gilbertson, BA[1]*; Joscelyn Tatro, MS*[1]*; Lisa Schroder, BS*[1]*, MBA; Peter Cole, MD*[2]
[1]*University of Minnesota, St. Paul, Minnesota, USA*
[2]*Regions Hospital, Saint Paul, Minnesota, USA*

Background/Purpose: There is increasing recognition that a subset of patients who sustain scapula fractures have poor outcomes with nonoperative management. Furthermore, recent series of patients who sustained scapula fractures meeting certain displacement criteria have been shown to have good range of motion, strength, and functional outcomes following surgical fixation. The majority of nonoperative scapula outcomes studies consist of small retrospective series that include heterogeneous fracture types with varying degrees of displacement. There is only one study of 68 patients that reports outcomes at a minimum of 5 years from nonoperative treatment, which suggested patients with residual scapular deformity had significantly more clinical symptoms. There is another study of 22 patients documenting good to excellent outcomes at a mean of 10 years following open reduction and internal fixation (ORIF) of intra-articular fractures of the glenoid. The purpose of this study is to report 5- to 10-year functional outcomes after ORIF of both intra- and extra-articular scapula fractures.

Methods: Between January 2005 and December 2010, the senior author operated on 105 patients who sustained scapula fractures, of which 59 (56%) were referred for treatment. 46 patients (44%) presented directly to our institution, which represents 8.8% of all presenting scapula fractures. Patients were prospectively enrolled into a registry and completed standard follow-up. Medical records were reviewed to report demographics, fracture classification, complications, and subsequent procedures. For this study, patients were called back to clinic to record shoulder range of motion (ROM) and strength, return to work status, and to complete a Disabilities of the Arm, Shoulder and Hand (DASH) form as well as a Short Form General Health Survey (SF-36, SF-12). To date, 48 patients have either returned to clinic for examination (46) or completed mailed DASH and SF-36 forms (2). Patients with intra-articular fractures were analyzed separately from those with extra-articular fractures.

Results: There were 24 intra-articular fractures (OTA 14-B, 14-C2, 14-C3) with or without extra-articular patterns and 21 extra-articular fractures (OTA 14-A, 14-C1) with no intra-articular involvement. Three isolated acromion fractures (14-A1) were excluded from these results. Mean follow-up was 7.4 years (range, 4.3-10.7). There were 40 males and 5 females with a mean age of 51 years. The only perioperative complication was a screw placed intra-articularly, which was promptly exchanged 3 days postoperatively. Of the 24 intra-articular fractures, 2 went on to have a shoulder arthroplasty, 3 underwent removal of superficial implants, and 4 underwent manipulation of the shoulder under anesthesia at a mean of 1 year after surgery. In the extra-articular group, there were no subsequent arthroplasties, 4 patients desired implant removal, and 2 had manipulation under anesthesia at 13 and 14 weeks after surgery. In the intra-articular group, there were 7 suprascapular and 3 axillary nerve injuries. Mean DASH score was 10.5 (normative mean = 10.1). Mean ROM in degrees (injured/uninjured) was 128/136 (94%) in forward flexion, 103/112 (92%) in abduction, and 49/62 (81%) in external rotation. Mean strength in pounds of force was 17/20 (85%)

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

in forward flexion, 11/13 (85%) in abduction, and 14/16 (83%) in external rotation. In the extra-articular group, there were 2 suprascapular nerve injuries. Mean DASH score was 10.2. Mean ROM in degrees (injured/uninjured) was 145/151 (96%) in forward flexion, 116/125 (93%) in abduction, and 58/67 (89%) in external rotation. Mean strength in pounds of force was 16/18 (89%) in forward flexion, 12/13 (88%) in abduction, and 13/15 (87%) in external rotation. A paired t test revealed significant differences between the injured and uninjured shoulders in all ROM and strength measurements ($P < 0.05$). The mean SF-36 and SF-12 scores were comparable to the normal population (50 ± 10). Following surgery, 41/48 (85%) reported returning to a similar prior occupation.

Cohort classification, description, outcomes, and complications					
		Intraarticular		Extraarticular	
n		24		21	
Mean Follow Up (months)		89		88	
DASH		10.5		10.2	
		Injured/Uninjured (%)	P value (paired student t-test)	Injured/Uninjured (%)	P value (paired student t-test)
Range of motion (Injured/Uninjured degrees)	Forward flexion	128/136 (94%)	0.0277	145/151 (96%)	0.0308
	Abduction	103/112 (92%)	0.0350	116/125 (93%)	0.0035
	External rotation	49/62 (81%)	0.0003	58/67 (89%)	0.0359
Strength (Injured/Uninjured lbs of force)	Forward flexion	17/20 (85%)	0.0091	16/18 (89%)	0.0159
	Abduction	11/13 (85%)	0.0022	12/13 (88%)	0.0041
	External rotation	14/16 (83%)	0.0098	13/15 (87%)	0.0017
Suprascapular nerve injury		7		3	
Axillary nerve injury		2		0	
Complications		none		Intra-articular screw removed 3 days post-op	
Shoulder arthroplasty		2		0	
Implant removal (scapula)		3		4	
Shoulder manipulation under anesthesia		4		2	

Conclusion: Midterm outcomes of operatively treated scapula fractures reveal a small yet significant difference in shoulder ROM and strength compared to the uninjured shoulder; however, there were normal functional outcomes assessed with DASH and SF-36 forms.

See pages 49 - 106 for financial disclosure information.

Plate Fixation Does Not Beat Nonoperative Treatment for Displaced Midshaft Clavicular Fractures: A Meta-Analysis of Randomized Controlled Trials

Sarah Woltz, MD; *P. Krijnen, PhD; I.B. Schipper, MD, PhD*
Leiden University Medical Center, Leiden, NETHERLANDS

Purpose: Are patients with a displaced midshaft clavicular fracture really better off after plate fixation than after nonoperative treatment? This debate continues despite many relevant publications. Since the last meta-analysis, two new randomized trials (RCTs) have been performed on the subject. The aim of this study was to analyze whether patients with a displaced midshaft clavicular fracture are best treated with plate fixation or nonoperatively, by evaluating all available RCTs on this subject.

Methods: A systematic search of electronic databases (PubMed, Medline, Embase, and Web of Science) was performed to identify RCTs comparing nonoperative treatment with open reduction and plate fixation for fully displaced, midshaft clavicular fractures. Risk of bias of the studies was assessed according to the criteria stated in the Cochrane Handbook for Systematic Reviews of Interventions. Outcomes were nonunion, symptomatic nonunion (ie, nonunion with complaints to such a degree that a secondary operation was indicated), shoulder function (Constant Score and DASH [Disabilities of the Arm, Shoulder and Hand] Score) and number of secondary operations.

Results: Six RCTs (620 patients) were included. The risk of nonunion was lower in the operatively treated patients (RR 0.15, CI 0.07-0.33). One-third of the patients with a nonunion did not receive further treatment. Secondary operations for complications were indicated less often in the operatively treated patients (RR 0.42, CI 0.22-0.81), while in 17% of both groups a secondary operation was performed when including plate removal operations (RR 0.97, CI 0.57-1.67). Constant and DASH scores after 1 year were better after plate fixation with a mean difference of 4.4 points (CI 0.90-7.86) and 5.1 points (CI 0.06-10.08), respectively.

Conclusion: Plate fixation significantly reduces the risk of nonunion, but does not have a clinically relevant advantage regarding functional outcome. Secondary operations are common after both treatments. Overall, there is not enough evidence for routine operative treatment for all patients with a displaced, midshaft clavicular fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Operative Treatment of Displaced Midshaft Clavicle Fractures: Have Evidence-Based Recommendations Changed Practice Patterns?

Prism Schneider, MD, PhD, FRCSC[1]*; Julie Agel, ATC*[2]*; Richard Bransford, MD*[2]*; Edward Harvey, MD, MSc, FRCSC*[3]
[1]*University of Calgary, Alberta, CANADA;*
[2]*Harborview Medical Center / University of Washington, Seattle, Washington, USA*
[3]*McGill University, Quebec, CANADA*

Background/Purpose: In 2007, members of the Canadian Orthopaedic Trauma Society (COTS) conducted a randomized controlled trial (RCT) comparing open reduction and internal fixation (ORIF) with nonoperative management of displaced midshaft clavicle fractures. The findings were improved functional outcome scores, decreased malunion rates, and decreased nonunion rates with ORIF for displaced midshaft clavicle fractures compared with nonoperative treatment. A recent meta-analysis of 6 RCTs comparing ORIF versus nonoperative treatment of midshaft clavicle fractures concluded a significantly lower nonunion rate, significantly lower symptomatic malunion rate, and earlier return of function with ORIF. A survey was completed by members of the Canadian Orthopaedic Association to examine the influence of major fracture clinical trials on the practice of individual orthopaedic surgeons. This survey found that the 2007 COTS clavicle fixation study was perceived by most surgeons to be influential in improving patient care and 73% of respondents stated that this RCT changed their practice pattern. However, to date, this perceived change in practice pattern has not been quantified. This study aims to quantify practice pattern changes for management of displaced midshaft clavicle fractures.

Methods: This study is a dual-center retrospective radiographic review comparing treatment patterns prior to and following the RCT published by COTS in January 2007. Following institutional approval, eligible patients were identified through data registries as being aged 16 to 60-years of age with displaced midshaft clavicle fractures (AO/OTA 15B-1, 15B-2, 15-B3) between January 2001 and December 2014 at each of the 2 participating Level I trauma centers. Exclusion criteria were open fractures, pathological fractures, or patients previously enrolled in the COTS trial. Two groups were identified: pre-trial cohort (injury date between January 2001 and January 30, 2003, prior to COTS study enrollment) and post-trial cohort (January 2007 to December 2014). Statistical analysis used independent samples t tests for comparing groups, with significance established at $P < 0.05$. Odds ratios (ORs) were calculated for subgroup analysis of gender, age (<40 years vs >40 years), and pre- and post-trial.

Results: A total of 686 patients met inclusion criteria. The pre-trial cohort (n = 108) was comprised of 76.1% males, with a mean age of 37.7 (±13.9) years. The post-trial cohort (n = 578) was comprised of 68.5% males, with a mean age of 41.9 (±12.7) years. The mean ISS for the pre-trial group was 21.3 (±13.8), compared to the post-trial cohort mean ISS of 25.1 (±13.7) ($P = 0.01$). There was no significant difference between groups for gender ($P = 0.117$); however, the pre-trial cohort was younger ($P = 0.005$) compared with the post-trial cohort. There were no differences between the participating sites for age or gender. There was nearly a 10-fold significant increase in the patients treated with ORIF for displaced midshaft clavicle fractures from the pre-trial cohort (3.7%) to the post-trial cohort (34.1%) ($P < 0.001$). Patients

See pages 49 - 106 for financial disclosure information.

were more likely to undergo ORIF if their age was <40 years (OR = 2.0), or if their ISS was greater than 9 (OR = 1.2), indicating an injury in addition to the clavicle fracture; however, there was no increased likelihood of surgical treatment based on gender.

Conclusion: Quantifying changes in practice pattern following publication of evidence-based recommendations is important to further our understanding of the impact large RCTs are having on clinical practice, duration of time required for practice patterns to change, and the longevity of practice pattern changes. Although we did not measure union rates or functional outcomes, this study demonstrated a significant practice pattern shift towards more frequent ORIF for displaced midshaft clavicle fractures following the COTS trial.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Midshaft Clavicle Fractures: A Meta-Analysis Comparing Surgical Fixation via Anteroinferior Plating versus Superior Plating

Alex Nourian, BS; Satvinder Dhaliwal, MPH; Sitaram Vangala, MS; ***Peter Vezeridis, MD***
University of California, Los Angeles, Los Angeles, California, USA

Purpose: Midshaft clavicle fractures are common injuries. There has been a recent trend to treat acute midshaft clavicle fractures surgically. Open reduction and internal fixation with superior or anteroinferior plate application are common surgical approaches. Anteroinferior plate fixation may be desirable to superior fixation due to less prominence of the plate and fewer subsequent procedures to remove the hardware. However, few studies directly compare postsurgical functional outcomes for these two techniques. The purpose of this study was to compare the outcomes of clavicle fracture fixation using anteroinferior versus superior plate placement.

Methods: We performed a meta-analysis of studies that have reported on outcomes following superior or anteroinferior plate fixation for acute midshaft clavicle fractures (OTA 15-B). A computerized literature search in the PubMed, Scopus, and Cochrane Library databases was utilized to identify relevant articles. Only full text articles without language restrictions were evaluated. The inclusion criteria consisted of: (1) fracture of the midshaft clavicle, (2) surgery for acute fractures (within 1 month of the fracture), (3) adult patients (16 years of age and older), and (4) open reduction and internal fixation with plate application in either the anteroinferior or superior position. Studies were excluded if they did not specify plate location, evaluated patients suffering multitrauma, evaluated minimally invasive procedures, or studied operations for revision, nonunion, malunion, or infection. The primary measured outcomes were symptomatic hardware (hardware prominence or irritation) and surgery to remove symptomatic hardware. The secondary outcomes were time to union, fracture union, nonunion, malunion, DASH (Disabilities of the Arm, Shoulder and Hand) score, Constant score, and implant failure. Frequencies and proportions of cases were recorded for binary outcomes, while means and standard deviations were recorded for continuous outcomes. Other summary statistics provided were used to impute means and standard deviations under the assumption of normality when these were not reported. Continuous outcomes were compared between groups using linear mixed effects models, while binary outcomes were compared using mixed effects logistic regression models, including fixed group effects and random study effects. P values less than 0.05 were considered statistically significant. All analyses were performed using SAS v. 9.4).

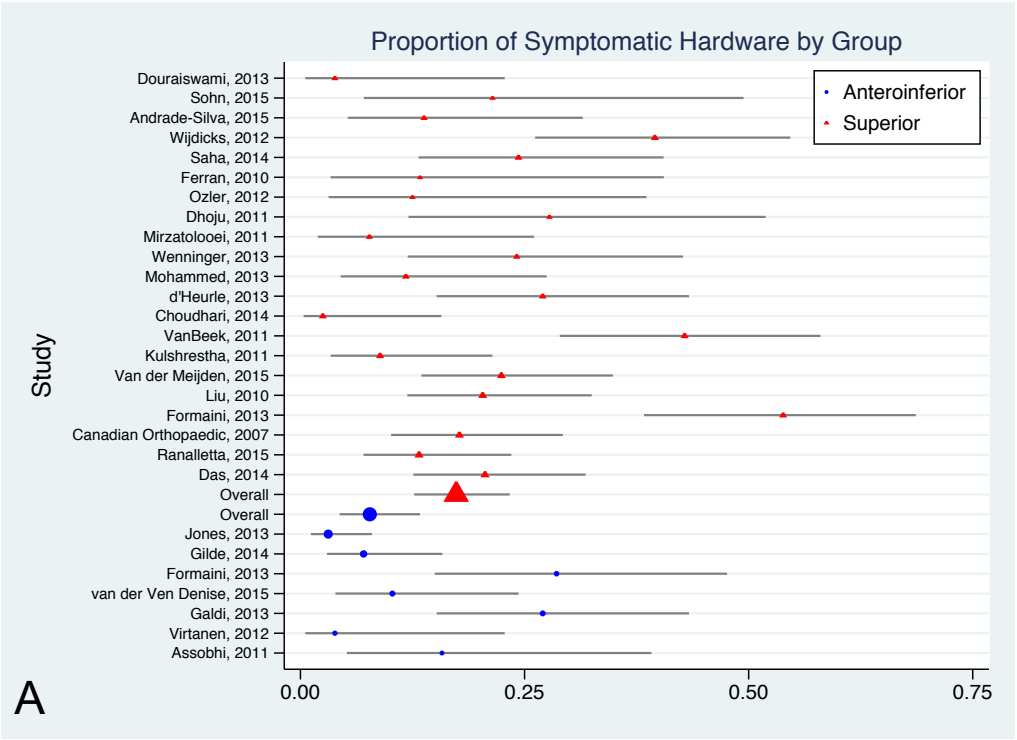
Results: A total of 1428 articles were identified among the three databases, of which 897 remained after removing duplicates. From that pool, 57 relevant studies were evaluated. Articles were excluded due to an inability to specify plate location (6), a subject pool not exclusively consisting of acute fractures (4) or midshaft fractures (2), a minimally invasive surgical approach (6), use of nonstandard plates (1), poor reporting of functional outcomes (2), and a duplicate group of patients (2). This left 34 articles to be used in our meta-analysis. Of these, 8 studies belonged to the anteroinferior group (N = 390) and 27 studies to the superior group (N = 1104). No significant differences were found with respect to the functional shoulder scores (DASH and Constant) between the two groups. There was no significant

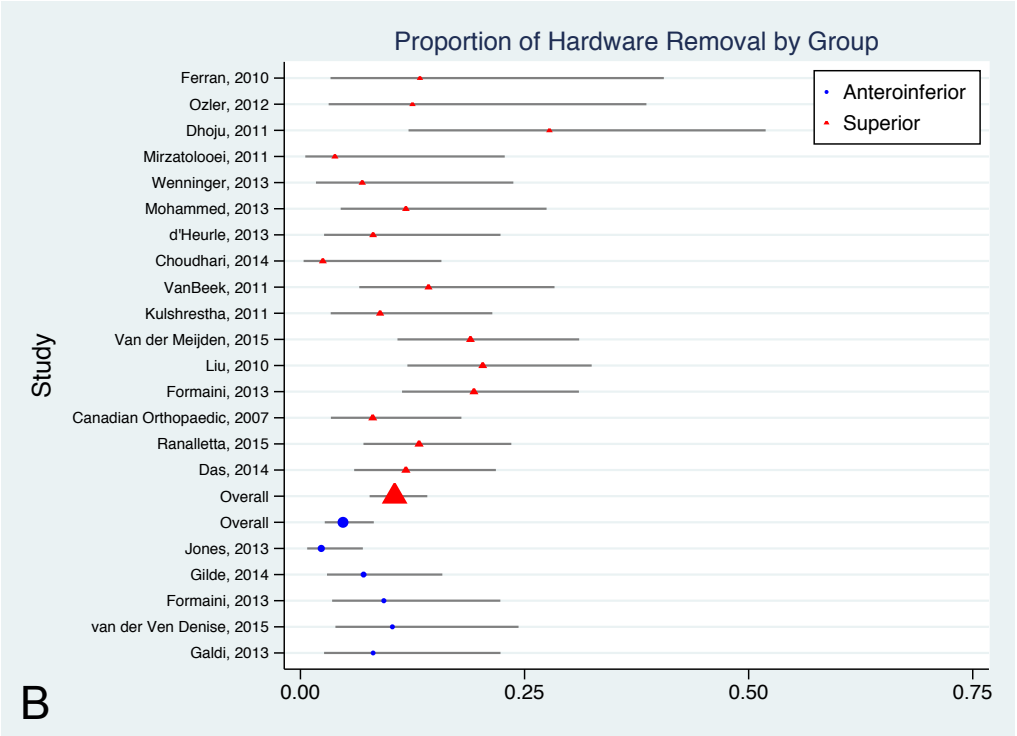
See pages 49 - 106 for financial disclosure information.

difference between each group for the probability of having a union (P = 0.41), a malunion (P = 0.28), a nonunion (0.29), and implant failure (0.39). The superior plating group had a much higher probability of suffering from symptomatic hardware (0.17) as compared to the anteroinferior group (0.08) (Fig. 1A, P = 0.005). Additionally, the superior group had a significantly higher rate of surgery for hardware removal (0.11 vs 0.05) (Fig. 1B, P = 0.008).

Conclusion: The findings of this study demonstrate that plating along the superior and anteroinferior aspects of the clavicle lead to similar operative outcomes such as union, nonunion, and malunion, as well as similar functional outcomes scores. Plates applied to the superior aspect of the clavicle are associated with higher rates of symptomatic hardware and more frequent hardware removal.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.





See pages 49 - 106 for financial disclosure information.

Preoperative Humeral Head Thickness Predicts Screw Cutout After Locked Plating of Proximal Humerus Fractures

Lorraine Stern, MD*[1]*; *John Gorczyca, MD*[2]
[1]*Advanced Orthopedics and Hand Surgery Institute, Wayne, New Jersey, USA*
[2]*University of Rochester, Rochester, New York, USA*

Purpose: Locked plating has evolved as the most common operative treatment of displaced proximal humerus fractures. However, screw cutout has been identified as a frequent postoperative complication, occurring in up to 23% of patients. CT scans are frequently obtained for diagnostic evaluation and preoperative planning for proximal humerus fractures. The purpose of this study was to utilize information available on the preoperative CT to create a simple and reproducible method to identify patients preoperatively who are at a higher risk for screw cutout postoperatively.

Methods: A retrospective review was conducted of all proximal humerus fractures treated with locked plating at our Level I trauma center from 1/1/05 to 12/31/14. Patients without a preoperative shoulder CT were excluded. Using digital images, the humeral head thickness was measured on the axial, coronal, and sagittal sections by the method demonstrated in Fig. 1. The same method was utilized for each of the three CT planes. The slices that contained the humeral head were identified and the central slice was utilized for measurement of the humeral head thickness. On that CT slice, a line was drawn between the outermost edges of the articular surface using software included in the digital imaging program. The thickness of the humeral head was measured at 90° from the center of that line (Fig. 1). Humeral head thickness was compared between those patients who had experienced postoperative cutout and those who had not. Statistical analysis was performed using a t test with significance set at 0.05.

Results: 269 patients were reviewed for inclusion, 96 of whom had a preoperative CT. This allowed for measurement of 288 CT slices. Of the 96 patients who were included, 17 (17.71%),

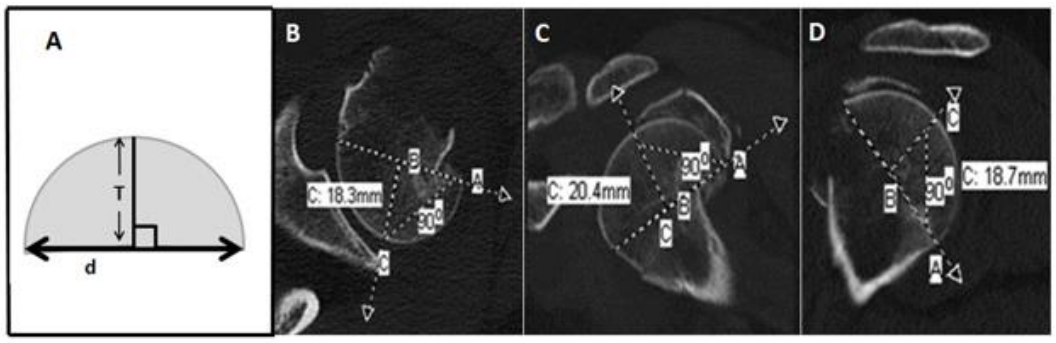


Figure 1: A. drawing depicts diameter of articular segment (d) and perpendicular thickness (T). Axial (B), coronal (C) and sagittal (D) images of a patient demonstrate how the humeral head thickness is measured in three planes using the digital imaging system software.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

developed screw cutout compared to 4 (2.31%) patients in the group who did not have a CT scan and were excluded. With regard to the AO-OTA classification, a majority of fractures were classified as 11-C (60.5%). 26% were classified as type 11-B and 13.5% were type 11-A. 11 patients sustained a fracture-dislocation of their proximal humerus, one of which was classified as 11-B3 and the remainder as 11-C3. The mean humeral head thickness was significantly smaller on the axial (18.2 mm vs 21.3 mm; P = 0.0031), coronal (18.9 mm vs 21.9 mm; P = 0.0084), and sagittal sections (18.7 mm vs 21.6 mm; P = 0.0033) in the patients who experienced screw cutout. When the smallest of the three measurements for each patient was analyzed, the risk of cutout was markedly greater when the humeral head thickness was less than 20 mm (24.53% vs 5.88%). Additionally, when the humeral head thickness was greater than 25 mm in any plane, the risk of cutout was reduced to zero.

Conclusion: A smaller humeral head thickness on preoperative CT is predictive of screw cutout following locked plating of proximal humerus fractures. The risk of cutout increases considerably when the humeral head thickness measures less than 20 mm, and is reduced to 0% when the thickness is 25 mm in any plane. This information may be helpful in counseling patients regarding the possibility of postoperative screw cutout.

See pages 49 - 106 for financial disclosure information.

Proximal Humerus Fracture Fixation Failure: A Retrospective Review

*John Williams, MD[1]; **William Uffmann, MD[1]**; Joshua Harmer, BS[1]; Robert Tashjian, MD[1]; Erik Kubiak, MD[2]*
[1]University of Utah, Salt Lake City, Utah, USA;
[2]University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA

Purpose: Proximal humerus fracture fixation has evolved over the last few decades with most fractures now being treated with locking plate fixation. Despite these advances in fixation, a large number of postoperative complications and fixation failures are observed. The aim of this study is to examine the incidence and risk factors for complications and fixation failure associated with proximal humerus fracture locking plate fixation.

Methods: We conducted a retrospective chart review of proximal humerus fracture patients seen at our Level I trauma hospital from January 2000 to July 2015. Demographic information, fracture pattern, injury mechanism, additional surgery, hardware complications including screw cutout and iatrogenic joint penetration, postoperative deep infection, postoperative arthrofibrosis, presence of osteonecrosis, and medical comorbidity data were recorded. Fisher's exact test was used to evaluate variables with statistical significance set at a P value of <0.05.

Results: 478 consecutive patients with proximal humerus fractures were identified. Those patients undergoing arthroplasty, blade plate fixation, suture fixation, intramedullary nail, or any other fixation methods were excluded. 304 patients (average age, 62.0) who underwent operative fixation with locking plate fixation were included in the study. 72 patients (23.7%) had a total of 103 complications associated with locking plate fixation. Over 77% of those complications occurred in 3- and 4-part fractures. Radiographic and clinical follow-up demonstrated postoperative collapse culminating in screw cutout and loss of reduction in 26 patients (8.6%), leading to operative intervention. The etiology was often multifactorial, with clinical and radiographic evidence showing some combination of osteonecrosis (13 patients, 4.3%), infection (9 patients, 3.0%), and nonunion (4 patients, 1.3%). Additionally, 19 patients (6.3%) had iatrogenic joint penetration noted on postoperative radiographs requiring additional surgical intervention in 3 cases. Additional surgical interventions were performed for symptomatic hardware (7 patients, 2.3%) and arthrofibrosis (9 patients, 3.0%) patients. Less common complications include reoperation for postoperative nerve palsy (1 patient, 0.33%), remote peri-implant fracture (3 patients, 1.0%), and heterotopic ossification or intra-articular graft impingement (1 patient each, 0.33%). There was no statistically significant difference between the 2 groups (complication and noncomplication groups) in Neer fracture classification. The presence of a dislocation at the time of injury (P = 0.000659), the use of fibular allograft at the time of surgery (P = 0.009781), and medical comorbidities of smoking (P = 0.000877), alcohol use (P = 0.0000063), and diabetes (P = 0.0001) were all statistically significant predictors of postoperative complications with locking plate fixation. Average follow-up was noted to be 187 days.

Conclusion: Proximal humerus fractures continue to present challenges in fracture fixation even with the recent increased use of locking plates. In our series of 304 patients, 72 patients

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Observed Patient Characteristics in Proximal Humerus Fractures Treated with Locking Fixation			
Characteristic	**Failures (N=72) (%)**	**No Failures (N=232) (%)**	**P-value (p)**
Fracture Type (Neer Type)			
2 Part	18 (25)	85 (36.6)	p = 0.086944
3 Part	27 (37.5)	73 (31.5)	p = 0.473286
4 Part	27 (37.5	74 (31.9)	p = 0.315383
Associated Dislocation	13 (18.1)	11 (4.7)	p = 0.000659
Fixation Augmentation			
Fibular Allograft	8 (11.1)	7 (3)	p = 0.009781
Medical History			
Tobacco Use (any)	11 (15.3)	8 (3.4)	p = 0.000877
Alcohol Use (any)	27 (37.5)	22 (9.5)	p = 0.0000063
Diabetes	27 (37.5	37 (15.9)	p = 0.0001
Mean Age (y)	59.4	62.1	p = 0.005899
Sex Male	23 (31.9)	109 (47)	p = 0.029289
Female	49 (68)	123 (53)	

(23.7%) had a postoperative complication. There was a significant difference in the incidence of concomitant shoulder fracture dislocations, augmentation with fibular allograft, and medical histories remarkable for diabetes, tobacco use, and alcohol consumption in the group with noted fixation failure. Fracture dislocations are more severe injury patterns and the use of fibular allograft augmentation may be a surrogate for poor bone quality at the time of the operation, further increasing their risk for complications. In those patients deemed at high risk for proximal humerus fixation failure, arthroplasty may need to be considered given the high rates of complications noted in our series.

See pages 49 - 106 for financial disclosure information.

Reverse Shoulder Arthroplasty for Proximal Humerus Fractures: Outcomes Comparing Primary Reverse Arthroplasty for Fracture versus Reverse Arthroplasty After Failed Osteosynthesis

***Steven Shannon, MD**; Eric Wagner, MD; Matthew Houdek, MD; William Cross, MD; Joaquin Sanchez-Sotelo, MD, PhD*
Mayo Clinic, Rochester, Minnesota, USA

Purpose: Surgical treatment of proximal humerus fractures in the elderly pose challenges in decision making. Reverse total shoulder arthroplasty (RTSA) has been established as a reliable option for salvage of failed hemiarthroplasty, although few studies have analyzed RTSA after failed open reduction and internal fixation (ORIF). The purpose of this study was to evaluate the outcomes of patients with failed osteosynthesis who undergo salvage RTSA compared to patients undergoing primary RTSA for proximal humerus fractures.

Methods: We retrospectively reviewed 18 patients who underwent primary RTSA for acute proximal humerus fractures and 26 patients who underwent arthroplasty following failed ORIF at our institution between 2003 and 2013. Minimum follow-up was 2 years, with a mean follow-up of 3 years (range, 2.0-6.0).

Results: There are no statistically significant differences in clinical outcomes between the 2 cohorts with regard to American Shoulder and Elbow Surgeons (ASES) scores, most recent forward flexion, or external rotation. The salvage RTSA cohort experienced a higher complication rate (8%) including dislocation and aseptic loosening. The primary RTSA cohort had a 5% complication rate, with 1 late prosthetic joint infection requiring reoperation.

Table 1: Patient Demographics

	Salvage RTSA	Primary RTSA	P-Value
Patients	26	18	
Side (Right : Left)	12 : 14	9 : 9	p =0.74
Follow up (yrs.)	2 (2-6)	3 (2. – 5)	p =0.14
Age (yrs.)	70 (54-87)	75 (60-88)	p = 0.13
Gender: Male : Female	3:23	4:14	P=0.18
BMI (kg/m2)	32.5 (22 –47)	31.4 (20 –52)	p = 0.71
Neer Classification			
3-Part	42% (11)	50% (9)	P=0.58
4-Part	58% (15)	50% (9)	

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 2: Clinical outcomes of prior ORIF patients before and after RTSA				
Parameters	Prior ORIF Before RTSA(n=26)	After Salvage RTSA(n=26)	Difference (95% CI)	*P* value
ASES	24.7	63.0	38 (33-43)	**P<0.0001**
Active range of motion				
Forward Flexion (degrees)	51	133	82 (65-96)	**P<0.0001**
External Rotation (degrees)	0.5	42	41.5 (27-53)	**P<0.0001**
Satisfaction	1.0	5.6	4.6 (4-5)	**P<0.0001**

Table 3: Clinical outcomes of prior ORIF s/p RTSA compared to acute RTSA				
Parameters	Salvage RTSA (n=26)	Primary RTSA (n=18)	Difference (95% CI)	*P* value
ASES	64.6	70.6	5.9 (1.69-14)	P = 0.2112
Active range of motion				
Forward Flexion (degrees)	130	133	3.1 (14-29)	P=0.785
External Rotation (degrees)	41.8	35.9	5.93 (13-25)	P=0.518
Satisfaction	5.18	4.8	0.4 (0.5-1.4)	P=0.371

Table 4: Clinical outcomes of 3-Part Fractures prior ORIF s/p RTSA compared to acute RTSA				
Parameters	Salvage RTSA (n=11)	Primary RTSA (n=9)	Difference (95% CI)	*P* value
ASES	62.3	66.6	4.2 (6-14)	P = 0.373
Active range of motion (degrees)				
Forward Flexion (degrees)	146	114	31.6 (10-63)	**P=0. 048**
External Rotation (degrees)	45.5	33.3	12.2 (15-39)	P=0.338
Satisfaction	6.2	5	1.2 (1-3)	P=0.1789

See pages 49 - 106 for financial disclosure information.

Table 5: Clinical outcomes of 4-Part Fractures prior ORIF s/p RTSA compared to acute RTSA

Parameters	Salvage RTSA (n=15)	Primary RTSA (n=9)	Difference (95% CI)	*P* value
ASES	62.5	73.3	10.7 (6-28)	P=0.187
Active range of motion (degrees)				
Forward Flexion (degrees)	126.6	147.2	20 (12-53)	P=0.189
External Rotation (degrees)	40	38.3	1.6 (21-24)	P=0.872
Satisfaction	5.1	4.5	0.5 (0.12-1)	P=0.0955

Table 6: Complications

	Salvage RTSA	Primary RTSA	P-Value
Complication Rate	8% (n=3)	5% (n=1)	0.782
Dislocation	1	0	0.331
Aseptic Loosening	1	0	0.331
Reoperation	0	1	0.331

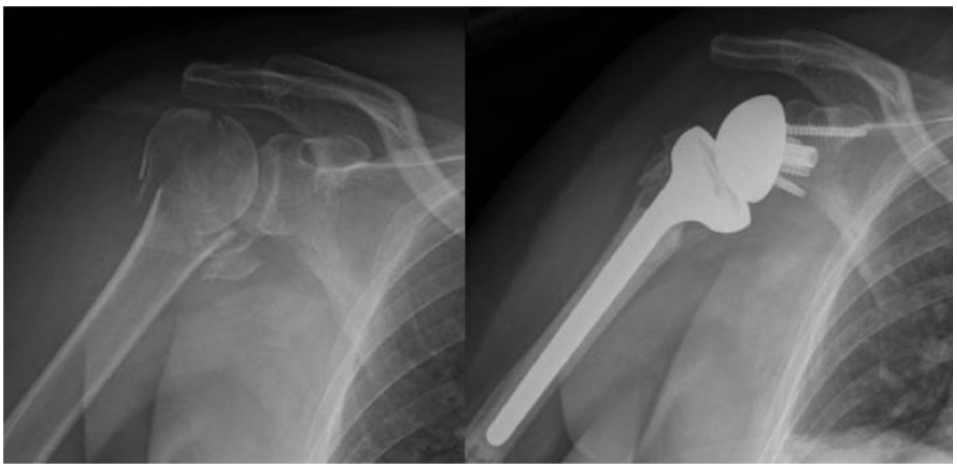


Figure 1: Acute 4-Part Proximal Humerus Fracture treated with RTSA.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

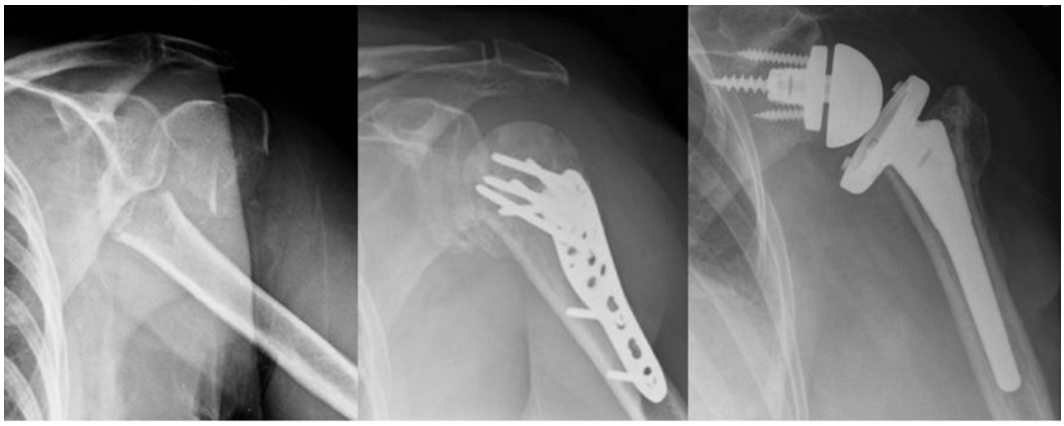


Figure 2: 4-Part Proximal Humerus Fracture that underwent ORIF with subsequent failure and salvage RTSA.

Conclusion: Although RTSA after failed ORIF does have a higher rate of complications when compared to acute RTSA, the revision and reoperation rate, as well as clinical outcomes and shoulder function, remained comparable. When a surgeon approaches these complex fractures in patients with poor underlying bone stock, this study supports either acute arthroplasty or ORIF with the knowledge that salvage RTSA still has the potential to achieve good outcomes if osteosynthesis fails.

See pages 49 - 106 for financial disclosure information.

Intermediate to Long-Term Outcomes Following Initial Treatment of Proximal Humerus Fractures in Ontario Canada: A Population-Based Retrospective Cohort

Lauren Nowak, MSc[1,2]*; Michael D. McKee, MD*[1]*; Aaron Nauth, MD, FRCSC*[1]*; Milena Vicente, RN*[2]*; Marissa Bonyun, MD*[2]*; Emil H. Schemitsch, MD*[1]
[1]*St. Michael's Hospital, Toronto, Ontario, CANADA;*
[2]*University of Toronto, Toronto, Ontario, CANADA*

Purpose: Proximal humerus fractures are a common fragility fracture in older adults. Intermediate to long-term outcomes following both surgical and nonsurgical initial treatment of proximal humerus fractures have not been evaluated at a population level. The purpose of this study was to utilize administrative data from Ontario, Canada to evaluate intermediate-term outcomes following initial treatment of proximal humerus fractures.

Methods: We used data from the Canadian Institute for Health Information to identify all patients aged 50 and older who presented to an ambulatory care facility with a "main diagnosis" of proximal humerus fracture from April 1, 2004 to March 31, 2013. Intervention codes from the Discharge Abstract Database (DAD) and procedure codes from the Ontario Health Insurance Plan (OHIP) were used to categorize patients into fixation, replacement, closed reduction, or nonoperatively treated with no reduction groups. We used intervention and procedure codes to identify instances of complication-related operations following initial treatment (including fixation, replacement, hardware removal, rotator cuff repair, and irrigation and debridement) at 2 to 5 years post initial treatment.

Results: The majority of patients (25,104 [76.6%], 95% confidence interval [95% CI] 76.2-77.1%) were initially treated nonsurgically, while 2979 (9.1%, 95% CI 8.8-9.4%) underwent initial fixation, 1419 (4.3%, 95% CI 4.1-4.6%) received primary joint replacement, and 3258 (10.0%, 95% CI 9.5-10.3%) were initially treated with a closed reduction procedure. Complete 2- and 5-year outcome data are presented in Table 1. In the nonoperatively treated group, the total number of complication-related operations increased from 434 (1.7%, 95% CI 1.6-1.9%) 2 years post initial treatment to 492 (2.0%, 95% CI 1.8-2.1%) at 5 years. A total of 799 patients (26.8%, 95% CI 25.3-28.4%) initially treated with operative fixation returned to the operating room for a complication-related operation at 2 years post initial treatment, and this number increased to 896 (30.1%, 95% CI 28.5-31.8%) at 5 years post initial treatment. In the group treated initially with a replacement procedure, 123 (8.7%, 95% CI 7.3-10.3%) returned for a complication-related operation at 2 years post initial treatment, and 192 (13.5%, 95% CI 11.9-15.4%) returned at 5 years post initial treatment. For the patients treated with an initial closed reduction procedure, the total number of complication-related operations increased from 660 (20.3%, 95% CI 18.9-21.7%) at 2 years to 689 (21.2%, 95% CI 19.8-22.6%) at 5 years post initial treatment.

Conclusion: The majority of proximal humerus fractures in patients 50 and older in Ontario, Canada are treated nonsurgically. Complication-related operations in the 5 years following initial nonoperative treatment are relatively low. The high risk of complication-related operations at 2 (26.8%) and 5 (30.1%) years following initial fixation of these injuries is concerning and suggests alternate approaches should be considered.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1: Two and Five Year Outcomes Following Initial Treatment of Proximal Humerus Fractures

Outcome / Group	Replacement	Fixation	Rotator cuff repair	Hardware removal	Repair	Irrigation & debridement	Total
Two-Year Outcomes							
Non-operative (n= 25,104)	0 (0.0%)	111 (0.4%)	80 (0.3%)	8 (0.0%)	28 (0.1%)	21 (0.1%)	248 (1.0%)
Reduction (n = 3,258)	148 (4.5%)	274 (8.4%)	147 (4.5%)	33 (1.0%)	24 (0.7%)	0 (0.0%)	660 (20.3%)
Fixation (n = 2,979)	98 (3.3%)	160 (5.4%)	87 (2.9%)	412 (13.8%)	15 (0.5%)	19 (0.6%)	799 (26.8%)
Replacement (n = 1,419)	62 (4.4%)	14 (1.0%)	14 (1.0%)	20 (1.4%)	7 (0.5%)	0 (0.0%)	123 (8.7%)
Total (n = 32,760)	308 (0.9%)	559 (1.7%)	328 (1.0%)	473 (1.4%)	74 (0.2%)	45 (0.1%)	1787 (5.5%)
Five-Year Outcomes							
Non-operative (n= 25,104)	0 (0.0%)	123 (0.5%)	97 (0.4)	10 (0.0%)	0 (0.0%)	25 (0.1%)	286 (1.4%)
Reduction (n = 3,258)	157 (4.8%)	284 (8.7%)	156 (4.8%)	34 (1.0%)	24 (0.7%)	0 (0.0%)	689 (21.1%)
Fixation (n = 2,979)	115 (3.9)	182 (6.1%)	105 (3.5%)	447 (15.0%)	16 (0.5%)	20 (0.7%)	896 (30.1%)
Replacement (n = 1,419)	93 (6.6%)	24 (1.7%)	25 (1.8%)	33 (2.3%)	11 (0.8%)	0 (0.0%)	192 (13.5%)
Total (n = 32,760)	365 (1.1%)	613 (1.9%)	383 (1.2%)	524 (1.6%)	82 (0.3%)	52 (0.2%)	2019 (6.2%)

See pages 49 - 106 for financial disclosure information.

Can You Drive Before You Walk?
Driving Tests for Patients with Surgically Treated Ankle Fractures
Sean Ho, MBBS, M.Med (Ortho); *Mei Leng Chan, Doctor of Philosophy (OT);*
Ernest Kwek, FRCS (Edin) (Ortho)
Tan Tock Seng Hospital, SINGAPORE

Purpose: There is no clear consensus on when patients with surgically treated right ankle fractures can return to driving, or how best to assess their fitness to drive. Through a rigorous battery of off-road and on-road tests, we aim to determine if these patients are able to drive a car safely, even before weight bearing has been initiated.

Methods: A prospective grant-funded clinical trial was conducted. Patients aged 25 to 65 years who underwent surgery for right ankle fractures and held a valid Class III driving license were recruited. The surgeon and an occupational therapist assessed the patients at 2, 6, and 12 weeks pos surgery. A Short Musculoskeletal Function Assessment (SFMA) questionnaire was administered and parameters like braking time were measured using a driving simulator. Patients who met the minimal criteria were then subjected to a full on-road driving test with a driving instructor.

Results: A total of 22 patients (8 females, 14 males) were recruited (Table 1). The mean age was 43.2 (±13.0) years. There was a significant improvement ($P < 0.05$) in the SFMA and braking time at 6 and 12 weeks postsurgery (Figs. 1 and 2). Nearly all (91%) patients passed the on-road driving test at 6 weeks, before their fractures had healed or weight bearing was initiated.

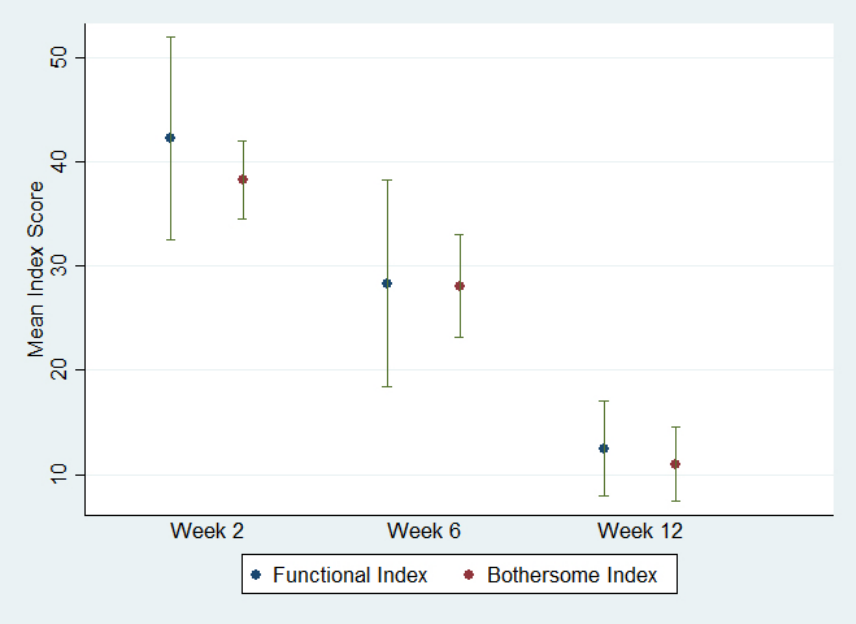
Conclusion: This novel study shows that patients with surgically stabilized ankle fractures are able to safely drive cars at 6 weeks postsurgery, even before they have recovered from their injuries. We also showed that the ability to drive correlates with improvements in the SFMA scores and braking times.

Table 1. Demographics

Gender, n (%)	Male 14 (63.6) Female 8 (36.4)
Age	41.5 (31 – 57)
Height (m)	1.69 (1.61 – 1.71)
Weight (kg)	71 (62 – 75)
BMI	25.30 (21.83 – 27.34)
Driving Experience (Years)	16.72 (5 – 41)
Mechanism of Injury, n (%)	
Sports	7 (31.8)
Fall	11 (50.0)
Road Traffic Accident	3 (13.6)
Others	1 (4.5)

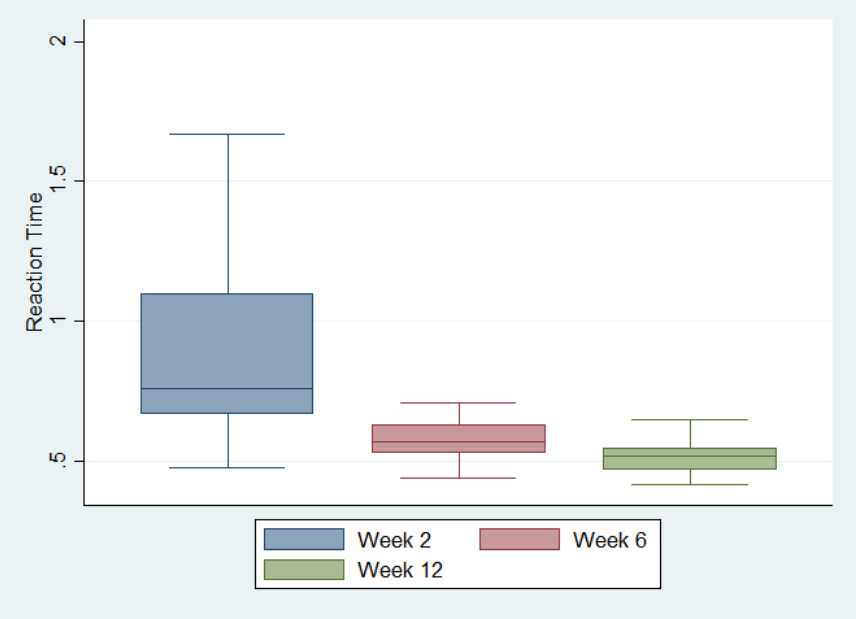
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Figure 1.



Statistical difference between functional and bothersome index at week 2 and week 6 as well as between week 6 and week 12 ($p<0.05$)

Figure 2.



Statistical difference between reaction time at week 2 and week 6 as well as between week 6 and week 12 ($p<0.05$)

See pages 49 - 106 for financial disclosure information.

PROMIS Computer Adaptive Tests Compared with Time to Brake in Patients with Complex Lower Extremity Trauma

Seewan Kim, BS[1]*; Daniel Wiznia, MD*[1]*; Leon Averbukh, BS*[2]*; Andrea Torres, BS*[1]*; Edward Kong, BS*[1]*; Chang-Yeon Kim, BS*[1]*; Michael Leslie, DO*[1]
[1]*Yale University, New Haven, Connecticut, USA;*
[2]*New York Institute of Technology, New York, New York, USA*

Background/Purpose: A current standard in the literature for measuring a driver's ability to brake after a lower extremity trauma is total time to brake (TTB), which shows significant improvement at 6 weeks after weight bearing. The TTB is the sum of the time required to react, move the foot to the brake pedal, and apply enough brake pressure to stop the vehicle. However, using just one objective measurement may not produce a full assessment of driving ability. The PROMIS Initiative (Patient Reported Outcomes Measurement Information System) may be a useful adjunct to TTB in evaluating driving ability. The system uses item response theory and computer adaptive testing to obtain precise outcome measurements in the least amount of time. Recent studies have validated the PROMIS physical function (PF) and pain interference (PI) computer adaptive tests (CATs) to evaluate recovery after lower extremity traumas. The purpose of this study was to compare the PROMIS PF CAT and PI CAT to TTB in assessing a patient's readiness to drive after a lower extremity orthopedic trauma.

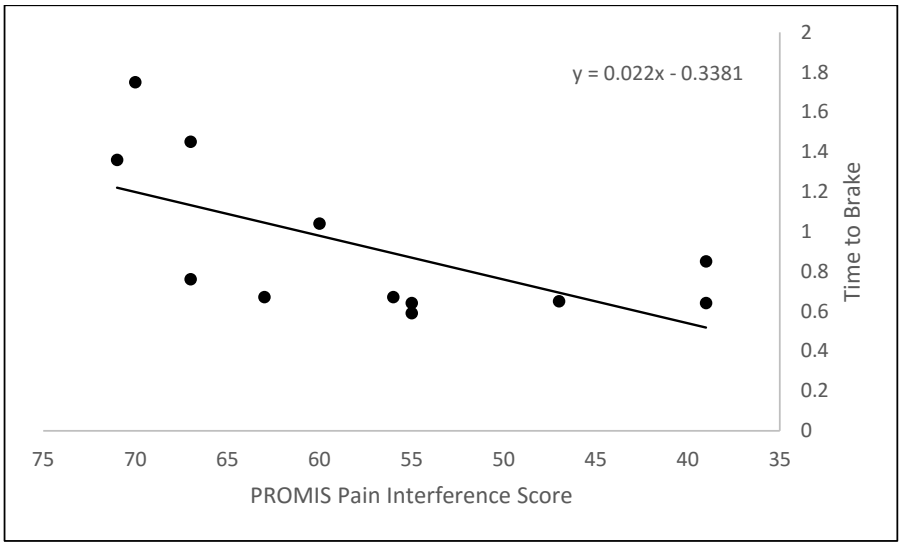
Methods: The study involved 70 patients with lower extremity injuries, located in the pelvis, acetabulum, hip, femur, knee, tibia/fibula, ankle, and foot. These patients were tested on a driving simulator constructed using the Vericom Stationary Reaction Timer. A control group of six healthy volunteers with no history of prior lower extremity fracture or surgery was tested to establish a normal mean value for TTB. The simulator consisted of a digital driving scene displayed on a computer, a speedometer, and a timer that recorded the patient's ability to depress the brake in response to an on-screen stimulus. After completing the driving simulation test, patients completed the PI and PF instruments through the PROMIS online Assessment Center. The PROMIS instrument employs an algorithm that selects questions based on answers to previous questions, eliminating the need for the patient to answer all questions in the bank. All statistical testing was done using IBM SPSS version 21.

Results: 63 patients were enrolled, after excluding 7 patients who did not meet inclusion criteria. The patient group was 75% male, with an average age at injury of 45 years. Injury laterality consisted of 26 left-sided, 33 right-sided, and 5 bilateral injuries. The most frequent sites of lower extremity injury were the acetabulum (18.8%) and ankle (29.7%). 11 patients (17.2%) received nonoperative management and 53 patients (82.8%) received surgical fixation. The mean TTB for the healthy control group was 0.61 seconds (min = 0.56, max = 0.64, SD = 0.03, 95% CI = 0.58-0.64). When the injuries were stratified as above knee (pelvis, acetabulum, hip, femur) or below knee (tibia/fibula, ankle, foot), TTB significantly improved with time for right below-knee injuries (B = -0.008 sec/day, P = 0.041). For right-sided injuries that were below the knee, there was a statistically significant correlation between TTB and PROMIS PI score (B = 0.022, P = 0.029). There was no significant correlation between TTB and PROMIS PF (B = -0.009, P = 0.32). Figure 1 graphs the TTB for right-sided injuries that

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

were below the knee as a function of the PROMIS PI score. In our linear regression model, the TTB range for healthy controls (0.61 seconds or less) is associated with a PROMIS PI score of T=43 or less.

Figure 1. Time to Brake vs. PROMIS Pain Interference Score.



Conclusion: The correlation between the PROMIS PI score and TTB suggests that the PROMIS PI score can add to TTB when assessing driving ability. We found that the patients who regained normal TTB had a PROMIS PI score below T = 43, compared to the average pain interference score of T = 50 for the US general population. Our study demonstrates that the PROMIS Pain Interference CAT correlates to TTB, and can be used as an additional measure to determine when patients may return to driving.

See pages 49 - 106 for financial disclosure information.

Serial Radiographs Do Not Change the Clinical Course of Nonoperative Stable Weber B Ankle Fractures

Lucas Marchand, MD[1]; *Zachary Working, MD[1]; Ajinkya Rane, MD[1]; Lance Jacobson, MD[1]; Erik Kubiak, MD[1]; Thomas Higgins, MD[2]; David Rothberg, MD[1]*
[1]*University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA;*
[2]*University Orthopaedic Center, Salt Lake City, Utah, USA*

Purpose: Stable Weber B ankle fractures are a common nonoperatively treated ankle fracture. These patients often receive serial radiographic evaluations to verify maintenance of stability. The primary purpose of this study was to document the natural history of patients with stable Weber B ankle fractures clinically, to record frequency of follow-up, and the quantity of radiographs. The secondary purpose was to evaluate ankle stability in these patients over time using repeated radiographic measurements and to determine whether these images changed over the course of treatment.

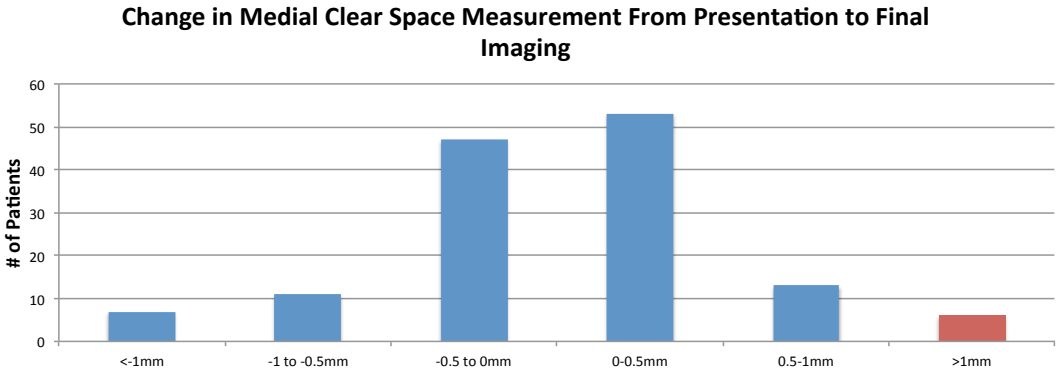
Methods: A retrospective review was performed using an IRB-approved university database to capture patients who sustained closed ankle fractures with treatment codes consistent with nonoperative fracture treatment (CPT code 27886). These patients were seen and treated at a Level I trauma center over a 5-year time period (2010-2015). Injury radiographs were reviewed to capture patients with closed Weber B fractures that did not receive surgery within the first week after injury. 134 consecutive patients were captured with AO/OTA classification 44-B1.1 fractures. Clinical records were reviewed for the number of follow-up visits, number of radiographs, clinical course, and need for operative intervention. Radiographs at the time of injury and final follow-up were evaluated; parameters including medial clear space (MCS), talar tilt, and Mueller-nose (MN) measurement for talofibular distance were performed in standardized fashion. Statistical comparisons of radiographic measurements at the time of injury and final follow-up including a paired 2-tailed t test for comparison of MCS and MN measurements and Wilcoxon paired signed rank test for talar tilt due to a non-normal distribution.

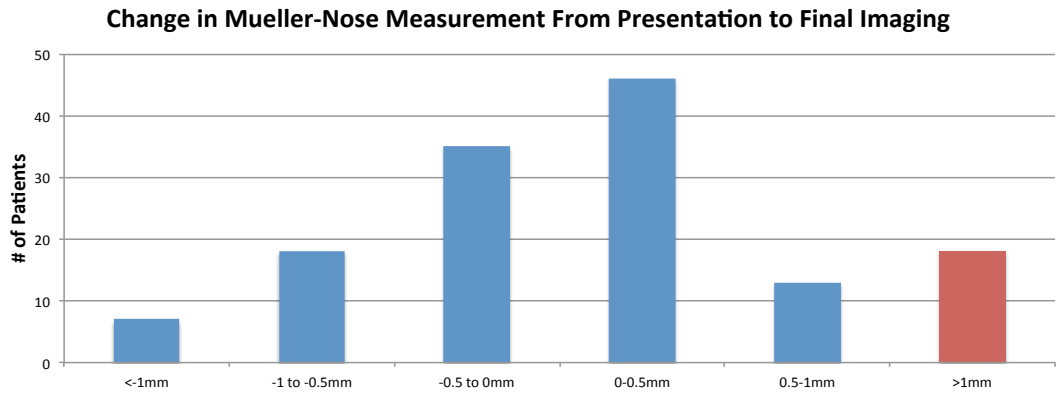
Results: 134 patients were captured using the selection algorithm. Average follow-up was 82.3 days (median 54 days with interquartile range of 38-83 days). Patients followed up an average of 2.6 visits in our clinics (SD 1.06). Patients received an average of 11.2 individual radiographic images to evaluate their injury (SD 3.9, maximum 29). No patients progressed to surgery in the cohort. Mean MCS at the time of injury was 3.4 mm (SD 0.8) and was 3.3 mm (SD 0.7) at the time of final follow-up ($P = 0.1$). Mean talar tilt at the time of injury was 0.8° (SD 0.8) and was 0.7° (SD 0.9) at the time of final follow-up ($P = 0.14$). Mean MN measurement at the time of injury was 3.5 mm (SD 1.0) and was 3.5 mm (SD 0.8) at the time of final follow-up ($P = 0.47$). Figure 1 is a histogram demonstrating the distribution of the changes in radiographic measurements over the clinical course. Only five patients (3.7%) were identified with a change in MCS greater than 1 mm, of which the average MCS in this subgroup was 1.2 mm (SD 0.2). Only 17 patients (13%) were identified with a change in MN greater than 1 mm, of which the average MCS in this subgroup was 1.4 mm (SD 0.6).

Conclusion: No patients with standard follow-up for stable AO/OTA 44-B1.1 fractures

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

proceeded to surgery for loss of tibiotalar reduction or any other cause. Radiographic relationships were conserved during the follow-up period in these patients with minimal change at the time of final follow-up. Stable AO/OTA 44-B1.1 fractures can likely be followed without repeat serial radiographs. Reducing the number of radiographs these patients receive would streamline their care, minimize exposure to radiation, and eliminate excess cost to the patient and health-care system. Further investigation including long-term follow-up of these patients with clinical outcomes is in process.





See pages 49 - 106 for financial disclosure information.

Equivalent Functional Outcomes Following Injury-Specific Fixation of Posterior Malleolar Fractures and Equivalent Ligamentous Injuries

Ashley Levack, MD, MAS*[1]*; *Stephen Warner, MD, PhD*[1]*; Elizabeth Gausden, MD*[2]*; David Helfet, MD*[1]*; Dean Lorich, MD*[2]
[1]*Hospital for Special Surgery, New York, New York, USA;*
[2]*Hospital for Special Surgery-Cornell, New York, New York, USA*

Background/Purpose: Supination external rotation (SER) IV and pronation external rotation (PER) IV ankle fractures (OTA 44) characteristically consist of a posterior injury involving the posterior inferior tibiofibular ligament (PITFL) or a posterior malleolar (PM) fracture in addition to a medial injury to either the deltoid ligament or a medial malleolar fracture. Previous studies have suggested that the presence of a malleolar fracture predisposes patients to poorer outcomes compared to fracture patterns with intact malleoli and corresponding ligamentous injuries. Specifically, the presence and increased size of a PM fracture has been associated with inferior outcomes compared to equivalent injuries with an intact PM. Although the size of the PM fracture fragment has traditionally determined whether surgeons treat the fragment with fixation, the indication for operative fixation of PM fractures to restore the anatomy of the PITFL has increased in favor. The purpose of this study was to determine if the presence of a PM fracture in rotational ankle fractures affects functional outcomes when addressed with anatomic fixation methods.

Methods: A prospective institutional registry of operatively treated ankle fractures was used to identify all operatively treated SER IV and PER IV ankle fractures from 2004 to 2014. Additional inclusion criteria were age >18, minimum 1-year Foot and Ankle Outcome Score (FAOS), and injury-specific anatomic repair of the posterior injury. Of the cases meeting inclusion criteria, radiographs were reviewed to determine posterior injury fixation method (posterior malleolar plating or PITFL repair with a screw and soft-tissue washer). Patient demographics, medical comorbidities, and injury characteristics were recorded for each case. Independent samples t tests and $\chi 2$ were used to compare baseline characteristics and the primary outcome of FAOS scores between groups. A P value of less than 0.05 was deemed statistically significant.

Results: Of the 312 patients who met the inclusion criteria, 224 fractures were treated with injury-specific anatomic repair using either a buttress plate for PM fracture fixation (n = 161) or screw with soft-tissue washer for PITFL repair (n = 63). The PM plate group was significantly older than the PITFL repair group at the time of surgery (mean 53.7 vs 44.2; P <0.001). The PM plate group also had significantly more women (76.4% vs 39.7%; P <0.001) and lower mean body mass index compared to the PITFL group (27.5 vs 30.5; P = 0.013). There were no statistically significant differences between the two groups in type of rotational pattern (SER vs PER), fracture side, rate of open fractures, or smoking status. The PM plate group had a higher rate of hypertension (P = 0.008) but there was no difference in the presence of other recorded comorbidities. The groups showed no difference in FAOS scores for any of the five summary domains (Symptoms, Pain, Activities of Daily Living, Sports, or Quality of Life). Median length of follow-up at the time of most recent outcome measurement was 39.6 months in the PM group and 32.1 months in the PITFL repair group (P = 0.002).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusion: Previous studies have suggested that patients with PM fractures have inferior clinical outcomes compared to those with equivalent ligamentous injuries. In our cohort of rotational ankle fractures treated with injury-specific fixation, we have demonstrated comparable clinical outcomes in stage IV rotational ankle fractures with and without PM fractures, indicating that the presence of a PM fracture may not result in inferior outcomes compared to ligamentous equivalent injuries if these fractures are addressed in an anatomic injury-specific manner. Prior studies suggesting that the presence of a PM fracture predisposes to inferior clinical outcomes have not uniformly addressed the posterior fracture fragments with anatomic reduction and fixation. In this study, the PM fracture group contained a significantly older and thinner population, with a higher percentage of female patients. Further analysis will determine the potential significance of the different patient demographics and comorbidities between the two groups.

See pages 49 - 106 for financial disclosure information.

Δ Articular Inflammatory Cytokine Response is Greater in Acute Plafond Fractures than in Acute Tibial Plateau Fractures

Justin Haller, MD[1]; Lucas Marchand, MD[2]; David Rothberg, MD[2]; Erik Kubiak, MD[2]; ***Thomas Higgins, MD***[3]
[1]*Harborview Medical Center, Seattle, Washington, USA;*
[2]*University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA;*
[3]*University Orthopaedic Center, Salt Lake City, Utah, USA*

Purpose: The intra-articular inflammatory response has been proposed as playing a role in the development of posttraumatic osteoarthritis (PTOA). Prior studies have demonstrated an elevated inflammatory response following tibial plateau fracture. However, the reported rate of PTOA following tibial plateau fractures is not as high as other lower extremity articular fractures such as tibial plafond fractures. The purpose of this study is to evaluate the presence of inflammatory cytokines and matrix metalloproteinases (MMPs) following acute plafond fractures, and to compare this response to acute tibial plateau fractures.

Methods: After IRB approval, investigators prospectively aspirated synovial fluid from the injured and uninjured joints of 45 patients with tibial plateau fractures and from 19 patients with plafond fracture. Patients with open fracture, history of autoimmune disease, preexisting arthritis, or presentation greater than 24 hours from injury were excluded. The concentrations of interleukin (IL)-1ß, IL-1RA, IL-6, IL-8, IL-10, monocyte chemoattractant (MCP)-1, tumor necrosis factor (TNF)-α, MMP-1, -3, -9, -10, -12, and -13 were quantified using multiplex assays. Repeated measures analysis of variance (ANOVA) was used to test for differences on the log-transformed variables. A Bonferroni correction was used so that the adjusted alpha level for significance was $P < 0.004$.

Results: We enrolled 45 patients with tibial plateau fracture and 19 patients with tibial plafond fracture. Mean patient age was 42 years (range, 20-60) and there were 64% male patients. There were 24 Schatzker 1-3 (OTA 41B) plateau fractures and 21 Schatzker 4-6 (6 OTA 41B3 and 15 OTA 41C) plateau fractures. There were 8 OTA 43B plafond fractures and 11 OTA 43C plafond fractures. All inflammatory cytokines and MMPs except MMP-13 were significantly elevated in acute plafond fractures in the injured as compared to uninjured ankles. There was no difference in inflammatory cytokine or MMP concentration in OTA 43C plafond fractures as compared to OTA 43B plafond fractures. When comparing concentrations of acutely injured joints, IL-8 ($P < 0.001$), IL-1ß ($P = 0.002$), and MMP-12 ($P = 0.001$) were significantly higher in plafond fractures as compared to tibial plateau fractures. Concentrations of IL-1RA ($P = 0.008$) and MCP-1 ($P = 0.005$) were higher in acute plafond fractures compared to tibial plateau fractures, and MMP-10 ($P = 0.01$) was less in acute plafond fractures compared to plateau fractures (Fig. 1).

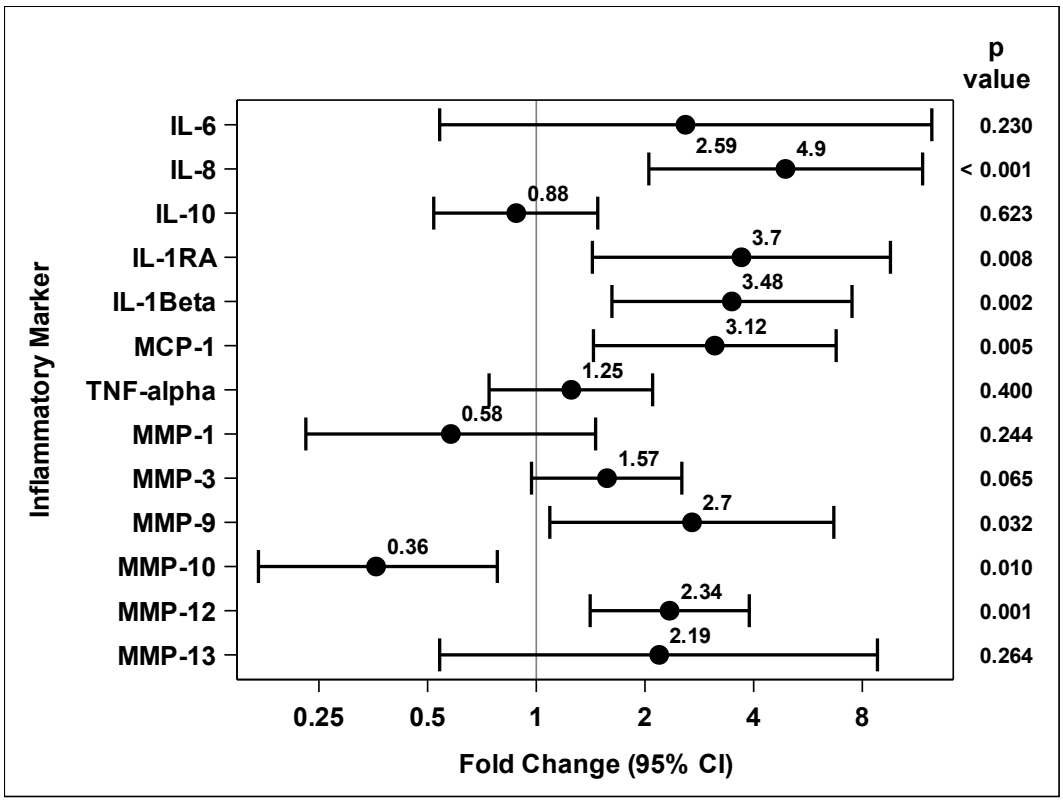
Conclusion: There is a significant inflammatory response in acute plafond fractures compared to the uninjured ankle. Most interesting, there were several inflammatory cytokines that were significantly elevated in acute plafond fractures as compared to acute tibial plateau fractures. Previous work in degenerative arthritis has suggested a correlation between inflammatory response and development of arthritis, and the role of inflammatory cytokines in PTOA is

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

being explored currently. The higher inflammatory response in plafond fractures than plateau fractures is consistent with the clinical finding that plafond fractures have higher rates of PTOA than tibial plateau fractures. This may suggest an association of the inflammatory response with PTOA and indicates that these biomarkers merit further investigation for a possible role in the development of PTOA.

Figure 1. Fold Change in Inflammatory Responses Between Pilon vs. Plateau Fractures



See pages 49 - 106 for financial disclosure information.

Δ Negative Pressure Therapy Dressings versus Standard Dressings for Closed Calcaneus Fractures: Preliminary Results of a Prospective Randomized Study of Wound Complications

*Camille Connelly, MD; **Amanda Schroeder, MD**; Michael Archdeacon, MD; Ryan Finnan, MD; Frank Avilucea, MD; Theodore Toan Le, MD; John Wyrick, MD; Michael Archdeacon, MD*
University of Cincinnati, Dept of Orthopaedics, Cincinnati, Ohio, USA

Purpose: This study was undertaken to compare early wound complications obtained with incisional negative pressure wound therapy (NPWT) versus standard wound dressings after open reduction and internal fixation of calcaneus fractures.

Methods: Skeletally mature patients with operative closed calcaneus fractures presenting consecutively to our Level I trauma center between February 2011 and February 2016 were randomized to the incisional NPWT or standard dressing groups. All surgeries utilized the standard lateral extensile approach to the calcaneus. Patients randomized to the standard wound care group received standard absorptive dressings (small hemovac wound drain, bacitracin/polysporin ointment, nonadherent dressing, and gauze). Patients randomized to the incisional NPWT group received an incisional vacuum dressing (nonadherent dressing, NPWT sponge, single-use pump and a small hemovac wound drain). All fractures were splinted postoperatively. NPWT dressings were maintained for 2-4 days. Main outcomes measures were: initial surgical wound healing (first 4-6 weeks postoperatively) with specific attention directed toward epidermolysis/skin edge necrosis, superficial infection (prolonged wound drainage [more than 8 days], wound erythema, oral antibiotic prescription, and deep infection (hospital readmission, parenteral antibiotics, surgical intervention). Secondary outcomes compared visual analog scale (VAS) scores through 6 weeks and functional outcome scores at 12 months (Short Form-36, Short Musculoskeletal Function Assessment, American Orthopaedic Foot & Ankle Society).

Results: 39 patients with 44 closed calcaneus fractures were prospectively enrolled and randomized to the treatment groups. All patients were available for primary outcome evaluation (surgical wound healing) and VAS evaluations through 6 weeks postoperatively. 29 of 44 patients were available for follow-up at least 6 months (12 ± 0.8, range 2-45 months). 26 patients had associated injuries and 13 presented with isolated calcaneus fractures. Comparison of incisional NPWT and standard dressings showed the following: 4 acute complications requiring intervention, including 1 superficial infection in the NPWT group (5%) and 3 deep infections in the standard dressing group (13%), P = 0.2389. Late complications included 2 deep infections in the NPWT group presenting at 7 and 8 weeks postoperatively. VAS scores in NPWT and standard groups were 7.1 ± 2.7 and 7.6 ± 2.4 at hospital discharge (P = 0.5723) and 2.4 ± 1.9 and 3.5 ± 2.9 at 6 weeks (P = 0.2673).

Conclusion: Preliminary results have shown no significant difference in pain, functional outcome scores, and overall wound complications in incisions treated with incisional NPWT versus standard gauze dressings. There is a trend toward lower acute deep infection rates in the incisional NPWT dressing group; however, continued enrollment to reach statistical power is needed.

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Treatment of Primary Ligamentous Lisfranc Injuries:
Comparison between Screw Fixation and Tightrope Fixation

Harish Kempegowda, MD[1]; *Shannon Alejandro, MD[1]; Amrut Borade, MD[1]; Benjamin Wagner, MD[1]; Jove Graham, PhD[2]; Gerard Cush, MD[1]; James Gotoff, BS[1]; Daniel Horwitz, MD[3]*
[1]*Geisinger Medical Center, Danville, Pennsylvania, USA;*
[2]*Geisinger Center for Health Research, Pennsylvania, USA;*
[3]*Geisinger Health Systems, Danville, Pennsylvania, USA*

Background/Purpose: Primary ligamentous Lisfranc injuries are frequently missed during initial presentation and are notorious to delayed healing, which leads to long-term disability. The ideal treatment for the primary Lisfranc injury is still under debate with various treatment options including nonoperative, screws, tightropes, and arthrodesis. There are a few case reports on tightrope fixation for Lisfranc injuries reporting advantages including early full weight bearing and no secondary procedure for hardware removal; however, there are no clinical studies. The objective of this study is to analyze and compare the clinical results of the tightrope fixation to the screw fixation for pure ligamentous Lisfranc injuries.

Methods: After obtaining IRB approval, we conducted a retrospective study to identify all skeletally mature patients who were treated for Lisfranc fracture-dislocation injuries between September 2006 and November 2014. The inclusion criteria for the study were skeletally mature patients treated with tightropes or screws for acute Lisfranc injury with an injury duration of less than 3 months duration from the date of surgery. Excluded were comminuted intra-articular fractures of 1st and 2nd metatarsal base and other modalities of treatment including nonoperative, Kirshner wires, plates, and arthrodesis. Primary outcomes measured included demographics, mechanism of injury, quality of reduction, rate of planned and unplanned implant removal, complications including infection and hardware irritation, return to preinjury status, full weight bearing, and the reduction maintained or not at last follow-up. Patients with a minimum follow-up of 6 months were included for analysis. The reduction was considered acceptable if the Lisfranc joint was anatomically reduced or diastasis was <2 mm and poor if the diastasis at the joint space was >2 mm.

Results: A total of 51 out of 168 patients met the criteria, of which 27 belonged to tightrope group and 24 belonged to screw group. Detailed analysis for each group are in Table 1. Both groups were identical for many of the preoperative characteristics including demographics ($P = 0.10$), surgical wait ($P = 0.59$), smoking ($P = 0.99$), other associated foot and ankle injuries ($P = 0.53$), and diabetes ($P = 0.99$). The quality of reduction based on immediate postoperative radiographs ($P = 0.07$), maintenance of the reduction ($P = 0.78$), infection rate ($P = 0.99$), and skin problems ($P = 0.15$) were similar in both groups. Implant removal rate including planned or unplanned ($P \leq 0.0001$), broken hardware ($P = 0.02$), and return to full weight bearing ($P \leq 0.0001$) are significantly different between the two groups. Average follow-up duration for tightrope group was 72 weeks (range, 38-168) and screw group was 79 weeks (range, 40-175).

Conclusion: Our study suggests that the tightrope fixation carries advantage over the screw

See pages 49 - 106 for financial disclosure information.

Table 1A. Comparison of surgical and post-surgical characteristics between patients receiving tightropes vs. screws for Lis Franc fractures.

	Tightrope (n=27)	Screws (n=24)	p-value
Age in years, Mean (SD)	30 (17)	38 (17)	0.10
Males, N (%)	14 (52%)	12 (50%)	0.89
Side, N(%)			0.64
Left	10 (37%)	10 (43%)	
Right	17 (63%)	13 (57%)	
Nunley and Vertillo Classification, N (%)			0.23
II	22 (81%)	16 (67%)	
III	5 (19%)	8 (33%)	
Diagnosed on X-ray, N (%)*	22 (81%)	23 (100%)	0.05
CT scan used in (%)	11 (41%)	14 (58%)	0.21
Mechanism of Injury, N(%)			0.0001
Motor vehicle crash	1 (4%)	11 (46%)	
Crush	1 (4%)	0 (0%)	
Fall	7 (26%)	9 (38%)	
Sports	7 (26%)	0 (0%)	
Twist	11 (41%)	4 (17%)	
Diabetes, N (%)	1 (4%)	1 (4%)	0.99
Smoking, N (%)	4 (15%)	4 (17%)	0.99
Wait between fracture and surgery in days, Mean (SD)	15 (12)	11 (11)	0.16
Other foot and ankle injuries, N (%)	8 (30%)	8 (30%)	0.78
Quality of reduction, N (%)			0.07
Acceptable (<2mm)	6 (22%)	1 (4%)	
Good	20 (74%)	23 (96%)	
Poor	1 (4%)	0 (0%)	
Implants removed, N (%)	0 (0%)	20 (83%)	<0.0001
Hardware broken, N (%)	0 (0%)	5 (21%)	0.02
Infection, N (%)	1 (4%)	3 (13%)	0.33
Skin problems, N (%)	0 (0%)	1 (4%)	0.47
Any revision other than implant removal, N(%)	1 (4%)	2 (8%)	0.46
Radiographs at final follow-up, N(%)			0.66
Good	25 (93%)	21 (88%)	
Poor	2 (7%)	3 (13%)	
Arthritic changes, N (%)	2 (7%)	6 (25%)	0.13
Weeks to full weight bearing, Mean (SD)	6 (2)	13 (5)	<0.0001

fixation in terms of lower reoperation rate and early full weight bearing. Given the high rate of good quality of reduction and its maintenance as well as advantages of low secondary procedures and early weight bearing, tightropes can be utilized routinely in the treatment of primary ligamentous lesions especially for the athletes and the young adults where fine movements are desired.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

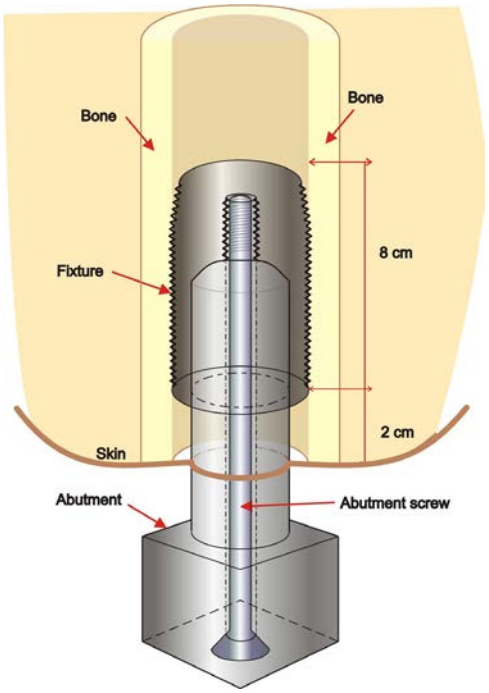
An Osseointegrated Percutaneous Prosthetic System for Treatment of Transfemoral Amputees: Medium and Projected Long-Term Follow-Up

Örjan Berlin, MD, PhD; *Kerstin Hagberg, PT, PhD;*
Katarzyna Kulbacka-Ortiz, Research Assistant; Rickard Brånemark, MD, PhD
Gothenburg University, Gothenburg, SWEDEN

Purpose: In 2014 we published the first prospective study on the results of bone-anchored amputation prostheses in transfemoral amputees (TFAs). The OPRA study (Osseointegrated Prosthesis for the Rehabilitation of Amputees) includes 51 patients with 55 implants recruited from 1999 to 2007. At the 2-year follow-up (FU) in May 2010, 3 patients were excluded (1 dead, 1 lost to FU, 1 withdrawn due to contralateral extremity problems). The aim of the current study is to report on the clinical outcome with a minimum of 5-year FU with this technique, and projected 10-year results.

Methods: The surgery consists of a two-stage procedure. First a titanium screw (fixture - F) is inserted intramedullary into the remaining skeleton (S1 operation). Six months later a transdermal implant (abutment - A) is inserted into the fixture (S2 operation). The abutment is secured to the fixture by an abutment screw (AS).

Results: At 2-year FU 4 implants had been removed due to loosening (3) or infection (1), leaving 44 remaining patients (48 implants) in the study. The cumulative implant survival was 92%. The patients had an average of one superficial infection every 2 years, successfully treated conservatively with peroral or local antibiotics in all cases. There were 6 deep infections in 4 patients. All but one were successfully treated by conservative means. Four patients had 9 mechanical complications (bent or fractured As or ASs) and 3 skeletal fractures occurred. Prosthetic use, prosthetic functions, and global quality of life were all significantly improved ($P<0.001$). At 5-year FU no additional fixture losses were reported, but another patient had passed away unrelated to the procedure (43 patients/47 implants). Hence the implant survival rate remains stable at 92%. Between the 2- and 5-year FU superficial and deep infections occurred in 22 and 7 patients, respectively. Another 8 patients had bent or fractured As or ASs after trauma, and 15 patients had other mechanical problems due to wear leading to change of the A or AS. No F has been removed between the 2- and 5-year FU.



Conclusion: The observed cumulative success rate of 92% at 2-year FU remains stable at 5-year FU. Despite the general belief in the orthopaedic

See pages 49 - 106 for financial disclosure information.

community, deep infection does not correspond to loosening of the implant, and neither does a superficial infection necessarily continue to develop into a deep infection. Patients using the OPRA implant report stable improvements in prosthetic function at 2- and 5-year FU as compared to baseline, and preliminary results indicate that this improvement is stable until 10-year FU. However the mechanical issues are of concern in a long-term perspective and need to be continuously monitored. So far these issues have been successfully addressed and solved.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Improved Function and Quality of Life Following Osseointegrated Reconstruction of Posttraumatic Amputees

Vaida Glatt, PhD[1]; Munjed Al Muderis, FRACS, FRCS (Ortho), MB, ChB[2];
Kevin Tetsworth, MD[3]
[1]*Institute of Health and Biomedical Innov, Queensland, AUSTRALIA;*
[2]*School of Medicine Sydney, University of Notre Dame, Australia, New South Wales, AUSTRALIA;*
[3]*Royal Brisbane Hospital, Queensland, AUSTRALIA*

Background/Purpose: One of the major causes of lower limb amputation is severe trauma resulting in a mangled extremity or failed attempt at limb salvage. Unfortunately, at least one-third of all amputees still encounter symptomatic socket-residuum interface problems, leading to reduced prosthetic use and a markedly diminished quality of life. Over the last two decades, a new concept called osseointegration has emerged in an attempt to overcome the many issues associated with traditional socket-mounted prosthetics. By intimately connecting the artificial limb prosthesis to the residual bone, the problematic socket-residuum interface can now be potentially eliminated. This study introduces the Osseointegration Group of Australia Accelerated Protocol (OGAAP-1) using press-fit fixation for transcutaneous prostheses. The primary objective was to describe in detail this two-stage strategy (OGAAP-1) for the osseointegrated reconstruction of amputated limbs. The secondary objective was to assess the clinical outcomes and efficacy of the OGAAP-1 program in posttraumatic unilateral transfemoral amputees.

Methods: This was a prospective case series of 32 posttraumatic unilateral transfemoral amputees treated at a single center. The study included 25 males and 7 females, aged 24-67 (mean, 46.8) years, with a minimum 1-year follow-up. The main outcome measures included the Questionnaire for persons with a Trans-Femoral Amputation (Q-TFA), the Short Form Health Survey 36 (SF-36), K levels, and the Six Minute Walk Test (6MWT) and Timed Up and Go (TUG) tests, pre- and postoperatively. Adverse events were recorded including infection, revision surgery, fractures, and implant failures.

Results: Clinical outcomes were obtained pre- and postoperatively from 12 to 46 months, with a mean follow-up of 22 months. Compared to the mean preoperative values with socket prostheses, the mean postoperative values for all five validated outcome measures were significantly improved. Both the postoperative Q-TFA global score (46.88 ± 3.51 to 83.62 ± 3.47, $P < 0.0001$) and the SF-36 physical component summary (36.89 ± 1.81 to 48.49 ± 1,69, $P < 0.0001$) were markedly superior to those of the preoperative values. K levels improved in 16 patients, and remained unchanged in 16 patients; no patient had a reduction in their K level ($\chi^2 = 16.01$, df = 2, $P = 0.0003$). Both the 6MWT (193 ± 31.67 to 434 ± 23.78, $P < 0.0001$) and the TUG (11.17 ± 1.77 to 7.40 ± 0.4, $P = 0.04$) were also significantly improved. 8 participants were wheelchair-bound preoperatively, and could not perform the TUG and 6MWT; however, all 8 were able to do so after osseointegrated reconstruction, and their postoperative values were comparable to those of the prosthetic users who were ambulatory preoperatively. A total of 20 participants were adverse event-free, three of whom required elective soft-tissue refashioning 12 months after the second stage procedure to avoid redundant tissue

See pages 49 - 106 for financial disclosure information.

impingement, skin irritation, and infection. There were episodes of infection in 10 patients; 7 responded to oral antibiotics and 3 required surgical soft tissue-debridement, one patient also required IV antibiotics. Refashioning of the soft-tissue residuum was performed on 4 patients; 1 periprosthetic fracture occurred due to increased activity. There was one implant fatigue failure, which was revised successfully.

Conclusion: In these 32 posttraumatic unilateral transfemoral amputees, significant improvements were achieved in all of the outcome measures of health-related quality of life, ambulation ability, and functional levels. These findings are comparable to, or better than, those reported previously by other groups using alternative implants and rehabilitation protocols. Under the OGAAP-1 protocol the time interval between the initial procedure and fully independent ambulation was approximately 4.5 months. This contrasts markedly with the protracted interval between the initial procedure and independent ambulation previously reported for screw-type osseointegration implants, typically requiring as long as 9 to 12 months. The more rapid completion of reconstruction is likely due to a combination of factors, including the decreased interval between stages and the accelerated progression of weight-bearing exercises and rehabilitation. These results confirm the OGAAP-1 is a suitable alternative for posttraumatic unilateral transfemoral amputees experiencing socket-related discomfort, with the potential to reduce recovery time compared to other staged treatment protocols.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Paper 115

Δ Prognostic Factors for Predicting Reoperations after Operative Management of Open Fractures

*Mohit Bhandari, MD, FRCSC, PhD[1]; Kyle Jeray, MD[2]; Brad Petrisor, MD[3]; Jeffrey Anglen, MD, FACS[4]; Gregory Della Rocca, MD, PhD, FACS[5]; PJ Devereaux, MD[6]; Diane Heels-Ansdell, MSc[6]; Clifford Jones, MD, FACS[7]; Hans Kreder, MD[8]; Susan Liew, MD[9]; Kim Madden, MSc[6]; Sun Makosso-Kallyth, PhD[6]; Paula McKay, BSc[6]; Steven Papp, MD, FRCPC[10]; Parag Sancheti, MD[11]; Emil H. Schemitsch, MD[12]; Sheila Sprague, PhD[6]; Stephanie Tanner, MS[2]; **Paul Tornetta III, MD**[13]; Ted Tufescu, MD[14]; Stephen D. Walter, BSc, ARCS, PhD[6]; Gordon Guyatt, MD[6]; FLOW Investigators[6]*
[1]*MacOrtho Research, Ontario, CANADA;*
[2]*Greenville Health System University Medical Center, Greenville, South Carolina, USA;*
[3]*Hamilton General Hospital, Ontario, CANADA;*
[4]*Indiana University, Indianapolis, Indiana, USA;*
[5]*University of Missouri School of Medicine, Columbia, Missouri, USA;*
[6]*McMaster University, Hamilton, Ontario, CANADA;*
[7]*Orthopaedic Associates of Michigan, Grand Rapids, Michigan, USA;*
[8]*University of Toronto Sunnybrook Health Sciences Centre, Toronto, Ontario, CANADA;*
[9]*The Alfred Hospital, Melbourne, AUSTRALIA;*
[10]*University of Ottawa, Ontario, CANADA;*
[11]*Sancheti Institute, Maharashtra, INDIA;*
[12]*St. Michael's Hospital, Toronto, Ontario, CANADA;*
[13]*Boston Medical Center, Boston, Massachusetts, USA;*
[14]*University of Manitoba, Manitoba, CANADA*

Purpose: Open fractures are often complicated by infections, wound healing problems, and failure of fracture healing—many of which necessitate operative management and result in delayed return to function. Identifying factors that are associated with these detrimental outcomes may help to optimize the care of these challenging injuries. The FLOW (Fluid Lavage of Open Wounds) trial recently evaluated the effects of irrigation solution and pressure in 2447 patients with open extremity fractures of whom 323 required a reoperation. Using the data from this multicenter trial, we investigated the association between key baseline and surgical factors and risk of reoperation within 1 year.

Methods: Based on biologic rationale and previous reports in the literature, we identified 23 potential prognostic factors from the baseline, fracture characteristics, and surgical data collected as part of the FLOW trial. Selected factors are summarized in Table 1. We used a multivariable Cox proportional hazards regression analysis to investigate their association with increased risk of reoperation within 1 year to treat an infection, wound healing problem, or fracture healing problem (ie, primary outcome of the FLOW trial). All tests were 2-tailed with $\alpha = 0.05$.

Results: We found the following fracture characteristics were associated with an increased risk of reoperation: lower extremity fractures (hazard ratio [HR] = 2.93, 95% CI 1.97-4.35),

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

Gustilo-Anderson Type III fractures (HR = 1.49, 95% CI 1.14-1.96), and moderate to severe wound contamination (HR = 1.33, 95% CI 1.01-1.75). We also found that patients who received a surgical preparation solution in the emergency room and those who received an iodine-based preparation solution in the operating room had decreased risk of reoperation (HR = 0.66, 95% CI 0.48-0.91 and HR = 0.53, 95% CI 0.30-0.94, respectively). Delayed time to initial surgery (≥6 hours from injury) was not associated with an increased risk of reoperation.

Conclusion: As expected, Gustilo-Anderson Type III fractures, highly contaminated wounds, and fractures of the lower extremity were associated with an increased risk of reoperation. Results of this analysis also suggest that surgeons' choice of skin preparation solution and the use of a skin preparation solution in the emergency room may have an impact on rates of reoperation following an open fracture, warranting further investigation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1: Factors associated with re-operation within one year to treat an infection, wound healing problem or fracture healing problem in open fractures

Independent Variable	Frequency n (%)	Adjusted Hazard Ratio (95% CI)	p-value
Gender			
Male	1598 (69.48)	1.00	0.5111
Female	702 (30.52)	1.097 (0.833-1.443)	
Smoking status			
Current smoker	750 (32.61)	1.020 (0.803-1.296)	0.8696
Non-smoker	1550 (67.39)	1.00	
Mechanism of Injury			
High energy	2029 (88.22)	0.940 (0.605-1.463)	0.7849
Low energy	271 (11.78)	1.00	
Major Concomitant Trauma			
Yes	310 (13.48)	1.00	0.5080
No	1990 (86.52)	0.897 (0.650-1.237)	
Work-related Injury			
Yes	332 (14.43)	1.351 (0.996-1.833)	0.0533
No	1968 (85.57)	1.00	
OTA Fracture Class			
A	713 (31.00)	1.00	
B	710 (30.87)	1.092 (0.802-1.487)	0.5778
C	877 (38.13)	1.235 (0.919-1.661)	0.1619
Location			
Lower extremity fracture	1582 (68.78)	2.927 (1.970-4.351)	<.0001
Upper extremity fracture	718 (31.22)	1.00	
Wound Contamination			
Mild	1765 (76.74)	1.00	0.0439
Moderate/Severe	535 (23.26)	1.329 (1.008-1.753)	
Wound Prep in ER			
Yes (Iodine, Chlorhex, Alcohol)	569 (24.74)	0.660 (0.481-0.906)	0.0100
No	1731 (75.26)	1.00	
Randomized Solution			
Saline	1144 (49.74)	1.00	0.0055
Soap	1156 (50.26)	1.382 (1.100-17.37)	
Randomized Pressure			
Very Low	770 (33.48)	1.056 (0.798-1.396)	0.7042
Low	755 (32.83)	1.00	
High	775 (33.70)	1.026 (0.775-1.358)	0.8596
Time to Incision from Injury			
<6 hrs	458 (19.91)	1.00	0.7535
≥6 hrs	1842 (80.09)	1.044 (0.797-1.369)	
Iodine Prep Solution in OR			
Yes	1195 (51.96)	0.527 (0.296-0.935)	0.0287
No	1105 (48.04)	1.00	
Chlorhexidine Prep Solution in OR			
Yes	1019 (44.30)	0.651 (0.370-1.145)	0.1366
No	1281 (55.70)	1.0	
Alcohol Prep Solution in OR			
Yes	389 (16.91)	0.883 (0.640, 1.221)	0.4524
No	1911 (83.09)	1.0	
Other Prep Solution in OR			
Yes	137 (5.96)	1.067 (0.568-2.008)	0.8387
No	2163 (94.04)	1.0	

See pages 49 - 106 for financial disclosure information.

Initial Fixation Approach			
Plate	919 (39.96)	1.00	
Nail	714 (31.04)	1.091 (0.790-1.506)	0.5982
External fixation	354 (15.39)	1.322 (0.931-1.879)	0.1192
Other internal fixation	281 (12.22)	0.645 (0.403-1.034)	0.0683
No initial fixation	32 (1.39)	0.466 (0.114-1.908)	0.2882
Local Antibiotics at Wound			
Yes (beads)	73 (3.17)	1.433 (0.890-2.341)	0.1371
No	2227 (96.83)	1.00	
Amount of Muscle Debrided			
None/Small	2025 (88.04)	1.00	0.2462
Moderate/Large	275 (11.96)	1.233 (0.865-1.758)	
Amount of Skin Debrided			
None/Small	1979 (86.04)	1.00	0.8324
Moderate/Large	321 (13.96)	0.962 (0.678-1.366)	
Wound closed at initial procedure?			
Yes	1936 (84.17)	1.00	0.1371
No	364 (15.83)	1.260 (0.929-1.710)	
Fracture Severity (Gustilo Type-Post Op)			0.0036
Type I/II	1471 (63.96)	1.00	
Type III	829 (36.04)	1.49 (1.14-1.96)	
Post Op Fracture Gap			
<1cm	2067 (89.87)	1.00	0.4034
1cm or greater	233 (10.13)	0.856 (0.594-1.23)	

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Paper 116

Δ What Factors are Associated with Infection in Open Fractures? A Predictive Model Based on a Prospective Evaluation of 2338 Patients

Paul Tornetta III, MD[1]; Gregory Della Rocca, MD, PhD, FACS[2]; Saam Morshed, MD[3]; Clifford Jones, MD, FACS[4]; Diane Heels-Ansdell, MSc[5]; Sheila Sprague, PhD[5]; Brad Petrisor, MD[6]; Kyle Jeray, MD[7]; Mohit Bhandari, MD, FRCSC, PhD[8]; FLOW Investigators
[1]Boston Medical Center, Boston, Massachusetts, USA;
[2]University of Missouri School of Medicine, Columbia, Missouri, USA;
[3]University of California San Francisco, San Francisco General Hospital, Orthopaedic Trauma Institute, San Francisco, California, USA
[4]Orthopaedic Associates of Michigan, Grand Rapids, Michigan, USA;
[5]McMaster University, Hamilton, Ontario, CANADA;
[6]Hamilton General Hospital, Ontario, CANADA;
[7]Greenville Health System University Medical Center, Greenville, South Carolina, USA;
[8]MacOrtho Research, Ontario, CANADA

Purpose: The primary risk of open fractures is infection. The majority of data regarding infection in open fractures exist in tibial shaft fractures, which have been reported to have the highest rate of infection. Additionally, upper extremity injuries are thought to be more resistant to infection than lower extremity injuries. The purpose of this study is to analyze a large series of open fractures of the lower and upper extremities to determine the risk factors that predict the development of infection.

Methods: This study was a prospective evaluation of soap and irrigation pressure on a combined event outcome. The trial showed no difference in irrigation pressure and a slight advantage using saline rather than soap on the primary outcome of revision surgery. In this study, a statistician used a Cox proportional hazards regression analysis to identify the factors associated with "any" and "deep" infection. Results are presented as hazard ratios (HRs) and 95% confidence intervals (CIs). Irrigation pressure and use of soap were included in both models as they were the basis of the initial study. A research team identified the most likely factors that would contribute to infection and limited the number of factors to the number of events/10 as is recommended for regression analysis.

Results: We analyzed 2338 patients with upper extremity (UE) and lower extremity (LE) open fractures to identify the risk factors for infection. The average age was 45 and 69% were male. Location was divided into tibia (883) (shaft, plateau and pilon), other LE (726), and UE (729). There were 289 infections of which 156 were deep. For all factors found to be predictive, the following text shows HRs and P values (also see data tables). The factors associated with any infection were: location (tibia vs UE: 5.13, other LE vs UE: 3.63; P <0.001), high-energy mechanism of injury (0.61; P = 0.019), degree of contamination (moderate vs mild: 1.08, severe versus mild: 2.12; P = 0.004) and need for flap coverage (1.82; P = 0.017). The factors associated with deep infection were: location (tibia vs UE: 2.72, other LE vs UE: 2.98; P <0.001), Gustilo type 3 (1.57; P = 0.016), delayed closure (1.89; P = 0.003), and need for flap (2.05; P = 0.017).

Δ OTA Grant

See pages 49 - 106 for financial disclosure information.

Conclusion: We performed a regression analysis of the trial data to determine the risk factors for any infections and for deep infections. Having a tibia fracture was the strongest predictor of any and deep infection. Degree of contamination and grade 3 open fracture predicted any and deep infection, respectively. Finally, the need for a flap for coverage predicted any and deep infection and a delayed closure predicted deep infection independent of the requirement for a flap. Soap and irrigation pressure were not predictive in this model.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

What Factors are Associated With Infection in Open Fractures? A Predictive Model Based on a Prospective Evaluation of 2338 Patients

Cox proportional hazards regression analysis with time to Any Infection as the dependent variable. N=2338 with 289 events (complete case). Our main analysis for Any Infection excludes 7 patients with delayed definitive fixation who experienced an infection prior to definitive fixation.

Independent Variable	Incidence of Predictors n (%)	Adjusted Hazard Ratio (95% CI)	p-value
Age (10-year increase)	45.1 (17.8) mean (SD)	1.04 (0.96, 1.12)	0.376
Male	1622 (69.4)	1.05 (0.79, 1.39)	0.733
Fracture location			<0.001
Tibia	883 (37.8)	5.13 (3.28, 8.02)	
Other lower extremity	726 (31.1)	3.63 (2.38, 5.55)	
Upper extremity	729 (31.2)	1.00	
High energy mechanism of injury	2058 (88.0)	0.61 (0.41, 0.92)	0.019
Current smoker	754 (32.2)	1.08 (0.84, 1.40)	0.537
Other major injury*	722 (30.9)	0.91 (0.69, 1.19)	0.496
Comminuted or segmental fracture	1579 (67.5)	1.21 (0.91, 1.60)	0.182
Bone loss	512 (21.9)	1.19 (0.90, 1.58)	0.223
Degree of contamination			0.004
Mild	1799 (76.9)	1.00	
Moderate	416 (17.8)	1.08 (0.78, 1.49)	
Severe	123 (5.3)	2.12 (1.35, 3.32)	
Method of definitive fixation			0.148
Nail	792 (33.9)	1.00	
Plate	1177 (50.3)	1.36 (0.997, 1.86)	
Other	369 (15.8)	1.30 (0.86, 1.98)	
Bone grafting at initial surgery	50 (2.1)	0.95 (0.35, 2.60)	0.918
Type III post-operative Gustilo Type	846 (36.2)	1.23 (0.92, 1.64)	0.161
Total operating time ≥120 minutes	997 (42.6)	1.11 (0.86, 1.44)	0.429
Time to first incision from injury			0.126
<6 hours	465 (19.9)	1.00	
6 to 12 hours	980 (41.9)	0.92 (0.68, 1.23)	
>12 to 24 hours	785 (33.6)	0.71 (0.50, 1.02)	
>24 hours	108 (4.6)	1.27 (0.66, 2.43)	
Wound ***not*** closed at initial I&D	373 (16.0)	0.95 (0.66, 1.38)	0.796
Randomized solution			0.922
Soap	1178 (50.4)	1.01 (0.80, 1.28)	
Saline	1160 (49.6)	1.00	
Randomized pressure			0.833
High	784 (33.5)	1.00	
Low	772 (33.0)	1.05 (0.79, 1.41)	
Very low	782 (33.4)	1.09 (0.82, 1.46)	
Time-dependent variables			
Wound flap (re-operation)	108 (4.6) ever	1.82 (1.11, 2.99)	0.017

* At least one of the following: femoral fracture, pelvic fracture, spinal fracture, liver injury, bowel injury, splenic injury, other abdominal injury, hemo/pneumothorax, closed head injury, urogenital injury, traumatic amputation, vascular injury, lung contusion, thoracic injury, hip fracture, spinal injury.

See pages 49 - 106 for financial disclosure information.

What Factors are Associated With Infection in Open Fractures? A Predictive Model Based on a Prospective Evaluation of 2338 Patients

Cox proportional hazards regression analysis with time to Deep Infection as the dependent variable. N=2346 with 156 events (complete case).

Independent Variable	Incidence of Predictors n (%)	Adjusted Hazard Ratio (95% CI)	p-value
Age (10-year increase)	45.1 (17.7) mean (SD)	1.07 (0.96, 1.18)	0.220
Male	1626 (69.3)	0.92 (0.64, 1.33)	0.663
Fracture location			<0.001
Tibia	885 (37.7)	2.72 (1.57, 4.71)	
Other lower extremity	729 (31.1)	2.98 (1.72, 5.18)	
Upper extremity	732 (31.2)	1.00	
Current smoker	758 (32.3)	1.03 (0.73, 1.47)	0.855
Other major injury*	724 (30.9)	1.03 (0.72, 1.45)	0.892
Type III post-operative Gustilo Type	852 (36.3)	1.57 (1.09, 2.27)	0.016
Total operating time ≥120 minutes	1000 (42.6)	0.98 (0.69, 1.39)	0.921
Time to first incision from injury			0.083
<6 hours	467 (19.9)	1.00	
6 to 12 hours	985 (42.0)	0.77 (0.52, 1.13)	
>12 to 24 hours	786 (33.5)	0.54 (0.34, 0.87)	
>24 hours	108 (4.6)	0.88 (0.36, 2.16)	
Wound ***not*** closed at initial I&D	380 (16.2)	1.89 (1.24, 2.90)	0.003
Randomized solution			0.955
Soap	1181 (50.3)	0.99 (0.72, 1.36)	
Saline	1165 (49.7)	1.00	
Randomized pressure			0.817
High	787 (33.5)	1.00	
Low	774 (33.0)	1.10 (0.75, 1.62)	
Very low	785 (33.5)	0.98 (0.66, 1.46)	
Time-dependent variables			
Wound flap (re-operation)	110 (4.7) ever	2.05 (1.14, 3.71)	0.017

* At least one of the following: femoral fracture, pelvic fracture, spinal fracture, liver injury, bowel injury, splenic injury, other abdominal injury, hemo/pneumothorax, closed head injury, urogenital injury, traumatic amputation, vascular injury, lung contusion, thoracic injury, hip fracture, spinal injury.

Sensitivity Analysis #1 – Outcome: Deep Infection

- Same as the main model except remove operative time and time to first incision from injury (these two variables account for much of the missing data).
- N=2401. No substantial changes for any predictor variables (ie. no changes in the conclusions).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Pilot Randomized Clinical Trial to Compare Intramedullary Nailing to Uniplanar External Fixation for Open Tibial Shaft Fractures in Tanzania

Max Liu, BA[1]; David Shearer, MD[1]; ***Kurt Yusi, MD[1];*** *Saam Morshed, MD[1]; Edmund Eliezer, MD[2]; Billy Haonga, MD[2]*
[1]University of California San Francisco, San Francisco General Hospital, Orthopaedic Trauma Institute, Institute for Global Orthopaedics and Traumatology, San Francisco, California, USA; [2]Muhimbili Orthopaedic Institute, Dar es Salaam, TANZANIA

Background/Purpose: The incidence of severe musculoskeletal injuries continues to climb in low- and middle-income countries (LMICs). Much can be gained from conducting research in these settings to evaluate treatments and therapeutic outcomes. The randomized controlled trial (RCT) is the most rigorous study design and provides the most unbiased results. However, conducting a large-scale RCT in developing settings poses significant challenges. Indeed, a recent scoping review of clinical orthopaedics research conducted in LMICs found that between 2004 and 2014, only 22 RCTs achieved Level 1 evidence. We report a pilot prospective RCT comparing superficial infection rates between the intramedullary (IM) nail and external fixator (EF) for the treatment of open tibia fractures in Tanzania.

Methods: Enrollment for the 2-month pilot RCT began in December 2015. All patients with open tibia fractures who presented to the study center were screened for eligibility. Patients with AO/OTA Type 42 open tibia fractures who met criteria were invited to enroll in the study. Any open fracture wound that was primarily closable at the index operation was included (Gustilo Type I, II, or IIIA). Patients were randomized to receive either a SIGN (Surgical Implant Generation Network) interlocking IM nail or AO single bar, uniplanar EF. All patients were invited for a follow-up wound check at 2 weeks. The primary outcome was surgical site infection (SSI) incidence as defined by CDC guidelines. All data entry was conducted on REDCAP using password-protected laptops. Four international investigators, two local investigators, and three local research coordinators served as the core research team for this study.

Results: 95 patients presented with open tibia fractures at the study site during the2 -month enrollment period and were screened for eligibility. Among patients screened, 40 patients (42%) met the eligibility criteria and all eligible patients consented to participate in the study (100% enrollment rate). 20 participants were randomized to each treatment arm. 38 patients (95%) were male and 2 (5%) were female. The average age was 33 ± 12 years (range, 18-70; median, 29). The most common mechanism of injury was road traffic injury (92.5%). 5% of patients had associated injuries (3 floating knees and 2 mild head injuries). The mean time from injury to presentation was 11.9 ± 7.4 hours. The mean time from presentation to surgery was 11.6 ± 8.9 hours. IM nail operations took on average 88 ± 88 minutes while EF operations took 47 ± 14 minutes (P = 0.0465). 39 patients attended the 2-week wound check visit. One patient could not be contacted. A total of 12 patients (30%) had superficial site infections; 7 (17.5%) were in the EF group and 6 (15%) were in the nail group (P = 1.000). No patients had deep infections.

Conclusion: In summary, this pilot study achieved a high screening rate, enrollment rate,

See pages 49 - 106 for financial disclosure information.

and early follow-up using the established protocol. These data demonstrate the feasibility of implementing and executing a large-scale RCT for open tibia fractures in this setting. Many unique solutions were developed to address the lack of available research infrastructure that may be useful to other investigators aiming to conduct research in LMICs. Based on the results of this pilot, this investigation will be expanded into a large-scale RCT powered to address the primary research hypothesis with follow-up to 1 year.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Clinically Important Subgroups within a Large Cohort of Gustilo Type IIIB Open Tibia Fractures: An Analysis of Surgical Rehospitalizations

Reza Firoozabadi, MD, MA*[1]*; *Renan Castillo, MD*[2]*; Robert V. O'Toole, MD*[3]*; Anthony Carlini, PhD*[2]*; CAPT (ret) Michael Bosse, MD*[4]*; METRC Consortium*[2]
[1]*Harborview / University of Washington, Seattle, Washington, USA;*
[2]*John Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA;*
[3]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA;*
[4]*Carolinas Medical Center, Charlotte, North Carolina, USA*

Purpose: Comparison of treatment, outcomes, and resource consumption following major limb trauma require appropriate stratification of injuries by type and severity. At present, the Gustilo-Anderson classification is the most commonly employed grading system for open fractures. There is growing evidence, however, that this classification may not adequately characterize the full burden of injury. A Gustilo Type IIIB tibial fracture with no bone loss and only a 2 ? 2-cm pretibial skin defect that is closed with a rotational flap likely has a different clinical course and outcome than a Type IIIB tibial fracture with severe contamination, a 5-cm bone defect, and loss of the anterior compartment that requires free tissue transfer and bone defect reconstruction. Recognizing the limitations the Gustilo open fracture classification system imposes on extremity trauma research and evaluations of resource consumption, the OTA developed a new Open Fracture Classification (OTA-OFC). The OTA-OFC assigns the fracture an injury severity value (range 1-3) in 5 domains: Bone Loss, Muscle Injury, Skin Injury, Arterial Injury, and Contamination. The purpose of this study is to delineate the various component injuries in open fractures classified as Gustilo Type IIIB by using the new OTA- FC, and to evaluate whether these additional details result in meaningful differences in the incidence of surgical rehospitalization. Surgical hospitalization included all forms of readmission related to the extremity trauma (planned and unplanned) after definitive wound closure.

Methods: Data were obtained from three large prospective, multicenter studies enrolling open tibia fractures. A total of 431 Gustilo Type IIIB tibia fractures with at least 6 months of clinical follow-up were included in this analysis. We documented the 5 parameters of the new OTA-OFC to determine the discrete distribution of injury captured in what is currently being classified as a "Type IIIB" open fracture, and classified each subject according to his or her surgical rehospitalization status at 6 months post injury. For each domain, we evaluated, using the Cochran-Armitage (C-A) test, whether there was a trend in the risk of surgical readmission with injury severity value.

Results: For contamination, bone loss, and muscle injury domains, there was statistically significant evidence of a positive association between the risk of surgical readmission and injury severity (Table I). The evidence was weaker for skin and arterial domains.

Conclusion: All Gustilo Type IIIB tibia fractures are not equal. As currently applied, the OTA-OFC classification includes injuries of varying severity as defined by the extent of bone loss, muscle injury, skin injury, arterial injury, and contamination. These subgroups are clinically important; with increasing severity within each category the risk of hospital

See pages 49 - 106 for financial disclosure information.

hospitalization increases. The spectrum of injury within the Gustillo IIIB category is too broad to allow for meaningful comparisons for research purposes, resource allocation planning, or reimbursement determination. Extremity trauma research should consider adopting the OTA-OFC for classification of Gustillo IIIB injuries in order to better stratify an individual patient's injuries to enable comparison of treatments, outcomes, and resource consumption.

Table I

	Severity	Cases	% Surgical Readmission	C-A p-value
Contamination *	[1] None or minimal	103	43.7	0.001
	[2] Surface contamination visible	191	63.4	
	[3] Deep tissue or bone or high risk environment	137	64.2	
Bone Loss *	[1] None	67	47.8	0.001
	[2] Bone missing but some contact	202	55.5	
	[3] Segmental bone loss	162	67.9	
Skin Injury	[1] Can be approximated	46	47.8	0.060
	[2] Cannot be approximated	252	59.1	
	[3] Extensive degloving	133	62.4	
Muscle Injury *	[1] No necrosis, some injury intact function	63	41.3	0.036
	[2] Loss of muscle but functional, local necrosis	268	63.1	
	[3] Extensive muscle necrosis	100	59.0	
Arterial Injury	[1] No arterial injury	310	56.1	0.118
	[2] Artery injury w/o ischemia	110	69.1	
	[3] Artery injury with distal ischemia	11	36.4	

*Please refer to OTA-OFC for details in regards to scoring system.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Operative Stabilization of Unstable Flail Chest Injuries Reduces Mortality to that of Stable Chest Wall Injuries

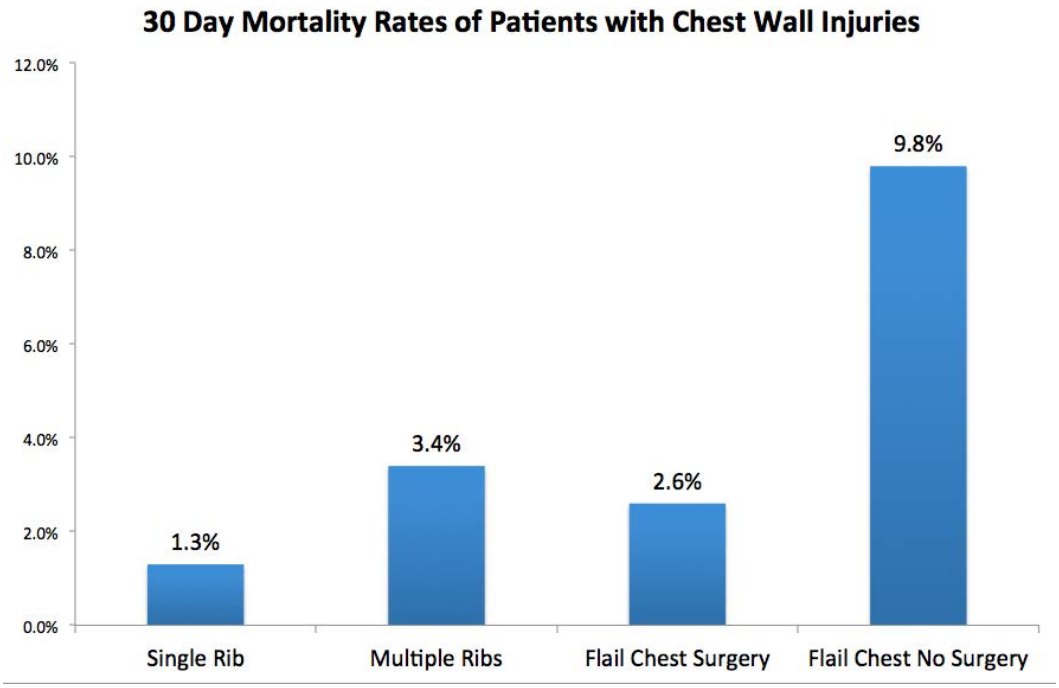
Niloofar Dehghan, MD, MS, FRCSC[1]*; Emil H. Schemitsch, MD*[2]*; Milena Vicente, RN*[1]**;**
Aaron Nauth, MD; Michael D. McKee, MD[2]
[1]*University of Toronto, Toronto, Ontario, CANADA;*
[2]*St. Michael's Hospital, Toronto, Ontario, CANADA*

Purpose: A flail chest injury is defined as an unstable chest wall injury, which has high rates of short-term mortality and long-term morbidity. Patients with multiple rib fractures without an unstable (or flail) segment have a better prognosis, and single rib injuries are typically considered innocuous with little long-term deficit. Surgical fixation of flail chest injuries, while rare, has become more popular in recent years with the rationale being that such repair may reduce the mortality and morbidity of this injury. We sought to define the injury patterns, management, and clinical outcomes associated with these three chest wall injury patterns in the last decade.

Methods: This study is a retrospective cohort study (Level III), utilizing administrative healthcare data, and residents over the age of 16 who were admitted to hospital with rib fractures from March 2003 to March 2013 were included for analysis. Patients were divided into three specific groups based on injury: (1) flail chest (with an unstable chest wall segment), (2) multiple rib fractures (without an unstable chest wall segment), and (3) single rib/sternum fractures. Outcomes included rate of surgical repair, days on mechanical ventilation, days in ICU, days in hospital, rate of chest tube placement, and rates of complication, including pneumonia, tracheostomy, readmission, and death.

Results: In total 117,204 patients with fractures of the chest wall were identified: flail chest 1.5% (1708 patients), multiple rib fractures 41% (47,611 patients), and single rib fractures 58% (67,884 patients). Flail chest patients had significantly worse outcomes compared to multiple rib fracture patients in all categories ($P < 0.0001$): cardiac arrest requiring CPR (cardiopulmonary resuscitation) 5% versus 1%; pneumonia 39% versus 13%; mechanical ventilation >48 hours 46% versus 7%; ICU admission 65% versus 14%; chest tube insertion 56% versus 11%; tracheostomy 12% versus 1%; ventilator-associated pneumonia 7% versus 1%; length of stay 16.7 days versus 5.7 days, 30-day readmission to hospital 26% versus 16%; 30-day mortality 9.5% versus 3.4%; and 1-year mortality 14% versus 9%. Similarly, multiple rib fracture patients had significantly worse outcomes compared to single rib fracture patients ($P < 0.0001$ for all outcomes). Of the 1708 patients with flail chest injury, only 4.5% (77 patients) were treated surgically. While patients undergoing surgical fixation of flail chest injury had significantly more complications compared to those treated nonoperatively (ie, pneumonia, mechanical ventilation, and tracheostomy), they had a significantly lower death rate acutely at 30 days (2.6% vs 9.8%, $P = 0.035$), and long term at 2 years (8% vs 17%, $P = 0.038$). When adjusting for age, pneumonia, mechanical ventilation, ICU admission, and length of stay, flail chest patients treated with surgical fixation had significantly lower 30-day mortality (odds ratio [OR] 0.16, $P = 0.02$), compared to those treated nonoperatively. Surgery decreased the 30-day mortality rate of flail chest patients (2.6%) to that of multiple rib fracture patients (3.4%). In addition, the number of patients undergoing surgical fixation dramatically increased from 1% prior to 2010 to 10% after 2010 ($P < 0.0001$).

See pages 49 - 106 for financial disclosure information.



Conclusion: To our knowledge, this is the largest study of chest wall injuries to date, and defines the landscape of current treatment. From it we conclude: (1) Stability of the chest wall is critical: patients with flail chest injuries had an early 9.5% mortality rate, over three times higher than multiple rib fracture patients at 3.4% ($P < 0.001$). The stability of the chest wall, rather than the number of ribs fractures, may be the most important prognostic factor. (2) Surgical stabilization of an unstable chest wall (flail chest patients) decreased early mortality (2.6%) to that of patients with multiple rib fractures and a stable chest wall (3.4%). (3) Surgical fixation of flail chest injuries has increased significantly from 1% to 10% after 2010. Although there are some drawbacks of our study, it does provide preliminary evidence that the increasing rate of surgical fixation of flail chest injuries may be warranted by reducing mortality. Prospective randomized controlled trials in this area are required to better assess the potential benefits of surgical fixation of patients with rib fractures and flail chest injuries.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Influence of Timing of Femur Fracture Fixation on Outcomes Following Major Trauma

James Byrne, MD; *Avery Nathens, MD, PhD; David Gomez, MD, PhD; Richard Jenkinson, MD, MSc*
Sunnybrook Hospital, University of Toronto, Toronto, Ontario, CANADA

Purpose: Femur fractures are common in trauma, frequently occurring in patients with multiple injuries resulting from high-energy mechanisms. Internal fixation by intramedullary nailing is often considered the best definitive management; however, the optimal timing for fixation remains unclear. While guidelines recommend early fixation, there is a lack of high-quality evidence to support a benefit to patient outcomes. The purpose of this study was to determine the effect of early (<24 hours) versus delayed (≥24 hours) femur fracture fixation on selected patient outcomes.

Methods: We identified all adult patients (≥16 years) with closed femur shaft fractures admitted to trauma centers participating in the American College of Surgeons Trauma Quality Improvement Program (ACS TQIP) over 2012-2014. Patients who died or were discharged before 48 hours were excluded. Two analytic approaches were used. First, we used a propensity score (PS)-matched study design to reduce confounding by indication, matching patients who underwent early fixation (EF) to those who had delayed fixation (DF) based on the propensity for delayed fixation derived from baseline patient and injury characteristics. Outcomes of interest were pulmonary embolism (PE), pneumonia, decubitus ulcer, and death. Secondary outcomes were ICU and overall hospital length of stay (LOS). A subgroup analysis was also performed on patients with isolated femur fractures (defined as femur fracture without severe injury to any other body region). In our second approach, we estimated each trauma center's odds of delayed fixation after adjusting for that center's unique patient case mix. Trauma centers were then categorized by the overall median odds ratio for delayed fixation as "early fixation" or "delayed fixation" centers. This approach allowed for outcomes to be compared between hospitals with different practices with respect to femur fracture fixation timing, and reduced potential for confounding by indication at the patient level.

Results: During the study period 15,055 patients with femur shaft fractures were admitted to 211 trauma centers participating in ACS TQIP. Median age and ISS were 38 years (IQR [interquartile range], 24-61 years) and 10 (IQR, 9-19), respectively. EF was achieved in 11,018 patients (73%). Advanced age, comorbidity, higher ISS, and severe injuries to the head, chest or abdomen were associated with DF (Table 1). PS-matching yielded a well-balanced cohort of 7624 patients. After PS-matching, DF was associated with a significantly higher odds of PE, pneumonia, and decubitus ulcer, but no difference with respect to mortality (Table 2). DF was also associated with significantly longer ICU and hospital LOS (median 9 vs 7 hospital days; RR 1.26; 95% CI 1.21-1.32). Similar results were found in patients with isolated femur fractures. When we compared patient outcomes between trauma centers based on femur fracture fixation timing, patients treated at delayed fixation centers had significantly higher odds of PE (odds ratio [OR] 1.43; 95% CI 1.13-1.81) and longer hospital LOS (RR 1.13; 95% CI 1.11-1.16) compared to those managed at early fixation centers.

See pages 49 - 106 for financial disclosure information.

TABLE 1. Selected Baseline Characteristics Before Propensity Score Matching

Parameter	Early Fixation (n = 11,018)	Delayed Fixation (n = 4,037)	Standardized Difference (%)
Patient Demographics			
Median age, years (IQR)	34 (23 – 55)	53 (30 – 74)	53.1
Male gender (%)	62.8	52.8	20.4
Comorbid illness (%)			
Coronary artery disease	2.3	6.8	22.1
Hypertension	21.2	38.0	37.5
Diabetes mellitus	7.9	16.7	26.8
Chronic renal failure	0.4	1.8	13.9
Bleeding disorder	3.0	8.5	23.7
Functionally dependent	2.1	5.9	19.2
Injury Characteristics			
Mechanism (%)			41.6
Motor vehicle collision	44.5	33.8	
Fall	25.7	44.8	
Motorcycle	12.1	8.1	
Pedestrian	7.1	6.6	
Other	10.6	6.7	
ISS (%)			27.6
9-15	67.7	62.7	
16-24	17.8	13.0	
25-47	13.7	21.5	
48-75	0.8	2.8	
Severe injury AIS ≥3 (%)			
Head	7.9	14.2	20.2
Chest	21.8	26.8	11.8
Abdomen	6.0	10.7	17.0
ED Characteristics			
Shock (SBP ≤ 90mmHg) (%)	3.7	5.7	9.6
GCS motor component < 3 (%)	4.1	9.3	21.0
Assisted respiration required (%)	6.0	11.3	19.0
Transfusion of pRBCs in first 12 hours (%)	12.2	17.1	14.1
Early Surgical Intervention (<48 hours)			
Craniotomy or intracranial monitor insertion (%)	0.6	3.7	21.2
Thoracotomy or laparotomy (%)	2.3	5.1	14.9

Standardized differences > 10% considered significant

TABLE 2. Outcome Frequency After Propensity Score Matching

Outcome	Early Fixation (n = 3,812)	Delayed Fixation (n = 3,812)	Odds Ratio† (95% CI)
Pulmonary embolism, n (%)	67 (1.8)	101 (2.7)	1.53 (1.16 – 2.00)
Pneumonia, n (%)	212 (5.6)	282 (7.4)	1.41 (1.19 – 1.69)
Decubitus ulcer, n (%)	58 (1.5)	99 (2.6)	1.80 (1.37 – 2.36)
Death, n (%)	59 (1.6)	69 (1.8)	1.19 (0.84 – 1.70)

† Estimated using mixed multilevel model accounting for propensity score-matched pairs and clustering of patients within trauma centers

Conclusion: In patients with femur shaft fractures, delayed fixation is associated with increased odds of adverse outcomes, including PE, pneumonia, and decubitus ulcer. Even after adjusting for patient case mix, significant variability exists across trauma centers with

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

respect to timing of femur fracture fixation. These differences in practice appear to affect patient outcomes, with higher rates of PE and longer hospital LOS at trauma centers with a tendency toward delayed fixation.

See pages 49 - 106 for financial disclosure information.

Prospective Evaluation of PTSD and Depression in Orthopedic Injury Patients With and Without Concomitant Traumatic Brain Injury

Jaicus Solis, MD*; Alan Jones, MD; Kenleigh Roden-Foreman, BA; Evan Rainey, MS; Monica Bennett, PhD; Michael Foreman, MD; Ann Marie Warren, PhD*
Baylor University Medical Center, Dallas, Texas, USA

Purpose: The presence of psychiatric symptoms after injury, specifically those of posttraumatic stress disorder (PTSD) and depression, are becoming increasingly recognized as both a significant morbidity and a major determinant of overall outcome. Traumatic brain injury (TBI) has a known negative impact on patient outcomes with concomitant orthopaedic injury, but the specific association of concurrent TBI, orthopaedic injury, and the development of PTSD and depression has not been examined. The purpose of this study was to examine rates of PTSD and depressive symptoms in orthopaedic trauma patients who also sustained a TBI.

Methods: This prospective cohort study included patients 18 years and older with orthopaedic injuries admitted to a Level I trauma center for greater than 24 hours. Demographic and injury-related data were gathered in addition to assessments of PTSD and depression during initial postinjury hospitalization, as well as 3, 6, and 12 months later. Presence of orthopaedic injury and TBI was based on ICD-9 coding. Generalized linear models were used to determine if rates of PTSD and depressive symptoms at 3, 6, and 12 months postinjury were associated with TBI.

Results: A total of 214 orthopaedic trauma patients were included. Of these, 44 (21%) sustained a TBI. No significant differences were found between demographic factors; however, all injury-related variables, including injury severity, Glasgow Coma Scale, ICU length of stay (LOS), and total LOS, were significantly different between TBI and non-TBI groups ($P < 0.001$). Those with TBI had significantly higher odds of having depressive symptoms 6 months postinjury ($P = 0.038$) and PTSD symptoms 12 months postinjury ($P = 0.04$).

Conclusion: Presence of a TBI in addition to orthopaedic injury was associated with higher rates of depression at 6 months and PTSD at 12 months postinjury. The implications of these data suggest that sustaining a TBI at time of injury places one at risk for later negative psychological outcomes. This important finding may help clinicians identify patients at higher risk for PTSD and depression after injury and target these patients for screening, intervention, and referral for treatment.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Combined Orthopaedic and Vascular Injuries: A Multicenter Analysis

*Paul Tornetta III, MD[1]; **Amir Shahien, MD[1];** Matthew Sullivan, MD[2]; Reza Firoozabadi, MD, MA[3]; Keyin Lu, BS[3]; Lisa K. Cannada, MD[3]; Mark Timmel, BS[4]; Ashley Ali, MD[4]; Kasey Bramlett, PA-C[5]; Andrew Marcantonio, DO, MBA[6]; Megan Flynn, MD[7]; Heather Vallier, MD[8]; Rick Nicolay, BS[9]; Brian Mullis, MD[9]; Alexandra Goodwin, MD[10]; Anna Miller, MD, FACS[10]; Peter Krause, MD[11]; Hassan R. Mir, MD[12]*

[1]*Boston Medical Center, Boston, Massachusetts, USA;*
[2]*University of Pennsylvania Hospital, Philadelphia, Pennsylvania, USA;*
[3]*Harborview / University of Washington, Seattle, Washington, USA;*
[3]*Saint Louis University, St. Louis, Missouri, USA;*
[4]*University of South Florida, Tampa, Florida, USA;*
[5]*Lahey Clinic, Burlington, Massachusetts, USA;*
[6]*Lahey Hospital and Medical Center, Burlington, Massachusetts, USA;*
[7]*Metro Health System, Cleveland, Ohio, USA;*
[8]*Metrohealth Medical Center, Cleveland, Ohio, USA;*
[9]*Eskenazi Health, Indianapolis, Indiana, USA;*
[10]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA;*
[11]*Louisiana State University Health Sciences Center, New Orleans, Louisiana, USA;*
[12]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA*

Purpose: Combined orthopaedic and vascular injuries are limb-threatening. Salvage requires revascularization and boney reconstruction with the goal of a solid union with good distal flow. The local anatomy often dictates the success of such salvage attempts, with more central injuries easier to manage than more distal injuries due to vessel size and soft-tissue coverage. The purpose of this study is to review a large multicenter experience with combined orthopaedic and vascular injuries to identify the current salvage and amputation rates and, where possible, the variables that predict amputation. Specifically, we hypothesized that the order of vascular and osseous reconstruction and the ischemia time may play a role.

Methods: We reviewed 199 patients presenting to 9 trauma centers with combined orthopaedic and vascular injuries. All patients for whom the orthopaedic service was involved with the decision for salvage versus amputation were included. Demographic data on patients, level of vascular injury, boney injury, ischemia time, order of repair, and complications including infection, vascular failure, nonunion, compartment syndrome, amputation were documented.

Results: We reviewed 199 patients (M: 150, F: 49), aged 17-85 years (average, 39.5) with 116 left and 83 right combined orthopaedic and vascular injuries. The most common fractures were: tibia (71), femur (52), and humerus (29). 27 of the injuries were closed and the rest were open. 38 (19%) were treated with amputation upon admission as they were deemed to be unsalvageable. Of the remaining 161 who had attempted salvage, 36 (22%) required late amputation. The most common reasons for failure of attempted salvage were: infection/wound failure (14), failed vascular repair (9), and compartment syndrome/myonecrosis (4). Closed injuries were successfully salvaged in 25/27 cases (93%). The highest rate of amputation was in tibia fractures with a combined amputation rate of 62%. In those attempted to

See pages 49 - 106 for financial disclosure information.

be salvaged, 21/48 (44%) required amputation. The rates of salvage and acute and delayed amputation are seen in the attached table. The ischemia time for successful salvage was less than those who went on to late amputation (5.3 ± 3.8 hours vs 7.5 ± 9.2 hours; P = 0.03). 124 patients had their definitive vascular repair prior to the boney reconstruction and 37 had it after. In the attempted salvage group there were a total of 74 complications, including 19 deep infections, 10 wound complications, 15 vascular complications, and 7 nonunions. Of the 15 vascular complications, 13 (87%) had the definitive vascular repair performed prior to the definitive osseous repair, although this was not statistically significant.

Combined Orthopaedic and Vascular Injuries: A Multicenter Analysis

Bony Injury Location and Outcome

	Successful Salvage	Immediate Amputation	Delayed Amputation	Total Ampuation	Percent Amputation
Humerus n = 29	23	3	3	6	20.7%
Elbow Dislocation n = 4	4			0	0
Radius/ Ulna n = 14	10	4		4	28.6%
Hand n = 1		1		1	100%
Pelvis n=1	1			0	0
Femur n = 52	37	6	9	15	28.8%
Knee Dislocation n = 24	21		3	3	12.5%
Tibia/ Fibula n = 71	27	23	21	44	61.9%
Ankle Dislocation n = 2	1	1		1	50%
Foot n = 1	1				0
Total n = 199	125	38	36	74	37.2%

Conclusion: In this series of combined orthopaedic and vascular injuries, we found a high rate of acute and late amputations. The complication rate for salvage attempts was 74%, which included a 22% rate of amputation after attempted salvage, primarily in open fractures. Vascular repair failure occurred in 15 (12%), the majority of which resulted in amputation (9 cases). Ischemia time had a marked influence on the ability to salvage the extremity with successful salvage averaging 5.3 hours compared to 7.5 for failed salvage attempts. Finally, 13 of the 15 vascular repairs that failed were performed prior to definitive boney stabilization. It is possible that other protocols, such as shunting and stabilizing the osseous injury prior to vascular repair may protect the repair, although this needs more study.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

MRI of Trauma Patients Treated with Contemporary External Fixation Devices Is without Significant Adverse Events: A Multicenter Study

Brett Hayden, MD[1]*; Raminta Theriault, BS*[1]*; Kasey Bramlett, PA-C*[2]*; Robert Lucas, BA*[3]*; Michael McTague, MD*[3]*; Robert Ward, MD*[1]*; Michael Weaver, MD*[3]*; Andrew Marcantonio, DO, MBA*[4]*; Scott Ryan, MD*[1]
[1]*Tufts Medical Center, Boston, Massachusetts, USA;*
[2]*Lahey Clinic, Burlington, Massachusetts, USA;*
[3]*Brigham and Women's Hospital, Boston, Massachusetts, USA;*
[4]*Lahey Hospital and Medical Center, Burlington, Massachusetts, USA*

Background/Purpose: External fixation is frequently used in multitrauma patients for provisional stabilization of fractures and dislocations. Magnetic resonance imaging (MRI) is often required in these patients to diagnose associated spinal injuries and characterize ligamentous injury in knee dislocations. One disadvantage of MRI, however, is the possible magnetic interaction with components of external fixators. Refusal to perform MRI in patients with external fixators by radiologists or radiology technicians is variable, and creates a clinical problem. Ex vivo studies assessing force and heating response of external fixators inside active MRI machines have been published in both the biomechanical and orthopaedic literature. No studies have evaluated clinical outcomes in patients with external fixators who have had MRI scans. The purpose of this study is to report the safety of placing current MRI components inside and outside the MRI bore during MRI scans.

Methods: IRB approval was obtained at each of four trauma centers involved in the study (three Level I, one Level II). A retrospective review of surgical databases identified patients with external fixator applications over a 10-year period from January 2005 to January 2015. Patients were identified with billing records for CPT codes for external fixation and cross-referenced with MRI records at the institution of treatment. Hospital records and imaging studies were reviewed to identify injuries, type and site of external fixation, strength of the MRI magnet, body part imaged with MRI, and any adverse events that occurred. Adverse events were defined as catastrophic pullout of the external fixation device or significant damage to the MRI machine from attraction of the external fixation.

Results: After retrospective review of all four centers, 1444 patients were identified from the CPT billing database for external fixators in the 10-year time period of January 2005 to January 2015. 38 patients with 44 external fixators were identified who obtained an MRI with the fixator inside or outside the MRI bore. 12 patients with 13 external fixators had an MRI with the external fixator inside the MRI bore (Table 1). 27 patients with 32 external fixators had an MRI with the external fixator outside the MRI bore. There were no cases of catastrophic failure of the external fixators or damage to the MRI machine with the external fixators inside or outside the bore. The most common reason for obtaining an MRI with a fixator inside the bore was to evaluate knee ligamentous structures following a knee dislocation, while the most common reason for obtaining an MRI with a fixator outside the bore was to evaluate cervical spine injuries in polytrauma patients.

See pages 49 - 106 for financial disclosure information.

	Injury	Open/Closed	Type of MRI (Company)	Joint	Body Part MRI	Complications
1	Knee Dislocation	Closed	Synthes Large Ex Fix	Knee	Knee	None
2	Knee Dislocation	Closed	Synthes Large Ex Fix	Knee	Knee	None
3	Knee Dislocation	Closed	Synthes Large Ex Fix	Knee	Knee	None
4	Knee Dislocation	Closed	Stryker Hoffmann II Ex Fix	Knee	Knee	None
5	Knee Dislocation	Closed	Stryker Hoffmann II Ex Fix	Knee	Knee	None
6	Left Knee Dislocation Right Knee Ligamentous Injury	Closed	Stryker Hoffmann II Ex Fix	Knee (Left)	Left Knee	None
7	Left Knee Dislocation Right Knee Ligamentous Injury	Closed	Stryker Hoffmann II Ex Fix	Knee (Left)	Right Knee	None
8	Tibial Plateau Fracture	Closed	Stryker Hoffmann 3 Ex Fix	Knee	Knee	None
9	Pelvic Ring Injury	Closed	Stryker Hoffmann 3 Ex Fix	Pelvis	Knee	None
10	Pathologic Acetabular Fracture	Closed	Synthes Large Ex Fix	Hip	Pelvis	None
11	Ankle Soft Tissue Injury	Closed	Synthes Large Ex Fix	Ankle	Ankle	None
12	Calcaneus Fracture Midfoot Dislocation	Open	Synthes Large Ex Fix	Foot	Foot	None
13	Wrist Dislocation Perilunate Fracture/Dislocation	Open	Synthes Small Ex Fix	Wrist	Brachial Plexus	None

Conclusion: While no universal guidelines exist, there are circumstances in which obtaining MRI scans of patients with external fixators can be safe and effective. This study fills a large void in the current literature. This is the first clinical series with the primary outcome of safety when placing modern external components both inside and outside the MRI bore during a scan.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

See pages 49 - 106 for financial disclosure information.

Predictors of Long-Term Functional Outcome in Operative Ankle Fractures

Daniel Dean, MD[1]*; Bryant Ho, MD*[2]*; Albert Lin, BS*[2]*; George Ochenjele, MD*[3]*; Daniel Fuchs, MD*[2]*; Anish Kadakia, MD*[2]
[1]*Medstar Georgetown University Hospital, Washington, District of Columbia, USA;*
[2]*Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA;*
[3]*R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA*

Background/Purpose: Risk factors associated with short-term functional outcomes in patients with operative ankle fractures have been established. However, no previous studies have reported on the association between these risk factors and long-term functional outcomes. Using the Patient Reported Outcomes Measurement System (PROMIS) physical function (PF) and pain interference (PI) measures, we attempt to identify predictors of long-term functional outcome in patients with operative ankle fractures.

Methods: We retrospectively reviewed a multicenter cohort of patients 18 and older who underwent operative management of a closed ankle fracture from 2001-2013 with a minimum of 2 years follow-up. Patients with posterior pilon variants, Maisonneuve fractures, prior ankle surgery, and chronic ankle fractures were excluded from the study. Patients meeting inclusion criteria were contacted and evaluated using the PROMIS PF and PI computerized adaptive tests. PROMIS scores are standardized to a US population with a mean of 50 and a standard deviation of 10. Higher PF scores represent increased physical function, while increased PI scores are indicative of higher pain. Patient risk factors including sex, age, diabetes, smoking, ASA (American Society of Anesthesiologists) class, BMI (body mass index), education level, ankle dislocation, energy of injury, and fracture pattern were obtained through a retrospective chart review. Univariate and multivariate regression models were developed to determine independent predictors of physical function and pain at long-term follow up.

Results: In total, 199 patients met inclusion criteria. Of those, 142 patients (64 females, 78 males) with a mean age of 52.7 years (SD = 14.7) averaging 6.3 years of follow-up (range, 2-14) participated. Patients had a mean PF score of 51.9 (SD = 10.0) and a mean PI score of 47.8 (SD = 8.45). Multivariate analysis demonstrated that independent predictors of decreased PF score included higher age (β = -0.16, P = 0.03), higher ASA class (β = -10.3, P <0.01), and higher BMI (β = -0.44, P <0.01). Predictors of decreased PI score included higher ASA class (β = 11.5, P <0.01) and lower BMI (β = -0.41, p<0.01). Sex, presence of diabetes, smoking status, education level, presence of ankle dislocation, energy of injury mechanism, and fracture pattern did not independently predict long-term pain or functional outcomes.

Conclusion: At long-term follow-up of operative ankle fractures, increased ASA class, increased BMI, and higher age at time of surgery are independently predictive of decreased physical function. Factors that are associated with increased pain at long-term follow-up include lower BMI and higher ASA class. ASA class had the strongest effect on both physical function and pain. The findings from this study suggest that patients with increased ASA class at the time of surgery may deserve increased counseling regarding expected outcomes following operative intervention.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Supination External Rotational Ankle Fracture Injury Pattern Correlates with Regional Bone Density

Stephen Warner, MD, PhD[1]; Elizabeth Gausden, MD[2]; Ashley Levack, MD, MAS[1]; David Helfet, MD[1]; Dean Lorich, MD[3];
[1]Hospital for Special Surgery, New York, New York, USA;
[2]Hospital for Special Surgery-Cornell, New York, New York, USA;
[3]New York Presbysterian Hospital, New York, New York, USA

Background/Purpose: Rotational ankle fractures (OTA 44) can present with an array of possible osseous and ligamentous injury combinations in reliable anatomic locations. Stage IV rotational ankle fractures have injuries posteriorly with either a posterior inferior tibiofibular ligament (PITFL) rupture or posterior malleolus fracture, and medially with either a deltoid rupture or medial malleolus fracture. What accounts for these different injury patterns and whether specific patient and injury factors underlie the different injury patterns is unclear. The purpose of this study was to determine whether causative factors exist that could account for the various injury patterns seen with rotational ankle fractures.

Methods: A prospective registry of operatively treated supination external rotation stage IV (SER IV) ankle fractures from 2014 through 2015 was used to identify patients. Patient demographics, medical comorbidities, and injury characteristics were recorded for each case. All patients included in the study had preoperative radiographs and CT imaging of the injured ankle. A GE Picture Archiving and Communication System was used to calculate regional bone density from CT scans by using average Hounsfield Unit measurements on axial images from the distal tibia and fibula. Preoperative MRI and intraoperative direct observations were used to define and record the precise osseous and ligamentous injuries. Patients were grouped into those with no posterior or medial malleolar fracture (equivalent group), those with either a posterior or medial malleolus fracture (bimalleolar group), and those with both posterior and medial malleolar fractures (trimalleolar group).

Results: Patients in the equivalent, bimalleolar, and trimalleolar groups had no significant differences in age, body mass index, medical comorbidities, mechanism of injury, dislocation rate, or open fracture rate. Female gender was less common in patients in the equivalent group compared to the trimalleolar group (55% vs 87%, $P = 0.03$) but not the bimalleolar group (55% vs 72%, $P = 0.4$). Regional bone density at the ankle, as measured with Hounsfield Units, was significantly higher in the equivalent group (371) compared to the bimalleolar group (271, $P < 0.0001$) and trimalleolar group (228, $P < 0.000001$). In addition, regional bone density was significant higher in the bimalleolar group compared to the trimalleolar group ($P = 0.02$). Logistic regression analysis controlling for age and gender supported these significant differences between the equivalent, bimalleolar, and trimalleolar groups. Similarly, after controlling for age and gender, logistic regression analyses identified regional bone density as a significant predictor of a medial malleolus fracture over a deltoid rupture ($P = 0.002$) and of a posterior malleolus fracture over a PITFL rupture ($P = 0.018$).

See pages 49 - 106 for financial disclosure information.

Conclusion: Rotational ankle fractures occur with a variety of osseous and ligamentous injuries, which may be indicative of underlying patient or injury characteristics. In our cohort of SER IV ankle fractures, regional bone density at the ankle significantly correlated with the presence and number of malleolar fractures compared to ligamentous ruptures. Treating surgeons can use this information to anticipate bone quality during operative fixation based on ankle fracture injury pattern. In addition, the presence of a trimalleolar ankle fracture is a significant indicator of poor bone quality and may represent the first clinical sign of abnormal bone metabolism in many patients. Clinicians should strive to optimize bone metabolism in patients with trimalleolar ankle fractures postoperatively.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

The Role of Computed Tomography Scans in Surgical Planning for Trimalleolar Fractures

John Hwang, MD*; Peter Gibson, MD; Jacob Didesch, MD; Michael Bercik, MD; Kenneth Koury, MD; Joseph Ippolito; Mark C. Reilly, MD; Mark Adams, MD; Michael Sirkin, MD*
Rutgers University - New Jersey Medical School, Newark, New Jersey, USA

Background/Purpose: The role of preoperative CT scans in surgical planning for the treatment of trimalleolar ankle fractures is unclear. Often, plain radiographs provide poor estimation of the posterior malleolus fracture pattern and size. This issue is further complicated by the lack of professional agreement on treatment methods relating to posterior malleolar fragments, even when the morphology is well-understood. Due to the complexity of posterior malleolar fractures and the difficulties in evaluating the plain radiographic findings, a CT scan is often helpful. Our hypothesis is that a CT scan will affect decision-making regarding the treatment of trimalleolar ankle fractures, leading to a higher rate of fixation of the posterior malleolus.

Methods: A retrospective chart review was performed, after IRB approval, to generate a web-based questionnaire of 10 distinct trimalleolar ankle fracture cases. Inclusion criteria for the cases consisted of trimalleolar ankle fracture diagnosis, age greater than 18 years of age, presence of preoperative radiographs, and preoperative CT scans. Exclusion criteria were inadequate or missing imaging. The survey first presented the preoperative radiographs, asking the surgeon their operative preference, in addition to whether or not they would order a CT scan prior to performing the desired operation. Subsequently, CT scan images were presented of same patient and changes to the surgeons' treatment plan were evaluated. Choices for operative management included: no fixation, percutaneous anterior-to-posterior fixation, percutaneous posterior-to-anterior fixation, open reduction and internal fixation, or syndesmotic screw fixation only. The survey was distributed to members of the OTA. Operative preference and effect of CT scan on recommended operation were then analyzed.

Results: A total of 171 orthopaedic surgeons completed the survey for a total observation of 1710 distinct cases. Using radiographs alone, respondents deemed posterior malleolus fixation was required for 938 (54.9%) of the cases compared to 1053 (61.6%) after the CT scan was reviewed (P <0.001). Following evaluation of the radiographs, respondents stated they would order a CT 39.8% of the time. The surgeons' operative plan changed in 442 (26%) cases after review of the CT images. Of the 442 observations in which the operative plans were altered, the surgeon had initially stated that they would not have requested CT 50.2% of the time. After completing the survey, 33 of 171 individuals (19.2%) said that they would be more likely to order CT scans for trimalleolar ankle fractures in the future.

Conclusion: The importance of obtaining CT imaging of trimalleolar ankle fractures is becoming more evident. OTA member surgeons recommended operative fixation of significantly more cases after reviewing CT scans than when based on plain radiographs alone. Our survey shows that in 26% of cases, surgeons would alter their operative plan on

See pages 49 - 106 for financial disclosure information.

the basis of the advanced imaging. In 50.2% of those cases the surgeon failed to appreciate the benefit of a preoperative CT scan and would not have ordered one after the review of the plain radiographs alone. CT scan appears to be a valuable adjunct in determining the fixation management of posterior malleolus fractures and should be strongly considered when determining the preoperative plan for this fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Implant Failure Rates and Cost Analysis of Contoured Locking versus Conventional Plate Fixation of Weber B Fibula Fractures

Lewis Moss, MD[1]*; Robert Ravinsky, MDCM, MPH*[2]*; Stuart Gold, MD*[1]*;*
[1]*Harbor UCLA Medical Center, Torrance, California, USA;*
[2]*University of Toronto, Division of Orthopaedic Surgery, Toronto, Ontario, CANADA*

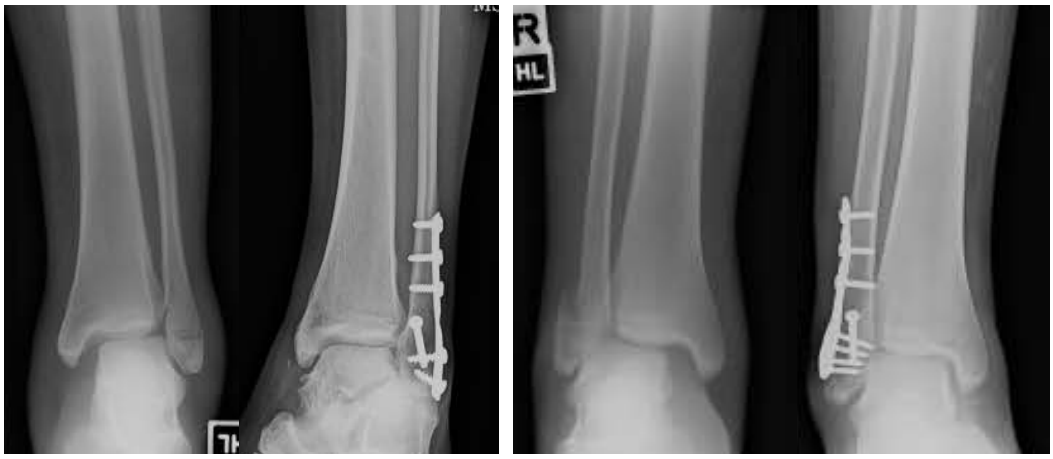
Background/Purpose: Distal fibula fractures associated with rotational ankle injuries are one of the most commonly encountered and surgically treated injuries in orthopaedics. There has been a recent shift toward the use of fracture-specific locking plates, including those for distal fibula fractures; however, a clinical benefit of this shift has not been demonstrated in the literature. The aim of this study was to evaluate the relative use, failure rates, and cost of contoured locking and standard one-third tubular plates used for the treatment of Weber B fibula fractures (OTA-44B).

Methods: This retrospective cohort study compared findings of 330 consecutive patients over a 3-year period with rotational ankle injuries involving Weber B type fractures of the distal fibula treated with open reduction and plate fixation. The primary outcome was failure of the lateral plate fixation, indicated by loss of fibular fracture reduction, deformation of the fibular plate, or loss of distal screw fixation. Secondary outcomes were surgical wound infection requiring surgical debridement and implant removal, and persistent implant-related symptoms requiring implant removal. Patient, injury, and surgical characteristics were compared between the treatment groups and analyzed as risk factors for the outcome measures studied. An analysis of differential cost between the two constructs was performed. Statistical analysis was performed using Student *t* and X^2 tests with significance set at a *P* value <0.05.

Results: Eleven patients were lost to follow-up. The remaining 319 patients had at least 4 weeks of postoperative follow-up and were included in the study; 97 were treated with a distal fibular contoured locking plate (CLP), and 222 with a one-third tubular plate (OTP). A significant increase in the relative use of CLPs versus OTPs was observed at our institution during the study period. The two groups were comparable with respect to BMI (body mass index), history of diabetes, surgical delay, and length of follow-up. The CLP group was on average older than the OTP group, 44 ± 13 and 38 ± 13 years, respectively ($P < 0.001$), and had a lower proportion of smokers, 27% and 17%, respectively ($P = 0.04$). There were no mechanical failures of lateral plates or distal fibular fixation in either group. Five cases required surgical revision within 4 weeks of the index surgery, all for revision of syndesmotic fixation--one in the CLP group and four in the OTP group ($P = 0.61$). The rate of deep infection requiring surgical debridement and/or implant removal was 6.2% in the CLP group and 1.4% in the OTP group ($P = 0.017$). The rate of lateral plate removal for either infection or symptomatic implants was 9.3% in the CLP group and 2.3% in the OTP group ($P = 0.005$). A typical CLP construct cost $800 more than a comparable construct using a one-third tubular plate. Based on a calculated estimate of 60,000 locking plates used annually in the US, this translates to a potential avoided cost of $50 million/year nationally.

See pages 49 - 106 for financial disclosure information.

Conclusion: The use of contoured locking plates for the treatment of Weber B distal fibular fractures has increased, and is associated with significant increased cost. This study demonstrates that this increased use is unsubstantiated by outcomes, as there were no lateral plate failures in either the contoured locking or standard plate groups. Furthermore, the CLPs may carry a higher risk of implant-related complications.



1-A 1-B

FIGURE 1. Preoperative and 12 week postoperative anteroposterior mortise ankle radiographs of similar lateral malleolar fractures. Both with a single interfragmentary lag screw, and neutralization plates of comparable lengths. **A**, treated with conventional one-third tubular plate. **B**, treated with contoured distal fibular locking plate and locking distal fragment screws.

TABLE 1. Demographic Data and Baseline Characteristics

	One Third Tubular Plate (n=222)	Contoured Locking Plate (n=97)	P value
Age (yr), mean (SD)	37.9 (13.1)	44.4 (13.3)	**0.0001**
Female (%)	37.4	60.1	
Body Mass Index, mean (SD)	30 (6.1)	30 (6.2)	0.86
Diabetes (%)	8.6	13.4	0.19
Smoking (%)	27.2	16.5	**0.04**
Time to Surgery (days), mean (SD)	10.0 (8.3)	10.1 (8.1)	0.86
Length of Follow Up (weeks), mean (SD)	22.5 (30.0)	23.7 (23.2)	0.72
median (25-75 percentile)	13.6 (10.0-22.7)	17.1 (10.5-26.5)	
Open Injury (%)	0.5	2.1	0.17
Syndesmotic Fixation, (%)	27.9	30.9	0.59
Lag Screw(s), (%)	92.8	56.7	**0.0001**

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

TABLE 2. Outcomes for OTP and CLP groups

	One Third Tubular Plate	Contoured Locking Plate	P value
Failure/Revision*	1.8 % (4/222)	1.0 % (1/97)	0.610
Infection	1.4 % (3/222)	6.2 % (6/97)	**0.017**
Hardware Removal**	2.3% (5/222)	9.3 % (9/97)	**0.005**
Symptomatic Hardware	3/5	4/9	
Infection	2/5	5/9	

(*) All 5 revisions were due to failure of syndesmotic fixation or failure to recognize and stabilize a syndesmotic injury at the time of the index surgery
(**) Removal of atleast all lateral hardware for any reason

TABLE 3. Cost breakdown of lateral malleolar plate constructs

	Conventional	Contoured Locking
Plate	1 (one-third tubular) at $166 each	1 (fibular locking) at $585 each
Lag Screw	1 (non-locking) at $21 each	1 (non-locking) at $21 each
Proximal Screws	3 (non-locking) at $21 each	3 (non-locking) at $21 each
Distal Screws	2 (non-locking) at $21 each	4 (locking) at $110 each
Total*	$292	$1109

* Contoured locking construct costs $811 more than the conventional construct

See pages 49 - 106 for financial disclosure information.

Physiological Widening of the Medial Clear Space and Syndesmosis with Stress Examination

***Jacob Didesch, MD**; Peter Gibson, MD; John Hwang, MD; Kenneth Koury, MD; Joseph Ippolito; Mark C. Reilly, MD; Mark Adams, MD; Michael Sirkin, MD*
Rutgers University - New Jersey Medical School, Newark, New Jersey, USA

Purpose: Both cadaveric and clinical studies have validated the use of stress radiographs for evaluation of ankle stability after fractures to the fibula. However, to our knowledge no study has reported the amount of physiological widening that occurs with manual external rotation stress test in uninjured ankles. The purpose of this study was to assess the amount of medial clear space widening that occurs with a manual external rotation stress test in uninjured ankles.

Methods: A cohort of adult patients undergoing operative fixation of unstable ankle fractures were prospectively enrolled to have their contralateral ankle undergo manual external rotation stress examination. The study was IRB-approved and all patients signed an informed consent. Exclusion criteria were age less than 18 years, prior ankle injury or known instability to the unaffected extremity, systemic musculoskeletal disorders, polytrauma, and incidental abnormal radiographic findings. Fluoroscopic images of the unaffected ankle were performed in the operating room prior to fixation of the injured ankle. A nonstressed mortise view and manual external rotation stress view were obtained with a standardized marker to correct for magnification differences. The images were de-identified and presented in a randomized order to three separate reviewers. The reviewers were blinded as to whether the images were stress or nonstress images. Each reviewer measured the medial clear space. A power analysis performed based on prior studies measuring medial clear space widening, as well as a post hoc analysis of our data, determined that 7 subjects were needed for adequate statistical power. Statistical analysis comparing means between stress and nonstress examinations, average amount of medial clear space widening, and inerobserver reliability were performed.

Results: 30 fluoroscopic images on 15 separate patients were obtained with a mean medial clear space on the nonstress mortise of 3.1 mm (SD 0.69; range, 1.9 to 4.2; 95% CI 2.75, 3.45) compared with the stressed mortise mean of 3.3 mm (SD 0.71; range, 2.0 to 4.7; 95% CI 2.94, 3.66). This difference was not statistically different ($P = 0.43$). The change in clear space from the nonstressed to the stressed view ranged from -0.7 mm to 1.5 mm with the majority (93%) widening less than 0.7 mm (95% CI -0.3, 0.7). Interobserver reliability was excellent between all observers (intraclass correlation coefficient [ICC] 0.92).

Conclusion: Previous literature suggests that a medial clear space of 5 mm or an increase in width of medial clear space by 2 mm after stress examination are evidence of ankle instability in the setting of fibula fractures. Our data show that no physiologically healthy ankles widened beyond these established cutoffs either before or after the manual external rotation stress. Therefore these values remain valid assessments of ankle stability, and the use of manual external stress radiographs is unlikely to result in false positives using these thresholds.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does a Patient's Self-Reported Ability to Weight-Bear Immediately After Injury Predict Stability for Ankle Fractures?

Bonnie Chien, MD[1]*; Kurt Hofmann, MD*[2]*; Mohammad Ghorbanhoseini, MD*[3]*; David Zurakowski, PhD*[4]*; Edward Rodriguez, MD*[3]*; Paul Appleton, MD*[5]*; John Ellington, MD*[6]*; John Kwon, MD*[5]
[1]*Harvard Combined Orthopaedic Residency Program, Boston, Massachusetts, USA;*
[2]*Tufts Medical Center, Boston, Massachusetts, USA;*
[3]*Beth Israel Deaconess Medical Center / Harvard Medical School, Boston, Massachusetts, USA;*
[4]*Children's Hospital Boston, Boston, Massachusetts, USA;*
[5]*Beth Israel Deaconess Medical Center, Dept of Orthopaedics, Boston, Massachusetts, USA;*
[6]*OrthoCarolina, Foot and Ankle Institute, Charlotte, North Carolina, USA*

Background/Purpose: Determining the stability of ankle fractures, particularly for isolated Weber B fibula fractures, can be challenging. While the ultimate goal remains achieving an anatomic mortise, different techniques to predict ankle stability such as stress and weight-bearing radiographs have been utilized with variable results. History of injury and the ability to walk after sustaining ankle trauma may be predictive of stability. Therefore, this study seeks to determine whether a patient's ability to fully weight-bear immediately after injury is an effective indicator for ankle stability following ankle fracture. We hypothesize that the ability to weight-bear immediately after injury has a high predictive value for a stable mortise whereas the inability to fully weight-bear at the time of injury predicts instability.

Methods: A prospective study was conducted of 121 patients who sustained an isolated unilateral lateral malleolar, bimalleolar, or trimalleolar ankle fracture. Patients' ability to weight-bear after injury was elicited on initial presentation and correlated with ankle radiographs that were deemed stable or unstable based on commonly used indices to assess stability (ie, widening of the medial clear space). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were determined using standard formulas in order to assess a patient's ability to bear weight as a predictor of ankle fracture stability (sensitivity) and a patient's inability to bear weight as a predictor of instability (specificity).

Results: For the entire cohort, patients who were able to weight-bear immediately after injury were over 8 times more likely to have a stable fracture than those who could not (odds ratio [OR] = 8.7, $P < 0.001$). PPV for being able to fully weight-bear as it relates to stability was 73%. Inability to weight-bear was 85% specific among patients with an unstable fracture. When analyzing patients with radiographic isolated fibula fractures (n = 67), PPV = 82%, NPV = 53%, specificity = 79%, while the OR was 5.0 ($P = 0.003$) for those who could weight-bear having a stable fracture. When subanalyzing patients who presented with isolated fibula fractures and an anatomic mortise (n = 43), PPV = 74%, NPV = 52%, specificity = 62%, while the OR was 3.6 ($P = 0.07$) for those who could weight-bear having a stable fracture.

Conclusion: Patients ability to weight-bear immediately after injury is a specific and prognostic indicator for stability across a range of ankle fracture subtypes. Patients with an isolated fibula fracture and anatomic mortise were 3.6 times more likely to have a stable fracture if they were able to fully weight-bear at time of injury. While a patient's history does not preclude the need for appropriate imaging studies and clinical judgment, it may aid in the assessment of ankle stability following fracture.

See pages 49 - 106 for financial disclosure information.

Gravity Reduction View: A Novel Radiographic Technique for the Evaluation and Management of Weber B Fibula Fracture

Lauren K. Ehrlichman, MD[1]; Tyler Gonzalez, MD, MBA[2]; Alec Macaulay, MD[3]; Mohammad Ghorbanhoseini, MD[3,4]; John Kwon, MD[4]
[1]*Harvard Combined Orthopaedic Residency Program, Boston, Massachusetts, USA;*
[2]*Massachusetts General Hospital, Boston, Massachusetts, USA;*
[3]*Harvard Medical School, Boston, Massachusetts, USA;*
[4]*Beth Israel Deaconess Medical Center, Brookline, Massachusetts, USA*

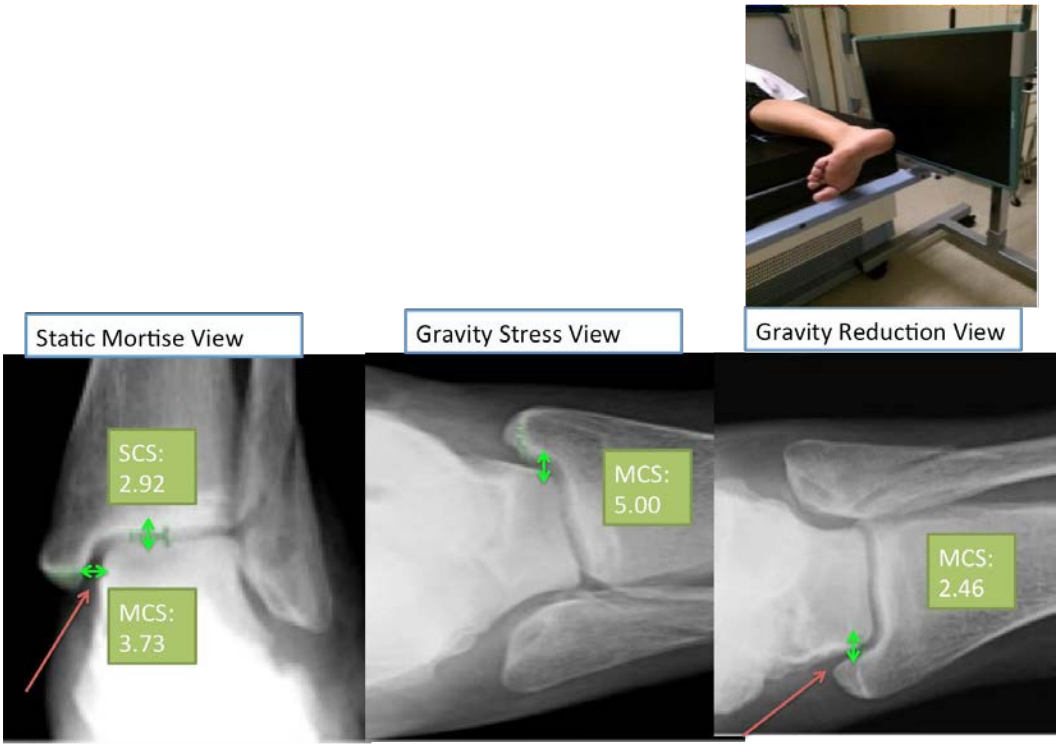
Background/Purpose: The determination of stability and ultimate need for operative stabilization of Weber B fibula fractures largely depends on the presence of a competent deltoid ligament. While various radiographic parameters and the application of manual or gravity stress have been proposed to elucidate instability, the prognostic capability of these modalities remains unclear. Given that a recent study found no difference between operative and nonoperative treatment for stress-positive Weber B ankle fractures, the value of stress views is questionable; what may be ultimately more important is the determination of anatomic positioning of the mortise. We propose a novel view, the Gravity Reduction View (GRV), which helps elucidate nonanatomic positioning and reducibility of the mortise. We also propose a treatment algorithm based on the use of the GRV.

Methods: To obtain the GRV, the patient is positioned in lateral decubitus with the injured fibula directed upward and elevated with a leg holder. The x-ray cassette is placed posterior to the heel, with the beam angled at 15° of internal rotation to obtain a mortise view. Our treatment algorithm is based upon the measurement of the medial clear space (MCS) on the GRV versus the static mortise view. If the MCS on GRV remains wide or decreases, surgery is recommended as the GRV confirms a nonanatomic mortise. If the MCS remains within normal limits on the static and GRV views, a trial of nonoperative treatment with immobilization and repeat radiographs in 1-2 weeks is undertaken. If the MCS is normal on repeat weight-bearing radiographs, the patient is treated conservatively; if increased, surgery is recommended. To further assess mortise stability, the MCS is compared to the superior clear space (SCS).

Results: 23 patients with Weber B distal fibula fractures were managed according to this treatment algorithm. The mean age was 49.1 years old (range, 18-74). Of these patients, 15 underwent operative treatment and 10 patients were initially treated nonoperatively, although 2 patients demonstrated late displacement and were treated surgically. Using this algorithm, all patients had a final MCS that was less than the SCS (final mean MCS for patients treated operatively or nonoperatively 2.85 mm vs mean SCS of 3.34), indicating effectiveness of the treatment algorithm.

Conclusion: The Gravity Reduction View is a novel radiographic view in which deltoid competency, reducibility and initial anatomic positioning of the mortise are assessed by comparing a static mortise view with the appearance of the mortise on the reduction view (GRV). We have developed a treatment algorithm based on the GRV and have found it to be predictive of mortise alignment and useful in guiding treatment.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.



See pages 49 - 106 for financial disclosure information.

Complications and Functional Outcomes After Pantalar Dislocation

Kaeleen Boden, BA[1]*; Douglas Weinberg, MD*[2]*; Heather Vallier, MD*[3]*;*
[1]*MetroHealth System, Cleveland, Ohio, USA;*
[2]*University Hospitals/Case Medical Center, Cleveland, Ohio, USA;*
[3]*MetroHealth Medical Center, Cleveland, Ohio, USA*

Purpose: Pantalar dislocations without associated fracture are extremely rare and have high risks of potentially devastating complications, including infection and osteonecrosis. Limited information on recovery and later function exists. Therefore, the study aim is twofold: (1) to evaluate complications and secondary operations following pantalar dislocations without fracture, and (2) to assess functional outcomes.

Methods: 19 patients were identified from a trauma registry between 2002 and August 2014 with open (n = 14) or closed (n = 5) pantalar dislocations without talus fracture. Open injuries underwent surgical debridement, and patients had open reduction with external fixation (n = 13) or Kirschner wires (n = 5), except one patient who underwent below the knee amputation (BKA) primarily due to nonreconstructable foot trauma. Charts and radiographs were reviewed to identify complications including infection, osteonecrosis (ON) and arthrosis (PTA). Data on pain, pain medications, ankle range of motion, and secondary procedures were also collected. After a minimum of 1 year Foot Function Index (FFI) and Musculoskeletal Function Assessment (MFA) surveys were obtained.

Results: Ten men and nine women with mean age 40.0 years (range, 19 to 68) were studied. Mechanism of injury was motor vehicle collision (n = 15), motorcycle crash (n = 2), or fall from height (n = 2). Twelve patients were treated for other ipsilateral (n = 16) and/or contralateral (n = 9) injuries. Two patients had superficial traumatic wound healing problems, which healed with dressing changes, and one other patient developed cellulitis 4 months after injury. No deep wound infections occurred. Thirteen patients had increased talar body density consistent with ON, but only two patients developed ON with collapse, and 39% of patients developed PTA in tibiotalar (n = 3) or subtalar (n = 6) or both (n = 3) joints. At most recent follow-up, 15 patients (85%) reported at least mild pain, and 6 patients (33%) were taking prescription narcotics. Mean dorsiflexion and plantar flexion were 11° and 25°, respectively. To our knowledge no secondary procedures were performed. Collection of functional outcome data is ongoing, but currently 11 patients with a mean follow-up of 4.9 years have mean FFI and MFA scores of 31.0 and 29.7, respectively, indicating a degree of continued disability after injury compared with an uninjured population (FFI of 12 and MFA of 9.0).

Conclusion: Persistent pain and functional limitations are common after pantalar dislocation. Osteonecrosis occurred often, but was not usually associated with collapse of the talus. No deep wound infections occurred. Overall, achieving favorable outcomes by both clinical and functional criteria remains a concern following this severe injury.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Ankle Fractures: What Role Does Insurance Play in Postoperative Recovery?

*Wajeeh Bakhsh, MD[1]; **Sean Childs, MD**[2]; John Gorczyca, MD[2]; Catherine Humphrey, MD[1]; Kyle Judd, MS, MD[2]; Gillian Soles, MD[3]; John Ketz, MD[3]*
[1]University of Rochester Medical Center, Rochester, New York, USA;
[2]University of Rochester, Rochester, New York, USA;
[3]University of Rochester Medical Center, Pittsford, New York, USA

Purpose: Ankle fractures are common injuries that occur across a wide variety of patients. Therefore, exploration of determinants of patient outcomes holds great clinical significance. This study aims to explore any relationship that may exist between a patient's level of insurance and factors affecting their postsurgical course and outcomes.

Methods: A retrospective analysis was performed from January 2013 to January 2015 in all patients who had operatively treated ankle fractures (OTA 44A-C). Patients were separated into 2 groups, insured and under/uninsured patients. Medical records from all patients were evaluated to determine the amount of narcotic refills and compliance with follow-up visits. Additionally, patient outcomes were tracked via prospectively collected VAS (visual analog scale) pain scores and PROMIS (Patient Reported Outcomes Measurement Information System) scores. Perioperative complications, including revision surgery, were also evaluated. Data were compared between the two groups using statistical analysis. Statistical significance was determined as $P < 0.05$.

Results: A total of 150 patients met criteria for evaluation. 34 patients were noted to be under/uninsured (23%) and the remaining 116 (77%) were insured. No significant difference was noted between the groups in terms of age, fracture pattern, syndesmotic injury, or medical comorbidities. The underinsured group was found to have a significantly higher mean postoperative narcotic requirement, 2.6 refills, than the fully insured group, 1.2 refills ($P < 0.01$). Missed appointments were also significantly higher in the underinsured group (average 1 visit) versus the insured group (average 0.2 visits, $P < 0.01$). Both groups had a similar number of postoperative office visits, with the fully insured group visiting more often (6.4 and 6.3, respectively). VAS pain scores were higher for the underinsured at 1 year out from surgery (3.2) versus the fully insured (1.4, $P < 0.01$). Analysis of PROMIS (National Institutes of Health [NIH]) data demonstrates that in categories of function, pain, and mood, the underinsured group performed significantly worse than the insured group. Mean function scores were 37.6 ± 6.2 in the underinsured, versus 43.9 ± 8.7 in the fully insured indicating worse function in the underinsured ($P < 0.01$). Mean pain scores in the underinsured and fully insured groups were 59.6 ± 10.1 and 54.3 ± 9.2, respectively ($P = 0.03$). Mood scores were an average of 55.2 ± 12.4 in the underinsured group, with 47.4 ± 10.5 in the fully insured group, with higher scores indicating worse depressive mood symptoms ($P < 0.01$). Average body mass index was also significantly different between the groups (34.9 underinsured, 30.0 fully insured, $P < 0.01$). Postoperative complication and repeat surgery rates were similar across the groups, with $P = 0.90$.

Conclusion: Despite similar patient demographics and fracture characteristics, there were significant differences in insured versus under/uninsured patients. Underinsured patients

See pages 49 - 106 for financial disclosure information.

had significantly higher narcotic usage with worse pain and PROMIS score outcomes. There was a higher rate of missed appointments in the underinsured, with a similar number of follow-up visits meaning costly increased rescheduling requirements. Further understanding of the psychosocial factors of this subset of patients is needed to identify means and potentially improve outcomes in operatively treated ankle fractures.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Number and Type of Fractures on CT Scan Is not a Predictor for Stability in Lisfranc Injuries

Guido Stollenwerck, MD[1]*; Martijn Poeze, MD, PhD*[2]
[1]*Alrijne Hospital, Leiderdorp, NETHERLANDS;*
[2]*Maastricht University Medical Center, Maastricht, NETHERLANDS*

Background/Purpose: Lisfranc injury is frequently accompanied by fractures of the metatarsal and/or tarsal bones. These fractures may vary from clearly visible on conventional radiographs to subtle small avulsion fractures on detailed CT imaging. It is unknown whether this CT imaging can be used to predict stability of the Lisfranc complex and subsequent determine the treatment plan. The gold standard for testing instability is the intraoperative stress testing. The aim of this study is to determine whether the number and type of fractures, as well as congruency of the Lisfranc complex, on CT imaging can be correlated with the stability.

Methods: In total 36 consecutive patients between 2007 and 2014 with a Lisfranc injury were analyzed using CT scan (coupes 0.7-1 mm), including 18 women and 17 men, median age 42 years (range, 13-84 years). After standard radiographs and CT scanning, a weight-bearing radiograph or intraoperative stress testing evaluated stability. One-way ANOVA (analysis of variance and X^2 test was used. CT-based parameters were assessed blinded from the presence of (in)stability.

Results: After stress testing, 10 injuries were classified stable and 26 injuries unstable. There was a significant difference in incongruency on CT scan for stable injuries 3/10, and unstable injuries 17/24 ($P = 0.035$). However, in 30% of patients false positive and false negative results for congruency in predicting instability was present. The number of fractures was on average 3.4 (34/10) in the stable group and 4.5 in the unstable group (117/26) (not significant). Regarding the localization of the fractures over the tarsal and metatarsal bones, only a significant difference in the involvement of the cuboid was present, 1/10 in the stable group versus 12/26 in the unstable group ($P = 0.046$).

Conclusion: Incongruency on CT scan of the Lisfranc injury is correlated with instability, whereas the number of fractures does not correlate. Regarding the type of fractures the existence of tarsal fractures seems to matter but is not a good predictor for stability in Lisfranc injuries.

See pages 49 - 106 for financial disclosure information.

Treatment of Closed Rotational Ankle Fractures Between Trauma-Trained versus Non-Trauma-Trained Orthopaedic Surgeons: A Quality and Cost Comparison

Walter Virkus, MD[1]; Robert Wetzel, MD[2]; Anthony Sorkin, MD[1]; Samuel Cheesman, BA[1]; Edwin Lee, PT, MBA, CPHQ[1]; Lauren Hill, BS, CCRC[1]; Laurence Kempton, MD[1]
[1]Indiana University Health Methodist Hospital, Indianapolis, Indiana, USA;
[2]Case Western Reserve University, Cleveland, Ohio, USA

Purpose: Rotational ankle fractures are common injuries that are treated by both orthopaedic trauma specialists and nontrauma orthopaedists on a routine basis. We evaluated the differences in radiographic outcomes and operative costs between providers who had completed a trauma fellowship versus those who had not. Our hypothesis was that outcomes and cost would be similar between these two groups of providers.

Methods: We identified surgically treated rotational ankle fractures treated from July 2013 through June 2014 at our Level I trauma center and at 8 of 17 other hospitals in our health system using a CPT code search for 27792, 27814, 27822, 27823, and 27829. Fractures included OTA 44-A-C injuries (lateral malleolus, bimalleolar, trimalleolar, and syndesmotic ankle injuries). We excluded open fractures, pilon fractures, isolated medial malleolus fractures, and cases performed by surgeons who left our system during the study period. We excluded cases that involved multiple procedures in a single operative setting to avoid incorporating non-ankle fracture-related costs. Patients with poor quality postoperative or follow-up radiographs were excluded from the radiographic analyses. Minimum radiographic follow-up was 6 weeks due to low likelihood of loss of reduction beyond this time point. Remaining patients were grouped into those treated by trauma-trained orthopaedic surgeons (TTOS) and non-trauma-trained orthopaedic surgeons (NTTOS). Quality of the initial reduction and final follow-up reduction were blindly graded by three surgeons using previously defined criteria. Implant-related costs of treatment for each procedure were calculated with a surgical inventory program we use to monitor cost of care. The software has the ability to calculate operative costs by summing all itemized costs associated with individual operating room patient encounters. Radiographic and operative cost differences between TTOS and NTTOS patients were analyzed using Fisher's exact test and Mann-Whitney *U* test, respectively.

Results: Our CPT code search yielded 295 fractures, of which 87 met exclusion criteria, leaving 208 fractures for analysis, 119 in the TTOS group and 89 in the NTTOS group. Acceptable fracture reduction was observed in 202 of 205 fractures, with the three unacceptable reductions being in the NTTOS group ($P = 0.08$). Three NTTOS patients lacked immediate postoperative radiographs for review, and 11 TTOS and 10 NTTOS patients were lost to follow-up prior to 6 weeks postoperative. There were five cases in which fracture reduction changed from acceptable to unacceptable during the follow-up period. This left 102/105 in the TTOS group and 74/79 in the NTTOS group with adequate reductions at final follow-up ($P = 0.29$). Cost analysis based on list price of implant-related costs revealed the median operative cost for the NTTOS group was $2940 (range, $633-$6447) versus $1233 (range, $304-$19,720) for the TTOS group ($P < 0.001$). Further analysis revealed that high cost drivers were locking plates, adjunctive external fixation, suture button fixation, and cannulated screws. Table 1 demonstrates significant differences in implant use between the two groups.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Of the five cases with late loss of reduction, three occurred in locking plate cases and two occurred in nonlocking plate cases ($P = 0.66$).

Table 1: High-cost Implant Usage in NTTOS versus TTOS

	Non-trauma Orthopaedists (n=89)	Trauma-trained Orthopaedists (n=119)	p-value*
Locking Plates	82	10	<0.0001
Cannulated Screws	35	3	<0.0001
Suture Button Fixation	14	0	<0.0001
External Fixator	0	4	0.14

*Two-tailed Fisher's exact test

Conclusion: Our study found no significant differences in radiographic outcomes of operatively treated rotational ankle fractures between orthopaedic surgeons with and without trauma fellowship training. However, cost analysis demonstrated significantly higher implant-related costs for the NTTOS group with median operative session cost more than twice that of the TTOS group. The primary contributor to this difference was the use of locking plates and cannulated screws. Further investigation evaluating the clinical benefit of expensive, technologically advanced implants is warranted. Assuming radiographic outcomes adequately approximate clinical outcomes, our series demonstrated improved patient care value (quality:cost ratio) in the patients treated by TTOSs.

See pages 49 - 106 for financial disclosure information.

Complication Rates Following Operative Treatment of Closed Calcaneus Fractures in the Medicare Population

Benjamin Kelley, BA[1]; Kent Yamaguchi, MD[2]; Dean Wang, MD[1]; Andrew Jensen, MD[2]; Sai Devana, BS[1]; Anthony D'Oro, BS[3]; Zorica Buser, PhD[3]; Jeffrey Wang, MD[3]; Frank Petrigliano, MD[1]; Nelson SooHoo, MD[1]
[1]Department of Orthopaedic Surgery, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, California, USA;
[2]University of California Los Angeles, Los Angeles, California, USA;
[3]Department of Orthopaedic Surgery, Keck School of Medicine, University of Southern California, Los Angeles, California, USA

Background/Purpose: Calcaneus fractures can result in significant disability secondary to deformity and subtalar arthritis. Open reduction and internal fixation (ORIF) has been advocated by some authors, but some clinical studies indicate that benefits of operative fixation may be offset by the risks of short-term complications. The purpose of this study was to use a large Medicare population database to report on short-term complication rates and subtalar fusion rates following operative management of calcaneus fractures. In addition, the study examined the effects of reversible patient factors of obesity, smoking, and type 2 diabetes (T2DM) on these complication rates.

Methods: This retrospective, large database study identified all Medicare-insured patients within the PearlDiver Patient Record Database who underwent treatment for closed fractures of the calcaneus during the 8-year period from 2005-2012. The PearlDiver database is a publicly available, national database including approximately 51 million patients. Patients treated for closed fractures of the calcaneus were identified by cross-referencing CPT and ICD-9 codes for closed treatment, percutaneous fixation, ORIF, or primary subtalar fusion. Primary subtalar fusion was subdivided into "early" (procedure occurring <6 months after diagnosis) or "late" (procedure occurring >6 months after diagnosis). All patient groups were stratified into demographic categories based on diagnoses of type 2 diabetes, tobacco use disorder, and obesity (body mass index [BMI] >30 kg/m^2). Outcomes measured for all treatment groups were postoperative 90-day complication rates of infection, thromboembolism, medical complications, as well as 2-year subtalar fusion and 2-year non-subtalar fusion rates (ankle, triple, midtarsal, tarsometatarsal). Patients with diagnoses of these complications prior to surgical intervention as well as those with associated fractures of the ankle, tarsal, and metatarsal bones were excluded. Demographic information queried from the database included patient gender and age. A X^2 test was performed to test the association between categorical variables and report the odds ratio (OR) with a 95% CI. Significance was set at $P < 0.05$.

Results: A total of 40,038 patients diagnosed with closed calcaneus fracture were identified. Of these patients, 13.2% (n = 5288) were managed operatively. Within this group, 81.1% were treated with ORIF, 7.5% with percutaneous treatment, 5.6% with early primary subtalar fusion, and 5.8% with delayed primary subtalar fusion. Of patients undergoing ORIF, 14.6% were diagnosed with obesity (BMI >30), 29.8% smoking, and 30.7% T2DM. Statistically significant differences in rates of postoperative infection, thromboembolism, and medical complication

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

were found in obese patients (P <0.01), smokers (P <0.01), and T2DM patients (P <0.01) as compared to their respective reference groups (Table 1). Rates of subtalar fusion within 2 years following ORIF were significantly higher in smokers compared to nonsmokers (P <0.01). Rates of non-subtalar fusion within 2 years following ORIF were significantly higher in obese patients compared to nonobese patients (P <0.01) and T2DM patients compared to non-T2DM patients (P <0.01). In patients undergoing primary subtalar fusion, there was a significantly higher rate of postoperative infection in patients treated within 6 months of diagnosis compared to delaying treatment for more than 6 months (P <0.01).

Table 1: Postoperative Complication and Subtalar Fusion Rates Following ORIF for Closed Calcaneus Fracture

		Odds Ratio (95% CI)				
		90 day Infection	90 day Thromboembolism	90 day Medical Complication	2 Year Subtalar Fusion	2 Year Non-Subtalar Fusion
Comorbidity	**Reference**					
Obesity (BMI > 30)	Non-Obese (BMI < 30)	**18.6% vs 7.3% 2.9 (2.3-3.7)**	**4.8% vs 1.8% 2.7 (1.7-4.2)**	**27.1% vs 9.4% 3.6 (2.9-4.4)**	2.5% vs 1.5% 1.7 (1.0-3.1)	**2.7% vs 0.7% 3.9 (2.1-7.2)**
Smoker	Non-Smoker	**11.8% vs 7.4% 1.7 (1.4-2.1)**	2.8% vs 2.0% 1.4 (0.9-2.0)	**18.9% vs 10.8% 1.8 (1.5-2.1)**	**2.5% vs 0.9% 2.9 (1.7-4.8)**	1.2% vs 0.9% 1.3 (0.7-2.4)
Type 2 Diabetes	Non-Type 2 Diabetic	**16.1% vs 7.0% 2.5 (2.1-3.1)**	**3.9% vs 1.8% 2.2 (1.5-3.2)**	**33.3% vs 8.1% 5.6 (4.7-6.7)**	1.4% vs 1.7% 0.81 (0.5-1.4)	**2.2% vs 0.6% 3.7 (2.0-6.7)**
Male	Female	8.6% vs 8.7% 0.98 (0.81-1.2)	2.4% vs 1.7% 1.5 (0.97-2.3)	**7.3% vs 15% 0.45 (0.37-0.55)**	1.8% vs 1.9% 1.36 (0.84-2.2)	0.7% vs 1.1% 0.59 (0.31-1.1)

Note: Bold indicates a significant difference between the comorbidity and its reference (p < 0.05)

Conclusion: Obesity, smoking, and T2DM are independently associated with increased postoperative complications following ORIF for closed calcaneus fracture in the Medicare population. Smoking is associated with higher 2-year rates of subtalar fusion while obesity and T2DM are associated with higher 2-year rates of other fusions. Calcaneus fractures managed with primary subtalar fusion within 6 months of diagnosis may be at greater risk of postoperative infection as compared to those treated after 6 months.

See pages 49 - 106 for financial disclosure information.

Syndesmosis Reduction and Fixation Using Intraoperative 3D Imaging

***Morad Mohamad, MD**; Victor Dubois-Ferrière, MD*
Hôpitaux Universitaires de Genève, Genève, SWITZERLAND

Background/Purpose: Ankle syndesmotic injuries are common. They requires anatomic reduction and fixation to restore the normal biomechanics of the ankle joint and prevent long-term complications. Intraoperative CT can provide accurate assessment of syndesmotic reduction. However, there is evidence that evaluating the tibiofibular relationship based on three-dimensional (3D) imaging of the injured side may not be sufficient. The purpose of this study is to assess the quality of reduction of tibiofibular syndesmosis using intraoperative CT scan, and using the uninjured ankle CT scan as a template to guide the reduction.

Methods: All patient underwent intraoperative or preoperative CT scan of their uninjured ankle. The injured ankle syndesmosis was reduced and temporarily fixed with a Kirschner wire. An axial slice, 1 cm proximal to the tibial plafond, was obtained with an intraoperative CT scan, and compared to the uninjured ankle CT at the same level. If the reduction did not match to the uninjured side, the reduction was revised and CT repeated. Finally the syndesmosis was fixed with 3.5-mm screws and a final intraoperative CT scan was obtained. A greater than 2-mm anterior-posterior or medial-lateral displacement compared with the untreated ankle was considered significant malreduction.

Results: Using the technique described, 17 patients have been treated. Ten patients had a fracture Weber C-type, 5 a Maisonneuve fracture, and 2 had a revision of syndesmosis malreduction. Position of the fibula in postreduction CT scans showed a mean anterior-posterior displacement of 0.88 (±0.67) mm as compared to the uninjured ankle. The medial-lateral position showed a mean displacement of 0.91 (±0.55) mm.

Conclusions: The results of this study indicate that fixation of syndesmosis using the contralateral side as a reference and under O-arm control provides a more accurate method. This appears to be a promising technique to have up to 100% of anatomic reduction. To the best of our knowledge, this is the first study using the uninjured ankle CT as template to guide syndesmosis reduction.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Isolated Open Ankle Fractures: Are They Safe to Fix Acutely?
A Ten-Year Comparative Review of Two Trauma Centers

Nikita Lakomkin, BS[1]; David Joyce, MD[1]; Paul Whiting, MD[2]; Ashley Dodd, BS[1]; William Obremskey, MD, MPH[3]; Manish K. Sethi, MD[3]; Cory Collinge, MD[4];
[1]Vanderbilt University, Nashville, Tennessee, USA;
[2]University of Wisconsin, Madison, Wisconsin, USA;
[3]Vanderbilt Orthopaedic Institute, Nashville, Tennessee, USA;
[4]Vanderbilt Medical Center, Nashville, Tennessee, USA

Purpose: Little data exist to support the immediate fixation and wound closure of isolated open ankle fractures. Existing relevant series are few, small, and heterogeneous, and report widely differing rates of postoperative complications. The purpose of this study was thus to determine and compare the complication rates following early fixation of open ankle injuries over a 10-year period at two regional trauma centers (Level II and Level II). In addition, we sought to explore the relationship between the level of trauma center, open fracture type, time to definitive fixation, ASA (American Society of Anesthesiologists) score, and postoperative infections.

Methods: CPT codes for the operative treatment of 1469 ankle fractures were utilized to create a database that incorporated 105 open ankle fractures treated surgically at a Level I and II trauma center between 2000 and 2011. Retrospective review of hospital records was conducted to document patient demographic and injury characteristics, and determine the timing of definitive ankle fracture fixation. Records were reviewed to assess the rates of superficial and deep wound infection following surgery. χ^2 analysis was utilized to compare patient characteristics between the Level I and Level II trauma centers. A backwards, binary logistic regression model was constructed that incorporated trauma center level, Gustilo-Anderson open fracture type, ASA score, and time to fixation as the independent variables with postoperative infections as the dependent variable.

Results: 72 patients (4.9%) had open ankle fractures that were definitively treated at a Level I trauma center while 33 (2.2%) underwent fixation at a Level II center. 82.5% of patients were treated definitively with fracture repair and wound closure at the initial open fracture surgery (76.4% at Level I, 91% at Level II). Of the patients undergoing surgery at a Level I center, 6 (8.3%) developed superficial infections and 14 (19.4%) sustained a deep wound infection. Ankle fixations at the Level II trauma center resulted in 2 (6.1%) superficial infections and 2 (6.1%) deep wound infections. Open ankle fracture patients treated at a Level I trauma center presented with a significantly greater mean ASA score (2.24 vs 2.09, P = 0.01) but trended toward a lower mean Gustilo type (2.22 vs 2.55, P = 0.08). Patients at the Level I trauma center were no more likely to be treated within 24 hours than those at the Level II center (P = 0.81). Treatment at a Level II trauma center was associated with reduced incidence of infection (odds ratio [OR] = 0.241, P = 0.04), while a greater Gustilo type was associated with a higher infection rate (OR = 2.630, P = 0.03).

Conclusion: In a large, two trauma center series of isolated open ankle fractures, 82.5% of injuries were treated with a single definitive operation for debridement, fracture repair,

See pages 49 - 106 for financial disclosure information.

and wound closure. The overall postoperative infection rate was 22.9% (6.9% superficial, 16% deep). Patients presenting with higher Gustilo types were more likely to develop an infection. Patients were not more likely to be treated within 24 hours at a Level I center, and treatment at a Level II center was associated with reduced incidence of infection. The decision for immediate definitive repair and wound closure of open ankle fractures should be carefully considered against other options.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Preoperative CT Scan for Posterior Malleolar Ankle Fractures: An Institutional Protocol Influences Surgical Decision Making

Zachary McVicker, MD[1]*; Michael Maceroli, MD*[2]*; John Gorczyca, MD*[2]*; Catherine Humphrey, MD*[1]*; Gillian Soles, MD*[3]*; John Ketz, MD*[3]
[1]*University of Rochester Medical Center, Rochester, New York, USA;*
[2]*University of Rochester, Rochester, New York, USA*
[3]*University of Rochester Medical Center, Rochester, Pittsford, USA*

Introduction/ Purpose: Controversy exists regarding operative indications, surgical approach, and optimal fixation construct for the posterior malleolar (PM) component of ankle fractures. Surgical decision making is often based upon the fragment size measured on the lateral ankle radiograph. CT imaging provides further detail and fracture characterization but is not routinely obtained for standard ankle fractures. The purpose of this study is to evaluate the role of preoperative CT scans in evaluating and treating PM fractures.

Methods: A protocol was initiated at the authors' institution to obtain preoperative CT scans for all ankle fractures with an associated PM fragment. The CT scans were reviewed to characterize the PM fracture. Primary characteristics recorded were single fragment or multifragmentary PM, loose intra-articular fragments, impacted articular fragments, and percentage of the articular surface involved. The involvement of the articular surface was measured as the maximum percent noted on axial, sagittal, or coronal images. Details obtained from the CT scans were compared to the lateral projection on preoperative plain radiographs. This information was then compared to pre-protocol ankle fractures with a PM component. The surgical approach, fixation technique, and quality of reduction were recorded for all pre- and postprotocol patients. Surgical decisions and quality of PM reduction were compared between the two cohorts.

Results: From 2012-2015, preoperative CT scans were obtained for 72 ankle fractures with PM components according to an institutional protocol. The average size of the PM fracture measured on lateral radiographs was 24.1% of the total plafond compared to 26.9% ($P = 0.13$) measured on CT scan. Preoperative CT scans noted loose or impacted intra-articular fragments in 25/72 cases (34.7%) that were not seen on plain radiographs. 5/72 patients (6.9%) sustained multifragmentary (≥2 fragments) PM fractures appreciated on radiographs. An additional 26 patients (36.1%) had multifragmentary PM fractures that were not appreciated on plain radiographs. A total of 30 (41.7%) fractures were approached using posterior-based surgical exposures. PM fractures treated with direct reduction had significantly less residual displacement than those treated through indirect reduction techniques (0.4 mm vs 1.0 mm; $P = 0.01$). A cohort of 46 ankle fractures with a PM component was analyzed from 2010-2011 prior to the institutional CT scan protocol. In this cohort, a posterior-based surgical exposure was employed in 3 of 46 cases (6.5%) with a residual displacement of 0.7 mm. Approaches that utilized a direct lateral approach had a residual displacement of 1.2 mm.

Conclusion: An institutional protocol to obtain CT scans for all ankle fractures with a PM component resulted in significantly more posterior-based surgical exposures and direct reductions as compared to pre-protocol cases. This resulted in an improvement in the qual-

See pages 49 - 106 for financial disclosure information.

ity of PM fragment reduction. Ankle fractures with a PM component can have complex, multifragmentary patterns. While the measured size of the posterior fragment was similar on all imaging techniques, CT scans demonstrated significantly more fracture detail including impacted articular surface, loose fragments, and multifragmentary PM fractures not appreciated on plain radiographs.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Posttraumatic Osteoarthritis Risk Relative to Intra-Articular Calcaneal Fracture Severity

*Karan Rao, BS[1]; **Kevin Dibbern, BS**[1]; Phinit Phisitkul, MD[2]; John Marsh, MD[3]; Donald Anderson, PhD[1]*
[1]*The University of Iowa, Iowa City, Iowa, USA;*
[2]*The University of Iowa Hospitals & Clinics, Iowa City, Iowa, USA;*
[3]*Dept. of Orthopaedics, The University of Iowa Hospitals & Clinics, Iowa City, Iowa, USA*

Background/Purpose: Patients with high-energy intra-articular fractures (IAFs) face a significant risk of posttraumatic osteoarthritis (PTOA). Objective CT-based measures of fracture energy have been used to link fracture severity to PTOA risk following IAFs of the distal tibia but not the calcaneus. The Sanders classification is used as a prognostic marker for long-term clinical outcomes but has not been correlated with fracture energy. The purpose of this study was for the first time to objectively measure fracture energy in a series of calcaneal fractures and to establish the relationships between it and the Sanders classification, the quality of the surgical reduction, and clinical outcome in patients with intra-articular calcaneal fractures.

Methods: 18 patients with 19 IAFs of the calcaneus were consented for this IRB-approved study; they are the first to be analyzed from a series of 120 cases treated with percutaneous reduction and screw fixation that have been identified and are being followed. Preoperative CT scans were used to classify fractures according to Sanders et al and to assess their severity. Fracture severity was quantified by computing fracture energy using a CT-based image analysis methodology. Three experts independently measured the maximum articular stepoff from postoperative CT. PTOA development was graded using the Kellgren-Lawrence (KL) scale and outcomes were assessed with VAS (visual analog scale) pain scores for patients with >18-month follow-up. Because the measures to be compared mix ordinal and continuous values, agreement was assessed using concordance–the probability that the fracture energies correctly discriminate between pairs of Sanders classification and/or KL scores.

Results: The 19 calcaneal fractures analyzed for fracture severity ranged from Sanders class II to IV. Their fracture energies ranged from 12.3 to 24.5 J. A concordance of 0.75 was observed between Sanders classification and fracture energy. Ten patients with 11 IAFs were assessed for PTOA development, based on a follow-up time >18 months (range, 20-74 months) postinjury. There was a complex relationship observed between fracture energy, Sanders classification, articular stepoff, and KL grade. Interestingly, for those cases having an articular stepoff ≤2 mm, PTOA risk increased with fracture energy (Fig. 1). There was no such relationship observed between Sanders classification and KL grade.

Conclusion: The results suggest that fracture severity is more predictive of PTOA risk than is the Sanders classification. The residual articular stepoff is a likely confounder influencing PTOA risk when evaluating fracture energy versus KL grade. Due to a small sample size, statistical significance could not yet be conclusively established. These data suggest that higher initial injury severity as assessed by an objective metric could predict an increased risk of PTOA. This has implications for evaluation and treatment of calcaneal fractures with the aim of forestalling PTOA.

See pages 49 - 106 for financial disclosure information.

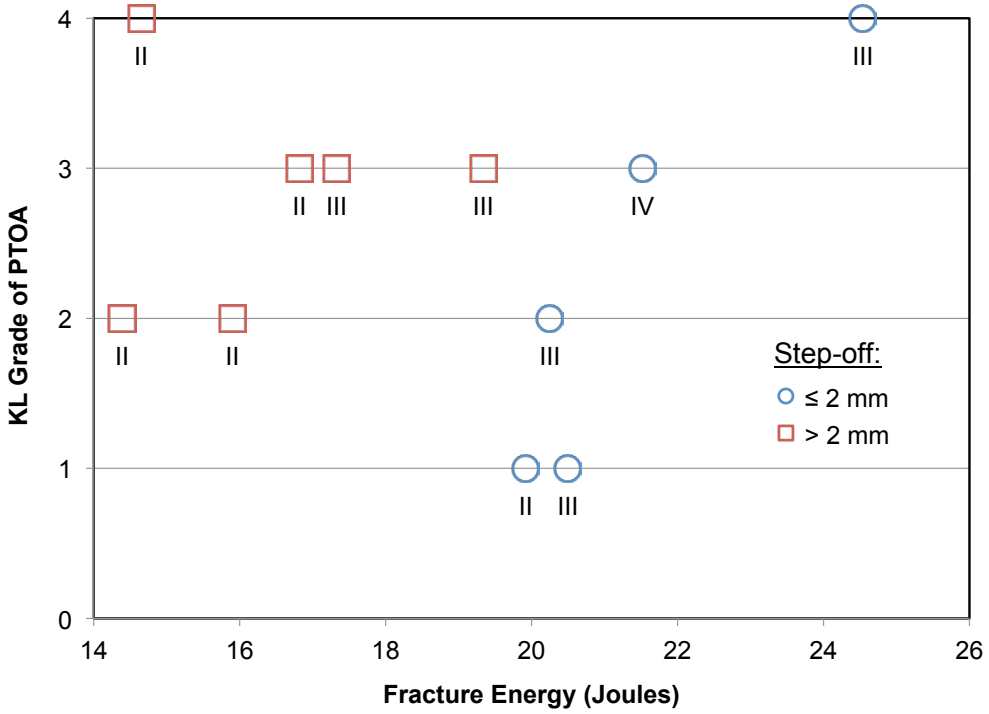


Figure 1. Fracture energy vs KL Grade. Labels below data points indicate the Sanders fracture classification.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Outcomes Following Syndesmotic Screw versus Anatomic Fixation in Rotational Ankle Fractures with Syndesmotic Injury

Ashley Levack, MD, MAS[1]*; Stephen Warner, MD, PhD*[1]*; Elizabeth Gausden, MD*[2]*; David Helfet, MD*[1]*; Dean G. Lorich, MD*[2]
[1]*Hospital for Special Surgery, New York, New York, USA;*
[2]*Hospital for Special Surgery-Cornell, New York, New York, USA*

Background/Purpose: Rotational ankle fractures (OTA 44) frequently involve injury to the ankle syndesmosis. Characteristic patterns of syndesmotic disruption involve either a soft-tissue avulsion of the posterior inferior tibiofibular ligament (PITFL) or an intact PITFL attached to a posterior malleolar fracture fragment. Both of these injuries compromise the integrity of the PITFL and associated transverse ligament, which provide nearly half of the overall strength of the syndesmosis. In combination with open reduction and internal fixation of medial and lateral malleolus fractures, syndesmotic instability must be addressed to restore proper ankle mechanics. The syndesmosis has traditionally been stabilized with transsyndesmotic screws; however, anatomic fixation of either the posterior malleolar fracture or soft-tissue repair of the PITFL to its native attachment along the posterior tibial tubercle has gained popularity in recent years. The strategy of anatomic fixation also includes deltoid ligament repair if there is no medial malleolar fracture and intraoperative stress testing indicates residual talar instability after posterior anatomic fixation. The purpose of this study is to compare disease-specific functional outcomes in operatively treated rotational ankle fractures undergoing syndesmotic fixation with either conventional transsyndesmotic screws or anatomic fixation of the posterior andmedially based injuries.

Methods: A prospective institutional registry of operatively treated ankle fractures from 2003 to 2015 was used to identify all adult (age >18) supination external rotation (SER) and pronation external rotation (PER) stage IV ankle fractures with a minimum of 1 year functional outcome data. Treatment differences reflect a change in the primary surgeon's evolution of treatment strategies from syndesmotic screws at the start of this prospective registry to his now preferred anatomic fixation method. Patient demographics, medical comorbidities, and injury characteristics were recorded for each case. Radiographs were reviewed for patients meeting the inclusion criteria and the type of syndesmotic fixation used was recorded (syndesmotic screws, anatomic repair, or combination of methods). One-way analysis of variance (ANOVA) and X^2 statistics were used to compare baseline characteristics between syndesmotic fixation groups. One-way ANOVA was also used to evaluate the primary outcome of Foot and Ankle Outcome Score (FAOS) summary domains by syndesmotic fixation type. A P value of less than 0.05 indicated statistical significance.

Results: Transsyndesmotic screw fixation alone (n = 69, 23.4%), anatomic fixation alone (n = 138, 46.8%) or combined techniques (n = 88, 29.8%) were utilized in 295 rotational ankle fractures. There were no statistically significant differences between the three groups in age at surgery, body mass index, sex, race, fracture side, rate of open fractures, smoking status, or the presence of recorded comorbidities. The anatomic fixation group consisted of significantly more SER ankle fractures (94.9%) compared to the syndesmotic screw (71.0%, P <0.001) and combined groups (72.7.%, P <0.001). There was no statistically significant difference in FAOS

See pages 49 - 106 for financial disclosure information.

scores for any of the five summary domains (Symptoms, Pain, Activities of Daily Living, Sports, or Quality of Life) between the three fixation groups. Additionally, no differences in outcome scores were found between the anatomic-only fixation group and fractures treated with syndesmotic screws (alone or in combination with anatomic fixation). In this cohort, 80.2% of patients with transsyndesmotic screw fixation underwent removal of hardware compared to 42.6% of patients without transsyndesmotic screws (P <0.001).

Conclusion: Transsyndesmotic screw fixation often requires a subsequent surgical procedure for screw removal. This analysis confirms higher rates of hardware removal in patients with transsyndesmotic screws compared to those without this type of syndesmotic fixation. In this cohort of rotational ankle fractures, the type of syndesmotic fixation method resulted in comparable disease-specific patient-reported outcome scores at a minimum of 1 year postoperatively. Given the equivalence in functional outcomes, surgeons should consider the option of anatomic fixation of syndesmotic injuries in rotational ankle fracture patterns to prevent the cost and risk of morbidity associated with additional surgery for syndesmotic screw removal.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Indications for Antibiotics and Surgical Debridement for Low-Energy Intra-Articular Gunshot Injuries

Mai Nguyen, MD[1]*; Michael Reich, MD*[2]*; Jeffrey O'Donnell, BS*[1]*; Jonathan Savakus, BS*[1]*; Nicholas Prayson, BA*[1]*; Dominic Grimberg, BS*[1]*; Joseph Golob, Jr., MD*[1]*; Amy McDonald, MD*[1]*; John Como, MD, MPH*[1]*; Heather Vallier, MD*[3]
[1]*MetroHealth System, Cleveland, Ohio, USA;*
[2]*Case Western Reserve University, Cleveland, Ohio, USA;*
[3]*MetroHealth Medical Center, Cleveland, Ohio, USA*

Purpose: Intra-articular (IA) gunshot wounds (GSWs) pose a challenging treatment dilemma due to the contamination of the joint, possible presence of an IA foreign body, and associated osteochondral and soft-tissue injuries. Despite their commonality, no standardized treatment algorithm exists for antibiotic administration or surgical debridement. The purposes of this study were (1) to determine the incidence of infection after IA GSWs and (2) to develop a standard protocol for treatment of IA GSWs to minimize infection risk.

Methods: An IRB-approved retrospective review of a prospectively collected database at an urban, Level I trauma center was performed. The incidence of infections requiring intravenous antibiotics or surgical debridement, and other complications in a cohort of 99 adult patients with IA GSWs over 4 years was determined. Patient injury and demographic characteristics were noted. Initial antibiotics (type, route, and duration) and any surgical interventions were recorded.

Results: 86 patients (87.9%) with 89 IA GSWs were followed for a mean of 8 months. The other patients had insufficient records. Most injuries (71.9%) were of the hip or knee. There were 12 vascular injuries (13.5%), 9 of which required acute surgical intervention. All patients had their tetanus immunization status updated. Most (89.5%) received antibiotic prophylaxis, consisting most often of cefazolin (85.9%). Based on injury pattern and surgeon preference, patients were either treated nonoperatively (43.8%), with surgical debridement only (22.5%), with surgical debridement and fracture fixation and/or neurovascular repair (31.5%), or with percutaneous fracture fixation without debridement (2.25%). Two patients (2.25%) developed deep infection. Both of them had vascular injuries; one had a dysvascular limb and was treated eventually with amputation, while the other had observation of arterial spasm and underwent neurolysis due to neuropraxia of multiple nerves. Patients with vascular injury are at higher risk of infection compared to those without vascular injury (16.7% vs 0, $P = 0.02$). Only 4 of the 39 injuries that were originally managed nonoperatively (10.2%) required elective surgeries: for extra-articular bullet removal (3 cases) and ulnar nerve allograft (1 case). None of the patients without surgical debridement of the injured joint developed infection.

Conclusion: The incidence of infection after IA GSWs is low, and IA GSWs do not appear to necessitate surgical debridement. No infections occurred after isolated IA GSW. Patients with vascular injury deserve special attention, as they are at higher risk of infection and other complications.

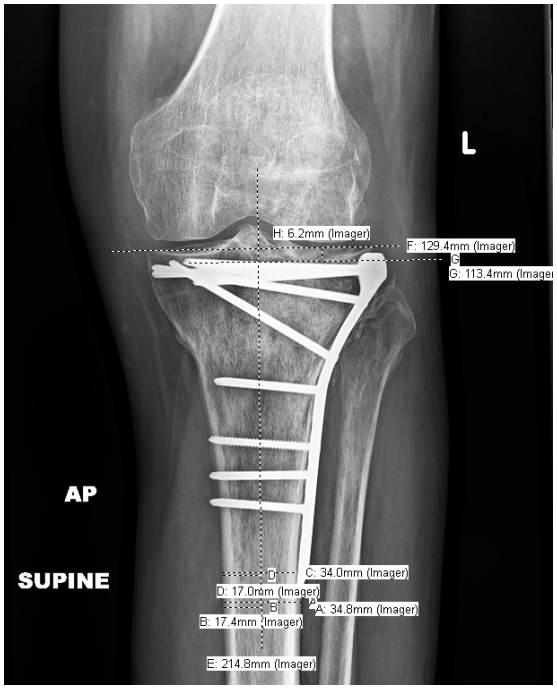
See pages 49 - 106 for financial disclosure information.

Association of Knee Alignment and Quality of Reduction with Subsidence After Internal Fixation of Tibial Plateau Fractures in Elderly Patients

Amrut Borade, MD[1]*; Harish Kempegowda, MD*[1]*; Jove Graham, PhD*[2]*; Michael Suk, MD*[3]*; James Gotoff, BS*[1]*; Daniel S. Horwitz, MD*[3]
[1]*Geisinger Medical Center, Danville, Pennsylvania, USA;*
[2]*Geisinger Center for Health Research, Danville, Pennsylvania, USA;*
[3]*Geisinger Health System, Danville, Pennsylvania, USA*

Background/Purpose: Tibial plateau fractures have been reported to occur in as much as 10% of all fractures in elderly osteoporotic patients. Subsidence within 3 months of open reduction and internal fixation (ORIF) with plating is a common complication in these patients, with some reports of as high as 85% incidence. Knee malalignment has been speculated to be a risk factor for subsidence but the association has not been clearly established. Femur-tibia axis (FTA) on knee AP radiographs has been established as a valid alternative to hip-knee axis (HKA) to assess knee alignment. We conducted this study with the intention to investigate the association of malalignment and quality of reduction with subsidence. Our hypotheses were: knee malalignment is a risk factor for subsidence and quality of reduction is associated with the final tibial plateau height in patients >50 years of age.

Methods: 99 patients older than 50 years of age with Schatzker I to V tibial plateau fractures internally fixed with plating were included. Retrospective review of the patient charts with immediate postoperative and final follow-up radiographs was done. Knee alignment was measured by the angle formed by the femur and tibia at the center of the tibial spine (FTAt) as described by Moreland et al with angles <20° and >40° of valgus considered as malalignment. To measure the tibial plateau height difference, the anatomic axis of the tibia was drawn and perpendiculars to this axis were drawn along the lateral and medial tibial plateaus (Fig. 1). Both the perpendiculars typically overlap in anatomically reduced state. Relative elevation of the operated tibial plateau over the nonoperated one was designated as "overreduction" and relative depression as "underreduction." Quantitative assessment of subsidence was done by measurement of the chronological change in the difference of the tibial plateau heights as described by Boraiah et al. >3-mm subsidence was considered "significant" as described by Ali et al. For all isolated unicondylar fractures, association between the immediate postoperative reduction (overreduction/anatomic reduction/



POSTER ABSTRACTS

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

underreduction) and the final articular state reached was performed. Logistic regression and X^2 tests were used for statistical analysis.

Results: 30% of the patients included were males with mean follow-up of 46 weeks, and 67% of them had low-energy injury. Malalignment appears to increase the risk of occurrence of significant subsidence (odds ratio 2.47, 95% CI 0.92-6.65) approaching statistical significance ($P = 0.07$). Out of the isolated unicondylar fractures (N = 81, Schatzker I to IV) 64% of the patients with overreduction postoperatively (30 of 47; mean height: 2.8 mm) ended up overreduced or anatomically reduced at final follow-up, whereas 100% of the patients with anatomic reduction postoperatively (N = 11) ended up underreduced. Thus, overreduction was effective in achieving better final anatomical state ($P < 0.0001$). The use of biological cement as a void filler (N = 23) was found to decrease the amount of subsidence but without statistical significance.

Conclusion: In this study knee malalignment was found to increase the risk of subsidence and overreduction was found to have preventive effect on subsidence. The major limitation of our study is a relatively small patient population. As patients with malalignment are at risk of subsidence, use of biological cement and protected weight bearing may be justified in them. Overreduction of the tibial plateau appears successful in achieving better final articular anatomy.

See pages 49 - 106 for financial disclosure information.

Staged Prone/Supine Fixation of High-Energy Multicolumnar Tibial Plateau Fractures: A Multicenter Analysis

Clifford B. Jones, MD[1]; David Komatsu, PhD[2]; J. Tracy Watson, MD[3]; Stephen A. Kottmeier, MD[4]; Elliot Row, MD[4]
[1]*The CORE Institute, Phoenix, Arizona, USA;*
[2]*Stony Brook University, Dept. Orthopaedics, Stony Brook, New York, USA;*
[3]*Saint Louis University, Dept. of Ortho Surgery, St. Louis, Missouri, USA;*
[4]*Stony Brook University Hospital, Stony Brook, New York, USA*

Background/Purpose: Historically, surgical tactics for tibial plateau fractures have emphasized anterior surgical approaches and techniques as supine patient positioning is most commonly performed to avoid potentially vulnerable retrocondylar neurovascular structures. However, occasionally the majority, if not entirety, of articular involvement is posteriorly based. Initial prone positioning to afford posterior medial surgical access, with subsequent supine positioning and additional definitive fixation employing an anterior approach, may offer a useful surgical strategy in several distinct fracture patterns. These include a subset of Schatzker type V (OTA type 41C) patterns with medial lesions in the coronal plane, and 3-column fracture-dislocations. In either scenario, medial and subsequent lateral column fixation may be performed supine in a "staged" manner. This may be performed in the same or delayed operative setting depending on soft-tissue concerns. This surgical strategy may prove advantageous and with less liability than supine-only positioning with regard to fracture visualization, reduction, and implant insertion in unique clinical scenarios. We present a surgical strategy to manage multicolumnar fracture pattern variants by addressing the predominant posterior fragment employing a Lobenhoffer approach in the prone position followed by supine patient repositioning and anterior approach access. This may be performed in the same or delayed operative setting. We predict this strategy will optimize surgical treatment generating satisfactory postoperative limb alignment, articular surface reduction, range of motion, and patient outcome scores.

Methods: A multicenter retrospective analysis was performed to assess staged fixation of multicolumnar tibial plateau fractures using a Lobenhoffer approach in the prone position followed by supine repositioning for anterior surgical access from three academic Level I trauma centers. 36 cases presenting with multicolumnar tibial plateau fractures met inclusion criteria for the staged protocol between 2003 and 2014. Patient demographic information was retrospectively reviewed with a mean follow-up time of 11.3 months (range, 3-36 months). Postoperative radiographic analysis, physical examination findings, and patient outcome scores from the KOOS (Knee injury and Osteoarthritis Outcome Score) questionnaire were recorded.

Results: The average time to union was 3.5 months (range, 3-9 months). 89% of patients had satisfactory articular reduction (less than 2 mm articular stepoff). All patients demonstrated satisfactory coronal (medial proximal tibia angle 87 ± 5°) and sagittal alignment (posterior proximal tibia angle 9 ± 4°). Condylar width averaged 1.6 mm. 30% of cases required posterior lateral columnar plating (in addition to posterior medial columnar plating), with only one of these cases requiring an extensile exposure modification (medial gastrocnemius origin

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

detachment) to gain access posterolaterally. In 14 cases the posterior approach was staged to allow for anterior soft-tissue recovery prior to subsequent staged supine positioning and lateral column fixation. The knee range of motion averaged 120° (total arc) of flexion. The average KOOS score was 79 / 100 (range, 29-95). 8.3% of the patients in the series developed a surgical site infection (n = 3) with 2 requiring formal irrigation and debridement. The most common aseptic complication was radiographic posttraumatic arthritis (20%). Clinically, one patient eventually required total knee arthroplasty.

Conclusion: High-energy multicolumnar tibial plateau fractures with significant posterior columnar involvement in some clinical scenarios may be predictably addressed with prone posterior access and fixation followed by supine repositioning and the inclusion of an anterior approach. This study demonstrates excellent postoperative radiographic results and acceptable clinical outcomes invoking the described staged protocol. We conclude that the Lobenhoffer approach in the prone position serves well to address extreme posterior columnar tibial plateau fracture variants with regard to fracture visualization, reduction, and ease of implant application. In this manner a desirable and predictable foundation upon which to complete osteoarticular reconstruction is afforded. Utilizing this tactic in our series produced satisfactory radiographic and clinical outcomes.

See pages 49 - 106 for financial disclosure information.

Lateral Tibial Plateau Fracture Fixation: Back to Basics

Florence Unno, MD[1]; Georg Osterhoff, MD[2]; Reza Firoozabadi, MD, MA[3]; Sean Nork, MD[4]
[1]Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia, CANADA;
[2]Zurich University Hospital, Zürich, SWITZERLAND;
[3]Harborview / University of Washington, Seattle, Washington, USA;
[4]Harborview Medical Center, Seattle, Washington, USA

Background/Purpose: Split-depression lateral tibial plateau fractures are typically treated with a combination of articular reduction and lateral plating. The split component of the fracture is usually managed with buttress plating, and the osseous metaphyseal defect after elevation of the articular surface can be managed with allograft, autograft, or a bone void filler such as an injectable calcium phosphate cement. Locking plates have been used increasingly in these fracture patterns despite a lack of supporting evidence. Both locking plates and bone void fillers have significant economic implications. The purpose of this study was to report the results of split-depression tibial plateau fractures treated with low-profile nonlocking small-fragment buttress plating combined with densely packed cancellous allograft bone as an efficient as well as economic alternative to other implants and bone substitutes.

Methods: This was a retrospective review of skeletally mature patients with operatively treated split-depression lateral tibial plateau fractures with a minimum of 6 months follow-up. Four patients who received a calcium phosphate injectable compound and three patients who were treated with a locking plate were excluded. The remaining 69 patients with an average age of 50 years (range, 18-81) were treated with a 3.5-mm nonlocking precontoured stainless steel lateral tibial plateau plate combined with allograft bone to fill the cancellous subarticular void. All fractures were treated with an open approach, direct visualization of the articular reduction, and buttress plating using cranial rafting cortical screws. Postoperative activity recommendations included 12 weeks of protected weight bearing. The immediate postoperative and final radiographs were reviewed to evaluate the articular reduction and the coronal plane alignment. The 6-month radiographs were reviewed to evaluate fracture healing, maintenance of the articular reduction, and any articular subsidence, with 2 mm set as the threshold.

Results: An accurate reduction of the articular surface was observed in 93%. All fractures healed and there was no displacement of the metaphyseal split component. At final follow-up, medial proximal tibial angle stayed satisfactory in all but one patient, indicating maintenance of the coronal plane alignment. In over half of the fractures, additional subchondral Kirschner wires or minifragment screws were placed cranial to the lateral plate and the associated 3.5-mm rafting screws. In 46% of the fractures there was an associated lateral meniscal tear, typically a peripheral detachment amenable to primary repair. The average amount of crushed cancellous allograft bone used to fill the metaphyseal void was 27 cm^3 (range, 10-75 cm^3). Three patients (4.3%) had subsidence of >2 mm,and two patients had minimal subsidence (<2 mm).

Conclusion: The use of a nonlocking precontoured stainless steel buttress plate with rafting

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

cortical screws and densely packed cancellous allograft resulted in predictable healing of displaced split-depression lateral plateau fractures. Articular subsidence was observed in 4.3% of fractures and there was only one case of secondary valgus malalignment. Despite increased popularity of more expensive locking implants and calcium phosphate injectable cements, a strategy based on articular reduction principles, optimization of the cost of implants, and protected weight bearing resulted in maintenance of reduction through healing in the vast majority of split-depression tibial plateau fractures.

See pages 49 - 106 for financial disclosure information.

The Use of a Calcium Phosphate Cement in Open Reduction and Internal Fixation (ORIF) for Tibial Plateau Fractures: A Comparison with Traditional ORIF

Miguel Perez-Viloria, MD[1]; Paolo deAngelis, BS[1]; Kempland Walley, BS[1]; Edward Rodriguez, MD[2]; Paul Appleton, MD[1]
[1]Beth Israel Deaconess Medical Center, Dept of Orthopaedics, Boston, Massachusetts, USA; [2]Beth Israel Deaconess Medical Center / Harvard Medical School, Medfield, Massachusetts, USA

Purpose: Tibial plateau fractures are reported to account for approximately 1% of all fractures. The treatment of choice is ORIF, with or without bone grafting. Several biocompatible calcium-based phosphate bone fillers have been developed, providing suitable alternatives to traditionally employed bone grafts. The goal of this study was to determine if a drillable calcium based cement indicated for filling defects in cancellous bones, combined with ORIF, is a successful treatment for tibial plateau fractures when compared against traditional, nonsupplemented ORIF.

Methods: Following IRB approval, all tibial plateau fractures treated operatively at our Level I trauma center between November 2009 and November 2014 were recruited retrospectively. Patients were eligible if they presented with a tibial plateau fracture and they were 20 years of age or older. Potential subjects were excluded if: the 3-month follow-up radiograph was missing, or the tibial plateau fracture was open, pathologically related, or periprosthetic. 118 patients were enrolled, and divided in two treatment groups: Traditional (nonsupplemented ORIF) and Filler (ORIF + filler), depending if a drillable calcium cement was used during surgery. Of the initial 118 patients, 51 belonged to the Filler group, and 67 to the Traditional group. Data were collected retrospectively from medical records, and radiographs were analyzed at 3, 6 and 12 months postoperatively. Radiographic measurements of interest included depression (mm), intercondylar widening (mm), and varus/valgus angulation (degrees). Comparisons between the two treatment groups were done using Student's *t* tests. Pearson X^2 tests were used to evaluate comparisons between groups with regards to gender, race, smoking habits, Schatzker's and AO classification, mechanism of injury, and diabetes status. Fracture subsidence (mm) was calculated for each patient with available radiographs by computing differences in plateau depression between 3 and 6 months, and 3 and 12 months. To further evaluate whether use of a filler yielded different results than traditional ORIF in fractures characterized by severe depression, measures extracted from preoperative radiographs were categorized using a scoring system similar to the anatomical radiographic Rasmussen score. Specifically, fractures were classified as Not Depressed if presented with 0 mm of depression, Slightly Depressed if depression was<5 mm, Depressed if depression was between 5 and 10 mm, and Very Depressed if depression was >10 mm.

Results: No difference was detected between the two treatment groups with regard to age, body mass index (BMI), gender, mechanism of injury, race, and diabetes at any point in the study's timeline. Of the 118 total patients, only 7.36% developed infections during recovery, all belonging to the Traditional group ($P = 0.004$). There were no differences in mean preoperative joint depression ($P = 0.28$), widening ($P = 0.11$), or angulation ($P = 0.54$) between the two treatment groups. All measures were significantly reduced at the 3, 6, and 12-month follow-up time points when compared to the preoperative values ($P < 0.0001$). Fracture

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

subsidence (mm) was calculated with available radiographs by computing differences in residual depression between 3 and 6 months, and 3 and 12 months. There was a significant difference in subsidence with fractures treated in the Traditional group showing a greater increase in plateau depression between 3 and 6 months ($P = 0.0268$) and 3 and 12 months ($P = 0.0005$). There were no differences in variations in angulation and widening between the two groups.

Conclusion: This comparative retrospective study suggests that the calcium phosphate drillable cement filler may be a helpful, less risky solution to preserve the level of reduction attained during surgical fixation of tibial plateau fractures, preventing postoperative subsidence while avoiding the multiple comorbidities involved in bone grafting. In addition, it may be a better treatment solution when compared to traditional bone grafts due to its increased malleability that allows for better filling of the fractured defects.

See pages 49 - 106 for financial disclosure information.

A Comparative Cohort Study of Mechanical Failure for Monoaxial and Polyaxial Locking Plates in the Treatment of OTA 33-A and 33-C Distal Femur Fractures

*Norele Cutrera, MD[1]; **Cory Collinge, MD**[2]*
[1]*Vanderbilt Medical Center, Nashville, Tennessee, USA;*
[2]*Texas Health Harris Methodist Fort Worth Hospital, Fort Worth, Texas, USA*

Background/Purpose: Distal femur fractures are challenging injuries to treat. Several generations of plate fixation have evolved over the past two decades, including locked monoaxial unicortical screw and plate systems designed for minimally invasive application (less invasive stabilization system [LISS]), monoaxial locking condylar plates, and polyaxial locking condylar plates (LCPs). Alternate screw trajectories enable surgeons to circumnavigate existing hardware, but design of these polyaxial or "variable angle" systems necessarily changed the plates, the screws, and their interface. A recent preliminary report by Tank et al has suggested that newer variable angle (VA)-LCPs may be associated with early mechanical failure compared to prior systems. The aim of our study is to compare mechanical failure rates in patients with distal femur fractures treated with of early and later generations of locking plates (LISS, LCPs, and VA-LCPs). Our secondary aims are to describe modes, timing, and risks of failure in these cases.

Methods: This retrospective case-control series evaluates mechanical fixation failure patients with OTA 33-A and C distal femur fractures treated with locked plating at a single Level I trauma center from 2010 to 2015. 170 of these patients were treated with a titanium monoaxial unicortical screw and plate system designed for minimally invasive application (LISS, DePuy Synthes); stainless steel monoaxial LCP (Periloc, Smith & Nephew; and Locking Condylar plate, DePuy Synthes; or a stainless steel "variable-angle" LCP (VA-LCP, DePuy Synthes). Exclusion criteria included patients age <18 years, distal femur fracture treated with any device other than a locked distal femur plate, or follow-up <6 months. Patient and injury factors were evaluated. Serial radiographs were analyzed for mechanical failure including implant breakage, bending, loosening, or change in alignment (>5°). Secondary outcome measures were modes of failure, time to failure, and risk factors for failure. Early failure was defined as <6 months and late failure >6 months.

Results: 148 cases were included for study. There were a total number of 23 mechanical failures (15%), including 6 of 37 (16%) LISS, 4 of 47 (8%) LCPs, and 13 of 64 (20%) VA-LCPs ($P = 0.26$). There were 10 and 13 failures in 33-A and C-type fractures, respectively ($P = 0.10$). Modes of failure included screw breakage/loosening, plate breakage, and loss of alignment. In the LISS group, all failures consisted of screw breakage or loosening. 3/4 failures (75%) were attributable to screw breakage or loosening in the LCP group. The most common mode of failure in the VA-LCP group was change in alignment, with 8/13 (62%) collapsing into varus ($P = 0.03$). The average time to failure was 7.2 months, 2.8 months, and 6.8 months for the LISS, LCP, and VA-LCP groups, respectively. Early failures comprised 3/6 (50%) in the LISS group, 4/4 in the LCP group, and 8/13 (62%) in the VA-LCP group.

Conclusion: Our study does not validate the theoretical concern that an altered screw-plate locking mechanism of VA plates could lead to screw disengagement and early mechanical

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

failure. This is one of the largest clinical studies to date regarding VA plates. This is also the first study to look at VA plates in the context of proper plate application and surgical technique. It is our subjective opinion that, particularly for distal femur plating, technique is essential to outcome. Little things matter, and they are not easily quantified. For example, fracture gap or distraction and plate position all play a role in outcome. Should we really expect a long segmental bone loss construct in a large, strong patient to maintain alignment until healed when we know large forces are at play and it will take a long time to heal?

See pages 49 - 106 for financial disclosure information.

Longer-Term Outcomes After Bicondylar Tibial Plateau Fractures: What Are the Risk Factors for Poor Outcome?

Cullen Griffith, MD[1]*; Peter Berger, BS*[1]*; George Reahl, BS*[2]*; Renan Castillo, PhD*[3]*; Robert V. O'Toole, MD*[1]*; Theodore T. Manson, MD*[1]
[1]*R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;*
[2]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[3]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA*

Purpose: Little is known about the longer-term outcome of bicondylar tibial plateau fractures and even less is known about risk factors for poor outcomes after these complex injuries. Our hypotheses were: (1) longer-term outcomes would be relatively poor for these high-energy injuries, and (2) radiographic and clinical risk factors could be identified that are associated with poor outcomes.

Methods: Our study group was composed of 68 bicondylar tibial plateau fractures (OTA 41-C3) treated operatively at a single Level I trauma institution from 2007-2013 with at least 2 years of follow-up (mean time from surgery, 5.1 years; range, 2.2-8.8). The demographics included a mean age of 52 years; 75% were male. Our primary outcome score was the WOMAC score (Western Ontario and McMaster Universities Osteoarthritis Index, which measures pain, stiffness and function with higher numbers being worse), which patients completed via a phone interview. Radiographs at time of injury and those nearest the 6-week follow-up point were reviewed. Radiographic parameters included intra-articular stepoff, condylar width ratio, and tibiofemoral alignment. Medical records were reviewed to evaluate previously suggested patient factors that might contribute to worse functional outcomes including: infection, compartment syndrome, time to definitive fixation, meniscus tear, medial collateral ligament calcification, nonunion, participation in organized physical therapy, and manipulation under anesthesia. Bivariate and multiple variable regression analyses were used to assess the independent association between each factor and WOMAC scores.

Results: The mean WOMAC score was surprisingly low at 13.4 (range, 0-60; 95% CI 10.2 to 16.6). Lower scores in the WOMAC scale reflect better outcomes. For comparison, scores after primary arthroplasty tend to be worse than this with scores typically around 20. Several factors were found to be associated with poor outcome (as measured by WOMAC) in the multiple variable regression model, with three showing strong predictive relationships: (1) surgical site infection (+16.9 [worse outcome] points on the WOMAC; 95% CI 8.9, 24.9; P <0.001), (2) failure to participate in physical therapy postsurgery (+10.3 [worse outcome]; 95% CI +18.8, +1.72; P = 0.02), and (3) varus or neutral alignment limb (tibiofemoral angle <2°) (+11.0 [better outcome]; 95% CI -20.9, -1.1; P = 0.03). Other factors suggested a relationship but were not statistically significant. These included compartment syndrome and postoperative malreduction >5 mm (P <0.1).

Conclusion: As might be expected, infection was identified as a risk factor for poor outcome (P <0.001). However, we also demonstrated that patients did better if they participated in physical therapy (P <0.02) or were in slight varus alignment postoperatively (P <0.03). It is possible that patients with more varus tibiofemoral angles (either by natural anatomy

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

or through malreduction) tend to unload the lateral joint, which typically has more intra-articular involvement, and therefore have an outcome advantage. The importance of physical therapy is also interesting as one might assume that worse injuries might be more likely to be prescribed therapy but patients with better socioeconomic factors might be more able to obtain physical therapy. Overall longer-term validated outcome scores appear to be reasonable with relatively low WOMAC scores.

See pages 49 - 106 for financial disclosure information.

Racial Disparities Seen in Outcomes After Operatively Treated Lower Extremity Fractures

Adam Driesman, BA*; Nina Fisher, BS; Sanjit Konda, MD; Roy Davidovitch, MD; Kenneth Egol, MD;*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: Racial and ethnic differences are known to affect care delivery and patient outcomes throughout many medical fields. While these disparities have been established in elective procedures where bias exists as to when and on whom surgery will be performed, only recently has literature shown that race does not affect short-term outcomes in orthopaedic trauma. At this time, however, whether race affects function in the long term after fracture has not been examined. The purpose of this study is to compare how race affects function at 3, 6, and 12 months postsurgery for following lower extremity fractures.

Methods: At a single institution, 447 operatively treated patients for a lower extremity fracture (207 tibial plateau, 51 tibial shaft, and 189 rotational ankle fractures) were prospectively followed for 1 year and included in this study. Race was stratified into four groups: Caucasian, African American, Hispanic origin, and other. Insurance information was collected and recorded at initial presentation. Long-term outcomes were evaluated using the Short Musculoskeletal Function Assessment (SMFA), pain scores, and physical examination at 3 months, 6 months, and 1 year. Univariate analysis was performed using χ^2 for dichomatous variables and analysis of variance (ANOVA) when comparing means between multiple groups, respectively. Multivariate logistic regression analysis was performed with the dependent variable being SMFA at 1 year and independent variables being age, sex, race, insurance type, Charlson Comorbidity Index (CCI), open fracture, and high-velocity mechanism.

Results: There were 230 (53.5%) Caucasians, 76 (17.5%) African Americans, 53 (12.3%) Hispanics, and 71 (16.5%) patients from other minorities in our study population. No differences between cohorts existed with respect to age, gender, body mass index (BMI), comorbidities, insurance status, or smoking history. When examining injury characteristics, minorities (African American, Hispanics, etc) were more likely to be involved in high-velocity mechanisms and tended to have a greater percentage of open fractures. Although there were no differences in the rate of wound complications and reoperations, long-term functional outcomes were worse in minorities, both in pain scores at 6 months and functional outcome scores at 6 and 12 months. Multivariate analysis revealed that only African American and Hispanic race continued to be independent predictors of worse functional outcomes at 12 months ($P \leq 0.01$, $\beta = 13.79$, 95% CI 6.294 to 21.285; $P = 0.03$, $\beta = 8.67$, 95% CI 0.894 to 16.440). No other demographic or injury characteristics had an effect on outcome scores.

Conclusion: Racial minorities have poorer long-term function following fractures of the lower extremity. While minorities were involved in more high-velocity accidents, this was not an independent predictor of worse outcomes. These ethnic disparities may result from multifactorial socioeconomic factors, including socioeconomic status and education levels that were not controlled for in our study. Orthopaedic trauma surgeons should therefore be

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

aware of these health-care disparities between ethnicities and look for early interventions to improve their recovery.

Table 1

	Caucasian	African American	Hispanic	Other	p value
# of patients (n=430)	230 (53.5%)	76 (17.7%)	53 (12.3%)	71 (16.5%)	
Patient Characteristics					
Age (yr)	47.3	43.4	44.3	45.8	0.25
Male	51.7%	47.4%	58.5%	50.7%	0.67
BMI (kg/m^2)	24.1	25.7	21.9	20.73	0.09
Medicaid	11.4%	19.0%	17.9%	13.6%	0.43
Medicare	13.0%	1.7%	20.5%	5.1%	0.01
Private Insurance	72.3%	78.0%	64.1%	79.7%	0.3
Worker's Comp	5.8%	7.9%	5.3%	3.6%	0.78
CCI	1	0.74	0.9	1.07	0.52
Smoking	27.5%	27.6%	22.6%	21.1%	0.67
Open Fracture	4.5%	11.3%	10.3%	6.5%	0.37
High Velocity Injuries	48.2%	66.0%	61.5%	67.4%	0.05
Outcomes					
3 Month SMFA	32.4	39.4	38.5	36.3	0.08
6 Month SMFA	16.2	28.6	31.7	24.8	<0.01
12 Month SMFA	11.9	19.9	20.5	20.6	<0.01
3 Month Pain	2.7	3.2	3.0	2.7	0.32
6 Month Pain	2.7	3.8	3.2	3.3	<0.01
12 Month Pain	2.9	4.4	2.6	3.2	0.06
Wound Complications	3.9%	5.3%	3.8%	4.2%	0.19
Reoperations	7.8%	15.8%	11.3%	9.9%	0.10

See pages 49 - 106 for financial disclosure information.

Inter-Rater Reliability of Modified RUST Scoring for Diaphyseal Tibia Fractures with Bone Defects

Paul Tornetta III, MD[1]*; Ellen MacKenzie, PhD*[2]*; William Obremskey, MD, MPH*[3]*;*
CAPT (ret) Michael J. Bosse, MD[4]*; Joseph Hsu, MD*[4]*; Saam Morshed, MD*[5]*;*
Jason Luly, MS[6]*; Robert V. O'Toole, MD*[7]
[1]*Boston Medical Center, Boston, Massachusetts, USA;*
[2]*Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA;*
[3]*Vanderbilt Orthopaedic Institute, Nashville, Tennessee, USA;*
[4]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[5]*UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA*
[6]*Johns Hopkins University, Baltimore, Maryland, USA;*
[7]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA*

Background/Purpose: Cortical scoring systems, such as the Radiographic Union Score for Tibia Fractures (RUST) were developed to improve the grading of callus formation and radiographic progression toward union in tibial diaphyseal fractures. The modified RUST (mRUST) added an additional scoring level and has demonstrated better agreement in diaphyseal and metadiaphyseal fractures. These methods have shown excellent agreement that has led to adoption in many fracture trials. However, cortical scoring has not been evaluated in the face of fractures with bone defects, where assigning a score may be more difficult. The current study seeks to evaluate the agreement of the mRUST in patients with operatively treated open tibial fractures associated with bone loss as it may relate to reporting in clinical trials.

Methods: All skeletally mature patients (≥18 years) with open diaphyseal tibia shaft fractures and a bone defect >1 cm treated operatively over a 5-year period at 17 centers were included. Patients with amputations were excluded. Defects were divided by their largest gap as <2.5 cm, 2.5-5.0 cm, or >5.0 cm. Radiographs between 11 and 13 months postinjury were selected for scoring. If no radiographs were available during this time fame the final available radiograph was used. Three experienced orthopaedic surgeons from a pool of 6 were randomly assigned to apply the mRUST to each case. Each of the cortices on the AP and lateral radiographs were graded as: 1 = no callus, 2 = callus present without bridging, 3 = bridging callus, and 4 = fracture line not visible (remodeled). The mRUST score is the sum of the 4 cortical scores (4-16). If any cortex could not be assessed due to an implant, the score was not calculated. Raters were blinded to the original films, defect size, and whether the patient received a bone graft. Inter-rater reliability of mRUST was assessed using two measures: (1) the intraclass correlation coefficient (ICC), and (2) Krippendorf's alpha. For both measures, a score close to 1 indicates agreement and a score close to 0 indicates non-agreement. Krippendorf's alpha is preferred for ordinal data such as the modified RUST. Absolute ICC was computed to allow comparison with other research on the mRUST.

Results: 234 patients (202 M, 32 F; average age 34 [range, 18-68]), met inclusion criteria. The average time between definitive fixation and the selected radiograph was 278 ± 103 days. All raters were able to score all four cortices on 171 (73%) subjects; two raters scored all four cortices on 28 (12%), and no raters were able to score all four cortices on 12 (5%) subjects. 160

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

(68%) subjects were internally fixed and 74 (32%) were treated with a ring external fixator. 112 (48%) had bone graft an average of 187 ± 91 days prior to the scored radiograph. The agreement based on Krippendorf's alpha was 0.67 (CI: 0.59-0.74) and the ICC was 0.69 (CI: 0.62-0.74). Higher agreement was seen for subjects treated with internal fixation as compared with external fixation (0.72 and 0.70 vs 0.54 and 0.51 for the Krippendorf's alpha and ICC, respectively). Bone grafting did not affect the level of agreement, but intermediate defects yielded slightly better agreement than did smaller or larger defects (ICC: 0.8 vs 0.65 and 0.64; Krippendorf's alpha: 0.79 vs 0.65 and 0.57).

Conclusion: Cortical scoring systems have become common tools in reporting radiographic progression toward union in lower extremity fracture trials. The purpose of this study was to assess one such cortical scoring method in the environment of open tibia fractures with bone loss. Agreement was found to be lower than prior trials of metaphyseal and diaphyseal fractures fixed with nails and plates. The agreement in the face of external fixation was the lowest reported in the literature. This may limit the usefulness of cortical scoring in determining the progression to union in patients with open fractures and bone loss, particularly if external fixation is used.

See pages 49 - 106 for financial disclosure information.

Does Concurrent Fibular Fixation and Intramedullary Tibial Nailing Increase Rates of Tibial Nonunion?

Michael Githens, MD[1]; Justin Haller, MD[2]; Reza Firoozabadi, MD, MA[3]
[1]Stanford University School of Medicine, Stanford, California, USA;
[2]Harborview Medical Center, Seattle, Washington, USA;
[3]Harborview / University of Washington, Seattle, Washington, USA

Purpose: Fibular osteosynthesis at the time of intramedullary (IM) fixation of tibia fractures can be beneficial for a number of reasons. There is a lack of objective evidence indicating whether or not fibular fixation increases rates of tibial nonunion after IM nailing. The purpose of this study is to determine the rates of tibial nonunion in patients who have undergone tibial IM nailing with concurrent fibular fixation.

Methods: A retrospective review of a prospectively collected database was performed at a single Level I academic trauma center. All tibia fractures treated with IM nailing from 2005 to 2014 were screened and all those treated concurrently with fibular fixation were analyzed. All patients 18 years and older with a tibia and fibula fracture treated with tibial IM nailing and concurrent fibular fixation who were determined radiographically and clinically healed or had a minimum 1-year follow-up were included for final analysis. Nonunion was defined as a fracture with no radiographic progression towards healing at 9 months after surgery on consecutive radiographs over a minimum 2-month period. Demographic data and injury characteristics, time to union, rates of union, rates of implant removal, and postoperative complications were recorded. A matched cohort of patients who underwent tibial IM nailing without fibular fixation was used for comparison.

Results: 166 patients met inclusion criteria after concurrent tibial IM nailing and fibular fixation during this time period. Mean follow-up was 20.6 months. There was an 11% rate of tibial nonunion. 57% of fractures were open. There was a 30% rate of smoking and 5% rate of diabetes in this cohort. In a matched cohort of 174 patients who underwent IM nailing without fibular fixation, there was no significant difference in patient demographics, injury characteristics, infection rates, postoperative complications, or rates of tibial nonunion. When the cohorts were pooled, the rate of nonunion was significantly higher in patients with open fractures, postoperative infections, and diabetes.

Conclusion: In these well matched cohorts, fibular fixation did not affect rates of union after tibial IM nailing. The rate of tibial nonunion in both cohorts is comparable to published rates of tibial nonunion after IM nailing without fibular fixation. This indicates that fibular fixation does not increase the rate of tibial nonunion after IM nailing. Open fractures and postoperative infection were seen at a significantly higher rate in the fractures that went on to nonunion in both cohorts, indicating that these are primary risk factors for tibial nonunion.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Effectiveness of Complex Combined Deformity Nonunion/Malunion Correction, Utilizing a Hexapod External Fixator

John Arvesen, MD[1]; J. Tracy Watson, MD[2]; Heidi Israel, PhD, RN[2];
[1]St. Louis University Hospital, St. Louis, Missouri, USA;
[2]St. Louis University Dept. of Ortho Surgery, St. Louis, Missouri, USA

Background/Purpose: Management of complex tibial nonunions / malunions with deformity has evolved from complex Ilizarov frames to accurate hexapod ring fixators. Few studies, all with limited patient numbers, have reported on their effectiveness with minimal data documenting the effectiveness to achieve mechanical axis realignment and deformity correction. The purpose of this study was to determine the efficacy of hexapod frames and their ability to achieve six-axis correction when treating complex tibial nonunions and malunions with deformity. Our hypothesis is that hexapod fixators can reproducibly correct complex limb deformities, restore mechanical axis alignment, and achieve union in patients with complex tibial nonunions and malunions.

Methods: This consecutive retrospective case series compared the pre- and postoperative mechanical axis in patients with hexapod frames applied for posttraumatic tibial nonunions or malunions. From 2003-2014, 57 patients met the inclusion criteria, of a tibial nonunion / malunion with a combined oblique plane deformity of greater than 5° in any plane, with accompaning deformities of translation, malrotation, and axial malalignment. Patients were excluded from the study who were less than 18 years of age, had combined tibial deformities less than 5°, or less than 1 year of follow-up. Patients were treated by the senior author with a hexapod device. Preoperative mechanical axis deviation, deformity parameters, and union status were assessed. Deformity data were computed and continual recalculation of correction parameters was performed at each follow-up visit using long alignment films with routine clinical follow-up examination. Postoperative anatomic and mechanical axis determination, adequacy of union, and additional procedures necessary to complete treatment were recorded. Final assessment of deformity included not only mechanical axis correction, but included adequacy of union, and any residual leg-length discrepancy, translation, or malrotation.

Results: The cohort consisting of 57 patients treated with a total of 60 frames (45 nonunions and 15 malunions) met the inclusion criteria. There were 41 male and 19 female patients with a mean age of 47.9 years (range, 25-78) and mean follow-up time of 106 weeks (range, 54-316 weeks). The mean treatment time of hexapod fixation was 164 days (SD 88.4). Average combined preoperative deformity was greater than 17.96° (SD 10.89) and was corrected to 9.68° (SD 5.33). Average mechanical axis was restored within 5° of the desired goal in all categories except in patients with severe preoperative valgus deformities. Two patients had a residual leg-length discrepancy that resulted in shoe lifts. 80% of patients achieved union without any additional bone grafting procedures. Union was accomplished with initial compression for 3 weeks to stabilize the nonunion and allow neovascularization to occur. This was then followed by slow distraction through the nonunion achieving regenerate bone that allowed deformity correction and consolidation to union. Six residual nonunion patients had continued deformity, with 3 patients opting for additional correction with a

See pages 49 - 106 for financial disclosure information.

second frame application. Overall, the study group demonstrated 95% (57/60) union rate at the end of treatment. All malunions healed without complication, through their corticotomy sites that were performed for correction.

Conclusion: Hexapod devices with their associated software treatment algorithms can be used as an accurate and reproducible treatment modality. Their ability to correct complex combined deformities with significant mechanical axis deviation is well demonstrated. Findings from this study reveal that complexity of the deformity did not demonstrate any difference with regard to achieving union. Both groups demonstrated considerable deformity correction with a more precise correction seen in the malunion group consistently achieving all goals. Additionally, patients treated only with compression/distraction techniques demonstrated a very high success rate with a minimum of complications and without the use of adjuvant bone grafting in 80% of the cases.

Tables

Table 1

All Patients (60)	
Descriptive Statistics	
Age	47.87 years old (25-78)
Sex	41M 19F
Location of Fracture	Proximal (11) , Middle (6), Distal (43)
Length of Frame Application	164.7 days (SD: 82.16) Range 49-467
Closed vs. Open Fracture	Closed (19), Open (41)
Previous Soft Tissue Flap/Transport	Yes (12), No (48)
Mechanism	Low (18) vs. High (42)
Type of Nonunion	Hypertrophic (32), Normotrophic (4), Atrophic (9)
Persistent LLD during treatment	2/60 Needed Shoe Lift post op
Prior Bone Defects	Yes (19), No (41)
Prior Bone Grafting	Yes (14), No (46)
Prior Antibiotics Beads	Yes (5), No (55)
Previous Infections	Yes (28), No (32)
Bone Grafting During Treatment	Yes (12), No (48)
Antibiotic Beads During Treatment	Yes (3), No (57)
Soft Tissue Flap/Transport During Procedure	Yes (2), No (58)
Residual Nonunions	6
Smoking History	Yes (33), No (27)
Diabetic History	Yes (5), No (55)
Average Follow Up	106 weeks

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 2

All Patients (60)							
Preoperative	Mean	Range	SD	**Postoperative**	Mean	Range	SD
Coronal Angulation	11.45	(0-49)	8.97	Coronal Angulation	5.1	(0-23)	4.81
Coronal Translation	5.67	(0-28.91)	7.07	Coronal Translation	5.06	(0-17.89)	5.03
Sagittal Angulation	12.1	(1-55)	9.23	Sagittal Angulation	8.52	(0-29)	6.46
Sagittal Translation	5.08	(0-22.98)	5.85	Sagittal Translation	4.12	(0-16.1)	4.5
Axial Rotation	2.6	(-15-25)	6.84	Axial Rotation	0		
Leg Length Discrepancy				Leg Length Discrepancy	(2/60)		
Nonunions (45)							
Varus Deformities	6						
Preoperative	Mean	Range	SD	**Postoperative**	Mean	Range	SD
Coronal Angulation	6.83	(4-14)	3.66	Coronal Angulation	4.33	(2-7)	2.07
Coronal Translation	4.43	(0-11)	5.05	Coronal Translation	6.26	(0-15.54)	6.33
Sagittal Angulation	14.67	(4-29)	11.38	Sagittal Angulation	10.33	(0-18)	6.28
Sagittal Translation	6.64	(0-20)	7.01	Sagittal Translation	5.41	(0-11)	4.08
Axial Rotation	8.17	(0-20)	7.23	Axial Rotation	0		
Leg Length Discrepancy				Leg Length Discrepancy	0		
Valgus Deformities	39						
Preoperative	Mean	Range	SD	**Postoperative**	Mean	Range	SD
Coronal Angulation	12.38	(0-49)	9.99	Coronal Angulation	4.9	(0-23)	5.17
Coronal Translation	6.82	(0-22.98)	7.74	Coronal Translation	5.46	(0-17.89)	5.24
Sagittal Angulation	11.67	(1-55)	9.73	Sagittal Angulation	9.44	(1-29)	6.84
Sagittal Translation	22.98	(0-22.98)	6.02	Sagittal Translation	4.6	(0-16.1)	4.84
Axial Rotation	1.64	(-15-20)	5.71	Axial Rotation	0		
Leg Length Discrepancy				Leg Length Discrepancy	(2/39)		
Malunions (15)							
Varus Deformities	2						
Preoperative	Mean	Range	SD	**Postoperative**	Mean	Range	SD
Coronal Angulation	16	(15-17)	1.41	Coronal Angulation	3.5	(3-4)	0.71
Coronal Translation	0	(0-0)	0	Coronal Translation	2.3	(0-4.6)	3.25
Sagittal Angulation	13	(7-19)	8.49	Sagittal Angulation	7	(5-9)	2.83
Sagittal Translation	0	(0-0)	0	Sagittal Translation	2.52	(0-5.03)	3.56
Axial Rotation	8	(7-9)	1.41	Axial Rotation	0		
Leg Length Discrepancy				Leg Length Discrepancy	0		
Valgus Deformities	13						
Preoperative	Mean	Range	SD	**Postoperative**	Mean	Range	SD
Coronal Angulation	10.08	(1-23)	7.37	Coronal Angulation	4.38	(0-11)	3.36
Coronal Translation	3.63	(0-16.49)	5.51	Coronal Translation	4.48	(0-16.52)	5.26
Sagittal Angulation	11.85	(1-25)	7.43	Sagittal Angulation	8.15	(1-27)	8.15
Sagittal Translation	2.98	(0-14.64)	4.56	Sagittal Translation	2.34	(0-11.4)	3.58
Axial Rotation	2.08	(-10-25)	8.86	Axial Rotation	0		
Leg Length Discrepancy				Leg Length Discrepancy	0		

See pages 49 - 106 for financial disclosure information.

Table 3

All Frames (60)	PreOp	Range	SD	PostOp	Range	SD
Angular Deformity	17.96	(2.83-55.73)	10.89	9.68	(2-25.46)	5.33
Translational Deformity	10.75	(0-51.89)	10.96	9.17	(0-31.44)	7.69
Nonunions (45)	**PreOp**			**PostOp**		
Angular Deformity	18.12	2.8-55.73	11.86	10.18	2-25.46	5.63
Translational Deformity	12.42	0-51.89	11.54	7.9	0-31.44	6.92
Malunions (15)	**PreOp**			**PostOp**		
Angular Deformity	17.47	6.4-29.07	7.58	8.16	2-17.12	4.1
Translational Deformity	5.73	0-22.9	7.2	4.77	0-17.5	5.4

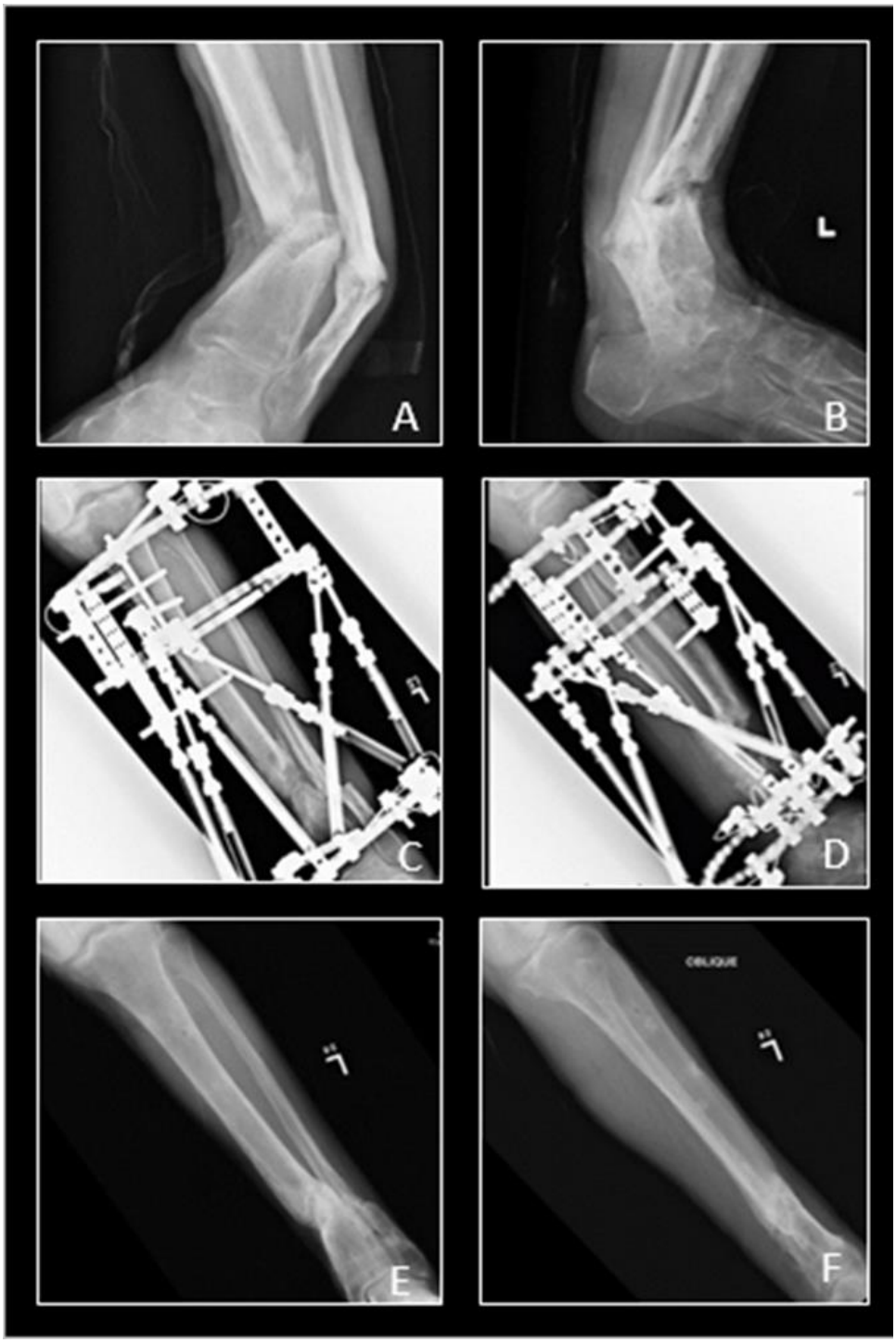
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 4

All Frames (60)							
Preoperative Deformity	**MPTA (mean)**	**Range**	**SD**	**Postoperative Deformity**	**MPTA (mean)**	**Range**	**SD**
MPTA <90 degrees (varus)	90.5	(90-92)	0.76	MPTA <90 degrees (varus)	89.25	(86-94)	2.66
MPTA >90 degrees (valgus)	87.34	(83-90)	1.78	MPTA >90 degrees (valgus)	87.78	(80-95)	2.77
Preoperative Deformity				**Postoperative Deformity**			
LDTA <90 degrees (valgus)	76.74	(47-89)	9.93	LDTA <90 degrees (valgus)	82.89	(67-96)	7.76
LDTA >90 degrees (varus)	101.98	(92-132)	10.7	LDTA >90 degrees (varus)	90.5	(72-106)	6.79
Nonunions							
Preoperative Deformity	**MPTA (mean)**	**Range**	**SD**	**Postoperative Deformity**	**MPTA (mean)**	**Range**	**SD**
MPTA <90 degrees (varus)	90.67	(90-92)	0.82	MPTA <90 degrees (varus)	89.25	(86-94)	3.59
MPTA >90 degrees (valgus)	87.67	(84-90)	1.56	MPTA >90 degrees (valgus)	87.59	(80-92)	2.24
Preoperative Deformity				**Postoperative Deformity**			
LDTA <90 degrees (valgus)	76.5	(47-89)	11.7	LDTA <90 degrees (valgus)	82.52	(67-96)	7.19
LDTA >90 degrees (varus)	102.26	(92-132)	10.1	LDTA >90 degrees (varus)	90.21	(72-106)	7.61
Malunions							
Preoperative Deformity	**LDTA (mean)**	**Range**	**SD**	**Postoperative Deformity**	**LDTA (mean)**	**Range**	**SD**
MPTA <90 degrees (varus)	90	(90-90)	0	MPTA <90 degrees (varus)	90	(88-92)	2.83
MPTA >90 degrees (valgus)	86.38	(83-89)	2.1	MPTA >90 degrees (valgus)	88.43	(81-95)	3.8
Preoperative Deformity				**Postoperative Deformity**			
LDTA <90 degrees (valgus)	77.8	(72-85)	4.97	LDTA <90 degrees (valgus)	85	(73-90)	7.14
LDTA >90 degrees (varus)	101.2	(92-121)	9.94	LDTA >90 degrees (varus)	91.1	(82-103)	6.52

See pages 49 - 106 for financial disclosure information.

Figure 1



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Prediction of Tibial Nonunion at the 6-Week Time Point

Keir Ross, BS[1]*; Kevin O'Halloran, MD*[1]*; Max Coale, BA*[1]*; Justin Fowler, MD*[1]*; Jason W. Nascone, MD*[1]*; Marcus F. Sciadini, MD*[1]*; Christopher Lebrun, MD*[1]*; Theodore T. Manson, MD*[1]*; Renan Castillo, PhD*[2]*; Robert V. O'Toole, MD*[1]*;*
[1]*University of Maryland Medical Center, R. Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA*
[2]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA*

Purpose: Tibial shaft fractures are the most common long bone fracture and nonunions are frequent. Early prediction of nonunion at the 6-week postoperative time point would have clinical utility and has not yet been explored in the literature. We hypothesized that a predictive model of tibial shaft fracture nonunion at 6 weeks postoperative from reamed intramedullary (IM) nail fixation could be developed based on commonly collected clinical variables and the Radiographic Union Score for Tibial fractures (RUST).

Methods: All tibial shaft fractures treated with IM nail fixation at our Level I trauma center from 2007 to 2014 were retrospectively reviewed. Only patients with minimum follow-up until healing of the fracture or until secondary operation to address nonunion were included and those with planned prophylactic nonunion surgery were excluded as were those with critical fracture gaps defined as 3 mm or greater for any of the four cortices of the tibia. Of the 323 patients included for study, 50 (15%) had gone on to nonunion. 42 commonly collected clinical and radiographic variables that had been previously hypothesized to be associated with nonunion were recorded and analyzed. Bivariate and multivariate regression analyses were used to determine variables significantly associated with nonunion.

Results: Using bivariate and multivariate regression models, four variables were found to have statistically significant associations with nonunion (odds ratio [OR] > or <1.0; $P < 0.01$). These variables included infection within 6 weeks of operation, standard RUST, modified RUST, and the previously reported Nonunion Risk Determination (NURD) score. The NURD score is based on a time zero nonunion prediction model created using clinical variables available at the time of definitive fixation. No other variables were significantly associated with nonunion. Both standard (OR = 0.64; P <0.01) and modified RUST (OR = 0.74; P <0.01) were significant predictors of nonunion and there was no significant difference between the two scores. While the difference between standard RUST and modified RUST score was not statistically significant, the standard RUST showed a stronger association with nonunion and was therefore used for further regression models. When using infection within 6 weeks, standard RUST, and the NURD score in a regression model, sensitivity and specificity for nonunion were both 82%. The NURD score was increasingly predictive with decreasing RUST score (Table 1). Based on this finding, patients were stratified into three categories of RUST scores including high (RUST 10 or greater), medium (RUST 6-9), and low evidence of healing (RUST<6 or infection within 6 weeks). All patients in the high RUST score group went on to union, regardless of NURD score. In the medium RUST score group, 25% of patients with a NURD score 7 or greater went on to nonunion. In the low RUST score group, 69% of patients with a NURD score 7 or greater went on to nonunion.

See pages 49 - 106 for financial disclosure information.

Table 1. Number of patients that went on to nonunion based on NURD and RUST scores

NURD Score:	High Evidence of Healing (RUST ≥ 10)			Medium Evidence of Healing (RUST 6-9)			Low Evidence of Healing (RUST < 6 or infection)		
	Number of nonunions	Total patients	%	Number of nonunions	Total patients	%	Number of nonunions	Total patients	%
0-1	0	11	0	0	22	0	0	4	0
2-3	0	5	0	2	71	3	1	17	6
4-6	0	9	0	6	80	8	15	50	32
7+	0	1	0	6	24	25	20	29	69

Conclusion: Three variables (RUST, presence of infection, NURD score) were found to best predict nonunion surgery based only on data available 6 weeks following reamed IM nail fixation of the tibia. Utilizing these variables we created a clinical prediction tool of nonunion that could aid in discussing prognosis with patients as well as in clinical decision making.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Factors Affecting Timing of IV Antibiotic Administration for Patients with Open Fractures

*Joshua Eccles, BSc[1]; **Katharine Harper, MD**[2]; Courtney Quinn, MD[2]; Frederick Ramsey, PhD[1]; Saqib Rehman, MD[3];*
[1]Temple University School of Medicine, Philadelphia, Pennsylvania, USA;
[2]Temple University Hospital, Philadelphia, Pennsylvania, USA
[3]Temple University Hospital, Moorestown, New Jersey, USA

Purpose: The objective of this study is to evaluate the time to antibiotic administration after patients with open fractures treated at one Level I trauma center. Our hypothesis is that patients will receive cefazolin faster than gentimicin, and those evaluated formally by the trauma surgery team will receive their antibiotics faster.

Methods: A retrospective study was performed at our Level I trauma center over a 2-year period from January 1, 2013 to March 31, 2015 where 117 patients with open fractures were evaluated. All adult patients who presented to the Emergency Department (ED) with open fractures of the extremities and / or pelvis were considered for this study. Subjects were identified using using the CPT codes 11010, 11011, and 11012. Patients aged 18 and older were analyzed for age, gender, body mass index (BMI), transportation method to the hospital, fracture location, Gustilo type, side of injury, presence of polytrauma, any associated injuries, mechanism of injury, antibiotics administered in the emergency department, the presence of an antibiotic allergy, postoperative antibiotic regimen, the number of repeat debridements (if indicated), the need for and type of soft-tissue coverage, and whether there was a reported infection at the operative site. Also included was whether patients were formally evaluated by the general surgery trauma team. Outcome measurements included time to intravenous (IV) antibiotic administration and time to surgical debridement. Statistical analysis was undertaken using both parametric (*t* test and analysis of variance) and nonparametric (Wilcoxon and Kruskal-Wallis) testing for the timing to administration of cefazolin, and the timing to administration of gentamicin, respectively. Statistical significance was defined as a *P* value <0.05 and high statistical significance was defined as a *P* value <0.01.

Results: Patients received IV cefazolin on average 17 minutes after arrival. 85 patients who were made trauma activations received cefazolin 14 minutes after arrival while 24 nontrauma patients received cefazolin 53 minutes after arrival (*P* <0.0001). There was no statistically significant difference between the timing to cefazolin based on Gustilo type. Patients with type I open fractures received antibiotics 18 minutes after arrival; type II, 19 minutes after arrival; type IIIa, 15 minutes after arrival; type IIIb, 13 minutes after arrival; and type IIIc, 13 minutes after arrival (*P* = 0.4912). The average time to gentamicin administration for all patients was 180 minutes. Patients not upgraded to a trauma received gentamicin 263 minutes after arrival, while patients upgraded to a trauma received gentamicin 176 minutes after arrival (*P* = 0.3750). Patients with type I fractures received gentamicin 165 minutes after arrival; type II, 188 minutes after arrival; type IIIa, 176 minutes after arrival; type IIIb, 227 minutes after arrival; and type IIIc, 424 minutes after arrival (*P* = 0.9620).

Conclusion: Overall, patients who arrive at our institution with open fractures receive IV

See pages 49 - 106 for financial disclosure information.

cefazolin within 1 hour after arrival and receive IV gentamicin within 3 hours after arrival. This is likely due to the fact that cefazolin is stocked in our hospital's ED, while gentamicin is not and has to be sent up from the hospital pharmacy. Gentamicin is not stocked in the ED due to weight-based dosing requirements precluding a standard dose. Patients formally assessed by the general surgery trauma team received their antibiotics more promptly. Improvements can be made in the treatment of nontrauma patients and for patients requiring gentamicin.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does Provisional Plating of Closed Tibia Fractures Have Higher Complication Rates?

Justin Haller, MD[1]; Michael Githens, MD[2]; Reza Firoozabadi, MD, MA[3];
[1]Harborview Medical Center, Seattle, Washington, USA;
[2]Stanford University School of Medicine, Stanford, California, USA;
[3]Harborview / University of Washington, Seattle, Washington, USA

Background/Purpose: Provisional plating is a useful adjunct to intramedullary nailing of tibia fractures. This technique allows an accurate reduction to be maintained during reaming and placement of a nail. Most of the literature reports on this technique in the setting of open fractures. The literature is scant with regard to outcomes of patients that undergo provisional plating for closed tibia fractures. The concern is that patients treated in this manner will have higher infection and nonunion rates. The purpose of this study was to compare the patient outcomes following provisional plating with standard reduction techniques for closed tibia fractures.

Methods: Patients with closed tibia fractures (OTA 42) treated with intramedullary nailing from January 2008 through December 2014 were identified in our prospectively collected orthopaedic trauma registry. Patients were excluded if they passed away during their initial hospital course, had incomplete radiographs, were skeletally immature, had a vascular injury, or had less than 6 months follow-up or were not healed at final follow-up. Medical records were reviewed for demographic data including age, gender, and mechanism of injury. Operative reports and fluoroscopic images were reviewed to document reduction strategy. Standard reduction techniques included closed reduction, percutaneous clamp application, and the use of a femoral distractor or external fixator. At final follow-up, additional surgical procedures and any complications were recorded including infection, implant removal, and nonunion. Radiographs at final follow-up were assessed for malunion >5°.

Results: During this period, there were 265 closed tibia fractures that underwent intramedullary nailing with 35 patients receiving provisional plating (PP) and 230 patients receiving standard reduction techniques. Nine patients (1 PP and 8 standard) died during hospitalization, 1 PP had a vascular injury, and 95 patients (6 PP and 89 standard) had insufficient follow-up. This left 27 patients in our PP cohort and 133 patients in our standard cohort. Mean follow-up was similar between the PP cohort (mean 13 months; range, 6-38 months) and standard cohort (mean 14 months; range, 6-79 months) ($P = 0.43$). We were unable to detect a difference in postoperative infection between the PP cohort (0/27, 0%) versus the standard cohort (5/133, 3.8%) ($P = 0.59$). Similarly, we were unable to detect a difference in nonunions between the PP cohort (2/27, 7.4%) versus the standard cohort (4/133, 3%) ($P = 0.27$). Malunion rates were similar between the PP (1/27, 3.7%) and standard groups (6/133, 4.5%) ($P = 1.0$). Finally, implant removal was similar between the PP (3/27, 11%) and standard groups (15/133, 11%) ($P = 1.0$).

Conclusion: We were unable to detect a difference in rates of infection, nonunion, malunion, or implant removal in patients with closed tibia fracture treated with provisional plating and intramedullary nailing compared with standard reduction techniques and intramedullary nailing.

See pages 49 - 106 for financial disclosure information.

Patient and Surgical Factors Associated with Fasciotomy in Adults After Tibia Fracture

Jeremy Shaw, MD, MS*; David Sing, BS; Brian Feeley, MD; Alan Zhang, MD*
University of California, San Francisco, San Francisco, California, USA

Purpose: Previous analysis of patient and surgical factors associated with fasciotomy after tibia fracture is inadequate. The purpose of the present study is to analyze patient and surgical factors associated with fasciotomy after tibia fracture and to examine complications using a large insurance database.

Methods: A retrospective cross-sectional analysis of patients who underwent surgical treatment for tibial fractures was performed using data from the Nationwide Inpatient Sample (NIS). All available data from 1998 through 2011 were queried. Patients admitted for a primary diagnosis of tibial fracture and who underwent an open reduction and internal fixation (ORIF), intramedullary nail fixation (IMN), or external fixation (Ex-Fix) were identified using ICD-9 coding. Patients were assigned to fracture fixation groups based on definitive surgery. Comorbidities and perioperative complications were recorded and analyzed. Descriptive statistics and multivariate analysis were used to analyze differences between various subgroups within the cohorts.

Results: Between 1998 and 2011, 83,403 had surgical treatment for tibia fracture. 60.7% were male and 39.3% were female. 2921 (3.5%) were treated with fasciotomy for compartment syndrome. Rate of fasciotomy decreased with age, with patients younger than 25 having a higher rate of fasciotomy than other age groups (compared to age 45-55: odds ratio [OR] 1.41, P <0.001). Male gender was strongly associated with fasciotomy after fracture fixation (OR 2.09, P <0.001). Medicaid patients were more likely to require fasciotomy than those with private insurance (OR 1.25, P <0.001). 19,029 patients (22.8%) had a closed tibial shaft fracture, 8711 (10.4%) had open tibial shaft fractures, and 33,278 patients (39.9%) had a single diagnosis of closed proximal tibial fracture. 66,514 (79.7%) were treated with ORIF, 10,853 (13.0%) IMN, and 6036 (7.2%) Ex-Fix. In multivariate analysis, Ex-Fix was associated with a higher rate of fasciotomy compared to ORIF (OR 2.53, P <0.001), while IMN was no different (OR 0.92, P = 0.242). Open and high-energy fractures had the highest proportion of fasciotomy. Fasciotomy rate ranged from 7.24% in open proximal tibia fractures to 1.95% in closed distal tibia fractures. Infection, amputation, and death were more common in patients who underwent fasciotomy (2.8% vs 0.8, 2% vs 0.4%, 1% vs 0.5%, respectively, P <0.001). The fasciotomy group had more inhospital complications and longer length of stay.

Conclusion: This is the largest study to date examining factors associated with fasciotomy following traumatic fracture of the tibia. Factors associated with fasciotomy included patients younger than 25 years of age, male sex, Medicaid insurance, as well as proximal, complex, and open fractures.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Use of a Defined Surgical Approach for the Debridement of Open Tibia Fractures

Luke Nicholson, MD; *Timothy Auran, BS; Geoffrey Marecek, MD*
University of Southern California, Los Angeles, California, USA

Background/Purpose: The importance of prompt operative debridement of open fractures is well-established. Extension of the traumatic soft-tissue wound allows exposure of the entire zone of injury and identification and debridement of all nonviable tissues. However, particularly with wounds over the medial face of the tibia, wound extension may prevent closure and result in the need for flap coverage. The use of a defined surgical approach, without disturbing the traumatic wound, has been proposed to minimize soft-tissue-ssociated complications. However, the effectiveness and safety of this technique have not been reported. In this study, the authors hypothesize that a defined approach to open tibia fracture debridement results in a lower incidence of subsequent return to the operating room.

Methods: All patients presenting with open tibia fractures at our institution were prospectively enrolled in the study. The method of debridement was at the discretion of the treating surgeon and consisted of extension of the traumatic wound or the use of a separate, defined approach. The anterolateral approach to the tibia was used in all defined approach cases. Patients underwent fracture fixation with either medullary nailing, internal fixation, or external fixation. Wounds amenable to primary closure were closed during the index procedure while noncloseable wounds were treated with negative-pressure wound therapy or antibiotic-impregnated bead pouch. Subsequent debridements were carried out until traumatic wounds were either amenable to primary closure or soft-tissue coverage was performed. To minimize potential for selection bias, patients presenting with an OTA skin score of III were excluded from analysis. Differences between groups were analyzed with the use of the Fisher exact test for categorical variables and the Student *t* test for continuous variables.

Results: 72 patients with 77 open tibia fractures were enrolled over a 13-month period. 9 patients with an OTA skin score of III were excluded from analysis. Of the remaining 68 open tibia fractures, 47 were managed with direct extension of the traumatic wound and 21 were managed with a defined surgical approach. Mean OTA open fracture score was 6.02 in the Direct group and 5.94 in the Defined group ($P = 0.803$). Mean number of trips to the operating room at time of final follow-up were 1.85 in the Direct group and 1.24 in the Defined group ($P = 0.007$). Soft-tissue flap coverage was needed in 9 patients in the Direct group and 0 patients in the Defined group ($P = 0.048$). There were 7 rotational soleus flaps, 1 rotational gastrocnemius flap, and 1 free latissimus flap performed at a mean 11.9 days from initial debridement in the Defined group. There was 1 deep infection necessitating return to the operating room in each group, and 1 superficial infection that resolved with oral antibiotics in each group ($P = 0.58$). 3 patients from the Defined group and 8 patients from the Direct group were lost to follow-up. Of the remaining 65 patients, mean follow-up was 16.2 weeks.

Conclusion: A defined surgical approach used for the debridement of open tibia fractures is a safe alternative to direct extension of the traumatic wound and may result in a decreased need for both return to the operating room and soft-tissue coverage procedures.

See pages 49 - 106 for financial disclosure information.

Posterior Malleolar Fractures Associated with Tibial Shaft Fractures and Sequence of Fixation

Harish Kempegowda, MD[1]*; Hemil Maniar, MS, MBBS*[2]*; Raveesh Richard, MD*[1]*; Akhil Tawari, MD*[1]*; Jove Graham, PhD*[3]*; Michael Suk, MD*[2]*; Michael Beebe, MD*[4]*; Chris Han, MD*[5]*; Paul Tornetta III, MD*[5]*; Erik Kubiak, MD*[6]*; James Gotoff, BS*[1]*; Daniel S. Horwitz, MD*[2]

[1]*Geisinger Medical Center, Danville, Pennsylvania, USA;*
[2]*Geisinger Health Systems, Danville, Pennsylvania, USA;*
[3]*Geisinger Center for Health Research, Danville, Pennsylvania, USA;*
[4]*Florida Orthopaedic Institute, Tampa, Florida, USA*
[5]*Boston University Medical Center, Boston, Massachusetts, USA*
[6]*University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA*

Purpose: The purpose of this study was to examine how often posterior malleolar injuries are associated with nailed tibia fractures and to determine the quality of reduction based on the sequence of fixation in associated fracture patterns.

Methods: Retrospective review of the charts at three Level I trauma centers was conducted to identify all skeletally mature patients treated with an intramedullary nail for tibial diaphyseal fracture. The data collected included demographic characteristics, injury characteristics, tibial fracture pattern, associated posterior malleolar fractures, surgical characteristics including sequence of fixation, evident intraoperative displacement of the posterior malleolar fragment on fluoroscopic images, and the quality of reduction. The quality of reduction was considered poor if there was an intra-articular step >1 mm and/or a fracture gap of >1 mm.

Results: A total of 1113 nailed tibia fractures were identified, of which 96 patients (61 males, 35 females) with an average age of 40.3 years (range, 18-66) had associated posterior malleolar fracture (9%). Fracture pattern included 79 (82%) distal spiral type (42-A1, B1), 12 (13%) oblique type (42-A2), and 5 (5%) transverse type (42-A3). Of the 96 patients, 70 posterior malleolus fractures underwent operative management (73%). 54 patients belonged to the malleolus-first group (75%) and 16 patients belonged to the tibia-first group (25%). Of the 54 patients, in the malleolus-first group, based on immediate postoperative radiographs, reduction was graded as anatomic/acceptable in 53 fractures and poor reduction of the posterior malleolar fragment was observed in 1 case (1.8%). Of the 54 patients, 16 were displaced (30%) and 38 were undisplaced (70%), and 25 were contiguous fractures (48%). 53 posterior malleolar fractures were diagnosed preoperatively whereas in one patient the posterior malleolar fragment was evident after the placement of guidewire, the posterior malleolar fragment was stabilized with screws, and then proceeded with tibial nailing to achieve anatomic reduction. Of the 16 patients in the tibia-first group, 11 were diagnosed preoperatively (69%) and 5 were diagnosed intraoperatively (31%). Obvious intraoperative displacement of the posterior malleolar fragment was observed in fluoroscopic images of 5 patients (31%). These five cases of intraoperative displacement were initially undisplaced and two of them were contiguous fractures. Placement of the nail resulted in fracture displacement and in all 5 cases of intraoperatively displaced fractures the reduction of posterior malleolar fragment was attempted by lag-in screw technique with the nail in situ; on

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

final postoperative radiographs acceptable reduction was noted in 3 cases (66%). Based on immediate postoperative radiographs, the quality of reduction was graded as anatomic/acceptable in 9 cases (56%) and poor reduction of the posterior malleolar fragment was observed in 7 patients (44%) (Table 2). These percentages of patients with intraoperative displacement and poor reduction were statistically significantly different from the malleoli-first fixed group ($P = 0.005$ and $P = 0.001$ respectively) (Table 3).

Conclusion: Many low-energy tibia fracture with a spiral configuration do have an associated posterior malleolus fracture. In order to avoid intraoperative displacement and poor reduction, we recommend fixation of the posterior malleolar fragment prior to nailing of the tibia in associated fracture pattern. This sequence appears to be highly successful in preventing intraoperative displacement when combined with a tibial nail.

See pages 49 - 106 for financial disclosure information.

Table. 1: Prevalence of concomitant tibial shaft fracture and posterior malleolar injury according to tibial fracture patterns and the energy of injury.

Fracture pattern	Low energy	High energy
Spiral types	57 (59%)	22 (23%)
Oblique types	8 (8%)	4 (4%)
Transverse types	1 (1%)	4 (4%)

Table 2. Preoperative and operative variables, compared between the tibia-first and malleolus-first groups.

	Tibia first (n=16)	Malleolus first (n=54)	P-value
Percentage of articular surface involvement, Mean (SD)	36.3 (13.1)	35.2 (10.8)	0.75
Displaced fractures, N (%)	4 (25%)	16 (30%)	0.99
Malleolus diagnosed preoperatively, N (%)	11 (69%)	53 (98%)	**0.002**
Nail size in mm, Mean (SD)	10.0 (0.6)	9.8 (0.9)	0.42
AP lock screws used in distal fragment of tibial nail, N (%)	8 (50%)	20 (37%)	0.39
Clamps used, N (%)	6 (38%)	19 (35%)	0.87
Contiguous fractures between tibial shaft and posterior malleolus, N (%)	6 (38%)	25 (48%)	0.46

Table 3. Intraoperative displacement and quality of reduction, compared between the tibia-first and malleolus-first groups.

	Tibia first (n=16)	Malleolus first (n=54)	Odds Ratio (malleolus vs. tibia first) [95% CI]	P-value
Intraoperative displacement, N (%)	5 (31%)	1 (2%)	0.042 [0.004, 0.391]	**0.005**
Quality of reduction, N (%)				
Anatomic or acceptable	9 (56%)	53 (98%)	--	
Poor	7 (44%)	1 (2%)	0.024 (0.003, 0.221)	**0.001**

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Proximal Tibia Shaft Fractures: Intramedullary Nail Treatment with Manual versus Tension Wire-Assisted Reduction

Razvan Nicolescu, MD*; Stephen Quinnan, MD; James Hutson, MD*
University of Miami / Jackson Memorial Hospital, Miami, Florida, USA

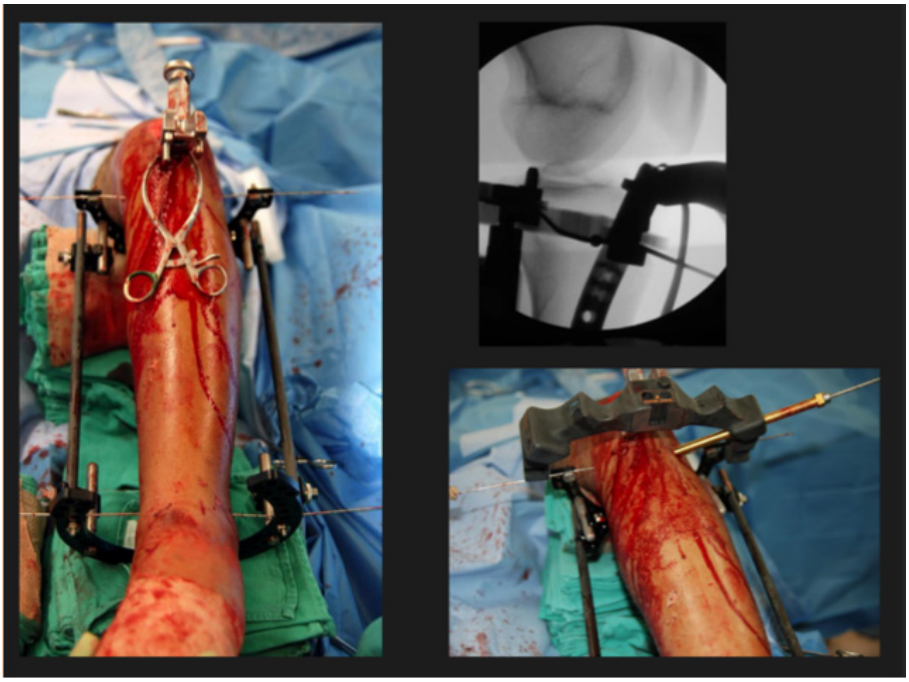
Purpose: We sought to compare the postoperative reduction achieved with proximal tibia shaft fractures treated with intramedullary nails using manual reduction to those treated with tension wire-assisted reduction.

Methods: All skeletally mature patients with proximal tibia shaft fractures treated with an intramedullary nail beginning with the first use of tension wire-assisted reduction in December 2007 through September 2015 were reviewed. 77 patients with proximal tibia fractures underwent intramedullary nailing at a single Level I trauma center. 42 of the 77 underwent tension wire-assisted intramedullary nailing, while the remaining 35 underwent conventional intramedullary nailing with manual reduction. The main outcome measurement was malreduction, defined as >5° of angulation in any plane.

Results: The manual reduction and tension wire-assisted groups showed similar age and gender demographics. Open fractures comprised 33% of the tension wire-assisted group and 57% of the conventional group. Additional surgical techniques, such as blocking screws and percutaneous plates, were frequently utilized within both groups ($P = 0.1944$). Nailing in the semiextended position via a suprapatellar approach was more frequently utilized by surgeons who applied the tension wire-assisted technique ($P = 0.0005$). Valgus malreduction occurred three times as often in the manual reduction group ($P = 0.0382$), while the incidence of apex anterior deformity was roughly equivalent ($P = 0.4994$) between the two groups. The series of proximal tibia fractures treated with tension wire-assisted nailing had a significantly lower rate of postoperative malalignment than the group treated with manual reduction intramedullary nailing ($P = 0.0124$).

Conclusion: Tension wire-assisted intramedullary nailing showed a distinct advantage in the treatment of proximal tibia fractures. Specifically, the rate of postoperative malalignment in the coronal plane was significantly lower among fractures treated with a tension wire reduction technique prior to nailing. No significant difference in malalignment was observed in the sagittal plane. The most prevalent form of malalignment in the manual reduction group was valgus, while the tension wire-assisted group contained an equal incidence of valgus and apex anterior malalignment. Additional surgical reduction techniques, including blocking screws, were frequently utilized in both groups. Semiextended technique was more commonly utilized in the tension wire-assisted group. In addition, it is notable that tension wire-assisted reduction allows for greatly decreased radiation exposure by eliminating the need to hold the fracture reduced during fluoroscopy, and the need for surgical assistants is almost eliminated. We therefore conclude that treatment of proximal tibia shaft fractures with tension wire-assisted reduction provides an effective means to improve the ease of surgery and postoperative results for these difficult fractures.

See pages 49 - 106 for financial disclosure information.



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Optimizing Fixation of Extra-Articular Distal Tibia Fractures (OTA 43-A): Does the Fibula Matter?

Michael Beebe, MD[1]; Rafael Serrano-Riera, MD[2]; Darryl Auston, MD, PhD[3]; Jonathan Quade, MD[4]; Anjan Shah, MD[4]; Benjamin Maxson, DO[5]; Anthony Infante, DO[4]; Roy Sanders, MD[6]; Hassan R. Mir, MD[4]; David Watson, MD[1]
[1]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[2]*Florida Orthopaedic Institute-University of South Florida, Tampa, Florida, USA;*
[3]*SUNY Upstate Medical University, Syracuse, New York, USA;*
[4]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[5]*Tampa General Hospital, Tampa, Florida, USA;*
[6]*Orthopaedic Trauma Service, Tampa, Florida, USA*

Purpose: The purpose of this study was to evaluate whether lateral column support either through fibular fixation or an intact fibula better maintained axial alignment in distal metaphyseal fractures of the tibia (OTA 43-A) treated with either an intramedullary (IM)rod or locking plate.

Methods: After IRB approval, our prospectively collected database was retrospectively reviewed for all isolated unilateral/bilateral extra-articular distal tibia fractures (OTA 43-A) treated with either a distal tibial locking plate or IM fixation between July 1, 2005 and June 30, 2015. 223 fractures (219 patients) were initially identified. 106 fractures were excluded--39 for incomplete follow-up, 3 for frame treatment, 38 for skeletal immaturity, and 26 for concurrent lower extremity injuries--allotting 117 fractures in 114 patients. Fractures were divided into four groups: Group 1, locking plate fixation with fibular support; Group 2, locking plate fixation without fibular support; Group 3, IM fixation with fibular support; and Group 4, IM fixation without fibular support. The age, sex, comorbidities, injury pattern, fixation construct, follow-up length, subsequent procedures, complications, initial anterior distal tibial angle (aDTA), initial lateral distal tibial angle (lDTA), final aDTA, and final lDTA were recorded.

Results: 50.4% of fractures were experienced by males. Average age was 49.7 ± 16.5 years. Average follow-up was 23.7 months (range, 12.0-114.5 months). 38% of fractures were open. 66 fractures were treated with a locking distal tibial plate (52 with fibular support, 14 without). 51 fractures were treated with an IM rod (26 with fibular support, 25 without). 9.4% underwent staged grafting secondary to bone loss. Overall, 19.7% had an unplanned return to the operating room (8.5% for repair of infected nonunion, 5.1% for debridement without implant removal or exchange, 4.2% for treatment of aseptic nonunion, and 1.7% for delayed amputation). Patient demographics and complications were comparable between groups (P >0.05). Change in alignment of more than 2° in either the frontal (lDTA) or sagittal (aDTA) plane was seen in 24.2%, 14.3%, 20.7%, and 16% of patients in groups 1-4 (P = 0.215). There were significantly more fractures in group 3 with a higher initial aDTA and fractures in group 2 with a lower initial aDTA; however, clinically both were within the normal anatomic variation. Importantly, there was no statistical significance between either lDTA or aDTA at final measurement between any of the groups in pairwise comparison, including those experiencing complications.

See pages 49 - 106 for financial disclosure information.

	Locking Plate; Fibula Fixed (Group 1) n = 52	Locking Plate; Fibula not Fixed (Group 2) n = 14	IM Rod; Fibula Fixed (Group 3) n = 26	IM Rod; Fibula not Fixed (Group 1) n = 25	Sig.
Age	49.7 (16.5)	50.6 (23.0)	50.8 (13.5)	43.7 (18.4)	p = 0.402
Sex [% Male]	50%	50%	46.2%	56.0%	p = 0.880
AO1 Classification					p = 0.501
43-A1	28.8%	28.6%	34.6%	32.0%	
43-A2	25.0%	42.9%	34.6%	40.0%	
43-A3	46.2%	28.6%	30.8%	28.0%	
Initial Alignment					
Lateral DTA	88.7 (2.2)	90.5 (2.5)	88.9 (1.9)	88.6 (3.5)	p = 0.089
Anterior DTA	84.3 (2.7)	82.2 (2.8)*	85.1 (3.6)*	84.2 (3.5)	p = 0.049
Final Alignment					
Lateral DTA	88.4 (3.1)	89.1 (2.3)	88.4 (2.3)	88.0 (4.1)	p = 0.916
Anterior DTA	83.7 (3.2)	82.1 (1.9)	84.1 (4.6)	84.3 (5.2)	p = 0.346

*Significant value after multivariate analysis

Conclusion: Based on our data, when treating OTA 43-A extra-articular fractures of the distal tibia, locking plates and IM fixation work equally well. Both appear to maintain initial alignment over time with minimal angular change, regardless of fibular fixation or support.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

OTA Classification is Highly Predictive of Acute Compartment Syndrome Following Tibia Fracture: A Cohort of 2885 Fractures

Michael Beebe, MD[1]; Darryl Auston, MD, PhD[2]; Rafael Serrano-Riera, MD[3]; Jonathan Quade, MD[4]; Anjan Shah, MD[4]; Anthony Infante, DO[4]; Benjamin Maxson, DO[5]; David Watson, MD[1]; Roy Sanders, MD[6]; Hassan R. Mir, MD[4]
[1]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[2]*SUNY Upstate Medical University, Syracuse, New York, USA;*
[3]*Florida Orthopaedic Institute - University of South Florida, Tampa, Florida, USA;*
[4]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[5]*Tampa General Hospital, Tampa, Florida, USA;*
[6]*Orthopaedic Trauma Service, Tampa, Florida, USA*

Purpose: Our objective was to determine the correlation between the OTA classification of tibial plateau, shaft, and pilon fractures to the development of acute compartment syndrome (ACS).

Methods: After IRB approval, our institution's prospectively collected database was retrospectively reviewed for all tibial plateau, shaft, and pilon fractures over a 10-year period. 3606 fractures were initially identified. Only skeletally mature patients, patients undergoing plate or intramedullary fixation, and fractures managed from initial injury through definitive fixation at our institution were included, leaving 2885 fractures in 2778 patients for analysis. Patients undergoing prophylactic fasciotomy were excluded. The database and patient charts were reviewed for age, sex, injury details, injury pattern, concurrent injuries, fixation construct, fasciotomy, and subsequent procedures. Univariate analyses were conducted using independent *t* tests for continuous data and X^2 tests of independence for categorical data. Bilateral injuries were analyzed independently with a bilateral variable. A simultaneous multivariate binary logistic regression was developed to identify variables significantly associated with ACS.

Results: The average age for all patients was 43.2 ± 17.6 years. 823 (28.5%) of fractures were open. 100 patients (3.6%) had bilateral fractures, while 7 (0.2%) had two discrete injuries at distinct time points. 954 fractures (33.1%) involved the proximal segment (OTA 41), 1270 (44.0%) involved the middle segment (OTA 42), and 811 (28.1%) involved the distal segment (OTA 43). 156 fractures (5.4%) were combined fractures of the same tibia. 1690 fractures (58.6%) underwent plate fixation alone, 1102 fractures (38.2%) underwent intramedullary fixation alone, and 91 (3.2%) underwent a combination of nail and plate fixation for combined injuries. 153 fractures (5.3%) occurred concurrently with femoral fractures, while 78 (2.7%) occurred in conjunction with a pelvic or acetabular injury. ACS was diagnosed in 136 patients (4.7%) with no patient developing a bilateral ACS. The average age of those developing ACS was 36.2 years versus 43.3 years in those without (P <0.001). Distal segment injuries (OTA 43) had a significantly lower percentage developing ACS when compared to both middle (OTA 42) and proximal (OTA 41) segment injuries (P ≤0.007) (Table 1). Type C fractures had a significantly higher rate of ACS when compared to types A or B (P <0.001). Group 1 fractures had a significantly lower rate of developing ACS when compared to both groups 2 and 3 (P ≤0.044). Open injury, bilateral tibial fractures, injuries involving

See pages 49 - 106 for financial disclosure information.

	Compartment Syndrome N = 136	No Compartment Syndrome N =2,749	p-Value	Odds Ratio	95% CI Lower	95% CI Upper
Age (st. dev)	36.2 (14.9)	43.3 (18.1)	<0.001	0.971	0.959	0.982
Open Injury	34.60%	28.20%	0.888	1.03	0.683	1.554
Segmental Injury	7.40%	4.70%	0.085	0.446	0.177	1.119
Bilateral Injuries	3.70%	7.10%	0.17	1.73	0.79	3.787
Concurrent Fracture						
Femur	8.80%	5.10%	0.572	1.208	0.626	2.626
Pelvis	4.40%	2.60%	0.438	1.419	0.586	3.437
Type of Fixation						
Plate	39.70%	38.20%	N/A (Reference)			
Intramedullary Rod	57.40%	58.60%	0.64	1.178	0.593	2.341
Both	2.90%	3.20%	0.908	0.93	0.272	3.177
OTA Classification						
Bone Segment						
1 (Proximal)	46.30%	31.80%	0.197	1.584	0.788	3.186
2 (Middle)	44.90%	41.30%	N/A (Reference)			
3 (Distal)	8.80%	26.90%	0.012	0.339	0.146	0.785
Fracture Type						
A	18.40%	29.60%	N/A (Reference)			
B	28.70%	34.80%	0.216	1.404	0.82	2.405
C	52.90%	35.60%	<0.001	3.061	1.831	5.116
Group (Comminution/Articular Involvement)						
1	16.20%	28.60%	N/A (Reference)			
2	36.80%	32.10%	0.012	1.993	1.165	3.41
3	47.10%	39.30%	0.044	1.689	1.015	2.81

two bone segments, fixation type, nor concurrent pelvic or femoral fractures predicted the development of ACS.

Conclusion: In this large cohort of tibia fractures we found that the age, sex, and OTA classification were highly predictive for the development of acute ACS. These findings can help to guide clinical practice and patient counseling.

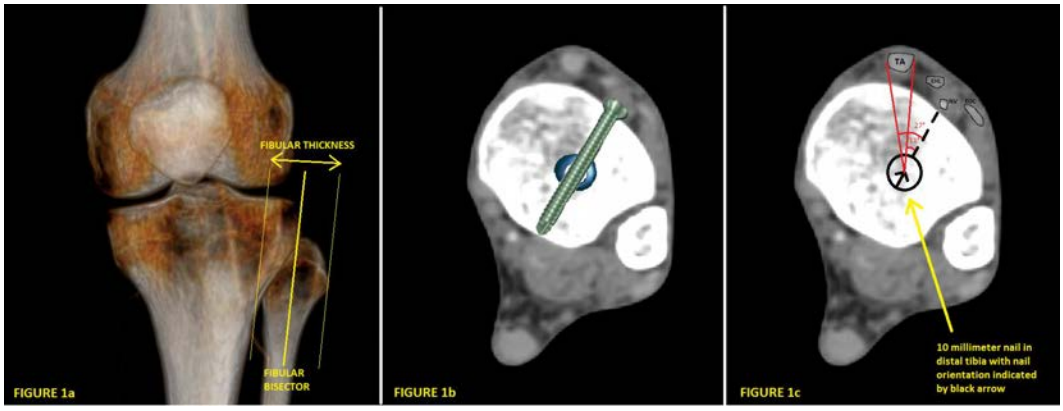
The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Anterior Anatomy of the Distal Leg Relative to Anterior and Anterior-Oblique Distal Locking Screws During Tibia Nailing: An Anatomical Risk Study Using CT Angiography

Phillip Mitchell, MD[1]; Eric Barcak, DO[2]; Kostas Triantafillou, MD[3]; Ed Perez, MD[3]; Cory Collinge, MD[4]
[1]*Vanderbilt University Department of Orthopedics, Nashville, Tennessee, USA,*
[2]*University of North Texas/ John Peter Smith Residency Program, Fort Worth, Texas, USA*
[3]*University of Tennessee/Campbell Clinic, Memphis, Tennessee, USA;*
[4]*Vanderbilt Medical Center, Nashville, Tennessee, USA*

Purpose: Our objective was to evaluate if there is a safe axis for insertion of distal tibia locking screws from the anterior or anterior oblique direction relative to the important anterior anatomical structures.

Methods: 20 patients with a CT of the lower extremity(ies) with contrast (CT angiography [CTA]) were evaluated. Exclusion criteria were any fracture below the level of the knee or vascular injury. Two and 3-dimensional CTA images (Phillips Intellispace) were manipulated to reflect the AP view of the proximal tibia used during intramedullary nailing ("fibular bisector radiograph"), shown in Figure 1. Using this view to determine the nail orientation, we simulated optimal nail placement in the distal tibia. Corresponding axial cuts were then used above the distal tibia's articular surface at 10 mm, 20 mm, 30 mm, and 40 mm. The location of the tibialis anterior (TA), anterior tibial neuromuscular bundle (NV), extensor hallucis longus (EHL), and extensor digitorum longus (EDL) were measured in relation to the central AP line of the nail. Injury was predicted if these lines contacted anterior structures came into contact with the TA tendon, neurovascular bundle, or common extensor tendons (Fig. 2).



Results: All AP screws (80/80, 100%) impacted the TA tendon, EHL tendon, and/or anterior tibial NV bundle between 10 mm and 40 mm cranial to the plafond. The neurovascular bundle was impacted by an AP locking screw in 53% of cases. Using the CT modeling and

See pages 49 - 106 for financial disclosure information.

estimating optimal distal nail positioning, a relatively consistent positioning of the distal leg anatomy was clearly seen. The medial extent of the TA tendon was greatest 10 mm cranial to the plafond and averaged 27° (95% CI, 22-33°) medial to the AP line. The maximum lateral border of the foot's common extensors, found 40 mm cranial to the plafond, averaged 71° (95% CI, 62-80°) lateral to the AP line.

Conclusion: The anterior tibial neurovascular bundle and foot and ankle extensor tendons are at high risk from AP-directed distal locking screws. The tendinous anatomy of the distal leg is at risk between 33° medial and 80° lateral to the AP axis of a tibial nail (Fig. 3). Our data indicate that distal locking screws placed from the AP direction should be thoughtfully applied and an open approach should be strongly considered.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

The Relationship Between the Distal Nail Target and Alignment of Distal Tibia Fractures

Elyse Brinkmann, MD*; Mitchell Bernstein, MD; Hobie Summers, MD; Michael Tripp, BS; Frank DiSilvio, BS; William Lack, MD;*
Loyola University Medical Center, Maywood, Illinois, USA

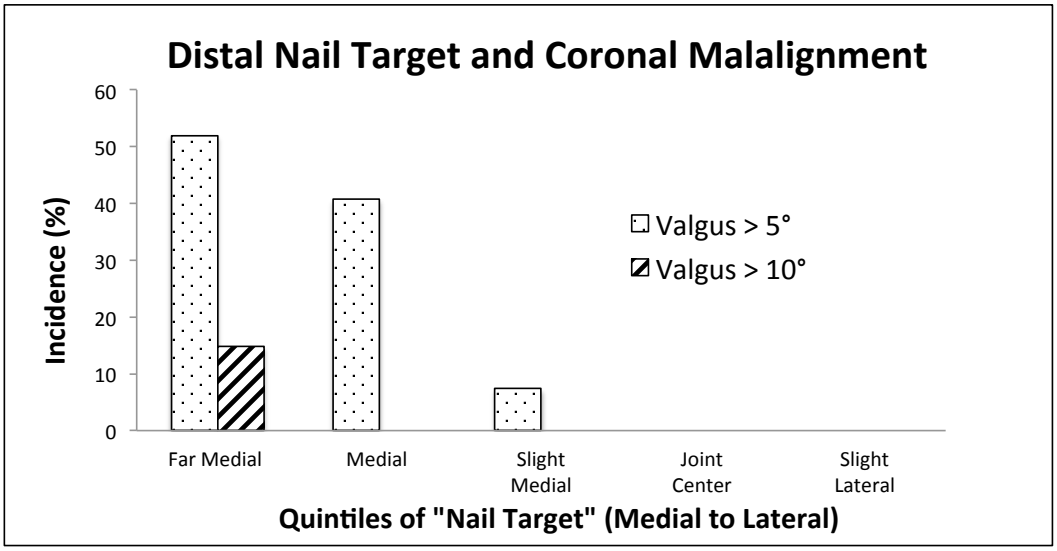
Background/Purpose: Alignment of metadiaphyseal fractures treated with intramedullary nailing is directly related to the relationship of the nail to the metaphysis. Optimal reaming paths have been well described for the proximal femur, distal femur, and proximal tibia. Malalignment of distal tibia fractures has been anecdotally related to the position of the nail within the distal metaphysis; however, the optimal nail target has not been well described. Our purpose was to assess the relationship between the distal nail target and alignment for distal tibia fractures treated with intramedullary nailing.

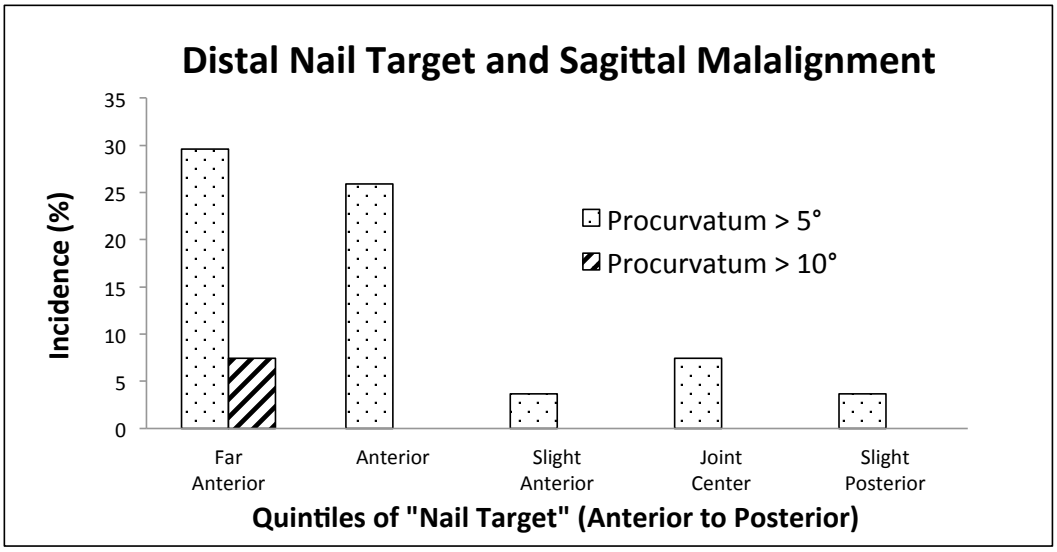
Methods: We performed a retrospective review of all distal tibia fractures (within 11 cm of the plafond) treated with intramedullary nailing at a Level I trauma center from 2005 to 2015 (n = 135), after excluding cases with insufficient postoperative imaging or combination of nailing with adjunctive fixation of the tibia. Alignment was assessed in the coronal plane on AP radiographs using the lateral distal tibial angle (LDTA) and in the sagittal plane on lateral radiographs using the anterior distal tibial angle (ADTA). The nail target was defined as the extrapolated intersection between the nail and plafond and was recorded as its relative position from lateral to medial and anterior to posterior. Fractures were grouped for comparison based on the relationship of the nail target to the joint center. Differences in alignment (LDTA and ADTA) were assessed with Student's *t* test analyses. The incidence of deformity was compared by X^2 analysis. Statistical significance was reported for $P < 0.05$.

Results: The population of 135 fractures included 36 cases of malalignment >5° (26.7%). This included 22 fractures in valgus, 9 in procurvatum, and 5 in both valgus and procurvatum. Assessing coronal alignment, nails directed medial to the joint center demonstrated relative valgus (mean LDTA 86.3 vs 89.3°, $P < 0.01$) and were more commonly in valgus >5° (27 of 81, 33.3% vs 0 of 54, 0%; $P < 0.01$). Valgus outliers (>10°) were more common for the far medial quintile of nail targets (4 of 27, 14.8% vs 0 of 108, 0%; $P < 0.01$). Assessing sagittal alignment, nails directed anterior to the joint center demonstrated relative procurvatum (mean ADTA 82.8 vs 81.0°; $P < 0.01$) and were more commonly in procurvatum >5° (16 of 81, 19.8% vs 3 of 54, 5.6%; $P = 0.02$). Procurvatum outliers (>10°) were more common for the far anterior quintile of nails (2 of 27, 7.4% vs 0 of 108, 0%; $P = 0.04$).

Conclusion: Our results quantify the relationship between the distal nail target and malalignment of distal tibia fractures treated with intramedullary nailing. Despite an overall rate of malalignment consistent with previous studies, we found that central as well as slightly posterolateral nail targets were associated with low rates of coronal (0%) and sagittal (5.6%) deformity. The location of the ankle joint center may be miscalculated given tibia-fibula overlap at the posterolateral ankle. We recommend a central nail target, with an emphasis on avoiding medial and anterior deviation. Further prospective research is necessary to determine causality and the degree to which the nail target can be controlled.

See pages 49 - 106 for financial disclosure information.





The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Debridement of Open Tibia Fractures More Than 48 Hours After Injury: Does Time to Surgery Matter?

Nathanael Heckmann, MD[1]; Kyle Mombell, MD[2]; Alexander Bradley, BS[1]; Geoffrey Marecek, MD[1]; Jason Davis, MD[3];
[1]University of Southern California, Department of Orthopaedic Surgery, Los Angeles, California, USA;
[2]Naval Medical Center San Diego, San Diego, California, USA
[3]University of California San Francisco - Fresno, San Francisco, California, USA

Background/Purpose: Surgical debridement is a critical step in the successful treatment of open tibia fractures. Although most surgeons aim for debridement within 6 to 24 hours, the optimal time to debridement is not known. Recent reports have suggested other factors such as Gustilo-Anderson type, prompt initiation of antibiotics, and time to definitive closure are more predictive of infection than time to surgery. We sought to determine the effect of a prolonged delay to surgical debridement for open tibia fractures. Our hypothesis is that time to surgery for open tibia fractures does not affect the infection or reoperation rates for open tibia fractures.

Methods: All patients treated for an open diaphyseal tibia fracture (OTA / AO 42) at a Level I trauma center between 2011 and 2015 were identified using CPT codes. Patients were excluded for age <18, less than 12 weeks of follow-up, or a history of prior surgery to the injured tibia. Patient factors such as age, gender, mechanism of injury, laterality, tobacco and drug use, medications (ie, NSAIDs [nonsteroidal anti-inflammatory drugs], steroids, anticonvulsants, etc), and comorbidities were recorded. The open fracture classifications of Gustilo-Anderson and the OTA were also applied. Patients were divided into 3 groups based on time to surgery: group A <24 hours, group B 24-48 hours, and group C >48 hours. Patient charts were reviewed for deep infection and unplanned reoperation for any cause. A Fisher's exact test was used to determine statistical significance between infection and reoperation rates among the various groups.

Results: We initially identified 149 patients, with 97 available for analysis after exclusion criteria were applied. The average follow-up was 56 weeks (range, 13 weeks-4 years, 6 months). There were 47 patients in group A, 28 in group B, and 22 in group C. Infection rates for groups A, B, and C were 12.8%, 10.7%, and 9.1%, respectively ($P = 0.959$). Reoperation rates for groups A, B, and C were 29.8%, 21.4%, and 27.3%, respectively ($P = 0.779$). In terms of Gustilo-Anderson classification, there were 19 type I, 46 type II, 8 type IIIA, 22 type IIIB, and 2 type IIIC with infection rates of 10.5%, 6.5%, 37.5%, 13.6%, and 0% ($P < 0.158$); and reoperation rates of 10.5%, 19.6%, 37.5%, 45.5%, and 100%, respectively ($P <0.008$). The groups did not vary in proportion of Gustilo-Anderson fracture types. No other factors assessed were predictive of infection or reoperation rates.

Conclusion: A delay of more than 48 hours to surgical debridement of open tibia fractures did not result in a greater infection or reoperation rates. The Gustilo-Anderson classification was more predictive of reoperation with Type IIIA, B, and C injuries having a statistically significant higher reoperation rate than the other types.

See pages 49 - 106 for financial disclosure information.

External Fixator As a Primary and Definitive Treatment for Open Fractures in Disasters and Conflicts

Abduljabbar Alhammoud, MD[1]*; Mason Al Nouri, Dr.*[1]*; Mahmood Ali Arbash, Dr.*[1]*; Bakry Mazz, MD*[2]
[1]*Hamad General Hospital, Doha, QATAR;*
[2]*Alzarzor Hospital, Aleppo, SYRIA*

Background/Purpose: War injuries usually occur as a result of high-energy trauma and may be caused by heavy weaponry, explosions, or collapsed structures. During these circumstances, the highest number of injuries occur in the musculoskeletal system. Furthermore, the femur, the tibia, and the humerus are very commonly involved in many cases and can present with varying levels of soft-tissue injury.

The first line of treatment in cases of long bone shaft fracture (open or closed) is intramedullary nailing, but external fixation is also indicated in some situations such as for damage control and massive soft-tissue injuries. In situations of conflict, poor countries with low budget health-care systems can be forced to use the external fixator as a primary and definitive treatment for open fractures. We aim to summarize the experience of one field hospital using external fixation as a primary and definitive treatment for the open femur, tibia, and humerus fractures.

Methods: This was a retrospective review of all war injuries that presented to one field hospital with very limited human and logistic resources. Between 2011 and 2015, 955 orthopaedic war injuries with open femur (334 cases), tibia (462 cases), and humerus (159 cases) fractures were managed with one orthopaedic team. Different types of external fixators were used according to availability with one new type locally invented.

Results: *Open femur fractures:* 334 presented with an open femur fracture; average age was 28.8 years (SD 11); 90.4% were male and 9.6% female. There were according, to Gustilo/Anderson classification, 24.9% type 1, 47% type 2, 28.1% type 3, and 14.7% with vascular injury. Most of the cases (247 [74%]) were managed by AO external fixator, 74 (22.2%) Orthofix, 10 (3%) locally invented, and 3 (0.9%) Hoffman. The external fixator was the primary and definitive method of treatment in 96 cases (28.7%), with an average 4.6 months to achieve full union. Using external fixator as the only treatment method in open femur fracture was statistically not significant in the classification of the fracture (*P* value 0.26) and the type of external fixator (*P* value 0.48). *Open tibia fractures:* 462 presented with open tibia fracture; average age was 27.9 years, with 91.3% male and 8.7% female. There were, according to Gustilo/Anderson classification 133 (29.8%) type 1,158 (35.5%) type 2 ,155 (34.7%) type 3, and 143 (31%) with vascular injury. Most of the cases (273 [59.1%]) were managed by AO external fixator, 115 (24.9%) Orthofix, 49 (10.6%) locally invented, and 24 (5.1%) Hoffman. The external fixator was the primary and definitive method of treatment in 143 (31%), with an average 2.5 months to achieve full union. Using external fixator as the only treatment method in open tibia fracture was statistically not significant regarding the classification of the fracture (*P* value 0.061) or type of external fixator (*P* value 0.235). *Open humerus fractures:* 159 presented with open humerus fracture; average age was 28.36 years, with 89.9% male

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

and 10.1% female. There were, according to Gustilo/Anderson classification 66 (41.5%) type 1, 41 (25.8%) type 2, 51 (32.1%) type 3, and 19 (11.9%) with vascular injury. Most of the cases (66 [41.5%]) were managed by AO external fixator, 30 (20.8%) Orthofix, 51 (32.1%) locally invented, and 10 (7.1%) Hoffman. The external fixator was the primary and definitive method of treatment in 52 (32.9%), with average 2.1 months to achieve full union. The main complication was the pin tract infection with 165 deep infection, 53 cases in femur (15.9%), 93 (20.1%) in tibia ,and 19 (11.9%) in humerus.

Conclusion: Satisfactory results can be obtained using definitive external fixation of open long bone shaft fractures (femur, tibia, humerus) if a stable fixation is achieved. Pin tract infections, although a common occurrence, are not a major problem and can be treated with local wound care and antibiotic therapy. The most common problem arising from the external fixation remains the decrease in the range of motion of the near joints, especially for fractures around the joint and when the external fixator is applied across the joint.

See pages 49 - 106 for financial disclosure information.

Large Femoral Defects in Open Femur Fractures: A 10-Year Retrospective Review

Basem Attum, MD[1]; Ashley Dodd, BS[2]; Amir Jahangir, MD[3]; Hassan Riaz Mir, MD, MBA[3]; Cory Collinge, MD[4]; William Obremskey, MD, MPH[3]; Manish K. Sethi, MD[3];
[1]Vanderbilt University Medical Center, Nashville, Tennessee, USA;
[2]Vanderbilt University, Nashville, Tennessee, USA;
[3]Vanderbilt Orthopaedic Institute, Nashville, Tennessee, USA;
[4]Harris Methodist Fort Worth Hospital, Fort Worth, Texas, USA

Purpose: Very little data exist on the management of large femoral defects in open femur fractures. The conventional method of treating these injuries has been fixation with a plate or nail and antibiotic cement followed by delayed autogenous bone grafting, but no study has yet to describe the long-term outcomes in patients with femoral defects greater than 5 cm. In a 10-year retrospective study of patients with open distal femur fractures with defects greater than 5 cm, our group sought to better understand the long-term outcomes in treating such complex injuries.

Methods: After obtaining IRB approval, through a CPT code search between 2004-2014 we identified 832 open femur fractures and reviewed each case for femoral defects greater than 5 cm. From each patient's radiograph, the size of defect and method of final fixation (plate vs intramedullary [IMN]) was recorded. The medical record was reviewed to identify individual patient factors including comorbid conditions and surgical complications related to the management of the open distal femur fraction. Multivariate analysis was utilized to identify relevant risk factors for complications.

Results: 832 open femur fractures were identified, and of these, 27 demonstrated bony defects greater than 5 cm. Demographics for these patients are demonstrated in Table 1. 61.5% (n = 16) were open distal femur fractures and 96.3% (n = 26) of the cases were treated definitively with open reduction and internal fixation (ORIF). The average defect size was 8 cm and each patient had an average of 3 surgeries for management of the injury including the initial incision and drainage. The average time to bone grafting of each defect was 139 days (17 weeks). Overall this patient group demonstrated a very high complication rate (55.6%, n = 15) driven by infection (29.6%, n = 8) and nonunion (44.4%, n = 12). The rate of amputation was 3.7% (n = 1). Multivariate analysis demonstrated that smoking, diabetes, American Society of Anesthesiologists (ASA) score, and defect size did not independently increase the risk of a complication.

Conclusion: Management of open femur fractures with large defects demonstrates a very high complication rate driven by infection and nonunion. However, these complications cannot be predicted based upon individual patient comorbid conditions or defect size. Interestingly in our series over a decade, the rates of amputation were very low. Given our data, patients with this injury should be counseled on the high risk of infection or nonunion and multiple operations but a relatively low probability of amputation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Demographics

Injury characteristics	**N=27**
Size of defect (cm), N (%)	
5 to <10 cm	20 (66.7%)
>10 cm	7 (66.7%)
Median defect size (IQR)	8.00 (6.35-10.00)
Location of injury, N (%)	
Distal femur	16 (61.5%)
Femoral shaft	5 (19.2%)
Supracondylar	5 (19.2%)
Postoperative complications	
Amputation, N (%)	1 (3.7%)
Infection, N (%)	8 (29.6%)
Malunion, N (%)	1 (3.7%)
Nonunion, N (%)	12 (44.4%)
Any complication, N (%)	15 (55.6%)

See pages 49 - 106 for financial disclosure information.

Confirming the Obesity Paradox in Hip Fractures: Short-Term Postoperative Outcomes

Stephen Belmustakov, BS; *John Thompson, MD; Babar Shafiq, MD; Jose Flores, MPH; Francis Abreu, MPH*
Johns Hopkins Medicine, Baltimore, Maryland, USA

Introduction: The obesity paradox describes an inverse epidemiological relationship between body mass index (BMI) and morbidity/mortality. Elevated BMI shows increased morbidity but decreased mortality in various populations. We sought to assess whether the obesity paradox extends to hip fractures in the short-term postoperative period and hypothesized that it would, with the goal of tailoring perioperative care to minimize complications in these subsets of patients.

Background/Purpose: The study consisted of 22,099 patients undergoing operative treatment for femoral neck and intertrochanteric fractures (OTA types 31-A/31-B; CPT codes 27235/27236/27244/27245) using the American College of Surgeons National Surgical Quality Improvement Program 2005-2013 databases. Patients were categorized based on World Health Organization body mass index (BMI) categories ranging from severe thinness (BMI <16) to severe obesity (BMI >40). After adjustment for various demographic and medical factors, logistic regression was used to predict the odds of 30-day postoperative morbidity/mortality, and ANOVA (analysis of variance) was used to compare length of stay (LOS) across BMI categories.

Results: The mean age was 79.3 (SD 11.9), and BMI (percentage) was distributed as severe thinness (1.99%), moderate thinness (2.10%), mild thinness (5.25%), normal (46.44%), overweight (28.36%), mild obesity (10.33%), moderate obesity (3.43%), and severe obesity (2.10%). When compared to normal BMI, severely thin and moderately thin patients had increased postoperative mortality (odds ratio [OR] 1.57, 95% Confidence Interval [CI] 1.10-2.24 and OR 1.89, 1.37-2.59, respectively) (Fig. 1). Mildly obese through severely obese patients had increased postoperative morbidity (OR 1.12, 0.91-1.39 and 1.42, 1.10-1.84, respectively) including wound infection (P <0.001), failure to wean ventilation (P <0.001), and postoperative renal impairment (P <0.001). However, overweight and mildly obese patients had decreased mortality (OR 0.72, 0.62-0.84 and 0.76, 0.52-1.11, respectively) (Fig. 1). Median LOS for all categories was 5 days.

Conclusion: Patients with elevated BMI undergoing surgery for hip fractures have decreased mortality but increased morbidity rates in the short-term postoperative period. In contrast, patients with significantly decreased BMI experience increased mortality rates, thus confirming the obesity paradox. Surgical and medical providers should have heightened awareness of high and low BMI during perioperative care for acute hip fractures to identify at-risk patients with the goal of minimizing postoperative complications. Optimizing nutrition for severely and moderately thin individuals prior to surgery may help improve survival while focusing on wound care, judicious use of anesthesia, and hydration may reduce morbidity in patients with mild to severe obesity. Recognition of patient elements suggestive of a more complicated hospital course is crucial in an era of health-care reform and stricter physician and hospital reimbursements geared toward personalized care.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

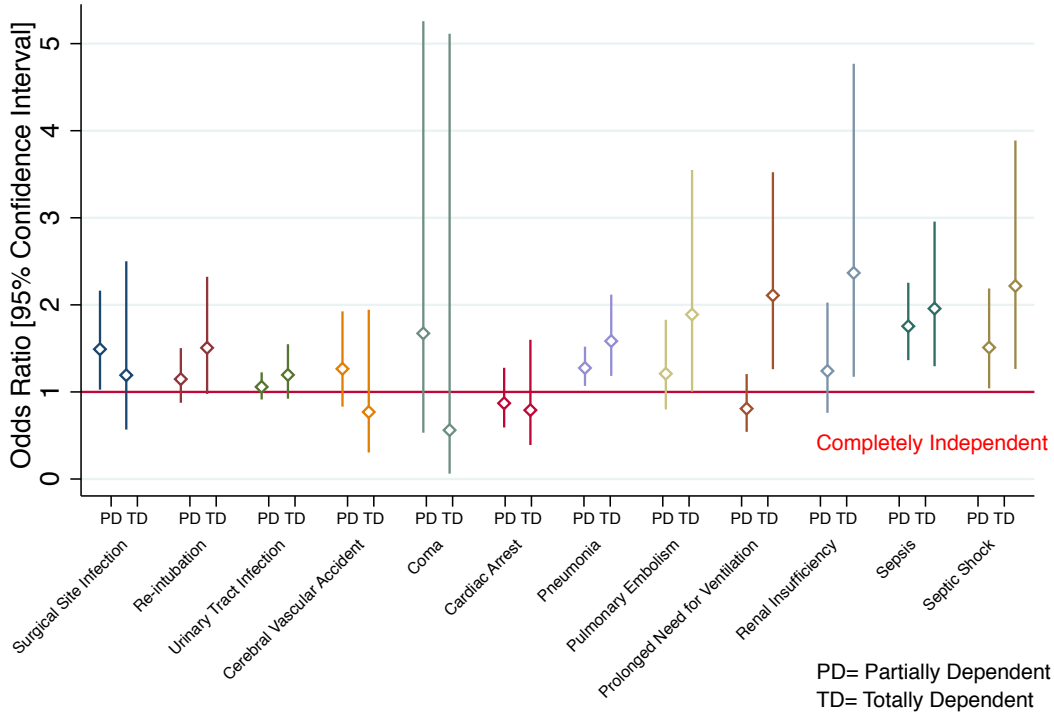


Figure 1: Odds Ratio for Post-operative Complications Associated with Impaired Functional Status. 12 post-operative complications were significantly associated with PD and TD, and after accounting for confounding variables 6 remained significantly associated with TD: pneumonia, prolonged ventilatory support, pulmonary embolism, renal insufficiency, sepsis, and septic shock.

See pages 49 - 106 for financial disclosure information.

What Is the Right Age for Fixation Versus Arthroplasty for Displaced Femoral Neck Fractures? An Economic Decision Analysis

Eric Swart, MD[1]*; Paulvalery Roulette, MD*[1]*; Kevin Bozic, MD, MBA*[2]*; Madhav Karunakar, MD*[1]
[1]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[2]*University of Texas at Austin Dell Medical School, Austin, Texas, USA*

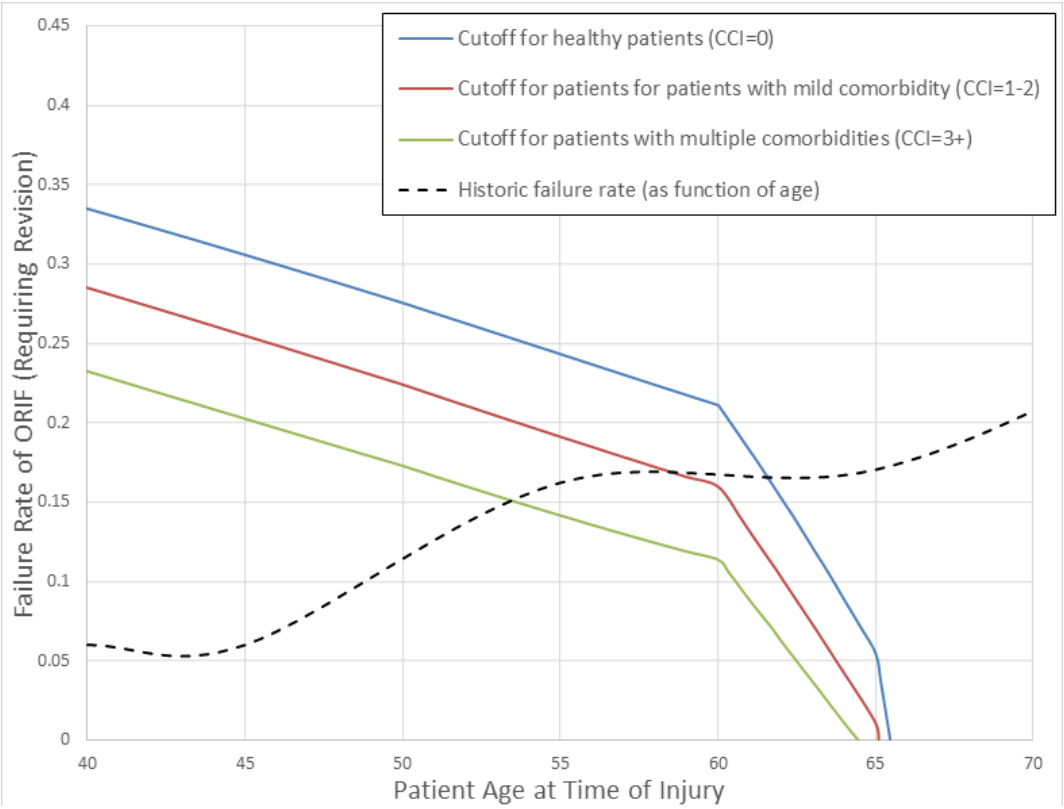
Background/Purpose: Displaced femoral neck fractures occur commonly in elderly patients who sustain low energy falls as well as in younger patients after high-energy trauma. It is generally agreed that active, healthier older patients should undergo total hip arthroplasty (THA), with hemiarthroplasty reserved for the most elderly patients with significant medical comorbidities. Alternatively, acute open reduction and internal fixation (ORIF) is usually the treatment of choice for younger patients. However, the exact age at which the transition between ORIF and THA should be made is poorly defined. For "middle aged" patients, both treatment options have potential drawbacks; ORIF may be unsuccessful and result in nonunion (NU) or osteonecrosis (ON) requiring revision operation, while THA in a relatively young patient carries the concern of future revision within the patient's lifetime. It is unclear which of these factors plays a greater role in clinical outcomes, and at what patient age that balance shifts. The purpose of this study is to employ decision analysis modeling techniques, based on high-quality data, to generate evidence-based treatment recommendations to aid in the decision between ORIF and primary THA for a patient with a displaced femoral neck fracture as both a function of age and medical comorbidity status.

Methods: A Markov decision analytic model was created to simulate outcomes of patients with displaced femoral neck fractures at various ages with three different levels of comorbidity as measured by the Charlson Comorbidity Index (CCI): (1) healthy (CCI of 0), (2) mild comorbidity (CCI of 1 or 2), and multiple comorbidities (CCI 3 or greater). Patients who underwent ORIF were modeled to either heal or go on to failure (NU or ON) requiring revision surgery to a THA, with revision/failure rates taken from those reported in high-quality prospective studies. Patients who underwent THA were modeled to have implant failure requiring revision at rates based on large prospective registry data. Costs were taken from a societal point of view, with operative costs based on Medicare diagnosis-related group reimbursement. Quality-adjusted life year (QALY) outcomes were modeled based on studies explicitly designed to measure utility after THA and revision THA, and the utility of patients who underwent ORIF was taken from large registry data. Perioperative mortality and life expectancy were taken from registry data, clinical reports, and US life tables. An incremental cost-effectiveness ratio (ICER) cutoff of $100,000/QALY was used. The model was run through base case conditions to determine the "cutoff" age above which arthroplasty would be the superior strategy, and then the effect of increasing medical comorbidity on that cutoff age was evaluated. Results were tested using 1 and 2-way sensitivity analysis, and 95% confidence intervals (CId) generated using probabilistic statistical analysis and Monte Carlo simulation.

Results: For an otherwise healthy patient with a displaced femoral neck fracture, primary THA was a cost-effective option for patients over 62 years of age. For patients with mild

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

comorbidity, that age changed to 59 years, and with multiple comorbidities it dropped to 53 years. The variable that the results were most sensitive to was the success rate of initial ORIF, and is shown graphically in Fig. 1.



Conclusion: The decision between initial attempted ORIF and primary THA in a patient with a displaced femoral neck fracture is a function of age, medical comorbidity, and predicted failure rate of ORIF. Based on current available evidence, primary THA is an economically viable alternative to ORIF for displaced femoral neck fractures in patients aged 53-62 years. Clinicians should consider age, patient comorbidities, and predicted failure rate of ORIF in determining the optimal treatment for an individual patient.

See pages 49 - 106 for financial disclosure information.

Treatment of Infraisthmal Femoral Fracture with Intramedullary Nail: Is Retrograde Nailing a Better Option Than Antegrade Nailing?

Joon-Woo Kim, MD, PhD[1]*; Chang-Wug Oh, MD, PhD*[1]*; Jong-Keon Oh, MD, PhD*[2]*; Kyeong-Hyeon Park, MD*[1]
[1]*Kyungpook National University Hospital, Daegu, SOUTH KOREA*
[2]*Korea University Guro Hospital, Seoul, SOUTH KOREA*

Purpose: Although intramedullary (IM) nailing is an ideal option for the treatment of femoral shaft fractures, it may be difficult to fix the fracture distal to isthmic level effectively due to widening of the medullary canal. Moreover, short working length of the IM nail can have a negatived effect on the union. We tried to compare the results of infraisthmal femoral shaft fractures treated with antegrade and retrograde nails.

Methods: 60 patients with infraisthmal femoral shaft fracture treated by IM nailing and followed for over 1 year were enrolled, including 38 cases of antegrade nailing (A group) and 22 retrograde nailing (R group). According to AO/OTA classification, there were 35 cases of type A fractures (A1: 1, A2: 11, A3: 23), 16 cases of type B fractures (B1: 2, B2: 7, B3: 7), and 9 cases of type C fractures (C2: 4, C3: 5). There was no obvious difference in age, gender, or level of fracture between the two groups. Radiologic evaluation including bony union, union time, and alignment were performed, and functional result was assessed by using the Knee Society scoring system. Complications including nonunion and malalignment were analyzed in accordance with the level of fracture, type of fracture, and operative method.

Results: Mean follow-up duration was 29.5 months (range, 12-133). In group A, primary bony union rate was 73.7% (mean 20.7 weeks; range, 12-41), and that of group R was 86.4% (mean 17.4 weeks; range, 12-30). We could not discover a significant difference in the union rate ($P = 0.251$, X^2 test) and union time ($P = 0.897$, Mann-Whitney test) between the 2 groups. There were no cases of malalignment greater than 10° in any plane in both groups. Mean Knee Society score in group A was 92 (range, 62-100) and that of group R was 91 (range, 83-95), showing no significant difference ($P = 0.297$, X^2 test). Although the level of fracture was not significantly related to the union rate ($P = 0.584$, Mann-Whitney test), patients who had ratio of the shortest distance from distal femoral joint line to the fracture to the shortest distance from distal tip of IM nail to the fracture less than 0.75 were found to be particularly prone to nonunion ($P = 0.003$, X^2 test).

Conclusion: Although no difference was found in terms of type of IM nail used for the treatment of infraisthmal femoral shaft fracture, IM nails with shorter working length distal to the fracture had a strong relationship to nonunion.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Complications in the Treatment of Femur Fractures in Patients with Preexisting Spinal Cord Injury

Crystal Perkins, MD; Madhav Karunakar, MD
Carolinas Medical Center, Charlotte, North Carolina, USA

Background/Purpose: Long-bone fractures in patients with a preexisting spinal cord injury (SCI) present a unique challenge to the orthopaedic surgeon. The incidence of at least one fracture during a patient's lifetime following SCI is 25% to 34%. The unique physiology of paraplegics, including a negative nitrogen balance, insensate skin, infectious risks, and osteoporosis, contribute not only to the fracture, but also to their altered healing potential and complications associated with treatment strategies. Based on the limited literature and variable findings, there is no consensus on the optimal treatment of long bone fractures in patients with preexisting SCI. The purpose of this study is to describe the outcomes of femur fractures treated both nonoperatively and operatively in patients with preexisting SCI and lower extremity paraplegia.

Methods: A retrospective review of consecutive patients 18 years of age and older who sustained a femur fracture in the setting of preexisting SCI and lower extremity paraplegia from 2005 to 2014 was performed. The medical record was used to record demographics, mechanism of injury, AO/OTA fracture classification, treatment, and length of hospital stay. Primary outcome measures included readmission, reoperation, hardware failure, infection, fracture union, decubitus ulcer formation, subjective care complaints, and mortality. Univariate analysis was conducted to examine the relationship between demographics, injury characteristics, and outcomes.

Results: 24 patients (19 male and 5 female) with an average age of 45 years were identified to have sustained a total of 27 femur fractures in the setting of a previous SCI and lower extremity paraplegia. The average time from SCI to femur fracture was 17 years (range,1.5-23 years). The most common mechanisms of injury were falls and wheelchair transfers. The most frequent locations included 8 spiral diaphyseal fractures (AO/OTA 32A) and 7 distal extra-articular fractures (AO/OTA 33A). 16 fractures were treated nonoperatively and 11 were treated operatively. The average length of stay for the nonoperative patients was 5.2 days and for the operative patients was 7.5 days ($P = 0.36$). There were significantly more patients in the operative group who required an unplanned secondary surgery (6) as compared to a single patient in the nonoperative group who later underwent operative intervention ($P = 0.01$). Secondary surgeries included removal of hardware, irrigation and debridement, and amputation. Four operative patients developed an infection as compared to none in the nonoperative group ($P = 0.02$), and three developed hardware failure. No patients died within 2 years of their fracture.

Conclusion: Surgical treatment of femur fractures in patients with a preexisting SCI and lower extremity paraplegia is fraught with complications. Operative management in our study cohort resulted in rates of reoperation of 55%, infection 36%, and hardware failure 18%. The occurrence of decubitus ulcers postinjury and readmission rates were similar among operatively and nonoperatively treated patients, and subjective care complaints were

See pages 49 - 106 for financial disclosure information.

insignificant. Based on our experience, we recommend nonoperative treatment of femur fractures in patients with preexisting SCI and lower extremity paraplegia.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Functional Outcomes After Vancouver B Periprosthetic Femur Fractures

I. Leah Gitajn, MD[1]; Michael Weaver, MD[2]; Marilyn Heng, MD[3]; Harry Rubash, MD[3]; Mark Vrahas, MD[3]
[1]R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;
[2]Brigham and Women's Hospital, Boston, Massachusetts, USA;
[3]Massachusetts General Hospital, Boston, Massachusetts, USA

Background/Purpose: Selecting optimal treatment for periprosthetic fractures, either fracture fixation or revision arthroplasty, can be challenging. In clinical practice, distinguishing between a stable well-fixed stem and a loose stem based on radiographs can be quite difficult. Furthermore, these patients are often frail with multiple medical comorbidities. Given this issue a growing number of orthopaedic surgeons recommend repairing the bone without revising the prosthesis in some select cases, suggesting that a potentially loose prosthesis will not be a problem given patients' limited functional needs, and that lesser surgery will allow a quicker, less risky, recovery. The purpose of this study was to (1) evaluate functional and global health outcomes after treatment for periprosthetic fracture, and (2) determine whether patients with loose femoral components have better functional outcomes when treated with surgical fixation alone or revision arthroplasty.

Methods: Patients treated for Vancouver B periprosethetic fractures at 3 Level I trauma centers between 2003 and 2014 were identified. Exclusion criteria were severe dementia, intraoperative fracture, known active prosthetic infection, significant polytrauma, bony metastatic disease, nonunion at presentation, and nonoperative management. Minimum follow-up was 6 months. 184 patients met inclusion criteria. 110 patients (60%) were alive at the time of the study and of these 68 patients (62%) were enrolled in the study. All associated hospital records were collected. At time of follow-up patients were administered two self-reported assessments using the Patient Reported Outcome Measurement Information System (PROMIS), physical function and general health. PROMIS instruments are reported on a scale quantified with standard methods: higher scores indicate higher physical function. The US population has an average score of 50 with standard deviation 10. Preoperative radiographs were used to classify fractures according to the Vancouver system. Linear regression was utilized to analyze the predictive association of demographic and treatment variables on PROMIS Physical Function domain score. Subgroup analysis was performed on patients classified as having loose femoral stems comparing fixation alone to revision arthroplasty.

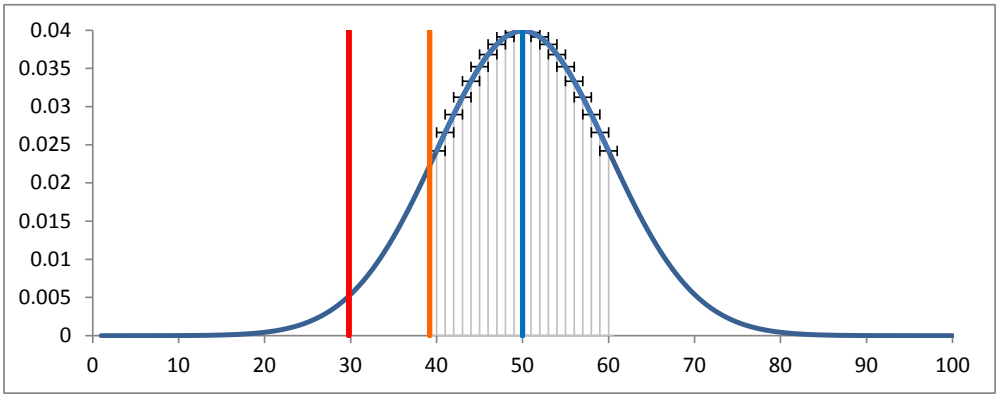
Results: The average PROMIS Physical Function score at mean follow-up of 5.2 years (range, 1-12 years) following treatment of periprosthetic femur fracture was almost 1.5 SDs worse than age-adjusted US population norms, which is equivalent to having worse physical function than approximately 90% of the US population adjusted for age (score of 36.1, SD 10.3). The mean global health score following treatment was below the mean for age-adjusted US norms, but was within 1 SD and was therefore worse than approximately 76% of age-adjusted US norms (score 43.6, SD 7.8). Using logistic regression analysis age (P <0.001), Charlson Comorbidity Index (P <0.001), and open reduction and internal fixation (ORIF, as opposed to revision arthroplasty) (P = 0.05) were independent risk factors for poor functional outcome. Stability of the femoral stem (loose vs well fixed) (P = 0.56) and

See pages 49 - 106 for financial disclosure information.

postoperative weight-bearing status ($P = 0.39$ for PWB [partial weight bearing] and $P = 0.95$ for WBAT [weight bearing as tolerated]) were not risk factors for poor functional outcome. Within the subgroup of patients with loose femoral stems (Vancouver B2/3 fractures) patients who were treated with revision arthroplasty reported significantly better physical function (39.2) than those treated with surgical fixation (29.8, $P = 0.003$). Six patients (9%) sustained mechanical failure requiring revision surgery after having undergone surgical treatment for periprosthetic femur fracture.

Figure 1: PROMIS Physical Function T-score for Vancouver B2/3 Fractures

Red line represents mean PROMIS physical function outcome score for patients who underwent ORIF; orange line represents mean PROMIS physical function outcome score for patients who underwent revision arthroplasty. Blue line represents population norm, gray lines represent 1 standard deviation.



Conclusion: Patients treated for periprosthetic femur fractures fare very poorly with regard to physical function compared to US general population age-adjusted norms. There is controversy with regard to the most appropriate treatment for periprosthetic femur fractures associated with loose femoral stems. In our study, among patients with loose femoral components, patient-reported physical function outcome measures were significantly better in patients who underwent revision arthroplasty as opposed to those who had fracture fixation alone. This study highlights the significant impact that periprosthetic femur fractures have on patients' lives and suggests that those patients treated with revision arthroplasty have superior functional outcomes.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

An Economic Analysis on the Role of Radiographs and Office Visits in the Follow-up of a Healed Intertrochanteric Hip Fracture

Harish Kempegowda, MD[1]*; Amrut Borade, MD*[1]*; Raveesh Richard, MD*[1]*; Akhil Tawari, MD*[1]*; Abby Howenstein, MD*[2]*; Erik Kubiak, MD*[2]*; Michael Suk, MD*[3]*; James Gotoff, BS*[1]*; Daniel S. Horwitz, MD*[3]
[1]*Geisinger Medical Center, Danville, Pennsylvania, USA;*
[2]*University of Utah, Salt Lake City, Utah, USA*
[3]*Geisinger Health System, Danville, Pennsylvania, USA*

Purpose: The purpose of this study was to evaluate the role and the necessity of radiographs and office visits obtained during the follow-up of intertrochanteric hip injuries after the fracture had healed radiographically.

Methods: A retrospective review was performed at two academic Level I trauma centers to identify all patients >60 years of age with documented radiological and clinical union of the hip fracture with a minimum follow-up of 1 year treated between January 2009 and August 2014. Radiological union was defined as visible osseous bridging on at least 3 cortices on AP and lateral views. The reduction was considered good if there was normal or slight valgus on alignment on the AP radiograph, less than 20° of angulation on the lateral radiograph, and less than 4 mm of displacement of any fragment. The reduction was considered acceptable if there was a good reduction with respect to either alignment or displacement, but not both. The reduction was graded poor if neither criterion was met. The number of office visits and radiographs obtained after the fracture had healed was documented specifically. Clinical charts were reviewed at each follow-up visit and any specific complaints were noted. The radiographs obtained during each follow-up were evaluated for fracture alignment, implant position, healing characteristics, and any pathological changes including arthritis, osteonecrosis, and heterotopic ossification. The amount paid by the Centers for Medicare and Medicaid services (CMS) to the institution for radiographs and clinic visit (E3 visit) was noted. Overall costs that would have been saved by avoiding additional radiographs and clinic visit were computed.

Results: A total of 465 patients (females 293, males 172) with an average age of 77.2 years (range, 60-98) met the criteria. The mechanism of injury included 411 low-energy ground level falls (89%), 22 motor vehicle accidents/motorcycle accidents (5%), 4 auto versus pedestrian (1%), and 23 others (5%). The most common fracture types were 203 OTA 31-A1 (44%), 171 OTA 31-A2 (39%), and 91 OTA 31-A3 (17%). Of the 465 fractures, the quality of reduction based on immediate postoperative radiographs was graded as good in 188 fractures (40%), acceptable in 253 fractures (55%), and poor in 21 fractures (5%). The surgical fixation of 465 fractures included 155 short nails (33%), 232 long nail (50%), 69 sliding hip screw devices (15%), and 7 trochanteric blade plates (2%). The average fracture healing time was 12.8 weeks (range, 6-22 weeks). Of the 465 patients with an average follow-up of 81.2 weeks (range, 52-368), radiographs of 455 patients (96%) obtained after the fracture healed did not reveal any changes including fracture alignment, implant position, or any other pathological changes. Radiographic changes visualized included 3 heterotopic ossification (1%), 3 hip arthritis (1%), 3 osteonecrosis of the hip (1%), and a case of helical blade

See pages 49 - 106 for financial disclosure information.

migration (0.5%). 8 of these 10 patients were symptomatic and 2 patients with heterotopic ossification on radiographs were asymptomatic. The average number of elective office visits and radiographs obtained after the fracture had healed were 3.1 (range, 1-8) and 2.8 (range, 1-8) respectively. According to Medicare refunds to the institution, radiographs and office visits accounted for direct costs of $360.81 and $192 respectively per patient.

Conclusion: The current study strongly suggests that there is a negligible role for elective office visits and radiographs during a follow-up of well-healed hip fracture, if there is a documented evidence of radiographic healing along with acceptable fracture alignment and implant position. Implementation of this simple measure leads to minimizing the direct cost by approximately $520 per patient as well as inconvenience to the elderly.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Reamed Intramedullary Nailing Affects Trauma-Induced Coagulopathy Based on Thrombelastography

Prism Schneider, MD, PhD, FRCSC[1]*; Elizabeth Davis, BS*[2]*; Matthew Galpin, RC*[3]*; Robert Hudson, BS*[4]*; Patrick Mitcham, BS*[2]*; Mark Prasarn, MD*[4]*; Joshua Gary, MD*[5]
[1]*University of Calgary, Calgary, Alberta, CANADA;*
[2]*University of Texas Health Science Center at Houston, Houston, Texas, USA;*
[3]*UTHSC Orthopaedic Trauma, Houston, Texas, USA;*
[4]*University of Texas at Houston, Houston, Texas, USA;*
[5]*UT Houston Department of Orthopaedic Surgery, Houston, Texas, USA*

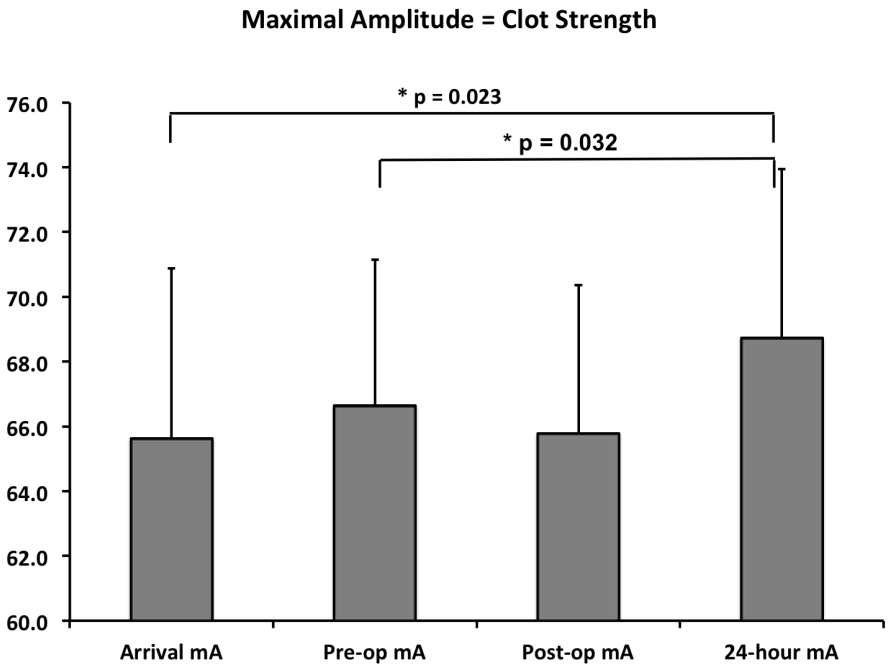
Background/Purpose: Reamed intramedullary nails (rIMNs) are the standard of care for adult diaphyseal tibia and femur fractures. However, reaming stimulates the immune system and raises proinflammatory cytokines. Patients suffering major trauma often experience trauma-induced coagulopathy (TIC), which correlates with morbidity and mortality; however, it is unknown whether intramedullary reaming and the release of inflammatory factors exacerbate TIC in orthopaedic trauma patients. Rapid thrombelastography (r-TEG) is a technology that evaluates the clotting function of whole blood and elevated maximal amplitude (mA) is associated with increased risk for venous thromboembolic events (VTEs). We hypothesized that TIC will be exacerbated in patients treated with rIMN fixation for lower extremity fractures, as demonstrated by increasing mA from r-TEG values following reaming.

Methods: This is a prospective cohort study of patients aged 18-75 years with femur fractures (AO-OTA 31, 32 and 33 A, B, C) or isolated tibia fractures (AO-OTA 41-A, 42-A, B, C, and 43-A) amenable to treatment with rIMN fixation. Exclusion criteria were pathologic fracture, preinjury anticoagulation therapy, previous history of VTEs, active malignancy, burns >20% body surface area, and pregnancy. r-TEG measures were taken on arrival to the emergency department (arrival r-TEG), 1 hour prereaming (pre r-TEG), 1 hour postreaming (post r-TEG), and 24 hours postreaming (24-post r-TEG). The primary outcome measure was the 24-hour postoperative mA values from the r-TEG analysis. Secondary outcome measures included admission r-TEG, 1-hour preoperative r-TEG, 1-hour postoperative r-TEG, and inhospital VTE. All r-TEG specimens were analyzed using a TEG thrombelastograph 5000 (Hemoscope Corporation), using our institutional standardized protocol. Statistical comparisons between groups were performed using the Wilcoxon rank-sum test.

Results: 29 patients were enrolled (n = 19 femur fractures, n = 10 tibia fractures), including 14 females and 15 males, with the most common mechanisms of injury being motor vehicle collisions (n = 14) and motorcycle collisions (n = 5). There were no significant differences between the femur and tibia fracture groups for age (P = 0.61), body mass index (BMI) (P = 0.35), ISS (P = 0.14), arrival pH (P = 0.42), lactate (P = 0.48), heart rate (P = 0.52), or systolic blood pressure (P = 0.55), therefore the data for all patients treated with rIMN were pooled. The mean age was 41.1 (±16.9) years, mean BMI was 28.3 (±8.0), and mean ISS was 14.5 (±9.7). Mean reaming time for femurs was 11.1 (±6.5) minutes and mean tibial reaming time was 27.6 (±11.6) minutes (P = 0.008). All patients underwent definitive rIMN within 72 hours from arrival. The mean mA for the 24-hour postreaming r-TEG analysis of 68.7 (±5.2) was

See pages 49 - 106 for financial disclosure information.

significantly higher when compared with the mean mA from the arrival r-TEG of 65.6 (±5.3) (P = 0.023). Similarly, the mean mA was 66.6 (±4.5) from the pre r-TEG and was significantly increased compared with the mean mA from the 24-post r-TEG (P = 0.032) (Fig. 1).



Conclusion: In this small prospective cohort group, there was an increase from both arrival and prereaming maximal amplitude, using r-TEG analysis, to the 24-hour postreaming mA, indicating increased coagulopathy in patients with diaphyseal femur and tibia fractures requiring treatment with rIMN. Future work will continue to investigate mechanisms and treatments to help prevent of the sequelae of trauma-induced coagulopathy.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Comparison of the Outcome Between Conventional Open Technique and Minimally Invasive Technique Using Dynamic Hip Screw Fixation for Intertrochanteric Fracture of Femur

Rajiv Maharjan, MBBS, MD*; Raju Rijal, MBBS, MD; Pashupati Chaudhary, MBBS, MS; Guru Prasad Khanal, MBBS, MD; Bikram Prasad Shrestha, MBBS, MD*
BP Koirala Institute of Health Sciences, Dharan, NEPAL

Background/Purpose: Rigid fixation and early mobilization using standard dynamic hip screw (DHS) should be considered as the standard treatment for intertrochanteric fractures. The potential drawbacks of conventional technique of DHS are large skin incision with considerable soft-tissue dissection, blood loss, pain, and delayed rehabilitation. Minimally invasive surgery (MIS) has the theoretical advantages of decreased blood loss, better cosmetic results, less pain, and faster rehabilitation. We conducted this randomized trial to compare the safety profile and functional outcome of a mini-incision technique versus conventional open technique for fixation ofintertrochanteric fractures using a DHS device.

Methods: 60 patients (skeletally mature) with closed traumatic isolated intertrochanteric femur fractures (AO/OTA 31-A1, A2) that had acceptable reduction before fixation by closed manipulation under image intensifier were randomized into conventional DHS group (n = 30, fixed by conventional open technique) or minimally invasive DHS group (n = 30, fixed by minimal incision technique) using same standard DHS device, and approach with similar type and regime of standard prophylactic antibiotics. Patients with previous ipsilateral hip fracture or surgery, congenitally deformed, or abnormally bowed femur were excluded. Ethical approval was obtained from Institutional Review Committee (IRC). Perioperative parameters were noted as per pro forma and similar protocol of physiotherapy was started for each patient. The patients were assessed at immediate postoperative period then at 2, 6, 12, 24, and 52 weeks postoperative.

Results: Mean age, gender distribution, mode of injury, fracture classification, side involved, and injury-surgery interval were symmetrically distributed among the two groups ($P > 0.05$) and hence randomization was successful. The duration of surgery, blood loss/transfusion requirement, postoperative pain (visual analog scale [VAS] score), and surgical site infection were less for minimal incision group ($P > 0.05$). The hospital stay, ambulatory status, and time to union were comparable for both the groups. At the final follow-up, complications like loss of reduction, malunion, and implant failure were not significantly different among the groups ($P > 0.05$). The functional status was assessed by modified Harris hip score and the average score was greater for mini-DHS group but not significant ($P > 0.05$).

Conclusion: Mini-incision DHS fixation for intertrochanteric femur fracture has advantages like shorter duration of surgery, less blood loss, and less postoperative pain in comparison to conventional open technique but the long-term functional outcome is not significantly different from conventional open technique.

See pages 49 - 106 for financial disclosure information.

Thromboelastography (TEG) Is Predictive of Blood Transfusion and Mortality in Patients with Traumatic Femur Fractures

Phillip Bostian, MD*; Michelle Bramer, MD; Alison Wilson, MD; Matthew Dietz, MD*
West Virginia University, Morgantown, West Virginia, USA

Background/Purpose: Femur fractures are associated with hidden blood loss and commonly require blood transfusions. Transfusions for hemoglobin abnormalities are associated with significant morbidity and mortality, including increased risk of sepsis, pneumonia, and venothrombotic events. The purpose of this study was to examine the coagulation kinetics of femur fracture patients by analyzing thromboelastography (TEG) results that were conducted on admission and their relationship to transfusions and mortality of these patients.

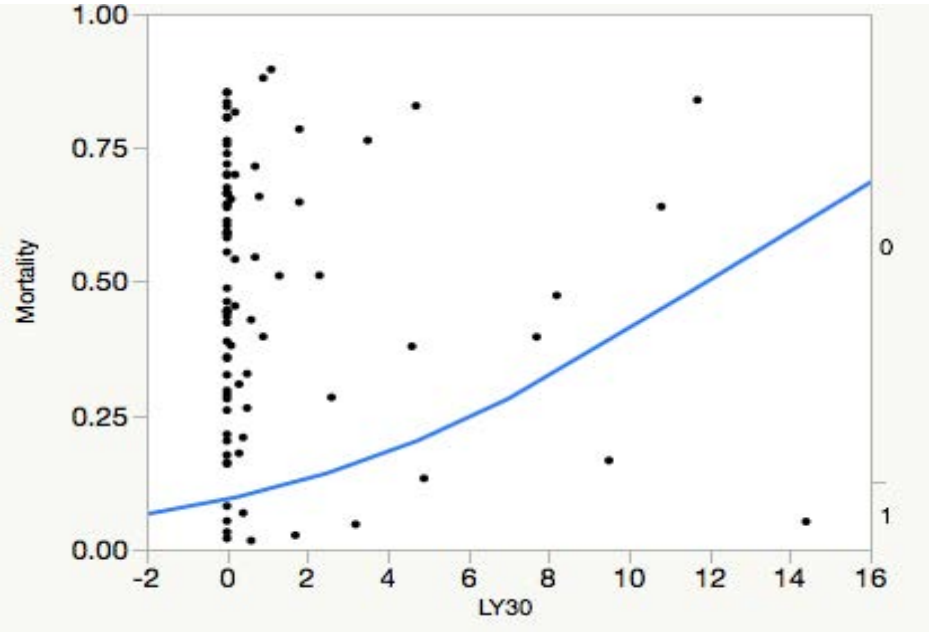
Methods: We retrospectively queried our Level I trauma center's registry for patients who arrived as priority 1 traumas with an associated diagnosis of femur fracture and received a TEG on admission between January 2012 and June 2015. Patients taking anticoagulants prior to admission were excluded. TEG variables R, MA, and LY30 were recorded. Blood product transfusion and mortality were also recorded. Statistical analysis was performed using logistic regression analysis, Pearson correlation, and analysis of variance with significance set at $P < 0.05$.

Results: 74 patients met inclusion criteria. Mean age was 50.3 years (range, 17-90 years). 64% (47/74) were male. The overall mortality rate was 11.6%. Compared to patients with an LY30 <1, patients with an increased value exhibited a threefold higher mortality rate. A significant correlation was noted between the degree of clot lysis at 30 minutes (LY30) and mortality rate ($r = 0.348$, $P = 0.0407$). There was a significant correlation between LY30 and the units of packed red blood cells transfused in the first 24 hours ($r = 0.259$, $P = 0.012$). Patients received an average of 3.65 units of packed red blood cells during the first 24 hours of admission. There was a large discrepancy between the calculated and intraoperative blood loss.

Conclusion: Increasing fibrinolysis in trauma patients with femur fractures is associated with more blood transfusions and higher rates of mortality. This study highlights the critical need to limit hidden blood loss associated with femur fractures. Blood conservation strategies should begin at patient presentation and focus on correcting specific coagulation abnormalities. Future studies should evaluate the utility of antifibrinolytics in reversing fibrinolysis as exhibited on TEG.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Probability of Mortality Based on LY30



See pages 49 - 106 for financial disclosure information.

Outcomes in Young Hip Fracture Patients

Tim Coughlin, BM BS BMedSci MRCS[1]; Gillian Janes, RGN MA PgCLTHE SFHEA[2]; Jessica Nightingale, BSc[1]; Christopher Moran, MD, FRCS[1]; Daren Forward, MD[1];
Ben Ollivere, FRCS (Ortho), MD, MBBS, MA[1];
[1]Queen's Medical Centre, Nottingham, UNITED KINGDOM
[2]Teesside University, Middlesbrough, UNITED KINGDOM

Purpose: Hip fractures in the young adult are rare and research has been more constrained than in the extensively investigated older population. We sought to establish the clinical outcomes of surgery in these patients and factors affecting recovery.

Methods: Over a 15-year period 830 patients were admitted to our center between the ages of 18 and 60 with a hip fracture. High-energy injuries such as road traffic collisions were excluded, as were those with bisphosphonate fractures and conservatively managed injuries. Letters were sent to 343 eligible patients of whom final complete clinical data were available for 73. Surgical outcomes data were available for all 343. The minimum period of follow-up was 9 months postinjury. Patients recorded Oxford Hip Scores (OHS) as the primary outcome measure and EuroQol (EQ)-5D was additionally taken as a quality of life measure. Baseline scores were recorded using patient recall and postintervention scores were taken following injury. Patients were stratified by type of fracture (OTA 31-A + subtrochanteric area/31-B1/31-B2+3) and type of operation (cannulated screws/total hip arthroplasty/hemiarthroplasty/sliding hip screw/intramedullary nail).

Results: The median change in OHS across all groups fell from 48.00 (interquartile range [IQR] = 0) at baseline to 41.00 (IQR = 19) postinjury. The preinjury visual analog scale [VAS] fell from 90 (IQR = 20) to 80 (IQR = 30). Wilcoxon signed rank test showed postinjury scores were significantly lower than baseline (OHS z = 70, P <0.001; EQ-5D z = 187, P <0.01; VAS z = 294, P <0.01). There were no domain-specific associations with poor outcomes in either the OHS or EQ-5D and additionally no association with age or gender was found in statistical analysis with the OHS, EQ-5D, or VAS. Testing pre- and postinjury OHS using the Kruskal-Wallis test found a statistically significant difference in distribution across fracture types with OTA 31-B1 fractures almost returning to baseline function whereas B2 and B3 fractures showed a moderate decline and all other 31 and subtrochanteric area fractures a larger still decline (P = 0.01). No significant variation was found across fracture types with the EQ-5D and VAS.

All operation types demonstrated a fall in OHS and EQ-5D comparing pre- and postinjury scores with a statistically significant variation across groups. Fall in OHS was greatest with hemiarthroplasty (-16.33, SD = 13.91) followed by dynamic hip screw (-13.32, SD 12.18), intramedullary nail (-10.44, SD 12.88), cannulated screws (-4.31, SD 5.82), and finally total hip arthroplasty (-2.00, SD 15.30). Negative change in EQ-5D followed the same pattern as for OHS.

Conclusion: This group of 343 young hip fracture patients, 73 of whom were included in this analysis, is one of the largest groups reported to date. It is clear that young patients

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

with hip fractures as a group do not do well as measured by the OHS, with a mean fall of 9 points. Within the data are important insights into these patients. Minimally displaced intracapsular fractures (OTA 31-B1) can almost return to baseline function with appropriate management. Patients with displaced intracapsular fractures (OTA 31-B2+3) managed with total hip arthroplasty came close to a return to baseline with a mean fall of only 2 points of the OHS. Those with undisplaced fractures or displaced fractures managed with an open reduction both ultimately receiving cannulated screw fixation did well with a mean fall of 4 points. At the other end of the scale patients managed with hemiarthroplasty had the worst outcome falling over 16 points on the OHS from baseline. Given that this group, from a fracture rather than patient perspective at least, were the same as those receiving total hip arthroplasty, great care needs to be taken in choosing hemiarthroplasty if the poorest outcomes are to be avoided.

See pages 49 - 106 for financial disclosure information.

Obesity Is Associated with High Perioperative Complications Among Surgically Treated Intertrochanteric Fractures of the Femur

Harish Kempegowda, MD[1]*; Raveesh Richard, MD*[1]*; Amrut Borade, MD*[1]*; Akhil Tawari, MD*[1]*; Jove Graham, PhD*[1]*; Michael Suk, MD*[2]*; Abby Howenstein, MD*[3]*; Erik Kubiak, MD*[3]*; James Gotoff, BS*[1]*; Daniel S. Horwitz, MD*[2]
[1]*Geisinger Medical Center, Danville, Pennsylvania, USA;*
[2]*Geisinger Health Systems, Danville, Pennsylvania, USA;*
[3]*University of Utah, Salt Lake City, Utah, USA*

Background/Purpose: The purpose of this study was to evaluate the hypothesis that obese patients undergoing surgical fixation for intertrochanteric fracture of the femur have more perioperative complications in comparison to nonobese patients. These data could help orthopaedic surgeons formulate necessary guidelines in managing hip fractures in obese individuals and to provide necessary counseling to the patients and their families. In addition this analysis may be critically important in determining hospital reimbursement for this patients.

Methods: A retrospective review at two academic Level I trauma centers was conducted to identify all skeletally mature patients who underwent surgical fixation of intertrochanteric fractures between June 2008 and December 2014. Descriptive data, mode of injury characteristics, OTA fracture classification, and associated medical comorbidities were documented. Patients were stratified into two groups based on the body mass index (BMI): nonobese group included those with a BMI of <29.9 kg/m^2 and obese group included those with a BMI of ≥30 kg/m^2. The outcomes measured included inhospital complications, length of stay, rate of blood transfusion, and fall in hemoglobin levels, operative time, and wound infection.

Results: In this study, 212 of 835 patients (25%) who were treated for intertrochanteric fracture of the femur had a BMI of 30 or greater. Patients with a high BMI (≥30) had a significantly lower mean age (74 vs 77 years, $P = 0.01$) than patients with a BMI <30, were more likely to have a high-energy injury (16% vs 10%, $P = 0.03$), were more likely to be diabetic (32% vs 23%, $P = 0.005$), and were more likely to have cardiac diseases (59% vs 48%, $P = 0.0007$). The mean duration of surgery was also greater for patients with high BMI (96 vs 86 minutes, $P = 0.04$), the mean estimated blood loss was higher (184 vs 118 mL, $P < 0.0001$), and the mean length of hospital stay was higher (6.3 vs 5.5 days, $P < 0.0001$). The group of patients with a high BMI had a significantly higher mean hemoglobin value prior to surgery (12.1 vs 11.8, $P = 0.02$) and showed a significantly larger change in hemoglobin after versus before surgery (-2.7 vs -2.3 units, $P = 0.002$) (Table 1A). The high BMI group had significantly higher percentages of patients with every complication examined (P values <0.05), with the exception of pulmonary embolism, deep vein thrombosis, wound infection/discharge, sepsis, and inpatient death. In order to eliminate the possibility that these results were being confounded by different rates of high-energy falls and diabetes in the high BMI group, however, we performed an additional analysis: we removed the patients with high-energy fractures from the cohort, and stratified the remaining low-energy trauma patients by whether or not they had diabetes. In the nondiabetic group (n = 541 patients total), the group with BMI ≥30 had significantly higher rates of overall ("any"), cardiac, and respiratory complications, acute

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

anemia, and electrolyte complications, but not the remaining complications. In the diabetic group, only the overall rate of complications ("any") and "other" complications showed a statistically significant difference between the low- and high-BMI groups (Tables 2A and 3A).

Conclusion: Obese patients are more likely to have had a high-energy fracture and are more likely to be diabetic than similar patients with a BMI of less than 30. However, within the subgroup of patients who had low-energy injuries and no diabetes, patients with BMI ≥30 were still more likely than patients with BMI <30 to experience many types of short-term complications including cardiac complications, respiratory complications, acute anemia, and electrolyte abnormalities. Institutions are scrutinized for increasing cost of care especially for hip fractures and the Centers for Medicare & Medicaid Services may need to consider higher complications among the obese patients while setting reimbursement levels.

See pages 49 - 106 for financial disclosure information.

Table 1A. Baseline and surgical characteristics, stratified by BMI group (<30 vs. ≥30).

	BMI <30 (n=623)	BMI ≥30 (n=212)	p-value
BMI category, N (%)			--
0.0-24.9	394 (63%)	--	
25.0-29.9	229 (37%)	--	
30.0-34.9	--	139 (66%)	
35.0-39.9	--	38 (18%)	
40.0 and above	--	35 (17%)	
Males, N (%)	216 (35%)	74 (35%)	0.95
Age in years, Mean (SD)	77 (15)	74 (14)	0.01
Method of injury, N (%)			0.05
Fall	565 (91%)	189 (89%)	
Motorcycle crash	2 (<1%)	4 (2%)	
Motor vehicle crash	14 (2%)	10 (5%)	
Pathologic	5 (<1%)	1 (<1%)	
Twist	2 (<1%)	0 (0%)	
Other			
Energy of injury, N (%)			0.03
Low	560 (90%)	178 (84%)	
High	63 (10%)	34 (16%)	
OTA classification, N (%)*			0.07
31A11	214 (35%)	55 (26%)	
31A12	79 (13%)	29 (14%)	
31A13	0 (0%)	0 (0%)	
31A21	143 (23%)	40 (19%)	
31A22	44 (7%)	16 (8%)	
31A23	29 (5%)	12 (6%)	
31A31	59 (10%)	27 (13%)	
31A32	23 (4%)	14 (7%)	
31A33	27 (4%)	16 (8%)	
Comorbidities			
Diabetes, N (%)	140 (23%)	68 (32%)	0.005
CVS, N (%)	300 (48%)	125 (59%)	0.007
Arrhythmia, N (%)	116 (19%)	47 (22%)	0.26
Pulmonary disease, N (%)	102 (16%)	33 (16%)	0.78
Renal disease, N (%)	89 (14%)	36 (17%)	0.35
CVA/stroke, N (%)	58 (9%)	23 (11%)	0.52
Hypothyroidism, N (%)	108 (17%)	34 (16%)	0.66
Surgical characteristics			
ASA Score, N (%)			0.94
1	14 (2%)	4 (2%)	
2	141 (23%)	50 (24%)	
3	389 (64%)	137 (65%)	
4	66 (11%)	20 (9%)	
	1 (<1%)	0 (0%)	
Days waited until surgery, Mean (range)	2.4 (0, 438)	2.5 (0, 300)	0.44
Duration of surgery in minutes, Mean (SD)	86 (54)	96 (65)	0.04
Estimated blood loss in mL, Mean (SD)**	118 (130)	184 (226)	<0.0001
Length of stay in days, Mean (range)	5.5 (0, 46)	6.3 (1, 51)	<0.0001
Blood units transfused, Mean (range)	0.7 (0, 7)	1.0 (0, 6)	0.0002
Lab values			
Hgb prior to surgery, Mean (SD)	11.8 (1.8)	12.1 (1.6)	0.02
Hgb after surgery, Mean (SD)	9.6 (1.6)	9.4 (1.5)	0.26
Difference in Hgb pre-post, Mean (SD)	2.3 (1.6)	2.7 (1.5)	0.002
INR prior to surgery, Mean (SD)	1.3 (0.5)	1.3 (0.5)	0.87
INR after surgery, Mean (SD)	1.4 (0.4)	1.5 (1.4)	0.39

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 2A. Perioperative and postoperative complication rates.*

	BMI <30 (n=623)	BMI ≥30 (n=212)	p-value
Perioperative complications, any, N (%)	116 (19%)	93 (45%)	<0.0001
Cardiac complications, N (%)	29 (5%)	18 (9%)	0.03
Respiratory complications, N (%)	24 (4%)	25 (12%)	<0.0001
Pulmonary embolism, N (%)	3 (<1%)	3 (1%)	0.05
Acute renal failure, N (%)	15 (2%)	11 (5%)	0.04
Acute anemia, N (%)	56 (9%)	29 (14%)	0.04
Electrolyte abnormalities, N (%)	11 (2%)	11 (5%)	0.006
Deep vein thrombosis (DVT), N (%)	3 (<1%)	4 (2%)	0.07
Wound infection/discharge, N (%)	9 (1%)	6 (3%)	0.22
Sepsis, N (%)	10 (2%)	8 (4%)	0.09
Other complications	16 (3%)	12 (6%)	0.03
Inpatient deaths, N (%)	17 (3%)	7 (3%)	0.67

*Complications were not recorded for 13 patients.

Table 3A. Perioperative and postoperative complication rates for low-energy injuries only, stratified by Diabetes and BMI group.

	No Diabetes			Diabetes		
	BMI <30 (n=427)	BMI ≥30 (n=114)	p-value	BMI <30 (n=133)	BMI ≥30 (n=64)	p-value
Perioperative complications, any, N (%)	74 (17%)	53 (48%)	<0.0001	31 (23%)	27 (43%)	0.005
Cardiac complications, N (%)	18 (4%)	13 (12%)	0.003	8 (6%)	3 (5%)	0.99
Respiratory complications, N (%)	18 (4%)	15 (14%)	0.0003	4 (3%)	5 (8%)	0.15
Pulmonary embolism, N (%)	1 (<1%)	1 (<1%)	0.37	0 (0%)	1 (2%)	0.32
Acute renal failure, N (%)	7 (2%)	4 (4%)	0.20	6 (5%)	7 (11%)	0.12
Acute anemia, N (%)	34 (8%)	18 (16%)	0.009	16 (12%)	10 (16%)	0.50
Electrolyte abnormalities, N (%)	4 (1%)	7 (6%)	0.002	7 (5%)	3 (5%)	0.99
Deep vein thrombosis (DVT), N (%)	2 (<1%)	2 (2%)	0.20	0 (0%)	2 (3%)	0.10
Wound infection/discharge, N (%)	4 (1%)	3 (3%)	0.16	4 (3%)	1 (2%)	0.99
Sepsis, N (%)	5 (1%)	4 (4%)	0.10	4 (3%)	3 (5%)	0.68
Other complications	12 (3%)	3 (3%)	0.99	3 (2%)	6 (9%)	0.06
Inpatient deaths, N (%)	13 (3%)	4 (4%)	0.77	3 (2%)	2 (3%)	0.66

See pages 49 - 106 for financial disclosure information.

Intraoperative Evaluation of the Anatomic Lateral Distal Femur and its Variation Due to Positioning

Patrick Bergin, MD[1]*; Taylor Mathis, MD*[2]*; Clay Spitler, MD*[1]*; Benjamin Stronach, MD*[1]*; Daniel Miles, BS*[1]*; Matthew Graves, MD*[1]
[1]*University of Mississippi Medical Center, Jackson, Mississippi, USA;*
[2]*American Sports Medicine Institute, Mountain Brook, Alabama, USA*

Background/Purpose: The complexity of management of distal femoral fractures varies widely but outcomes are directly related to quality of reduction as it relates to both articular congruity and coronal plane alignment. Preoperative evaluation of the contralateral anatomic lateral distal femoral angle (aLDFA) at our institution is used to judge coronal plane alignment. We have noticed significant variations of the aLDFA based on limb and C-arm position. Our hypotheses are that there is a most consistent position to evaluate the aLDFA, variation between patients and within the same patient will be significant, and that clinically significant malreductions may result despite matching the population average aLDFA or even the uninjured contralateral side.

Methods: 50 patients met inclusion criteria and enrolled in this prospective study. Inclusion criteria included lower extremity injuries needing fixation that would require intraoperative fluoroscopy with an intact distal two-thirds of the femur and an intact extensor mechanism. Fluoroscopic images were obtained of the distal femur in four positions differentiated by the position of the limb and the orientation of the C-arm beam to the femoral shaft (Images 1-4).

Results: There was significant variation from the population average of 81° using all of our measurements. We calculated the rate of variance of 3° and 5° and found a high rate of variability. Images 1 and 4 had 26%-28% of knees <78° or >84° (3° from 81°) and 4% of knees <76° or >86° (5° from 81°). Images 2 and 3 had 40% and 42%, respectively, over 3° and 10%-12% outside 5°. 70% of the extreme angles were in excessive valgus. Overall 96% of patients had at least one side-to-side difference of ≥3°, and 36% of patients had at least one side-to-side difference of ≥5°.

Conclusion: Reconstruction of the anatomic lateral distal femur angle is vital in fixation of fractures of the distal femur. This angle varies significantly between patients and even within the same patient. Our data have shown significant variability both within the same knee based on view chosen and between knees in the same person using the same projection. 48% of knees had a measured difference of 3° or more, and 12% had a measured difference of 5° or more comparing all images. One out of every eight patients could potentially result in a 5° malreduction despite perfectly matching a comparison image of the uninjured side with the use of imperfect imaging. Even with the most consistent imaging modalities, there is a 4% risk of significant malreduction matching the contralateral side.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Distal Femur Study Images

Image 1: Leg straight on the bed with C-arm vertical

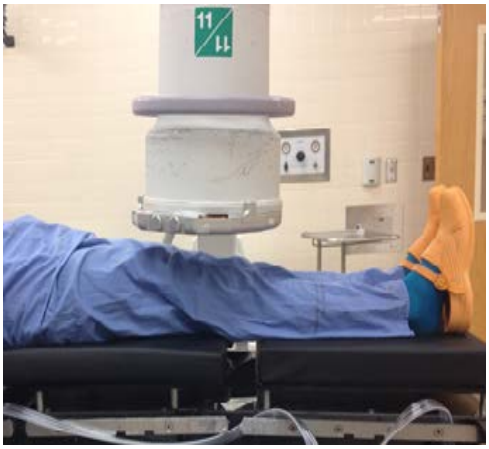


Image 2: Leg placed on foam leg ramp with C-arm vertical

Image 3: Leg placed on foam leg ramp with knee extended and C-arm vertical

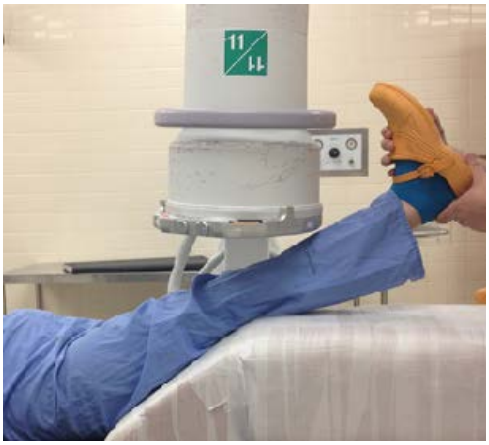
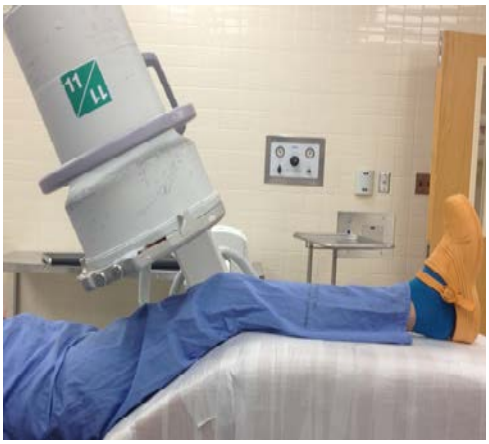


Image 4: Leg placed on foam leg ramp with C-arm perpendicular to femoral shaft



See pages 49 - 106 for financial disclosure information.

Intramedullary versus Extramedullary Fixation for Intertrochanteric Fractures: An Analysis of 13,276 Hips

Nathanael Heckmann, MD[1]; J Hill, BS[2]; Braden McKnight, BS[2]; William Pannell, MD[2]; Amir Mostofi, MD[3]; George Hatch III, MD[2]; Jason Davis, MD[4]; Geoffrey Marecek, MD[1]
[1]University of Southern California, Department of Orthopaedic Surgery, Los Angeles, California, USA;
[2]Keck School of Medicine of University of Southern California, Los Angeles, California, USA;
[3]Huntington Memorial Hospital, Pasadena, California, USA;
[4]University of California San Francisco - Fresno, San Francisco, California, USA

Background/Purpose: The optimal treatment for intertrochanteric fractures (OTA / AO 31-A) remains controversial despite several prospective randomized clinical trials. Recent studies have failed to demonstrate a difference in complication rates and functional differences when intramedullary hip screws or extramedullary sliding hip screws are used. Recent trends have shown a marked increase in the use of intramedullary implants despite their increased cost and lack of clear benefit. The purpose of the current study was to determine the differences in complication rates between intramedullary and extramedullary fixation for intertrochanteric fractures using a large population cohort.

Methods: The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database was queried for patients who sustained an intertrochanteric fracture. Patients under the age of 55 were excluded from the final analysis. Patients were divided into two groups based on their fixation type: intramedullary or extramedullary. Baseline patient characteristics were compared between the two groups using a Pearson's X^2 test for categorical variables and Mann-Whitney *U* for continuous variables. Short-term complications and 30-day readmission rates were computed for each group and compared by way of univariate analysis. Individual multivariate models were created for each complication to account for differences in baseline characteristics and confounding variables. Alpha was set at 0.05.

Results: After exclusion criteria were applied, a total of 13,276 patients were included in our analysis. Of these, 4392 (33.1%) received an extramedullary implant and 8884 (66.9%) underwent intramedullary fixation. The average (± SD) age of the extramedullary group was 81.4 ± 9.1 versus 81.8 ± 8.8 in the intramedullary group ($P = 0.241$). Patients who underwent intramedullary fixation were more likely to be female (74.1% vs 69.9%; $P < 0.001$), have an ASA (American Society of Anesthesiologists) 4 designation (19.1% vs 17.0%; $P = 0.008$), have hypertension (70.6% vs 68.8%; $P = 0.034$), a bleeding disorder (18.6% vs 16.8%; $P = 0.014$), and congestive heart failure (4.0% vs 3.0%; $P = 0.004$). On univariate analysis, intramedullary fixation was associated with increased 30-day mortality ($P = 0.003$), ventilator use ($P = 0.003$), transfusion ($P < 0.001$), and deep vein thrombosis ($P = 0.031$) as well as a decreased rate of urinary tract infection ($P = 0.001$) (Fig. 1). Postoperative hospital stay was on average 1 day shorter for the intramedullary group ($P < 0.001$). After multivariate analysis, ventilator use (odds ratio [OR] 1.48; CI 1.09-2.02; $P = 0.013$), transfusion rates (OR 1.14; CI 1.05-1.23; $P = 0.001$), and urinary tract infections (OR 0.83; CI 0.71-0.97; $P = 0.016$) remained significant. There was also an increased rate of combined serious adverse events

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

(OR 1.35; CI 1.01-1.79; $P = 0.040$) and any adverse event (OR 1.09; CI 1.02-1.18; $P = 0.018$) in the intramedullary fixation group.

Table I: Patient Outcomes Based on Fixation Type

Outcome	Extramedullary N (%)	Intramedullary N (%)	Univariate OR [95% CI]	Univariate P-value	Multivariate OR [95% CI]	Multivariate P-value
Readmission	311 (7.99)	679 (8.57)	1.08 [0.94-1.24]	0.287	1.44 [0.82-2.55]	0.205
Serious Adverse Event	475 (10.8)	1056 (11.9)	1.11 [0.99-1.25]	0.069	**1.35 [1.01-1.79]**	**0.040**
Death	235 (5.35)	556 (6.26)	**1.18 [1.01-1.38]**	**0.038**	1.14 [0.98-1.35]	0.097
Ventilator Use	55(1.25)	174 (1.96)	**1.57 [1.16-2.14]**	**0.004**	**1.48 [1.09-2.02]**	**0.013**
Stroke	34 (0.77)	47 (0.53)	0.68 [0.44-1.06]	0.090	0.70 [0.45-1.10]	0.118
Pulmonary Embolism	22 (0.50)	63 (0.71)	1.42 [0.87-2.31]	0.159	1.40 [0.86-2.28]	0.175
Cardiac Arrest	35 (0.80)	84 (0.95)	1.19 [0.80-1.77]	0.393	1.22 [0.43-3.48]	0.716
Myocardial Infarction	66 (1.50)	142 (1.60)	1.06 [0.79-1.43]	0.676	1.13 [0.83-1.52]	0.438
Renal Failure	11 (0.25)	25 (0.28)	1.12 [0.55-2.29]	0.747	1.11 [0.54-2.27]	0.774
Sepsis	60 (1.37)	129 (1.45)	1.06 [0.78-1.45]	0.694	1.03 [0.55-1.95]	0.925
Septic Shock	30 (0.68)	82 (0.92)	1.35 [0.89-2.06]	0.157	2.67 [0.77-9.27]	0.123
Return to OR	80 (1.82)	158 (1.78)	0.98 [0.74-1.28]	0.861	0.97 [0.74-1.28]	0.854
Other Adverse Events	2033 (46.3)	4359 (49.1)	**1.12 [1.04-1.20]**	**0.003**	**1.09 [1.01-1.17]**	**0.026**
Superficial SSI	39 (0.89)	56 (0.63)	0.71 [0.47-1.07]	0.099	0.70 [0.47-1.06]	0.092
Deep SSI	229 (5.21)	468 (5.27)	1.01 [0.86-1.19]	0.896	0.97 [0.82-1.14]	0.674
Urinary Tract Infection	288 (6.56)	456 (5.13)	**0.77 [0.66-0.90]**	**0.001**	**0.83 [0.71-0.97]**	**0.016**
Pneumonia	167 (3.80)	346 (3.89)	1.03 [0.85-1.24]	0.795	1.07 [0.88-1.30]	0.487
Transfusion	1616 (36.8)	3618 (40.7)	**1.18 [1.10-1.27]**	**<0.001**	**1.14 [1.05-1.23]**	**0.001**
Progressive Renal Failure	19 (0.43)	45 (0.51)	1.17 [0.68-2.01]	0.563	1.13 [0.67-1.95]	0.648
Deep Venous Thrombosis	44 (1.00)	129 (1.45)	1.45 [1.03-2.05]	0.032	1.37 [0.97-1.94]	0.078
Any Adverse Event	2090 (47.59)	4497 (50.6)	**1.13 [1.05-1.21]**	**0.001**	**1.09 [1.02-1.18]**	**0.018**
Operative Time, min (SD)	56.3 (39.2)	54.5 (36.6)		0.076		
Length of Stay, day (SD)	7.75 (8.63)	6.59 (5.93)		**<0.001**		
Time to Operation	1.40 (4.97)	1.17 (1.54)		0.596		
Operation to Discharge	6.43 (7.58)	5.43 (5.53)		**<0.001**		

Conclusion: Intramedullary fixation for intertrochanteric fractures was associated with an increased risk of pulmonary complications, increased rate of transfusion, and increased rates of serious complications. Extramedullary fixation was associated with an increased risk of urinary tract infection and prolonged postoperative hospital course. When given the choice between fixation types, using extramedullary fixation may help limit the number of pulmonary complications in a patient population with a relatively high risk of perioperative mortality.

See pages 49 - 106 for financial disclosure information.

Use of Inherent Anteversion of an Intramedullary Nail to Avoid Malrotation in Femur Fractures: A Prospective Study

Rahul Vaidya, MD[1]*; Radomir Dimovski, MA*[2]*; Zlatan Cizmic, BS*[2]*; Frederick Tonnos, DO*[3]*; Kerellos Nasr, MD*[1]*; Bryant Oliphant, MD*[1]
[1]*Detroit Medical Center/ Wayne State University, Detroit, Michigan, USA*
[2]*Detroit Receiving Hospital, Detroit, Michigan, USA;*
[3]*Detroit Medical Center/ Michigan State University, East Lansing, Michigan, USA*

Background/Purpose: Rotational malalignment after locked intramedullary (IM) nailing of femoral shaft fractures ranges from 19% to 56%. Differences greater than 15° lead to functional complaints. Several techniques have been suggested to avoid this problem especially in transverse or comminuted femoral shaft fractures. Espinoza et al have described a technique using the inherent anteversion of an IM nail to avoid malrotation in femur fractures (Espinoza Technique [ET]). The purpose of this study is to evaluate this technique in preventing malrotation in a prospective series of comminuted femoral shaft fractures.

Methods: A prospective IRB-approved study was performed from December 2012 to March 2016. 42 consecutive patients with comminuted (Winquist III and IV) femoral shaft fractures had locked IM nailing either with ET (19 patients) or our usual attempt at lining up proximal femur using the lesser trochanter and the patellar shadow over the distal femur. ET involved placement of second or third-generation femoral nails via "look back" lateral fluoroscopic views and superimposition of the drill and nail to bisect the femoral head. The distal locking screws were placed via a perfect circle fluoroscopic technique lining the perfect circle with a perfect lateral of the distal femoral condyles. Each patient had a CT scanogram conducted postoperatively to determine their femoral version for both lower limbs and leg lengths. Femoral version measurements were conducted using the Bonesetter application with axial cuts from CT scanograms. Version angles were measured with lines drawn along the axis of the femoral neck and the posterior aspect of femoral condyles. Outcome measurements included version of each femur, the difference in version, angle of each screw in comparison to the neck nail, as well as femur, tibia, and total leg lengths. Angles were also measured in second-generation IM nails from the central axis of the proximal locking screw and the two distal locking screws to assess what angle the nail actually produced. We also assessed our ability to center the proximal locking screws in the femoral head. Primary outcome of interest was a difference between operated and native femurs of >15° anteversion in the two operative groups, as a difference of this size results in notable asymmetry and complaint; null hypothesis was no difference between groups. Secondary outcomes included proportion of operated femurs with "normal" anteversion (8-15°), as well as a subgroup analysis of femoral anteversion agreement within 10° excluding those with abnormal native femoral anteversion (>15°). Given expectation of low cell counts, Fisher's exact test was the anticipated statistical test over X^2. All analyses were run as superiority (one-tailed) trials. Statistical analysis was performed using SAS 9.3 (SAS Institute).

Results: The average anteversion of the normal hips was 12.6 ± 7.1° (median 11.91°). The average anteversion using the ET was 9.9 ± 2.4° (range, 5.5-14.2°; median 10.53°). The average anteversion without this technique was 10.8 ± 8.3° (range, 1.1-35.4°; median 9.13°). In the ET

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

operative group, there was found to be 1/19 patients (5%) with a postoperative anteversion difference of >15° between native and operated limbs, as compared with 4/23 (17%) in the traditional approach group. The primary outcome of excessive difference between native and operated femoral anteversion between the traditional approaches and the ET group were found to be nonsignificant ($P = 0.24$). For secondary outcomes of interest, 14/19 (74%) in the Espinoza group exhibited operative anteversion between 8-15° ("normal"), versus 5/23 (22%) in the traditional approach group, a difference found to be statistically significant ($P = 0.0009$). Subgroup analysis of native leg versus operated leg differences excluding those patients with non-normal native leg anteversion resulted in the exclusion of 6 cases in the Espinoza group and 7 in the traditional group; this analysis demonstrated 0/13 cases >15° difference in the Espinoza group versus 5/16 (31%) in the traditional group, and was found to be statistically significant ($P = 0.037$). The average angle formed between the proximal and distal locking screws (we included first and second screws) was 9.4 ± 3.5° (range, 4.5-16.64°). We assessed our ability to center the proximal locking screws in the femoral head and found that we were on average 5.2 ± 5.0° off the center axis of the femoral head (range, 0-14.4°).

Conclusion: While the primary outcome of interest was found statistically nonsignificant, the increased incidence of clinically significant anteversion derangement was higher in the traditional group (17% vs 5%); the operative and risk burden on these patients potentially requiring revision is not discounted. Considering the Espinoza approach outperformed traditional approaches in terms of reliably creating 8-15° anteversion at a statistically significant level, the technique can be regarded as more reliable and consistent at creating a normal physiologic state. Subgroup analysis excluding those with native femur abnormalities also found superior performance in the Espinoza group (no large interfemoral anteversion derangements vs 33% in the traditional approaches group); this would suggest that it might be the preferred technique in those with normal native anatomy due to improved consistency of physiologic result. For those with native femural derangements, a modified Espinoza or traditional approach may be more appropriate. We found the ET better than our usual protocol for attempting to normalize the anteversion in comminuted femur fractures. It also takes less time. However, there are patients with inherent anteversions outside the norm and it is difficult to account for these using the ET. Technical aspects of this technique showed that there is some play in the locking mechanism of the second-generation nails we were using of about 5°, and our ability to place the proximal locking screw in the center of the head can vary approximately 5° as well. Although no technique is perfect, this one seems to improve our accuracy and variability and decrease the need for revision.

See pages 49 - 106 for financial disclosure information.

The Association Between Squat Depth and Outcomes of Operatively Treated Femoral Shaft Fractures: A Prospective Study in Dar es Salaam, Tanzania

Hao-Hua Wu, BA[1]; Max Liu, BA[1]; Saam Morshed, MD[2]; Edmund Eliezer, MD[3]; Billy Haonga, MD[3]; Lewis G. Zirkle Jr., MD[4]; David Shearer, MD[1]
[1]*Institute for Global Orthopaedics and Traumatology, UCSF OTI, San Francisco, California, USA;*
[2]*UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA;*
[3]*Muhimbili Orthopaedic Institute, Dar es Salaam, TANZANIA*
[4] *SIGN, Richland, Washington, USA*

Background/Purpose: In Sub-Saharan Africa and many other low- and middle-income countries (LMICs), performance of a full squat is required for essential activities of daily living, such as the use of pit latrines. However, traumatic lower extremity injuries, such as femoral shaft fractures, may compromise the ability to squat, even after operative treatment. Thus, objective tests utilizing squatting ability, such as the squat-and-smile test, have been used to assess outcomes in LMICs. However, to date, no study has evaluated the association between squatting and other established outcomes of operatively managed femur fractures in a resource-limited setting. The purpose of this investigation was to compare squat depth with patient-reported outcomes, complications, and reoperation in patients with operatively treated femoral shaft fractures.

Methods: In this IRB-approved prospective observational study, consecutive adult patients with diaphyseal femur fractures (OTA 32) treated by intramedullary nailing were enrolled at a tertiary medical center in Dar es Salaam, Tanzania. Squat depth, need for support, and expression of discomfort were assessed at 6 weeks, 3 months, 6 months, and 1 year postoperatively. Squat depth was graded on a four-point scale–unable to squat (1), hip above knee level (2), hip at knee level (3), and hip below knee level (4). A three-point scale was used to evaluate support (two-hand support [1], one-hand support [2], and no support needed [3]) and facial expression (pain/discomfort [0], neutral [1], smile [2]). EuroQol (EQ)-5D-3L, reoperation, and complications such as nonunion, malunion, and infection were recorded at these time points to assess for correlation.

Results: Out of 332 enrolled patients, 231 patients (70.0%) were followed up and had completed the squat-and-smile test at 1 year. Of included patients (mean age 32, SD 11; 14% female), 16 (6.9%) required reoperation and 21 (9.1%) reported an adverse event over the course of follow-up. Mean EQ-5D VAS (visual analog scale) was 86.7 (SD 16) and EQ-5D-3L health index was 0.91 (SD 0.11). A majority of patients (92.5%) were able to achieve a grade 3 or 4 squat depth at 1 year postoperatively. Average squat depth significantly increased from 2.5 (SD 0.8) at 6 weeks to 3.4 (SD 0.56) at 1 year ($P = 0.01$). Squat depth scores of 3 or above were significantly associated with a higher EQ-5D VAS (90.1, SD 12) than squat depth scores below a 3 (79.7, SD 17; $P = 0.026$). No significant association was found between squat depth and EQ-5D health index, reoperation, or complication rate ($P > 0.05$). Average support needed and expression did not significantly change over time and were not significantly associated with outcome measures ($P > 0.05$).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusion: For patients operatively treated for femoral shaft fractures, squat depth significantly improves over the course of 1-year postoperative follow-up. Patients who can squat at or below knee level report significantly higher self-rated health than those who cannot. Although squatting ability is not correlated with reoperation or complication rate, its association with patient-reported outcomes may suggest future use of the squat test as an objective functional tool to assess femur fracture recovery in resource-limited settings. Future research to evaluate reliability and responsiveness of the squatting assessment for femur fracture patients is needed.

See pages 49 - 106 for financial disclosure information.

The Reliability of Contralateral Templating for Femoral Shaft Fractures: A CT Study of Side-to-side Differences of Femoral Neck Version in 328 Femurs

Nathanael Heckmann, MD[1]*; Daniel Lorenzana, BA*[2]*; Timothy Auran, BS*[2]*; William Croom, MD*[2]*; Matthew Cavallero, MD*[3]*;Eric White, MD*[2]*; Jackson Lee, MD*[2]
[1]*University of Southern California, Department of Orthopaedic Surgery, Los Angeles, California, USA;*
[2]*University of Southern California, Los Angeles, California, USA;*
[3]*Indiana University Health Methodist Hospital, Indianapolis, Indiana, USA*

Background/Purpose: Malrotation is the most common deformity following intramedullary fixation of diaphyseal femur fractures (OTA / AO type 32). To prevent malrotation, many surgeons use fluoroscopic imaging of the contralateral extremity to provide a template for reduction; however, this practice does not account for side-to-side variations in native femoral version. The objective of this study was to determine the side-to-side differences in femoral neck version in a diverse population and to explore patient factors that are predictive of side-to-side variation.

Methods: Our institution's radiology database was screened for patients with bilateral lower extremity CT scans. Patients with complete CT imaging of bilateral femora were included in our study. Patients were excluded if they had an acute fracture of the femur, evidence of a prior femoral fracture, evidence of congenital hip dysplasia, or inadequate imaging. Femoral neck version was computed for each femur by measuring the angle between the posterior condylar axis and a line drawn down the center of the femoral neck and head. Demographic information was also recorded for each subject, including age, sex and ethnicity. Side-to-side differences in femoral neck version were correlated with demographic variables in a multiple linear regression model. All statistical analysis was performed using Stata 13 (StataCorp LP).

Results: After exclusion criteria were applied, 164 subjects (328 femora) with a mean age of 48.3 years (SD 14.0 years) were included in our study. Of these, 96 (58.9%) were male and 67 (41.4%) were female. The average femoral neck version was 8.9° in males and 10.0° in females. When compared in a pairwise fashion, there was a significant side-to-side difference in femoral version (5.4 ± 4.4°, $P < 0.01$). There was no systematic difference in version between the right (9.7 ± 9.4°; range, -19° to 38) and left (9.1 ± 9.4°; range, -24° to 33°) femora ($P = 0.31$). Average side-to-side difference was not significantly different between males (6.1 ± 5.1°) and females (4.8 ± 3.7°) ($P = 0.70$) or between white (5.0 ± 3.1°), black (5.4 ± 5.1°), Hispanic (5.1 ± 4.1°), or Asian (8.2 ± 6.1°) ethnicities ($P = 0.11$). There was a trend toward greater side-to-side difference in Asians compared to whites ($P = 0.06$) and Hispanics ($P = 0.06$). Asian ethnicity predicted a greater side-to-side difference in version in univariate regression (ß = 3.10, $P = 0.02$) and in a multivariate model controlling for age, sex, and ethnicity (ß = 3.17, $P = 0.04$). Of the patients examined, 53.6% had a side-to-side difference in version <5°, 17.7% had a difference in version ≥10°, and 4.3% had a difference in version >15°.

Conclusion: Side-to-side differences in femoral neck version are common and may affect femoral rotation during intramedullary fixation of diaphyseal femur fractures. An asymme-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

try of >10° was observed in almost 20% of the study subjects. In these cases, relying on the contralateral limb for rotational alignment could result in a difference from native anatomy that is clinically significant. Asian race was found to be a significant predictor of increased side-to-side differences in femoral version, while sex and age were not.

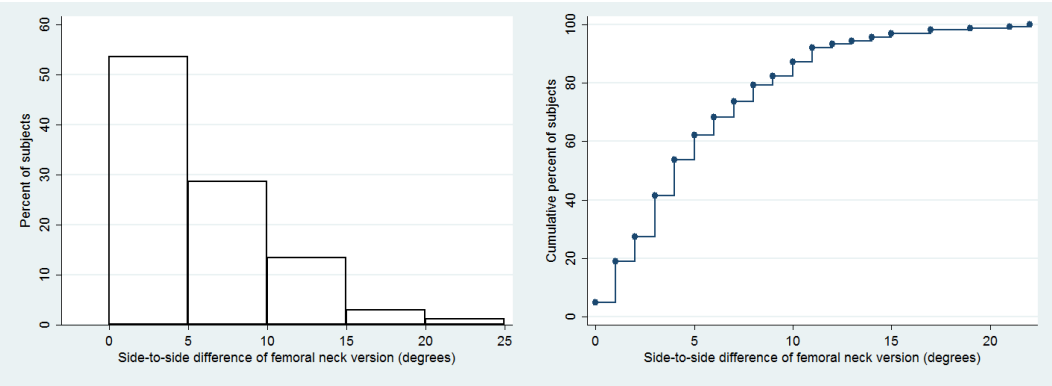


Figure 1: (a) histogram and (b) cumulative frequency plot demonstrating the absolute right-left (side-to-side) difference in femoral version.

See pages 49 - 106 for financial disclosure information.

An Assessment of Standard Imaging Protocols Following Stable Pelvic Ring Fractures: Is Surveillance Necessary?

Nina Fisher, BS*; Adam Driesman, BA; Sanjit Konda, MD; Kenneth Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: Geriatric patients presenting to the Emergency Department (ED) following a low-energy fall are commonly diagnosed as a lateral compression type 1 (LC1) pelvic ring injury. Given the global increase in the geriatric population, it is important that this type of injury be managed in the most effective way possible, both in terms of quality and cost of medical care. The purpose of this study was to investigate if obtaining injury CT scans and post ambulation radiographs alter the management of this injury pattern.

Methods: An EMR query was performed between 2012 and 2013 at two institutions within one hospital system using ICD-9 codes for pelvic ring injury. 277 pelvic fractures were identified, and 161 of these fractures were of low energy mechanism and classified as LC1 pelvic fractures (OTA type 61-B2) by initial radiographs. Retrospective chart review was performed to collect demographic information (age, gender, mechanism of injury) and determine if a pelvic CT scan and/or a post-ambulation radiograph was obtained for this cohort of patients.

Results: 127 females and 34 males were identified, with an average age of 69.23±20.8. One hundred and eight patients (67.1%) underwent a pelvic CT scan. Orthopaedic residents were responsible for ordering a CT scan on 18 (15.3%) of patients. ED staff were responsible for a CT scan on 49 (45.4%) of patients and other specialties, including general surgery and internal medicine, were responsible for the CT scan on the remaining (38.0%) patients. Additional fractures about the pelvis requiring surgical repair were discovered on 2 (1.9%) patients, however these patients were both poly-trauma victims. Pelvic hematomas were discovered on 2 (1.9%) patients and 1 patient required CT guided aspiration of pelvic fluid. CT scans were ordered regardless of the energy of the injury ($p = .021$), primarily due to ED protocol for incoming trauma. Sixty-eight (42.2%) patients underwent post-ambulation radiographs. Orthopaedic residents were responsible for ordering the post-ambulation films on 44 (64.7%) of these patients, while ED staff and other specialties were responsible for the orders on the remaining 24 (35.3%) patients. None of these 68 patients experienced changes in their medical care or treatment plan following the post-ambulation films. Patients who were admitted from the Emergency Department were more likely to undergo either a pelvic CT ($p = .001$) or a post-ambulation x-ray ($p < .0005$). The average cost of a pelvic CT and pelvic radiographs (3 views) were $1500 and $200, respectively, excluding the costs of radiologist interpretation.

Conclusions: Orthopaedic surgeons should be consulted when possible by the ED prior to additional imaging being ordered to prevent misuse of resources. While pelvic CT scans may continue to have diagnostic value, particularly in geriatric populations where there is a risk of more serious injuries (i.e. visceral injury, etc), post-ambulation radiographs offer no significant contribution to the patient's medical care and create higher costs for both the

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

patient and the hospital system. Orthopaedic surgeons should be educated on how to manage non-operative pelvic ring injuries without obtaining serial post-ambulation radiographs.

See pages 49 - 106 for financial disclosure information.

The Impact of Severe Obesity on 30-Day Rates of Adverse Events in Patients Undergoing Internal Fixation for Acetabular Fractures

Christian Pean, MS*; Sanjit Konda, MD; Philipp Leucht, MD, PhD; Kenneth Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Background/Purpose: Acetabular fractures are potentially devastating injuries that often require complex surgical treatment. Surgical outcomes in these fractures are affected by obesity, although the impact of severe obesity on inpatient outcomes for these patients has not been previously described in large data sets. This study sought to assess the impact of severe obesity and body mass index (BMI) on (1) occurrence of any adverse event; (2) rate of major complications; (3) infectious complications; (4) total operative time; and (5) total length of hospital stay following open reduction and internal fixation (ORIF) of acetabular fractures.

Methods: Patients undergoing ORIF for acetabular fractures from 2008-2013 were identified using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) using CPT codes 27226, 27227, 27228, and 27254. Patients with missing peri-operative data or BMI were excluded from analysis. Severe obesity was defined as a BMI greater than 35. Major complications, infectious complications, and minor complications were defined as previously described in the literature for the NSQIP database. BMI as a predictor of total hospital length of stay and total operative time was tested using linear regression analysis. Severe obesity and numerous other patient characteristics were tested for association with occurrence of any adverse event, major complications, and infectious complications using Pearson X^2 test for categorical variables or independent *t* tests for continuous variables. Risk factors with a *P* value of <0.2 after initial testing were included in a multivariate logistic regression to determine independent risk factors for outcomes.

Results: Of 636 patients who underwent ORIF for acetabular fractures in the database, 560 met inclusion criteria for analysis. 20.7% sustained an adverse event (either major or minor) during the 30-day postoperative period. 13.6% had a major complication with the most common being death (n = 25, 4.5% of cohort). Severe obesity had no effect on risk of major complications ($P = 0.685$) or infectious complications ($P = 0.074$). However, multivariate analysis revealed severe obesity was significantly associated with occurrence of any adverse event (major or minor) in the 30-day postoperative period (odds ratio [OR] 2.05, CI 1.063-3.953, $P = 0.29$; Table 1). Linear regression revealed BMI did not predict total length of hospital stay $F(1, 558) = 0.171$, $P = 0.680$. BMI significantly, albeit minimally, predicted longer operative time for patients with acetabular fractures, accounting for 2.3% of variability in operative time as determined by linear regression analysis $F(1, 558) = 14.27$, $P < 0.001$. The regression equation was: predicted total operative time in minutes = 45.67 + (2.19 x BMI).

Conclusion: Patients undergoing ORIF for acetabular fractures who are severely obese are more likely to have an adverse event in the 30-day postoperative period. BMI is also associated with longer operative time in these patients. The increased length of operative time in this patient group may have implications for hospital costs and resource utilization, and may contribute to the increased incidence of adverse events seen in this study.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1: Significant Risk Factors for Occurrence of Any Adverse Events as Determined by Multivariate Logistic Regression Analysis

Characteristic	Odds Ratio(95% CI)	P Value
Severe Obesity (BMI>35)	2.324 (1.105-4.887)	0.026
Age>70	2.083 (1.003-4.326)	0.049
ASA>3	2.008 (1.062-3.797)	0.032

See pages 49 - 106 for financial disclosure information.

Low Complication Rates Associated with Open Anterior Approach to the Posterior Pelvic Ring

Paul Whiting, MD[1]*; Eduardo Burgos, MD*[2]*; Frank Avilucea, MD*[3]*; Robert Boyce, MD*[4]*; Jason Evans, MD*[5]
[1]*University of Wisconsin, Madison, Wisconsin, USA;*
[2]*Hospital Militar Central, Bogotá, COLOMBIA;*
[3]*University of Cincinnati, Cincinnati, Ohio, USA;*
[4]*Vanderbilt University Medical Center, Nashville, Tennessee, USA;*
[5]*Hughston Clinic at Tri-Star Skyline, Nashville, Tennessee, USA*

Background/Purpose: Pelvic ring injuries often result from high-energy trauma, and many require operative stabilization. Fixation of the posterior pelvic ring is vital in restoring normal pelvic stability. While percutaneous techniques for posterior pelvic ring stabilization are safe and effective, anatomic reduction cannot always be attained. Theoretical concerns of the open anterior approach to the posterior pelvic ring include blood loss, wound complications, iatrogenic nerve injury, prolonged operative time, and lack of familiarity to surgeons without training in orthopaedic trauma. The purpose of this study was to investigate the perioperative complications associated with the open anterior approach to the posterior pelvic ring and to assess the effectiveness of this technique for obtaining reduction.

Methods: Over a 10-year period at a Level I trauma center, we identified all adult patients who underwent open reduction of a posterior pelvic ring fracture or dislocation via the lateral window of the ilioinguinal approach. We excluded patients who required the full ilioinguinal exposure. Charts were reviewed to record demographics, fracture classification, associated injuries, perioperative hematocrit, blood loss, operative time, and complications including wound complications, iatrogenic nerve injury, oblique abdominal muscle hernia, flank pain, DVT (deep vein thrombosis), and PE (pulmonary embolism). Reduction of the fracture/dislocation was assessed with postoperative pelvic CT. Reduction was considered anatomic if there was <2 mm of fracture displacement or if the sacroiliac (SI) joint was reduced to within 2 mm of the uninjured side.

Results: We identified 48 patients who underwent 50 open anterior approaches to the posterior pelvic ring (two bilateral). Average age was 36.9 years. Fracture patterns according to the OTA and Young-Burgess classification systems are displayed in Tables 1 and 2, respectively. Additional orthopaedic procedures were performed under the same anesthetic setting in 32 cases. For the 18 patients who underwent an isolated lateral window approach, average blood loss was 520.5 mL, and average operative time was 176 minutes (Table 3). Of the 42 patients with injuries involving the SI joint, postoperative CT scan was performed in 35 (Fig. 1), and reduction was anatomic in 28 cases (80%). Average residual displacement in the remaining seven cases was 5.1 mm (Table 4). There were 8 complications for an overall complication rate of 16%. Two cases of wound complications were managed with local wound care, and three nerve injuries recovered spontaneously. Three patients had flank pain. There were no cases of oblique muscle hernia, DVT, or PE.

Conclusion: The open anterior approach to the posterior pelvic ring is effective for obtain-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

ing reduction in a variety of injury patterns and is associated with a very low complication rate. When anatomic reduction of fractures or dislocations of the posterior pelvic ring is not possible using percutaneous means, surgeons should not hesitate to perform an open reduction prior to performing posterior pelvic ring fixation.

Table 1. OTA Fracture Classification

OTA (N=50)	
61-A2	16 %
61-B1	4 %
61-B2	30 %
61-B3	18 %
61-C1	14 %
61-C2	16 %
61-C3	2 %

Table 2. Young-Burgess Classification

Young-Burgess (N=50)	
LC-2	34 %
LC-3	8 %
APC-2	10 %
APC-3	16 %
VS	12 %
CM	4 %
Iliac Wing	16 %

LC = lateral compression, APC = anterior-posterior compression, VS = vertical shear, CM = combined mechanism.

Table 3. Perioperative Characteristics

PERIOPERATIVE CHARACTERISTICS (N=18)		
	Avg.	**Range**
Pre-Op Hct (%)	29.4	21 – 38
Post-Op Hct (%)	29.3	21 – 35
Change in Hct	-0.1	
EBL (ml)	521	200 – 1000
Op Time (hh:mm)	2:56	1:29 – 7:58

EBL = estimated blood loss

See pages 49 - 106 for financial disclosure information.

Table 4. Quality of Reduction

QUALITY OF REDUCTION (N=42)	
True Pelvic Ring Injuries (N=42)	**N**
No CT Scan	7 (16.7%)
CT Scan Performed	35 (83.3%)
• Anatomic • Displacement > 2mm* • *Avg Displacement: 5.1mm (range 3-7mm)	28 (80%) 7 (20%)

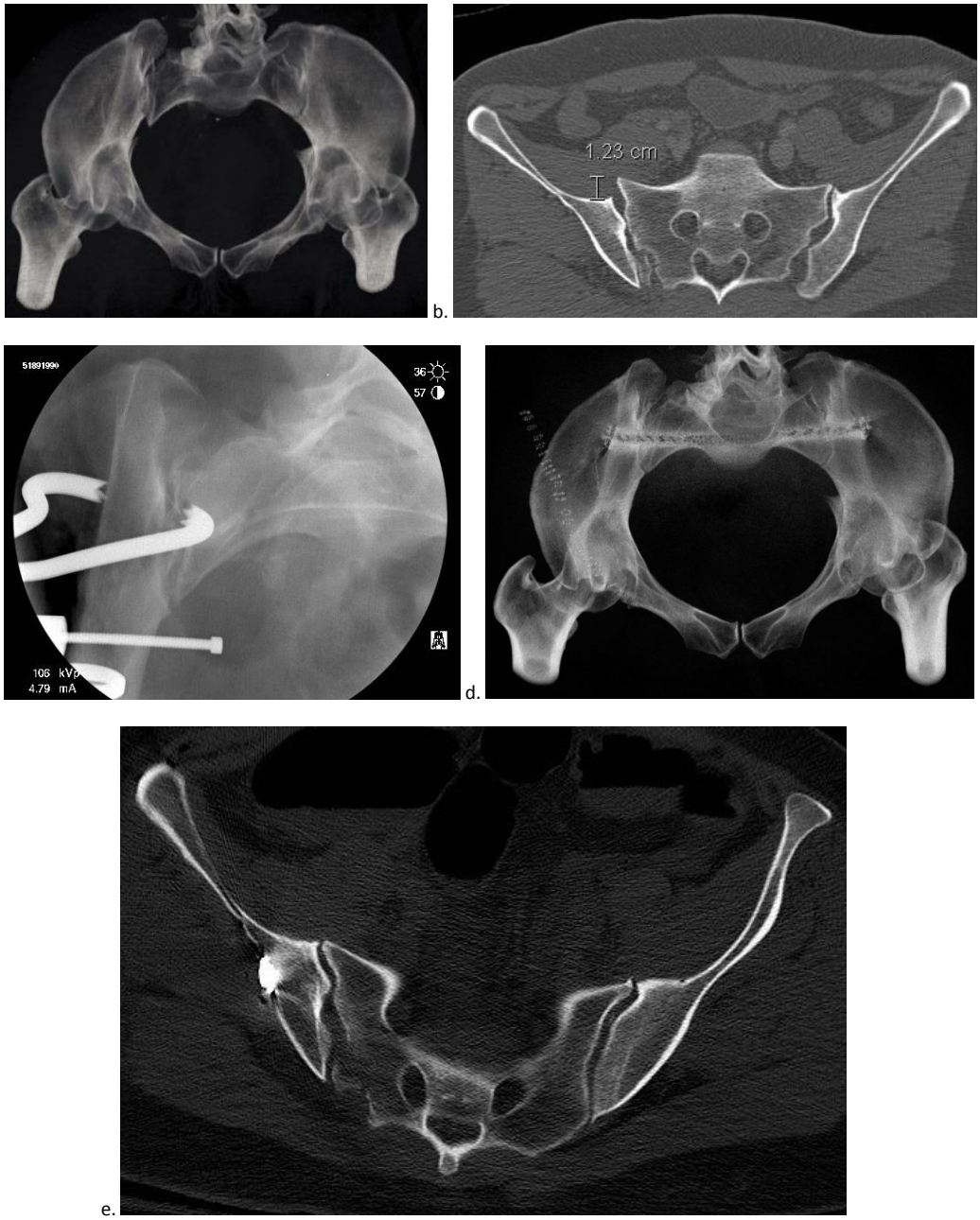
Table 5. Complications

COMPLICATIONS (N=50)	
	Total
Wound Complication	2 (4%)
• Drainage • Dehiscence	1 (2%) 1 (2%)
Nerve Injury	3 (6%)
• LFCN • L5 Nerve Root	2 (4%) 1 (2%)
Flank Pain	3 (6%)
Failure of Oblique Muscle Repair	0 (0%)
DVT	0 (0%)
PE	0 (0%)
Total Complications	8 (16%)

LFCN = lateral femoral cutaneous nerve, DVT = deep vein thrombosis, PE = pulmonary embolism

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Figure 1. Pre-operative volume-rendered inlet view (a) showing a complete right sacroiliac (SI) joint dislocation. Pre-operative CT (b) demonstrates 1.2cm of posterior displacement at the right SI joint. Intra-operative fluoroscopic image showing open reduction and clamping of the Right SI joint (c), after which percutaneous iliosacral fixation was performed. Anatomic reduction of the posterior pelvic ring, as judged on post-operative inlet view (d) and CT-scan (e), was achieved.



See pages 49 - 106 for financial disclosure information.

Comparison of Outcomes of Operative versus Nonoperative Treatment of Acetabular Fractures in the Elderly and Severely Comorbid Patient

Kempland Walley, BS[1]; Paul Appleton, MD[1]; Edward Rodriguez, MD[2];
[1]Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA
[2]Beth Israel Deaconess Medical Center / Harvard Medical School, Medfield, Massachusetts, USA

Background/Purpose: Acetabular fractures in the elderly and severely comorbid patient can be associated with high morbidity and mortality. However, differences in outcomes of acute open reduction and internal fixation (ORIF) versus nonoperative care of acetabular fractures in this patient population remain unclear. This retrospective study assesses morbidity, mortality and return to baseline ambulation of operative fixation versus nonoperative care of acetabular fractures in a subgroup of elderly (>75 years) and severely comorbid younger patients (>65 years) to evaluate outcomes after acute operative intervention versus nonoperative. Our hypothesis was that both nonoperatively and operatively managed patients exhibit poor return to baseline ambulatory status and similar mortality rates at 1 year.

Methods: A retrospective review of 243 patients who sustained an acetabular fracture between April 2005 and November 2014 was performed. 86 patients met inclusion criteria: age >75 with or without comorbidities, or age >65 if complicated by two or more medical comorbidities including diabetes, active cardiac disease (coronary artery disease, congenital heart disease, or past surgical intervention), active pulmonary disease (chronic obstructive pulmonary disease, asthma, cystic fibrosis, or pneumonia), neurologic disease (Alzheimer disease, dementia, Parkinson, parapalegia), malignancy, end-stage renal disease or dialysis, obesity marked by a body mass index (BMI) >30 kg/m^2, and end-stage liver disease. Outcomes measures evaluated were 1-year mortality, duration of hospital stay, return to preinjury ambulation status, and early treatment failure marked by conversion to a total hip arthroplasty (THA) within 1 year of treatment.

Results: 37 patients with acetabular fractures were treated with surgical fixation and 49 were treated nonoperatively. Operative patients did not demonstrate a statistically significant difference in mortality within 1 year of treatment compared to nonoperatively treated patients (P >0.05; Table 1). Operative patients demonstrated a statistically significant increase in early treatment failure marked by a conversion to a THA within 1 year when compared to conservatively treated patients (P <0.01; Table 1). No differences in age, duration of follow-up, hospital stay, or ability to return to baseline ambulation at latest clinical follow-up were found between groups (P >0.05 for all; Table 1). However, nonoperatively treated patients had a higher incidence of Alzheimer disease/dementia and Parkinson compared to operatively treated patients (P <0.05).

Conclusion: Initial nonoperative treatment does not preclude staged elective arthroplasty in those patients who develop symptomatic posttraumatic osteoarthritis and are able to undergo this procedure despite noting that early revision in our group was less frequent after nonoperative care.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Demographic and Clinical Outcome Variables

Variable	Operative (n = 37)	Non-Operative (n = 49)	p-value
Age, years (range)	78 (66-94)	81 (65-94)	*P > 0.05*
Total of younger patients (less than 75 but greater 65 years) with 2 or ore comorbidities, n (%)	7 (19%)	12 (24%)	*P > 0.05*
Follow-up, months	14 (1-60)	16 (1-60)	*P > 0.05*
Length of stay, days	8.3 (1-19)	8.6 (1-25)	*P > 0.05*
Return to baseline ambulation status at latest follow up (%)	24%	29%	*P > 0.05*
Conversion to THA, n (%)	5 (14%)	1 (2%)	***P < 0.01****
Mortality, n (%)	7 (19%)	10 (20%)	*P > 0.05*

Numerical variables were compared using student t test. Categorical variables were compared using Fischer's Exact Test. *denotes statistical significance.

See pages 49 - 106 for financial disclosure information.

Acetabular Fracture Reduction: Experience Matters!

Amanda Schroeder, MD[1]; Rafael Kakazu, MD[2]; Steven Dailey, MD[1]; Caleb Phillips, PhD[3]; Frank Avilucea, MD[4]; ***Michael T. Archdeacon, MD[1]***
[1]University of Cincinnati Orthopaedics, Cincinnati, Ohio, USA
[2]University of Cincinnati, Cincinnati, Ohio, USA
[3]University of Colorado - Boulder, Boulder, Colorado, USA
[4]University of Cincinnati Academic Health Center, Cincinnati, Ohio, USA

Purpose: Our objective was to investigate the influence of surgeon experience on open reduction and internal fixation (ORIF) of acetabulum fractures with regard to quality of reduction, estimated blood loss (EBL), operative time, and number of postoperative complications.

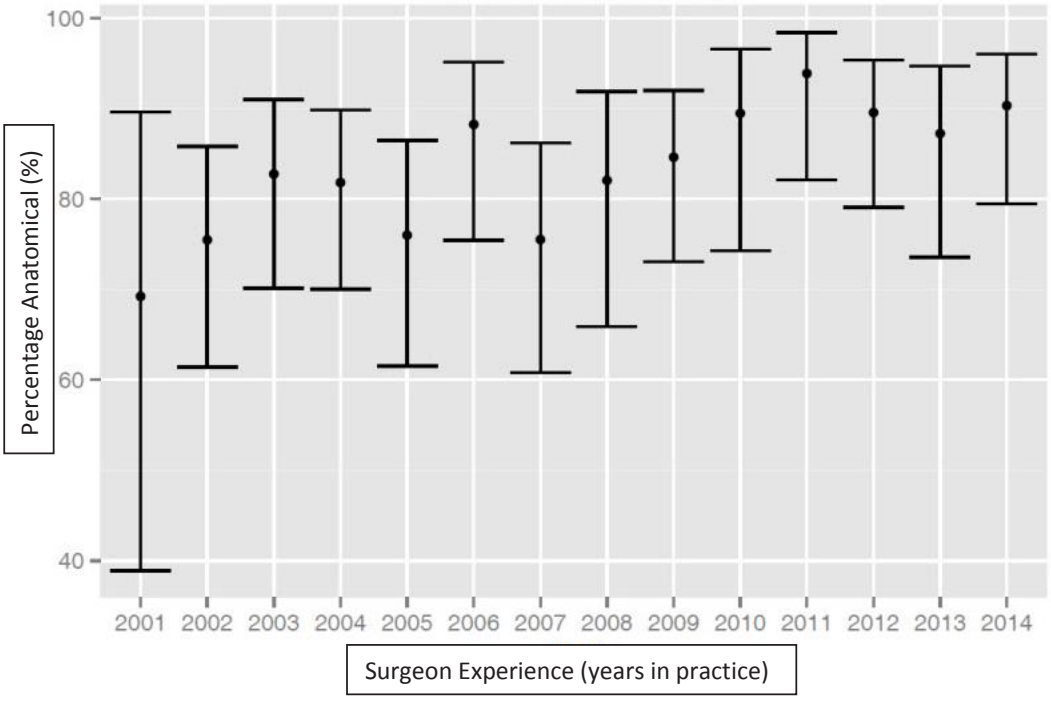
Methods: This is a retrospective evaluation of a prospectively collected acetabular fracture database from a single, fellowship-trained surgeon at an academic Level I trauma center. The quality of reduction of all acetabular fractures treated with ORIF between September 2001 and December 2014 was assessed using postoperative radiographs. A total of 715 patients sustained 716 consecutive acetabular fractures that were treated operatively during this period and are included in the study. The correlation between surgeon experience and outcome measurements was evaluated as a continuous variable using logistic regression analysis. A P value of 0.05 was considered statistically significant.

Results: There were no differences among years of experience in regard to EBL or postoperative complication rate ($P > 0.05$). Percentage of anatomic reductions was directly correlated with years in practice ($r = 0.780$, $P < 0.001$). For each additional year of experience, 1.3% more anatomic reductions were produced. Also, the rate of imperfect versus poor reductions increased over time when reductions were nonanatomic ($P < 0.05$). Operative time was negatively correlated to years in practice ($r = 0.133$, $P < 0.001$), with operative time decreasing by 3.2 minutes with each subsequent year of experience.

Conclusion: We found that quality of reduction of acetabular fractures is directly correlated with surgical experience; for each additional year of experience, an average of 1.3% more anatomic reductions were produced. Operative time is inversely proportional to surgical experience, with a mean reduction of 3.2 minutes annually. No significant difference was found for surgical experience with regard to EBL or number of complications.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Surgeon Experience vs. Quality of Reduction



See pages 49 - 106 for financial disclosure information.

THA Through the Posterior Approach After Previous Acetabular ORIF Does Not Pose a Risk to the Sciatic Nerve

Christina Morris-Berry, MD*; Theodore T. Manson, MD*
R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA

Purpose: Conversion total hip arthroplasty (THA) after previous acetabular fracture open reduction and internal fixation (ORIF) has been reported to have higher rates of dislocation, infection, and sciatic nerve injury than THA for primary osteoarthritis. This abstract details the results of specific protocol to protect the sciatic nerve during posterior approach to the hip for THA after previous acetabular ORIF. The hypothesis was that using the "inside-out" method of posterior column exposure for plate and screw removal would result in a low rate of sciatic nerve injury.

Methods: This was a retrospective review of a prospective database of all conversion THAs after previous acetabular ORIF performed by a single surgeon over a 5-year period from 2010 to 2015. The inclusion criterion was conversion THA for a diagnosis of posttraumatic osteoarthritis. In cases with posterior wall or column plates, a posterior approach to the hip was utilized. If the patient had preconversion THA sciatic nerve deficit, the nerve was identified beneath the gluteus maximus tendon and traced proximally, releasing the scar tissue from the lateral aspect of the nerve. After resection of the femoral head, the hip was extended and knee flexed and the soft tissues were cleared from the posterior wall and column to expose plates and screws that needed to be removed. This soft-tissue dissection started inside the acetabulum and proceeded up and over the acetabular rim and down onto the ischium and posterior column in a subperiosteal fashion, the "inside-out" exposure. Plates and screws were then removed under direct visualization.

Results: During this time period, 54 patients underwent conversion THA for posttraumatic osteoarthritis after acetabular ORIF through a posterior approach. Average follow-up was 10 months (range, 1 month-4 years). 16 patients (29.6%) had preoperative sciatic nerve motor deficits. No patients had a decrease in sciatic nerve motor grade after conversion THA. No patients had decrease in peroneal or tibial nerve sensation or new onset of paresthesias after conversion THA. The deep infection rate in this series was 6.6 %. Three patients had a postoperative dislocation (4.9%).

Conclusion: Conversion THA performed through a posterior approach to remove implants and place the hip prosthesis using an "inside-out" exposure of the bone did not result in sciatic nerve injuries in contrast to prior reports. However, in keeping with prior literature, dislocation and infection were present at increased rates in these challenging patients. The "inside-out" approach is a technique that may have utility in preventing nerve injury, at least addressing one of the 3 major complication sources in these difficult patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Novel Device for the Prevention of Pulmonary Embolism in Trauma Patients

***Peter Bates, FRCS (Trauma & Ortho)**, BSc;*
Nick Bunker, MBBS, MRCP, FRCA, FFICM, MD
Barts Health, London, UNITED KINGDOM

Background/Purpose: Pulmonary embolism is a major cause of mortality and morbidity following major trauma. It is the third most common cause of death for trauma patients who survive the first 24 hours and has a case fatality rate of between 25% and 50%. The acute coagulopathy of trauma is now well recognized and aggressively managed with blood products; consequently this often leads to a procoagulant state after the initial resuscitation, predisposing patients to venous thromboembolism (VTE). Major trauma patients are therefore at high risk of VTE but many of the prophylactic measures may be contraindicated. Compression stockings and pumps may not be suitable in lower limb fractures and early pharmacological prophylaxis may not be possible, particularly after severe head injury or ongoing bleeding risk. This may mean the only available prophylactic measure that is effective at preventing pulmonary embolism (PE) is an inferior vena cava (IVC) filter. The side effect profile of these devices has limited widespread use and the US Food and Drug Administration (FDA) advises caution in their use. Our purpose was to report the early experiences and complication profile of the Angel® Catheter, a novel device that combines a femoral central venous catheter with an IVC filter. It can be inserted at the bedside or in theater and acts as a temporary filter for short-term use when the PE risk is very high and no other prophylactic measures can be deployed. Interventional radiology is not required for insertion. When no longer required it can be removed following a venogram to check for trapped thrombus.

Methods: A prospective cohort of 38 patients have had an Angel® catheter inserted at a single Level I UK trauma center. The criteria for insertion were that no other prophylactic measures could be deployed and the risk of VTE remained high. 3 patients had the filter deployed in theater, prior to fixation of a pelvic fracture, and the remainder in critical care.

Results: The information regarding the patients requiring an Angel® catheter is included in Table 1. All patients were severely injured, as demonstrated by the high ISSs. All insertions were successful and most were retrieved without incident. One patient died with the device in situ (not VTE- related) and in one patient the catheter was accidentally displaced but caused no vascular injury. Insertion most frequently occurred in patients with pelvic and/or spinal fractures combined with head injuries. Injuries to multiple body compartments were very common. VTE screening was not performed and no patients developed a clinical PE with the catheter in situ. Importantly, 2 patients had clinically significant clots detected within the filter on retrieval, requiring a superior filter and a period of anticoagulation. One patient had the filter removed, collapsed 48 hours later, and died from a presumed PE.

Conclusion: The Angel® Catheter is easy to insert and was, in our series, associated with no morbidity. It successfully captured 2 clots in 38 high-risk patients, presumably preventing potentially fatal PE.

See pages 49 - 106 for financial disclosure information.

Male: Female	27:11
Age	35
Median ISS (IQR)	41(26-50)
Injuries (%)	
Head	21 (55)
Thoracic	20 (53)
Spine	13 (34)
Lower Limb	22 (59)
Abdominal viscera	9 (24)
Pelvis	26 (68)
Vascular	3 (8)
Patients alive at discharge (%)	34 (89%)
Mean catheter days	7.2

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Does Tranexamic Acid Decrease Blood Loss and Transfusion in Acetabular Fixation?

Justin Woods, MD*; Matthew Hess, BS; Amir Herman, MD, PhD; Jason Lowe, MD*
University of Alabama at Birmingham, Homewood, Alabama, USA

Purpose: Acetabular fractures requiring open reduction and internal fixation (ORIF) often result in high blood loss requiring perioperative transfusion, which increases the risk for surgical site infection. The purpose of this study was to evaluate the efficacy of tranexamic acid (TXA) to decrease blood loss and transfusion requirements during open acetabular fixation and determine its effect on postoperative infection rates and thromboembolic events. The authors hypothesized that TXA would decrease blood loss, transfusions, and postoperative infection rates, and not increase the risk of thromboembolic events.

Methods: A retrospective review of a prospectively collected database at a single Level I academic trauma center from January 2012 to December 2014 was performed. 450 patients with acetabular fractures who underwent ORIF were identified. 172 cases met inclusion criteria and were divided into two groups: 116 controls and 56 who received a 1-g intravenous dose of TXA preoperatively. For both cohorts, outcome measures included intraoperative estimated blood loss, intraoperative transfusion volume, transfusion-related adverse events such as deep venous thrombosis (DVT), and postoperative infection rates requiring surgical intervention.

Results: Mean estimated blood loss was not significantly different between the controls (839.1 mL) versus the TXA group (833.7 mL). Likewise, there was no significant difference between mean intraoperative transfusion volume for the controls (396.9 mL), and those receiving TXA (395.8 mL). The TXA group had a non-statistically significant increase in infection rate (7.1%) compared to controls (5.2%). The rate of DVT was higher in the control group (14.7%) than the TXA group (8.9%), but this also was not a statistically significant difference.

Conclusion: A single 1-g intravenous dose of TXA preoperatively does not significantly decrease blood loss and intraoperative blood transfusion requirements, nor change the risk for infection or thromboembolic events, for patients undergoing ORIF of acetabular fractures.

See pages 49 - 106 for financial disclosure information.

Treatment and Outcomes of Patients with Ipsilateral Acetabular and Femur Fractures: A Multicenter Retrospective Analysis

Lisa K. Cannada, MD[1]*; Hassan R. Mir, MD*[2]*; Justin Hire, CPT, MD*[3]*; Preston Boyer, BS*[1]*; Heidi Israel, PhD, RN*[1]*; Jason Halvorson, MD*[4]*; Gregory J. Della Rocca, MD, PhD, FACS*[5]*; Bryan Ming, MD*[6]*; Brian Mullis, MD*[7]*; Chetan Deshpande, MD*[8]
[1]*Saint Louis University, St. Louis, Missouri, USA;*
[2]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[3]*Dwight D. Eisenhower Army Medical Center, Fort Gordon, Georgia, USA;*
[4]*Wake Forest University School of Medicine, Winston-Salem, North Carolina, USA;*
[5]*University of Missouri School of Medicine, Columbia, Missouri, USA;*
[6]*UNT Health Bone & Joint Institute, Fort Worth, Texas, USA;*
[7]*Eskenazi Health, Indianapolis, Indiana, USA;*
[8]*Mercer University, Macon, Georgia, USA*

Purpose: The combination of ipsilateral acetabular and femur fractures are uncommon and associated with high-energy mechanisms. Orthopaedic complications from this combination may include heterotopic ossification (HO), osteonecrosis (ON) of the femoral head, and post-traumatic arthritis (PTA). There is a paucity of literature investigating the optimal treatment and outcomes. The goals of this study are to investigate the outcomes and complications of ipsilateral acetabular and femoral fractures.

Methods: A retrospective review of patients treated for ipsilateral acetabular and femoral fractures (excluding femoral head) was performed between 2007-2013 at 8 Level I trauma centers. Injury data and surgical details were collected. Surgical details included approach, positioning, and implant; order and timing of fixation (single/multiple procedures). The femoral fractures were classified according to the OTA classification system and according to Letournel for acetabular fractures. Nominal data were analyzed using X^2 analysis or Fisher's exact test as appropriate. Categorical data were analyzed using Mann Whitney *U* test. Analysis of variance (ANOVA) was performed to model combinations of variables.

Results: 101 patients met inclusion criteria and had sufficient data for analysis. There were 64 males and 37 females with an average age of 37 (range, 17-78). The median follow-up was 11 months. 87 patients (86%) were injured in either a motor vehicle or motorcycle crash. 54 patients had elementary and 47 had associated/combined pattern acetabular fractures. Age of 45 or greater was significantly associated with marginal impaction of the acetabular fracture ($P = 0.001$). There were 52 proximal, 41 shaft, and 8 distal femur fractures. 26 patients underwent stabilization of both fractures during the same anesthetic. 16 patients underwent fixation of both fractures using the same incision. Seven patients (7%) had ON, 29 (29%) had HO, 18 (18%) had PTA, and 14 (14%) had DVT/PE (deep venous thrombosis/pulmonary embolism). There were 9 superficial and 8 deep infections, resulting in an aggregate infection rate of 17%. 15 patients required additional surgery on their acetabular fracture, 12 required additional surgery on their femur, and 6 required additional surgery at both sites. The rate of ON was significantly higher in the associated/combined acetabular fractures with proximal femur fractures ($P < 0.05$). The rate of DVT (20%) in femoral shaft fractures with acetabular fractures was significantly higher than other femur fracture

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

locations (P <0.05). In addition, the rates of DVT and PE were significantly associated with age and time to surgical fixation (P <0.05).

Conclusion: This is the largest study to report the results of surgical treatment of ipsilateral acetabular and femoral fractures. In this cohort, approach and implants for fracture fixation had no impact upon the complication rate. Statistical analysis demonstrated the complications that occurred are multifactorial. The authors found that increased age was significantly associated with a higher risk of marginal impaction, DVT and PE (P <0.05), and longer time between admission and fixation of either fracture was significantly associated with higher rates of DVT, PE, and superficial infection (P <0.05). The complication rates for ON were found to be significantly higher when the associated acetabular fractures coexist in the same region (acetabular fracture and proximal femur). This study provides useful information regarding the prognosis and clinical outcome of patients with this predominantly high-energy injury complex.

See pages 49 - 106 for financial disclosure information.

Functional Outcomes in Acetabular Fractures in Older Patients: Operative versus Conservative Treatment. A Retrospective Review

Joseph Queally, MD FRCS (Tr & Orth); *James Rich, Med Student; Matthew Seah, BMedSci, MBChB, MSc, MRCSEd; Ronan O'Leary, MB BCh BAO; Peter Hull, FRCS (Tr & Orth); Andrew Carrothers, FRCS (Tr & Orth)*
Cambridge University Hospitals NHS Foundation Trust, Cambridge, UNITED KINGDOM

Background/Purpose: Acetabular fractures in older patients are increasing in incidence on a background of an aging population. The optimal management remains unknown with the two main options being conservative and operative treatment. Operative can consist of open reduction and internal fixation (ORIF) or, as has evolved more recently, ORIF combined with a total hip replacement. Difficulties with conservative management include the morbidity and mortality associated with prolonged immobilization. Difficulties with operative treatment include suboptimal fixation due to fracture comminution and/or poor bone quality due to osteoporosis and perioperative morbidity and mortality. The primary aim of this study was to compare functional outcomes in acetabular fractures in older patients treated conservatively with those in patients treated operatively. Secondary aims included comparison of radiological outcomes and complications.

Methods: Our institutional pelvic trauma database was reviewed for all patients aged 60 years or older who had conservative or operative treatment for a displaced acetabular fracture from January 2013 to December 2015. Functional outcome was assessed via the EuroQol (EQ)-5D and Oxford hip scores. Radiological outcome was assessed by AP pelvic radiographs. Complications were assessed by review of the patient's medical records.

Results: 40 patients underwent conservative treatment that consisted of weight bearing as tolerated. 12 patients received operative treatment (7 ORIF, 5 ORIF combined with total hip replacement). There were no significant differences between the groups in terms of age (80.2 years vs 76.8 years, $P < 0.05$) or fracture displacement at the time of injury. The follow-up time was similar at 11 months (SD 8.9) and 12.2 months (SD 6.1), respectively ($P < 0.05$). There was a significant difference in mortality with a higher rate in the conservatively managed group (10/40 vs 0/12) at time of follow-up. Of the remaining patients in each group, follow-up was high at 88% (25/30 and 12/12, respectively). Regarding the primary outcomes, patients in the operative group had a significantly higher functional outcome as measured by EQ-5D index (0-100) (76.7 vs 67.7, $P < 0.05$). There was no significant difference in the Oxford hip score (0-48) (30.4 vs 32.8, $P > 0.05$). On further subgroup analysis, patients who underwent ORIF combined with total hip replacement as opposed to ORIF alone fared best in terms of outcome for both functional (83.3 vs 78.8, $P < 0.05$) and Oxford hip scores (41 vs 32, $P < 0.05$). Significantly more patients in the conservative group were awaiting a total hip replacement for symptomatic posttraumatic osteoarthritis than in the ORIF group (4/25 vs 1/7, $P < 0.05$). Regarding postoperative complications, there was one myocardial infarction in the ORIF combined with total hip replacement group.

Conclusion: This is the first study that compares functional outcomes in acetabular fractures in older patients treated conservatively with operative treatment. Patients who underwent

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

operative treatment had a higher EQ-5D functional outcome. Of patients who had operative treatment, those who had ORIF combined with total hip replacement had the highest EQ-5D scores. Patients in the conservative group had a significantly higher mortality rate. Limitations to this study include it being a nonrandomized retrospective study. As the incidence of these fractures increases, a randomized controlled trial is now required to further investigate the above findings to determine the optimal treatment.

See pages 49 - 106 for financial disclosure information.

Negative Stress Examination Under Anesthesia Is Reliable in Predicting Union Without Displacement While Fully Weight Bearing

Darryl Auston, MD, PhD[1]*; Paul Whiting, MD*[2]*; Frank Avilucea, MD*[3]*; Michael Beebe, MD*[4]*; Jonathan Quade, MD*[5]*; Ross Daniel, BS*[6]*; Michael T. Archdeacon, MD*[7]*; Cory Collinge, MD*[8]*; Henry Sagi, MD*[9]*; Hassan R. Mir, MD*[5]

[1]*SUNY Upstate Medical University, Syracuse, New York, USA;*
[2]*University of Wisconsin, Madison, Wisconsin, USA;*
[3]*University of Cincinnati Academic Health Center, Cincinnati, Ohio, USA;*
[4]*Florida Orthopaedic Institute, Tampa, Florida, USA;*
[5]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[6]*University of Southern Florida Medical School, Tampa, Florida, USA;*
[7]*University of Cincinnati Dept of Orthopaedics, Cincinnati, Ohio, USA;*
[8]*Harris Methodist Fort Worth Hospital, Fort Worth, Texas, USA;*
[9]*Harborview Medical Center, Seattle, Washington, USA*

Background/Purpose: The ideal method for determining pelvic ring stability following trauma is a controversial topic because static radiographs and CT scans may not accurately reflect the degree of displacement that occurred at the time of injury. Stress examination under anesthesia (EUA) has been advocated as a potential method for quantifying the degree of pelvic instability and disclosing occult injuries following trauma. The purpose of this analysis was to investigate the predictive value of a negative EUA (stable pelvis) for determining pelvic ring union without displacement while permitting full weight bearing during the healing process.

Methods: Over a 5-year period, closed pelvic ring injuries in skeletally mature patients that were deemed stable after EUA were identified. A negative EUA was defined as one that did not reach operative criteria as defined by Sagi et al and was treated without internal fixation. To be included in the analysis, patients must have been able to fully weight-bear bilaterally immediately post-EUA. Patient demographics, fracture classification, associated injuries, and postoperative weight-bearing status were recorded. Charts and radiographs were reviewed to determine union and displacement.

Results: 34 skeletally mature patients out of a total of 896 who underwent EUA had a negative examination (stable pelvis). Average age was 38 years (range, 16-76), and 19 patients (55.8%) were male. 22 patients (64.7%) had Young-Burgess lateral compression (LC)-1 injuries with complete sacral fractures, 4 patients (12%) had LC-2 injuries, and 8 patients (24%) had anterior posterior compression (APC)-1 injuries. Seven patients (21%) had associated extremity injuries requiring restricted weight bearing and were excluded from the final analysis; immediate full weight bearing was permitted in the remaining 27 patients. Patients were followed until clinical and radiographic union (average 8 months; range, 3-34). At final radiographic and clinical follow-up, no patients demonstrated worsening deformity or interval displacement from the time of admission and EUA. There were no instances of delayed operative fixation following negative EUA.

Conclusion: A negative pelvic EUA after trauma accurately predicts the ability to fully

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

weight-bear and achieve union without further displacement. No patient in our series required delayed pelvic ring fixation. Unless otherwise dictated by associated injuries, immediate weight bearing as tolerated appears safe in the setting of a negative EUA.

See pages 49 - 106 for financial disclosure information.

Does Tranexamic Acid Reduce Intraoperative Blood Loss, Intraoperative Transfusion Rate, or Postoperative Transfusion Rate in Acetabular Fracture Surgery?

Seth Criner, DO, MS[1]*; Tony Pedri, MD*[1]*; Nathan Huff, BS*[1]*; Faers Qeadan, PhD*[1]*; Rick Gehlert, MD*[2]
[1]*University of New Mexico, Albuquerque, New Mexico, USA;*
[2]*University of New Mexico Health Sciences Library & Informatics Center, Albuquerque, New Mexico, USA*

Purpose: Tranexamic acid (TXA) is being widely used in total joint arthroplasty and has been shown to decrease blood loss and transfusion rate without increased risk of thromboembolic events. As a result of the findings in total joint arthroplasty, we started using TXA during pelvic and acetabular fracture surgery. Our hypothesis is that administration of intravenous TXA will reduce intraoperative blood loss, intraoperative transfused units, and postoperative transfused units of blood in acetabular fracture surgery without an increase in deep vein thrombosis (DVT) or thromboembolic events.

Methods: We did a retrospective review of patients under the care of a single orthopaedic traumatologist from 2010-2015. We reviewed a cohort of patients who received TXA and compared them to a matched cohort that did not. Data were collected on intraoperative blood loss, and units of blood product administered preoperative, intraoperative, and postoperative. In addition, administration of blood from cell saver was also recorded when used. We recorded preoperative/postoperative hematocrit. The approach used for surgery and the length of surgery were recorded, and the amount of blood loss per minute of surgery was calculated. It was important to calculate the rate of blood loss per minute of surgery because longer surgery increases blood loss. And finally we collected data on thromboembolic events such as DVT, pulmonary embolism (PE), and stroke. When we had parametric data a *t* test was used and when it was nonparametric we used a Wilcoxon score, which is based on median.

Results: We separated the patients into two groups based on the approach used at the time of surgery. Those patients were then split into a group that did and did not receive TXA. When comparing the group of patients that underwent a Kocher approach (no TXA n = 34, TXA n=19) there was no statistically significant difference using *t* test in intraoperative blood loss ($P = 0.47$), rate blood loss per min/surgery ($P = 0.71$), or length of surgery ($P = 0.81$). We did not have enough patients require cell saver, blood transfusion either intraoperative or postoperative to calculate significance. When looking at patients who had an anterior approach to the acetabulum there were 18 patients who did not receive TXA and 14 that did receive TXA. There was no statistically significant difference in the amount of cell saver transfused ($P = 0.32$) or length of surgery ($P = 0.52$). Intraoperative blood loss ($P = 0.13$) started to approach statistical significance. Rate of blood loss per min/surgery ($P = 0.02$) and intraoperative blood transfusion rate ($P = 0.05$) were statistically significant. We did not have enough patients receive a postoperative blood transfusion to calculate significance. There were no thromboembolic complications such as DVT, PE, or stroke in patients who underwent a Kocher approach. There were 2 patients who developed a DVT and 1 who

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Anterior Approach to Acetabulum

Variable	GROUP = TXA (N=12)	GROUP = no TXA (N=18)	P-Value
Cell Saver (ml) (Mean ± SD (N))	280.3 ± 145.4 (N=12)	448.6 ± 529.7 (N=18)	0.20°
Intraoperative blood loss (Mean ± SD (N))	900.0 ± 400.6 (N=12)	1347.2 ± 937.1 (N=18)	0.08°
Intraoperative blood transfusion (Mean ± SD (N))	1.1 ± 1.2 (N=12)	2.3 ± 2.2(N=18)	0.06°
Length of Surgery (min) (Mean ± SD (N))	280.3 ± 82.0 (N=12)	249.8 ± 101.9 (N=18)	0.37°
Postoperative blood transfusion (Mean ± SD (N))	0.2 ± 0.6 (N=12)	0.3 ± 0.7 (N=18)	0.63°
Rate blood loss per min/sx (Mean ± SD (N))	3.3 ± 1.6 (N=12)	5.4 ± 1.5 (N=18)	0.02°

Kocher Approach to Acetabulum

Variable	GROUP = TXA (N=21)	GROUP = no TXA (N=35)	P-Value
Cell Saver (ml) (Mean ± SD (N))	49.3 ± 140.3 (N=21)	67.9 ± 156.5 (N=35)	0.66°
Intraoperative blood loss (Mean ± SD (N))	533.3 ± 308.0 (N=21)	554.3 ± 460.9 (N=35)	0.85°
Intraoperative blood transfusion (Mean ± SD (N))	0.4 ± 0.7 (N=21)	0.6 ± 1.0 (N=35)	0.47°
Length of Surgery (min) (Mean ± SD (N))	213.3 ± 104.6 (N=21)	194.3 ± 61.7 (N=35)	0.39°
Postoperative blood transfusion (Mean ± SD (N))	0.1 ± 0.4 (N=21)	0.5 ± 1.1 (N=35)	0.15°
Rate blood loss per min/sx (Mean ± SD (N))	2.6 ± 1.1 (N=21)	2.7 ± 1.6 (N=35)	0.81°

developed a PE who underwent an anterior approach but did not receive TXA. There was 1 patient who received TXA and underwent an anterior approach who developed a DVT.

Conclusion: At this time it does not appear that the use of TXA decreases the rate of blood loss during acetabular surgery with the use of a Kocher approach. However, when using an anterior approach to the acetabulum there was a statistically significant decrease rate of blood loss per minute of surgery and intraoperative blood transfusion. There was a trend toward decreased intraoperative blood loss. There was no statistically significant increase in rate of thromboembolic events in patients who received TXA compared to those who did not. As a result, it appears to be safe to use TXA during acetabular fracture surgery. At this time, we recommend the use of TXA in patients undergoing an anterior approach to the acetabulum for fracture surgery. It does not appear to be beneficial to use TXA during the Kocher approach for acetabular surgery.

See pages 49 - 106 for financial disclosure information.

Postoperative CT Is a Superior Modality for Assessment of Acetabular Fracture Reduction

Diederik Verbeek, MD; Jelle van der List, MD; David Wellman, MD; David Helfet, MD
Hospital for Special Surgery, New York, New York, USA

Purpose: The quality of reduction after acetabular fracture surgery is an important predictor for clinical outcome. We hypothesized that pelvic CT after acetabular fracture fixation is superior to pelvic radiography (PXR) in detecting residual displacement and for predicting the need for total hip arthroplasty (THA).

Methods: All adult patients who received operative fixation for an acute acetabular fracture were identified from the prospective orthopaedic trauma database (1992-2012). Inclusion criteria consisted of at least 2-year follow-up (or an early conversion to THA following surgery) and availability of full radiographic imaging (both digital DICOM [Digital Imaging and Communications in Medicine] and predigital imaging were assessed when available), which yielded a cohort of 201 cases. Residual displacement was measured on postoperative PXR and graded according to Matta's criteria (anatomic 0-1 mm, imperfect 2-3 mm, poor >3 mm). The postoperative CT scans were evaluated in axial, sagittal, and coronal planes for quality of reduction. The same Matta measurement criteria were then applied to the CT scans. In order to be anatomic, all 3 reformatted images (axial, sagittal, and coronal) needed concentric reduction with 0-1 mm of gap or stepoff. The association between an anatomic (<2 mm) versus a nonanatomic reduction (≥2 mm) and the need for THA was determined for PXR and CT-based measurements. A subanalysis was performed in younger patients (<65 years). All measurements were performed by fellowship-trained traumatologists in blinded fashion. None of the surgeons performing measurements were involved in the surgical care of the patients.

Results: Based on PXR, 101 of the cohort of 201 patients (50%) had an anatomic, 66 (33%) an imperfect, and 34 (17%) a poor reduction. CT, however, showed that 74 anatomic reductions (73%) had residual displacement of ≥2 mm (imperfect [35%] or poor [39%] reductions). Furthermore, CT showed that 33 imperfect reductions (50%) had residual displacement of >3 mm (poor reductions) and 6 (9%) had <2 mm displacement on CT (anatomic reductions). Lastly, a poor reduction on PXR was confirmed on CT in 32 (94%); 2 (6%) were imperfect reductions on CT. Patients were followed up for a mean duration of 7.3 years (range, 0.2-23.2), and THA was performed in 45 patients (22%). In patients with an anatomic reduction on PXR, 17 (17%) required THA versus 28 (28%) in nonanatomic reductions ($P = 0.064$). Conversely, in patients with an anatomic reduction on CT (33), 1 (3%) required THA versus 44 (26%) in nonanatomic reductions (168); $P = 0.002$. In 150 younger patients, the difference for this association between both modalities was even more pronounced ($P = 0.202$ [PXR] vs $P = 0.005$ [CT]).

Conclusion: Computed tomography is able to more accurately detect residual displacement after acetabular fracture fixation than PXR. A substantial number of patients with an apparent anatomic acetabular reduction on PXR have a nonanatomic reduction according to CT imaging. The quality of reduction as assessed on postoperative CT (versus PXR) is

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

more strongly associated with eventual need for THA, particularly in younger patients. It is unlikely patients with an anatomic reduction on CT will require THA at midterm follow-up.

See pages 49 - 106 for financial disclosure information.

Postambulation Radiographs for Stable Pelvic Ring Fractures Are of Low Utility

Miranda Bice, MD[1]; Jenifer Jarrell, MD[1]; Angela Presson, PhD[1]; Erik Kubiak, MD[2]; David Rothberg, MD[1]
[1]University of Utah, Salt Lake City, Utah, USA;
[2]University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA

Background/Purpose: The standard of care for pelvic ring fractures presumed to be stable and subsequently planned for nonoperative treatment includes obtaining a radiographic series of the pelvic ring following ambulation to confirm stability prior to discharge. We believe that, with rare exception, these films do not change clinical decision making. The additional imaging does, however, contribute additional cost, radiation exposure, and potentially length of stay. The purpose of this study was to determine with what frequency postambulation radiographs led to a change in management of stable-appearing pelvic ring fractures.

Methods: An IRB-approved retrospective review of all patients with acute pelvic ring fractures treated at a single Level I academic trauma center from 2000-2015 was conducted. Subjects with incomplete radiographic or clinical records were excluded. All charts were reviewed for basic demographic information as well as intended treatment versus final treatment. If there was a change in treatment, it was noted whether clinical or radiographic findings prompted the change. Finally, if management converted from nonoperative to operative intervention, time to surgery was recorded. A descriptive statistical analysis was performed.

Results: 1050 patients were included. Based on initial evaluation, 695 pelvic ring fractures were initially determined to be stable and treated in a nonoperative manner. Early surgical intervention was performed on 355 unstable pelvic ring fractures. The mean age of this group was 38.6 years (SD 17.24) and 63% were male. 14 pelvic ring fractures initially thought to be stable and not requiring operative intervention did convert to surgical management (2%). The mean age of this group was 48.74 years (SD 20.19) and 71% were male. Of the 681 that remained nonoperative, the mean age was 48.17 years (SD 23.43) and 58% were female. Of those that converted from nonoperative to operative management, 12 did so within the first week following injury, one converted at 20 days, and one converted at 48 days. Instability as demonstrated on radiographs was observed in three patients that converted from nonoperative to operative management. Pain preventing adequate mobilization was the primary motivation for conversion of the remaining 11 patients. All 14 patients that converted from nonoperative to operative management had pain with attempted mobilization.

Conclusion: This study demonstrates the low-yield nature of postambulation radiographic evaluation to confirm nonoperative management for presumed stable pelvic fractures as only 3 patients out of 695 (2%) demonstrated radiographic changes on radiographs obtained after mobilization. All patients with radiographic changes also reported notable pain with attempted mobilization. The 11 patients requiring conversion to surgical from nonsurgical management without radiographic changes had significant pain preventing adequate mobilization. This may be indicative of dynamic instability that remained undetected with plain radiographic analysis. Each of the nonoperative failures could have been predicted

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

based on pain and inability to adequately mobilize even in the absence of repeat postambulation radiographs. In this cohort of patients, there was no asymptomatic patient who had a change in management based on radiographic findings alone. These results suggest that pain is a more likely determinant and therefore a more sensitive measure for prediction of conversion to surgical management than radiographic changes.

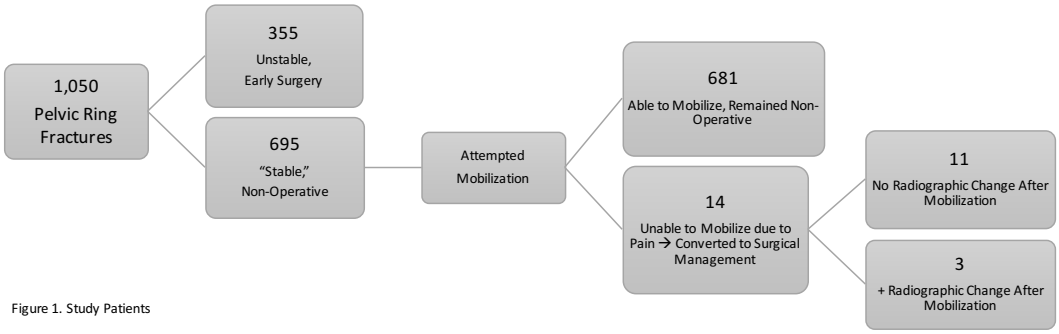


Figure 1. Study Patients

See pages 49 - 106 for financial disclosure information.

A Novel CT Assessment to Determine Hip Stability After Posterior Wall Fractures

Andrea Torres, BS[1]; Chang-Yeon Kim, BS, MS[2]; Michael P. Leslie, DO[2]
[1]Yale University, New Haven, Connecticut, USA
[2]Yale School of Medicine, New Haven, Connecticut, USA

Background/Purpose: Posterior wall fractures of the acetabulum are among the most common types of acetabulum fractures. The stability of these fractures determines whether the patient would benefit from surgical intervention, but methods of predicting the stability using plain radiographs and 2-dimensional CT vary widely in the literature. This study investigates the use of different CT measurements to predict the stability of posterior wall fractures. We hypothesized that a modified posterior acetabular sector angle (PASA) and an angle developed by the authors not previously reported in the literature would accurately predict the stability of the fracture and correlate with a history of dislocation at the time of injury.

Methods: A retrospective evaluation was conducted of 73 patients with unilateral posterior wall fractures of the acetabulum from 2010 to 2014. The modified PASA, measured between a line joining the centers of the femoral heads and a line through the edge of the fracture, and ischial wall fracture angle (IWFA), measured between a line parallel to the ischium and a line through the edge of the fracture, were measured on the axial CT at the level of the most medial excursion of the fracture. This was done to measure the angle at the level where the posterior wall defect was largest. Statistical analysis was performed using a logistic regression to assess independent predictors of dislocation with significance set at a P value of <0.05.

Results: The modified PASA was unable to be measured in nine patients. 42 patients presented to the emergency room with dislocated hips or a known history of dislocation. The modified PASA was the only significant predictor for dislocation ($P = 0.009$). Statistical analysis showed that for each degree decrease in the modified PASA, the odds of dislocation increase by 0.916. 13 patients with no dislocation had a modified PASA equivalent to that of patients with known dislocations. There was no statistically significant correlation between the IWFA and dislocation.

Table 1. Logistic regression data. The odds ratio for the PASA shows that the odds of having a hip dislocation increase by 0.916 for every point decrease in the PASA.

	B	S.E.	P-value	Odds Ratio
PASA	-.087	.033	.009	.916
IWFA	-.006	.022	.795	.994
Constant	-6.368	11.825	.590	.002

PASA – Posterior acetabular sector angle, IWFA – Ischial wall fracture angle

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusion: The modified PASA may adequately predict a history of hip dislocation, and thus stability, for posterior wall fractures that does not rely on determining the size of the wall defect. It might eliminate the indeterminate stability assessment present using methods that rely on measuring the fraction of the posterior wall involved. Further clinical studies to determine an acceptable cutoff for treatment direction are warranted.

See pages 49 - 106 for financial disclosure information.

Outcomes, Length of Stay, and Charges Associated with Treatment of Geriatric Acetabulum Fractures

Nickolas Nahm, MD[1]; Albert George, MD[1]; William Hakeos, MD[1]; Joseph Hoegler, MD[1]; Stuart Guthrie, MD[2]
[1]*Henry Ford Hospital, Detroit, Michigan, USA;*
[2]*Henry Ford Hospital System, Detroit, Michigan, USA*

Background/Purpose: The indications for treatment of geriatric acetabulum fractures are controversial. Recent studies question the use of open reduction and internal fixation, suggesting that total hip arthroplasty (THA) or nonoperative treatment may be more suitable treatment options. However, these studies are limited by small sample size, and no studies have examined perioperative outcomes and cost of treatment. In light of the scarcity of literature in this area, we examined outcomes associated with treatment of geriatric acetabulum fractures in a large nationally representative cohort.

Methods: The Nationwide Inpatient Sample from 1998 to 2010 was queried using ICD-9 diagnostic code 808.0 (closed acetabulum fracture) as a primary diagnostic code to identify patients with acetabulum fractures. These patients were clustered according to treatment by ICD-9 procedure codes: surgical fixation (ICD-9 procedure codes 79.19, 79.39 and 78.59), THA (ICD-9 procedure code 81.51), nonoperative treatment (ICD-9 procedure codes 79.09 and 79.75 as well as patients with no associated ICD-9 procedure code), and skeletal traction (ICD-9 procedure codes 93.44 and 93.46). Analysis was limited to geriatric patients (age 65 years or older). A weighted sample was generated as per the Healthcare Cost and Utilization Project guidelines. Outcomes evaluated included inpatient mortality, complications including cardiac, respiratory, vascular, gastrointestinal, genitourinary, wound, metabolic and neurologic, need for blood transfusion, length of stay, and charges. Generalized linear models fitted with generalized estimating equations controlling for clustering within the hospitals were utilized to estimate the association of treatment type with outcomes. $P < 0.05$ was considered statistically significant.

Results: 54,579 patients were included in the weighted sample. After controlling for age, gender, race, Charlson Comorbidity Index, and hospital characteristics including teaching status, region, annual case load, and location, the mortality associated with nonoperative treatment was significantly lower (odds ratio [OR] 0.311, $P < 0.001$) compared to surgical fixation (Table). In addition, cardiac, respiratory, vascular, genitourinary, gastrointestinal, and neurologic complications were significantly lower in patients treated nonoperatively compared to surgical fixation ($P < 0.001$; Table). Administration of blood transfusion was lower in nonoperative treatment compared to surgical fixation (0.2% vs 32.5%, $P < 0.001$). However, a higher proportion of THA patients had a blood transfusion compared to surgical fixation (46.3% vs 32.5%, $P < 0.001$). Length of stay was longer in patients treated with surgical fixation compared to nonoperative treatment (median 9 days vs 4 days, $P < 0.001$). In addition, the median charges for nonoperative treatment were lower than the charges associated with surgical fixation (median $9206 vs $54,447, $P < 0.001$) while THA was the most expensive treatment option ($70,524, $P < 0.001$). No differences in mortality and length of stay were seen in THA compared to surgical fixation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table. Outcomes associated with treatment of geriatric acetabulum fractures

	THA			Non-operative treatment			Skeletal traction		
	Odds Ratio	**95% CI**	**p value**	**Odds Ratio**	**95% CI**	**p value**	**Odds Ratio**	**95% CI**	**p value**
In-hospital mortality	1.747	0.981 to 3.111	0.058	0.311	0.192 to 0.505	<0.001	1.385	0.731 to 2.624	0.317
Complications									
Cardiac	0.899	0.584 to 1.384	0.629	0.344	0.252 to 0.470	<0.001	0.439	0.247 to 0.780	0.005
Respiratory	1.027	0.698 to 1.510	0.892	0.203	0.161 to 0.256	<0.001	0.411	0.276 to 0.611	<0.001
Vascular	1.057	0.715 to 1.561	0.781	0.279	0.210 to 0.371	<0.001	0.500	0.297 to 0.841	0.009
Wound	1.065	0.579 to 1.961	0.839	0.032	0.014 to 0.072	<0.001	0.004	0.000 to 0.058	<0.001
Genitourinary	1.026	0.595 to 1.768	0.928	0.520	0.365 to 0.741	<0.001	0.023	0.007 to 0.079	<0.001
Gastrointestinal	1.013	0.686 to 1.497	0.947	0.203	0.151 to 0.273	<0.001	0.697	0.446 to 1.091	0.115
Neurologic	0.313	0.106 to 0.926	0.036	0.182	0.111 to 0.299	<0.001	0.246	0.086 to 0.703	0.009
Metabolic	1.495	1.110 to 2.013	0.008	0.412	0.332 to 0.512	<0.001	0.648	0.461 to 0.910	0.012
Transfusion	1.61	1.192 to 2.173	0.002	0.004	0.002 to 0.007	<0.001	0.179	0.122 to 0.264	<0.001
Prolonged LOS	1.062	0.819 to 1.378	0.649	0.092	0.077 to 0.109	<0.001	0.501	0.394 to 0.636	<0.001
Excessive charges	2.404	1.617 to 3.573	<0.001	0.026	0.020 to 0.032	<0.001	0.125	0.089 to 0.175	<0.001

Reference: Surgical fixation. Prolonged LOS, >75th percentile of the entire cohort for LOS. Excessive charges, >75th percentile of the entire cohort for charges.

THA, total hip arthroplasty; LOS, length of stay

Conclusion: After adjusting for multiple relevant confounders, we found that the non-operative treatment of geriatric acetabulum fractures is associated with lower mortality, complications, length of stay, and charges compared to surgical fixation. In addition, no differences in mortality and length of stay were seen between THA and surgical fixation. However, the charges associated with THA were increased compared to surgical fixation. We conclude that surgical fixation should be examined closely in this medically fragile patient population, given the higher rate of mortality and complications.

See pages 49 - 106 for financial disclosure information.

Postambulatory Radiographs Do Not Change Management of Pelvic Ring Injuries

Luke Nicholson, MD[1]; Hardik Parikh, BA[1]; Geoffrey Marecek, MD[2];
[1]University of Southern California, Los Angeles, California, USA;
[2]Keck School of Medicine of University of Southern California, Los Angeles, California, USA

Purpose: Controversy exists regarding the management of pelvic ring injuries with minimal displacement. Management of lateral compression (LC) and anterior-posterior compression (APC) injuries is dependent on the potential for fracture displacement with nonoperative management. One technique for the management of potentially unstable pelvic ring injuries is to obtain postambulatory pelvic radiographs to evaluate for interval displacement of the injury necessitating surgical intervention.

Methods: All patients presenting to the authors' institution between 2012-2014 with pelvic ring injuries for which postambulatory radiographs were obtained were retrospectively identified. All injuries were classified by CT scan according to the AO/OTA pelvic ring classification. Patients were excluded if postambulatory films were obtained more than 6 weeks from the date of injury.

Results: 85 patients met inclusion criteria. There were 15 OTA 61-A type fractures, 49 OTA 61-B type fractures, and 21 OTA 61-C type fractures included. Postambulatory radiographs were obtained an average of 8.8 days after the date of injury while the patient was an inpatient. In no cases did review of postambulatory films change the initial management decision. All patients were managed nonoperatively. 50 patients were available for outpatient follow-up at a mean of 12.3 weeks postinjury. No patients were converted to operative management at time of final follow-up.

Conclusion: The routine use of postambulatory radiographs to evaluate for occult pelvic instability does not change management of pelvic ring instability. If the pelvic ring injury pattern is one at high risk for displacement or the patient's clinical examination suggests instability, a more appropriate tool to evaluate for instability may be a fluoroscopic examination under anesthesia.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Expandable Proximal Femoral Nail versus Gamma Proximal Femoral Nail for the Treatment of AO/OTA 31A1-3 Fractures

Michael Drexler, MD*; Yaniv Warschawski, MD; Tal Frenkel, MD; Eyal Amar, MD; Ehud Rath, MD; Gilad Eisenberg, MD; Nimrod Snir, MD; Ely Steinberg, MD*
Tel Aviv Souraski Medical Center, Tel-Aviv University, Tel Aviv, ISRAEL

Purpose: The gamma-proximal femoral nail (GPFN) and the expandable proximal femoral nail (EPFN) are two commonly used intramedullary devices for the treatment of AO 31A1-3 proximal femur fractures. The aim of this study was to compare outcomes and complication rates in patients treated by both devices.

Methods: A total of 299 patients (149 in the GPFN group and 150 in the EPFN group, average age 83.6 years) were treated for AO 31A1-3 proximal femur fractures in our institution between July 2008 and February 2013. Time from presentation to surgery, level of experience of the surgeon, operative time, amount of blood loss, and number of blood transfusions were recorded. Postoperative radiological variables, including peg/screw location, tip to apex distance, and orthopaedic complications, such as malunion, nonunion, surgical wound infection rates, cutouts, periprosthetic fractures and the incidence of non-orthopaedic complications were recorded. Functional results were estimated using the modified Harris Hip Score, and quality of life was queried by the Short Form (SF)-36 questionnaire.

Results: The GPFN and the EPFN fixation methods were similar in terms of functional outcomes, complication rates, and quality of life assessments. More patients (107 vs. 73) from the GPFN group were operated within 48 hours from presentation (44.81 hours vs 49.88 hours for the EPFN group, $P = 0.351$), and their surgery duration and hospitalization were significantly longer (18.5 days vs 26 days, respectively, $P < 0.001$). The GPFN patients were frequently operated by junior surgeons. Other intraoperative measures were similar between groups. Cutout was the most common complication, affecting 6.71% of the GPFN group and 3.33% of the EPFN group ($P = 0.182$).

Conclusion: Good clinical outcomes and low complication rates in the GPFN and the EPFN groups indicate essentially equivalent safety and reliability on the part of both devices for the treatment of proximal femoral fractures.

See pages 49 - 106 for financial disclosure information.

Older Patients Really Do Break More Easily: Decreased Collision Energy in Geriatric MVCs

Andrew Usoro, BA[1]*; Ashley Weaver, PhD*[2]*; Scott Wuertzer, MD*[1]*; Joel Stitzel, PhD*[2]*; Leon Lenchik, MD*[1]*; Anna Miller, MD, FACS*[3]
[1]*Wake Forest School of Medicine, Winston-Salem, North Carolina, USA;*
[2]*Virginia Tech-Wake Forest University Center for Injury Biomechanics, Blacksburg, Virginia, USA;*
[3]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA*

Purpose: As the population continues to age, an increasing number of motor vehicle collisions (MVCs) will involve older adults. This study was designed to examine the association between patient age and collision energy across various fracture patterns seen in older adults involved in MVCs compared to younger adults involved in similar crashes.

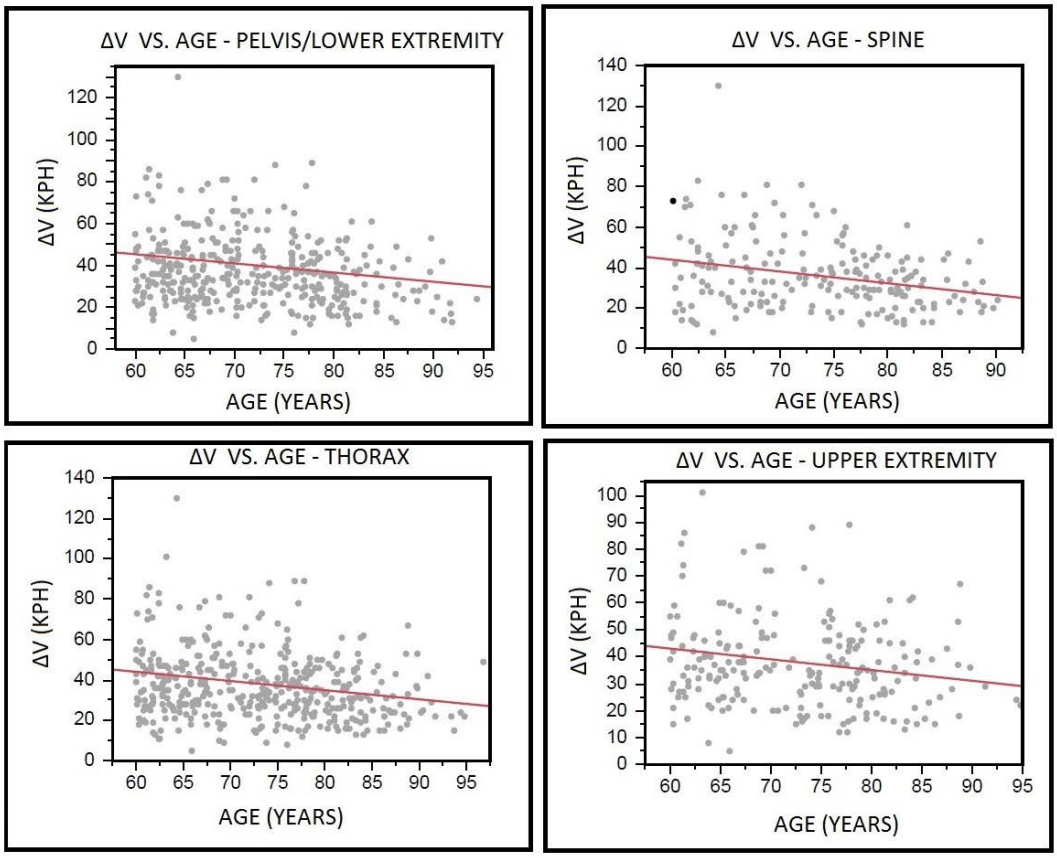
Methods: 862 subjects over 60 years of age from the National Highway Traffic Safety Administration's (NHTSA) Crash Injury Research and Engineering Network (CIREN) database were reviewed. Fractures were stratified into five categories: spine, upper extremity, pelvis/lower extremity, thorax, and head/face. For each fracture type, bivariate linear regression analysis was used to determine the association between age and change in velocity during the crash as well as age and absorbed energy level during the crash. The analysis was then repeated, stratified by gender. 900 subjects ages 20-50 from the NHTSA's CIREN database were also reviewed with identical analysis done for comparison.

Results: For adults over age 60, there were 377 men and 485 women, mean age 73 years (range, 60-97). For all fracture types except head/face, age was inversely correlated with both change in velocity (Δv) and absorbed energy. Compared to participants ages 60, the oldest participants had a significant decrease in required energy levels to sustain similar fractures. Specifically, for spine: Δv (53% decrease; $P < 0.0001$), absorbed energy (87% decrease; $P < 0.0001$); upper extremity fractures: Δv (37% decrease; $P < 0.0001$), absorbed energy (61% decrease; $P < 0.0001$); pelvis/lower extremity fractures: Δv (38% decrease; $P < 0.0001$), absorbed energy (37% decrease; $P < 0.0001$); and thorax fractures: Δv (41% decrease; $P < 0.0001$), absorbed energy (23% decrease; $P < 0.0001$). When stratified by gender, significant inverse association between age and energy for each of these four fracture types was seen in both women and in men. For head/face fractures, there was no significant association between age and absorbed energy. The analysis was then repeated in participants aged 20-50. Age was inversely associated with both Δv and absorbed energy for only thorax fractures: Δv (18% decrease; $P < 0.001$). There was no consistent significant association seen in spine, upper extremity, pelvis/lower extremity, or head/face fracture types.

Conclusion: In motor vehicles crashes involving adults, older adults demonstrated an inverse association between patient age and energy levels in all fracture types, except in head and face while younger adults showed an inverse correlation between age and energy levels in only thorax fractures. This study reveals that traumatic fractures in MVCs occur at lower velocities and require less energy with increasing age. Most importantly, it supports emerging data that bone density is an important contributor to fractures in "high-energy" MVCs.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

FIGURE 1. ΔV VS. AGE AMONG VARIOUS GERIATRIC FRACTURE PATTERNS



See pages 49 - 106 for financial disclosure information.

Implementation of a Hip Fracture Care Pathway Using Lean Six Sigma Methodology in a Level I Academic Trauma Center

Zain Sayeed, MSc MHA[1]; Afshin Anoushiravani, BSc[1]; Mouhanad El-Othmani, MD[1]; Gonzalo Barinaga, MD[1]; Yousuf Sayeed, MSc[2]; Eric Wright, BSc[1]; Monique Chambers, MD, MSL[1]; Paul Cagle, MD[1]; Khaled Saleh, MD, MSc, MHCM, FRCS(C), CPE[3]
[1]Southern Illinois University School of Medicine, Springfield, Illinois, USA;
[2]New York University, Brooklyn, New York, USA;
[3]Orthopaedic Education Inc., Springfield, Illinois, USA

Background/Purpose: The application of Lean Six Sigma (LSS) methodology represents a novel trend that is being adopted by academic institutions, private hospitals, and residency curriculums. Such management theory may be most useful in orthopaedic trauma settings; however, orthopaedic trauma literature rarely reports both positive and negative findings associated with LSS. The scope of this study is to illustrate the application of LSS principles in the implementation of a hip fracture integrated care pathway (ICP) designed to reduce the number of patients receiving operative care beyond 48 hours of admission.

Methods: A multidisciplinary team was assembled at a Level I academic trauma center to create a hip fracture ICP with use of LSS principles. From April 2011- April 2012, the multidisciplinary team examined hip fracture care to identify wastes occurring in the process that prolonged time to surgical intervention. By April 2012 several LSS tools including process flow maps, stakeholder and failure analyses, as well as patient focus groups, led to the formation of a standardized hip fracture order set. The ICP was designed to decrease time to surgery to less than 48 hours from April 2012 onward. The implementation of the ICP occurred in a prospectively observational manner. After a year of implementation, IRB approval was obtained to compare pre- and postimplementation metrics. Chart review allowed for direct comparison of pre- (April 2011- April 2012) and postimplementation (April 2012- April 2013) measurements including: time to surgery, percentage of patients operated beyond 48 hours, duration of surgery, complication detection, transfusion rate, length of stay (LOS), hospital cost and charge, 30-day readmissions, and inhospital mortality. Inclusion criteria for both cohorts included patient age >55 and radiographic evidence of hip fracture that indicated surgical intervention. Baseline characteristics were compared for respective cohorts including age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, fracture type (intertrochanteric, subtrochanteric, and femoral neck), and instrumentation (percutaneous hip screws, cephalomedullary nails, dynamic hip screws, hemiarthroplasty, and total hip arthroplasty). X^2 results were used for categorical data, and sample *t* tests were used to assess continuous variables. Significance was assigned to *P* values <0.05.

Results: A total of 505 hip fracture patients met inclusion criteria. A total of 221 patients entered the preimplementation cohort, and 284 were incorporated in the postimplementation cohort. Evaluation of baseline characteristics revealed no statistical significance between pre- and postimplementation cohorts with regard to gender, age, BMI, ASA score, fracture type, and instrumentation. The postimplementation cohort demonstrated reduction in time to surgery

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

that approached significance (preimplementation: 26.11 hours vs postimplementation: 22.75 hours, $P = 0.06$). The percentage of patients that received operative fixation beyond 48 hours significantly decreased (9.50% vs 4.23%, $P = 0.01$). Clinical outcomes were also assessed to elucidate the relationship of LSS application to well-known quality improvement metrics. Significantly more complications were detected in the postimplementation cohort (57.91% vs 77.19%, $P < 0.01$). In conjunction with complication detection, the postimplementation cohort displayed significantly shorter LOS (6.06 vs 5.28 days, $P = 0.02$) and decreased hospital cost by 9.7% ($P = 0.016$). 30-day readmission rate decreased from 22.62% to 17.19% following implementation of ICP ($P = 0.13$). Finally, the postimplementation cohort demonstrated a lower postoperative transfusion rate that approached significance (50.53% vs 58.37%, $P = 0.07$). In turn, this resulted in a 9.7% cost savings per case, and an estimated $1.164 million US in annual cost savings for our institution.

Conclusion: Our findings suggest that using LSS techniques to formulate an ICP at our institution resulted in significantly greater percentage of patients receiving operative care within 48 hours, and lower resource consumption. To our knowledge, this study offers a robust perspective of LSS application with regards to a hip fracture pathway, not elsewhere noted in orthopaedic literature. Future studies regarding LSS application should concentrate on delving into complication prevention, and ultimately how patient perception plays a role in quality of care.

Important Lean Six Sigma Principles

LSS Term	Description	Application in ICP Setting
DMAIC	An acronym for the following parameters: define, measure, analyze, improve, control.	Identification of key stake holders within the hip fracture ICP pathway and their contributions.
Failure Analysis	The process of determining cause of failure, and putting measures in place to prevent such occurrence.	Stakeholder analysis helped detect specific areas of process failure. Physician-to-physician peer evaluation of inability to perform surgery within 48 hours admission also aided in decreasing failure.
Standard Work	A concept whereby each work activity is precisely described and includes specifying cycle time, task sequence, and other steps involved within the process.	Each key stakeholder assessed their input into the process. i.e. anesthesia-preoperative pain management; emergency room physician-activate hip fracture order set and consult both orthopaedic and medicine teams.
Continuous Flow	One service moves from one process to the next. Where a unit of product flows from process to process. In effect, the batch quantity is one. A specific type of continuous flow is single-piece flow.	Our application of single piece continuous flow is modeled in our process flow map figure.
Value	The net difference between customer-perceived benefits and burdens; it is sometimes expressed as a ratio of benefits to burdens or a ratio of worth to cost.	For our implementation, the customer was considered to be the patient. During benchmark sessions, they described time as a value. A cost-analysis occurred with regard to time-to-surgery.
Lean Six Sigma	A fact based, data driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom line results by reducing variation, waste, and cycle time, while promoting standardization of flow.	The analysis method chosen by our comanagement team to help evaluate and create an integrated care pathway.
Lean	A comprehensive approach complemented by a collection of tools and techniques that focus on reducing cycle time, standardizing work, and reducing waste.	The application of Lean philosophy is evident in the DMAIC cycle described in discussion. Furthermore, successful reduction of cycle-time and value-stream mapping allowed for Lean implementation.
Kaizen	A term that means gradual unending improvement by doing small things better and setting and achieving increasingly higher standards. Kaizen is typically implemented as a small, intensive event or project over a relatively short duration, such as a week.	Kaizen meetings occurred amidst the ICP team. Furthermore, physician-to-physician interaction offered methods to enhance team morale and reinvest efforts toward decreasing time-to-surgery.

See pages 49 - 106 for financial disclosure information.

Baseline Characteristics of Hip Fracture Patients

Characteristics	Pre-Implementation	Post-Implementation	p-value
Gender (n, %)			
Female	164	217	.617
Male	57	67	
Age (mean, SD)	80.98 (10.21)	82.19 (9.99)	.182
BMI (mean, SD)	24.52 (6.91)	24.20 (5.09)	.568
ASA Score			
1			
2	28	35	.800
3	134	180	
4	59	69	
Fracture Type			
Femoral Neck	116	134	.443
Inter-trochanteric	96	140	
Sub-trochanteric	9	10	
Instrumentation			
Cephalomedullary nails	85	131	.305
Dynamic hip screws	31	33	
Hemi-arthroplasty	70	74	
Percutaneous hip screws	30	43	
Total hip arthroplasty	5	3	

Value Stream Map of Integrated Care Pathway

Clinical Outcomes of Pre- and Post-implementation of Hip Fracture Integrated Care Pathway

Outcomes	Pre-Implementation	Post-Implementation	p-value
Time-to-Surgery (mean, standard deviation [SD])	26.11 (24.74)	22.75 (15.27)	.061
% of Patients Operated Beyond 48 Hours	9.50%	4.23%	.01
Duration of Surgery (hrs. [SD])	1.16 (.559)	1.05 (.494)	.028
Detection of Complication	57.91%	77.19%	<.001
Transfusion Rate	58.37%	50.53%	.07
Length of Stay (LOS) (avg. days)	6.06	5.28	.023
Hospital Charge (USD)	Reference	-2.7%	.515
Hospital Cost (USD)	Reference	-9.7%	.016
30-Day Readmissions	22.62%	17.19%	.126
In-Hospital Mortality	1.8%	2.8%	.464

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Hoffa Fragments in the Geriatric Distal Femur Fracture: Myth or Reality?

Brian Hill, MD; *Praveen Nandamuru, BS; Lisa K. Cannada, MD*
Saint Louis University, St. Louis, Missouri, USA

Purpose: Previous research reported the frequency of coronal plane (Hoffa) fractures in high-energy supracondylar-intercondylar femur fractures. The study population was relatively young. However, the fracture patterns may not be similar to osteoporotic patients. The purpose of this study is to identify the frequency of coronal plane fractures seen in in elderly (≥60 years of age) patients. Our hypothesis is that elderly patients will have a significantly lower frequency of Hoffa fractures due to their bone quality combined with a likely different mechanism of injury.

Methods: Between 2011 and 2014, all patients over the age of 18 years treated for supracondylar femur fractures at two Level I trauma centers were reviewed. Patients were excluded if they did not have CT scans of their knee or if they had previous implants to the distal femur. Patient and injury characteristics along with fracture patterns were recorded. The patients were then stratified (≥60 years and <60 years) and compared to determine were differences in injury characteristics and/or fracture patterns with special attention to the incidence of coronal plane fractures. Binary comparisons were made using a Fisher exact test and ordinal or continuous variables were analyzed via Mann-Whitney *U* test. Significance was set at $P < 0.05$.

Results: 110 patients were identified with supracondylar femur fractures (12 OTA 33A; 2 OTA 33B; 96 OTA 33C). 32 of the 96 intercondylar fractures (33%) were in patients ≥60 years of age. Coronal plane fractures were visualized on CT scans in 56 (58%) of the 33C femur fractures. 44% of elderly patients sustained a coronal plane fracture compared with 66% percent of the younger cohort ($P = 0.04$). The elderly group included a higher percentage of females (81% vs 36%, $P = 0.0001$) and were more likely to sustain their injury due to a fall (59% vs 19%, $P = 0.0001$). The percentage of open fractures (30% elderly vs 46%) was not significantly different between the two groups ($P = 0.17$). The majority of coronal fractures were located on the lateral femoral condyle (86% elderly vs 60%, $P = 0.10$) in both groups. The average ISS was similar between the groups: 16 in both ($P > 0.05$).

Conclusion: The 58% of distal femur fractures with coronal fracture identified in this study population is higher than previously reported. This is the first study to specifically look at the rate of Hoffa fractures in the elderly. We found elderly patients more commonly sustained their injury as a result of a fall and had a lower percentage of patients with Hoffa fractures compared with the younger patients with higher-energy injuries. The occurrence rate of 44% in this study was higher than expected and is the first to provide a occurrence rate in the elderly of this fracture. It is important that a high index of suspicion be maintained for the Hoffa fracture in all distal femur fractures, regardless of age or mechanism of injury. This allows for proper planning and treatment of these fractures.

See pages 49 - 106 for financial disclosure information.

Economic Analysis of Bisphosphonate Use After Distal Radius Fracture for Prevention of Hip Fracture: Does It Make Financial Sense?

Suneel Bhat, MD, MPhil[1]; ***Asif Ilyas, MD, FACS***[2]
[1]*Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA;*
[2]*Rothman Institute, Jefferson Wayne, Pennsylvania, USA*

Background/Purpose: Osteoporosis is a common condition among the elderly population, and is associated with an increased risk of fracture. One of the most common fragility fractures involved the distal radius, and prior fracture of the distal radius is associated with risk of subsequent fragility fracture. Early initiation of treatment with bisphosphonates after fragility fracture has been suggested as a means of population hip fracture burden reduction. However, there have been no prior economic evaluations of the routine treatment of distal radius fracture patients with bisphosphonates, and the implications on hip fracture rate reduction.

Methods: Age-specific distal radius fracture incidence, age-specific hip fracture rates after distal radius fracture with and without risendronate treatment, cost of risendronate treatment, and risk of atypical femur fracture with bisphosphonate treatement were obtained from the literature. The direct costs of hip fracture management were from the average reimbursements for DRG (Diagnosis-Related Group) 482 and CPT 27245 obtained from public Medicare databases, and anesthesia reimbursements for CPT 01230 for a 1-hour case from the Medicare pricer. A unique stochastic Markov chain decision tree model was constructed from derived estimates. The tree was analyzed with a modified Monte Carlo simulation of a cohort of women 65 and older based of 2012 US population estimates. The results were evaluated with comparative statistics, and a one-way threshold analysis performed to identify the breakeven cost of bisphosphonate treatment.

Results: Routine treatment of the current population of all women over the age of 65 suffering a distal radius fracture with bisphosphonates would avoid 94,888 lifetime hip fractures at the cost of 19,464 atypical femur fractures and $19,502,834,240, or on average $2,186,617,527 annually, which translates to costs of $205,534 per hip fracture avoided. The breakeven price point of annual bisphosphonate therapy after distal radius fracture for prevention of hip fractures would be approximately $70 for therapy annually.

Conclusion: Routine treatment of all women over 65 suffering distal radius fracture with bisphosphonates would result in a significant reduction in the overall hip fracture burden, however at a substantial cost of over $2 billion dollars annually. To optimize efficiency of treatment either patients may be selectively treated, or the cost of annual bisphosphonate treatment should be reduced to cost-effective margins.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Do Nonoperatively Managed Hip Fracture Patients Have Lower Mortality Rate Than Historically Reported? A Matched Cohort Study Comparing Operative and Nonoperative Geriatric Hip Fracture Mortality

Jesse Chlebeck, MD[1]*; Christopher Birch, MD*[2]*; Gregory Frechette, BS*[1]*; Samy Ramadan, BS*[1]*; Bryan Brown, MD*[1]*; Michael Blankstein, MD*[1]*; Thomas Kristiansen, MD*[1]*; Craig Bartlett III, MD*[1]*; Patrick Schottel, MD*[1]
[1]*University of Vermont Medical Center, Burlington, Vermont, USA;*
[2]*University of Vermont - Fletcher Allen Health Care, Burlington, Vermont, USA*

Purpose: Hip fractures are common injuries and are a significant cause of mortality in geriatric patients. Timely operative management is uniformly recommended as a means of mitigating the increased risk of morbidity and mortality. Surprisingly, few studies exist that have directly compared the outcome of patients who were treated either operatively or nonoperatively. The purpose of our study is to report the mortality data and mean life expectancy of geriatric hip fracture patients who chose nonoperative management of their injury and compare that to an age and sex-matched operative cohort.

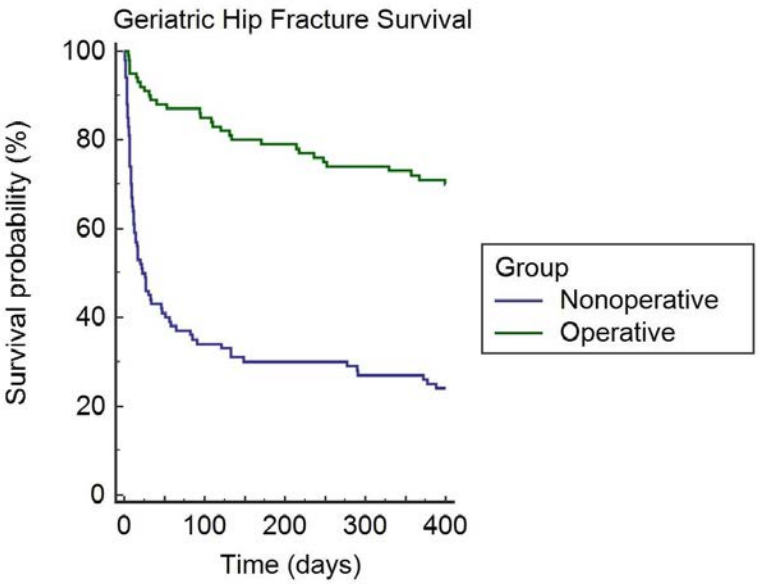
Methods: An institutional geriatric hip fracture database from an American College of Surgeons (ACS) Level I trauma center was queried. All patients older than 65 years of age with a femoral neck or intertrochanteric fracture (AO/OTA 31A and 31B) treated at our institution from September 2004 to January 2012 were enrolled. The patients were divided into operatively and nonoperatively managed cohorts. An age and sex-matched pairing was then performed. A chart review of all patients was conducted and the Charlson Comorbidity Index (CCI), length of hospital stay, as well as mortality data were collected. Patients with incomplete comorbidity or mortality information were excluded.

Results: 200 patients met the study inclusion and exclusion criteria. There were 100 patients in both the operative and nonoperative cohorts. The mean age in both groups was 86.2 (range, 65-102) years and 66% were female. There were more intracapsular femoral neck fractures in the operative cohort although this difference was not significant (64 vs 51; $P = 0.09$). The mean CCI was significantly higher in the nonoperative group (2.42 vs 1.72; $P = 0.001$). Nonoperatively managed patients were found to have a significantly higher inpatient (22% vs 1%; $P = 0.0001$), 30-day (55% vs 9%; $P = 0.0001$), and 1-year mortality (73% vs 27%; $P = 0.0001$). The mean life expectancy after a hip fracture in our nonoperative cohort was significantly shorter than the operative group (367 vs 2003 days; $P = 0.02$).

Conclusion: In our retrospective cohort study of age and sex-matched operative and nonoperative geriatric hip fractures, we found that nonoperatively treated patients had higher inpatient, 30-day, and 1-year mortality. The 1-year mortality rate of nonoperatively managed geriatric hip fracture patients was 73% (Figure 1). Our study design did not match the two cohorts for all known contributing factors that affect mortality such as prefracture mobility or being a resident in a long-term care facility and therefore we cannot conclude that surgery is the primary factor that decreased the mortality rate in our operative cohort. Instead, our results demonstrate the bleak overall prognosis for nonoperatively treated geriatric hip fractures even at an academic ACS Level I trauma center. Our findings offer

See pages 49 - 106 for financial disclosure information.

helpful outcome information for orthopaedic surgeons who treat geriatric hip fractures insofar as providing updated mortality data when discussing nonoperative hip fracture management with patients and their families.



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Are Geriatric Victims of High-Energy Trauma Likely to Return to Functional Independence?

I. Leah Gitajn, MD[1]; Stephen Breazeale, BS[1]; Peter Berger, BS[1]; Carrie Schoonover, BS[1]; Renan Castillo, MD[2]; Robert V. O'Toole, MD[1]; Christina Boulton, MD[1]
[1]RA Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA
[2]John Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Background/Purpose: As our population ages and the elderly maintain independent function later in life, the frequency of geriatric high-energy trauma is increasing. While low-energy trauma has been studied extensively in this population, there are no studies evaluating functional outcomes after high-energy trauma in the elderly. The purpose of this study was twofold: (1) to determine the mobility and physical function after geriatric high-energy trauma and (2) to compare physical function after high-energy trauma to that of age-adjusted norms after geriatric low-energy trauma. Our hypothesis was that a high-energy trauma mechanism would lead to more severe injury and poorer functional outcomes.

Methods: Patients studied presented to a single Level I trauma center from 2004-2009 with age >65 years and pelvic or lower extremity fracture caused by a high-energy mechanism (fall from height, MVC [motor vehicle collision], MCC [motorcycle collision], pedestrian struck). Patient chart review was performed to identify pertinent demographic, patient, and injury factors. Patient pre- and postinjury ambulatory status and living situation were then collected via telephone from either patients or their primary caregiver. The Patient Reported Outcomes Measurement Information System (PROMIS) was also used to assess physical function. Each PROMIS Physical Function question is a validated instrument in which higher scores indicate higher physical function and the population mean is 50. 536 patients with high-energy pelvis and lower extremity fractures were identified. Inhospital mortality was 7% (38 patients). For those who did not expire in the hospital, 1-year mortality was 5% (26 patients) and 5-year mortality was 20% (100 patients). Over half of patients, 308 (57%), were still alive at the time of the study. Of these, 105 were able to be reached by telephone. Eight patients declined participation and 97 patients were enrolled and made up the study group with average follow-up of 8.8 years (SD 1.7 years). 50% had 2 or more fractures, and the average ISS = 16. Prior to their injury all patients were able to mobilize outdoors.

Results: Currently, 91 patients (94%) are able to mobilize outdoors; however, 37% now require an assistive device compared with 1% preinjury. A small number of patients (4%) are now limited to walking indoors or require a wheelchair for mobilization (2%). Of the 97 patients analyzed, only 12 patients (12%) transitioned from living independently to needing assistance at home, and 4 patients (4%) required permanent residence in a skilled nursing facility (see table). In comparison, historical data show elderly patients with low-energy proximal femur fractures return to prefracture level of mobility only 40% of the time and one in four fails to regain sufficient independence to remain in their own home. The average PROMIS Physical Function score in our study group was 41 (SD 9.6), which compares favorably to age-matched US population 45.1 (age 65-74 years, mean 46.3 [SD 8.4] and age ≥75 years, mean 45.1 [SD 7.8]).

See pages 49 - 106 for financial disclosure information.

Conclusion: Contrary to our initial hypothesis, geriatric victims of high-energy trauma recover surprisingly well from their injuries. Their physical function approaches that of age-adjusted norms and is markedly superior to patients of similar age injured in low-energy mechanisms. Although many patients had a moderate decrease in functional status such as the addition of an assistive device, the vast majority maintained the ability for independent living (74%) and community ambulation (94%). Better functional outcomes despite higher injury severity suggest that elderly victims of high-energy trauma may represent a more robust subset of the elderly than those who are victims of low-energy trauma. This information is important in the counseling of patients and families following high-energy injury and can be used to guide expectations during rehabilitation.

TABLE 1: Functional Outcomes

		All patients
Pre-injury mobility		
	Mobilizes outdoors independently	96 (99%)
	Mobilizes outdoors with assistive device	1 (1%)
	Limited to walking indoors with assistive device	0
	Unable to walk	0
Current mobility		
	Mobilizes outdoors independently	55 (56%)
	Mobilizes outdoors with assistive device	36 (37%)
	Limited to walking indoors with assistive device	4 (4%)
	Unable to walk	2 (2%)
Pre-injury living arrangement		
	Nursing facility	1 (1%)
	Home with adult children	18 (19%)
	Home with spouse	54 (56%)
	Home alone	24 (25%)
Current living arrangement		
	Nursing facility	5 (5%)
	Home with adult children	20 (21%)
	Home with spouse	48 (49%)
	Home alone	24 (25%)

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Traction Views Aid in the Assessment of Lateral Wall Integrity in Intertrochanteric Hip Fractures

Paul Tornetta III, MD; ***Jonathan Yin, MD***
Boston Medical Center Boston, Massachusetts, USA

Background/Purpose: Lateral wall failure may cause catastrophic collapse after internal fixation of hip fractures. A recent publication proposed a threshold value of <20.5 mm of lateral bone at 3 cm below the innominate tubercle as having an increased risk of lateral wall failure. However, the measurement of lateral wall size is affected by rotation at the fracture site and the position of the limb. The typical external rotation of the leg and hip place the fracture off axis to the AP radiograph. We hypothesized that a traction internal rotation view would provide a more accurate assessment of the lateral bone and also would identify fracture extension. The aims of this study were to compare standard and traction radiographs in the assessment of the lateral wall measurement and to determine if traction views changed treatment.

Methods: We reviewed a consecutive series of patients with OTA type A1-2 fractures who had standard and traction internal rotation radiographs performed in the emergency department. Our routine practice during this time was to obtain a traction view of the hip in all such patients for preoperative planning. Measurements of the lateral wall depth as per Hsu et al were made of the standard and traction internal rotation views of the affected hip. Additionally, any fracture line extensions were documented. The standard of care at our institution is sliding hip screw (SHS) with intramedullary (IM) nails being used for more unstable 3- or 4-part fractures, in cases of thin lateral walls, or fracture line extension that might predict excessive collapse. We documented the procedure chosen for each patient and any change in procedure based on the traction view. All patients treated with SHSs were followed to union to evaluate for lateral wall failure. All patients were made weight bearing as tolerated postoperatively.

Results: We reviewed 74 consecutive patients (mean age 75; 52 F, 22 M). The mean lateral wall depth on the standard radiograph was 24.4 ± 8.8 mm and on the traction view was 31.8 ± 9.6 mm ($P = 0.0001$). 50 patients (68%) were treated with an SHS and 24 (32%) with an IM nail. Seven patients (11%) had distal secondary fracture lines visualized on the traction view that were not seen on the AP view and were treated with an IM nail. 13 patients had <20.5 mm on the standard radiograph and >20.5 mm on the traction view, all of whom were treated with an SHS. No patient treated with an SHS had lateral wall failure in follow-up.

Conclusion: Traction internal rotation views allowed for a better assessment of the lateral wall thickness as the plane of the fracture was more visible and the rotational malalignment that comes from external rotation of the limb was corrected. In this series, patients with >20.5 mm of lateral wall depth on the traction radiographs were treated with SHSs with no cases of lateral wall failure. 13% of patients had fracture extension to the lateral wall that was not seen on the AP views that resulted in the use of an IM nail instead of an SHS. We recommend a traction internal rotation view of intertrochanteric fractures if SHS is being considered.

See pages 49 - 106 for financial disclosure information.

Survivorship After High-Energy Geriatric Trauma

I. Leah Gitajn, MD[1]; Stephen Breazeale, BS[1]; Peter Berger, BS[1]; Carrie Schoonover, MD[1]; Renan Castillo, MD[2]; Robert V. O'Toole, MD[1]; Marcus F. Sciadini, MD[1]
[1]R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, Maryland, USA;
[2]John Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Purpose: The frequency of geriatric high-energy trauma is expected to increase as the population ages and older people increasingly participate in high-risk activities. However, there are no studies looking at survivorship beyond hospital discharge in this patient population. Many studies exist on survivorship from low-energy falls, particularly following proximal femur fractures. However, it is unclear how these compare to mortality after high-energy geriatric fractures because although the energy level is higher, these patients may have better baseline health than patients with low-energy injuries, such as hip fractures. The purpose of this study was to document survivorship after high-energy trauma and to identify predictors for mortality.

Methods: After IRB approval, review of a prospective trauma database at a Level I trauma center was performed to identify patients 65 years and older who sustained high-energy trauma (fall from height, motor vehicle collision (MVC), motorcycle collision (MCC), pedestrian struck) from 2004-2015. Survivorship was determined using the Social Security Death Index. Demographic and admission clinical data were obtained from medical records and the trauma registry. Multiple variable regression analyses were performed to identify independent predictors for survival. Our study group consisted of 1931 patients with a mean age 71 years and a mean ISS of 19.

Results: Overall, inpatient mortality was 8% (95% CI 6.6%-9%), 1-year mortality was 15.4% (95% CI 13.9%-17.1%), and 5-year mortality was 27.8% (95% CI 25.7%-30.1%). The table shows the results for four separate models: a logistic regression model of inhospital mortality, and three Cox proportional hazards (CPH) models of survival after hospital discharge stratified by ISS grouping. Results are presented as odds ratios (OR) for the logistic model and hazard ratios (HR) for the CPH model, both with 95% confidence intervals. Significance levels of $P < 0.1$, $P < 0.05$, and $P < 0.01$ are designated by single, double, and triple asterisks, respectively.

Conclusion: To our knowledge this is the first study to evaluate survivorship beyond hospital discharge in the setting of high-energy trauma in geriatric patients. We found that inhospital mortality was 8%, and the 1- and 5-year mortality in this patient population was 15% and 28%, respectively, which is statistically significantly lower than geriatric patients who sustained low-energy proximal femur fractures (30% and 45% in prior studies) at $P < 0.0001$ when evaluated using a binomial test. In our study group, both inhospital mortality and mortality after hospital discharge in geriatric victims of high-energy trauma was lower than that previously reported for geriatric patients sustaining fractures secondary to a low-energy ground-level falls. This may reflect that baseline health and higher level of preinjury function influence survival more than increased energy of the injury.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Multiple regression analysis for post-discharge mortality

	Logistic Regression For Hospital Death	Stratified CPH Models Beyond Hospital Discharge		
		ISS: 0-8 (N=225)	ISS: 9-15 (N=675)	ISS: 16+ (N=871)
	OR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)
Age	1.09 *** (1.06, 1.12)	1.03 (0.97, 1.08)	1.09 *** (1.07, 1.11)	1.07 *** (1.06, 1.09)
Male	2.10 *** (1.34, 3.35)	1.01 (0.49, 2.05)	1.22 (0.86, 1.72)	1.19 (0.91, 1.57)
BMI	1.00 (0.98, 1.01)	0.98 (0.96, 1.01)	0.98 ** (0.97, 1.00)	0.99 ** (0.98, 1.00)
Fracture Count	1.23 * (0.96, 1.56)	0.62 * (0.35, 1.08)	0.99 (0.79, 1.24)	0.88 * (0.77, 1.02)
GCS	0.83 *** (0.79, 0.87)	0.66 (0.31, 1.39)	0.91 (0.80, 1.04)	0.97 (0.93, 1.02)
LOS (Days)	0.99 (0.97, 1.00)	1.04 ** (1.01, 1.07)	1.03 *** (1.01, 1.05)	1.03 *** (1.02, 1.04)
Mechanism (MVC/MCC)	1.52 (0.88, 2.73)	2.04 * (0.96. 4.30)	1.35 (0.93, 1.96)	1.45 ** (1.04, 2.01)
Pelvic Fracture	1.59 ** (1.02, 2.46)	1.30 (0.51, 3.34)	1.04 (0.64, 1.68)	0.78 (0.57, 1.07)
Acetabula Fracture	1.70 * (0.93, 3.01)	0.45 (0.06, 3.34)	0.63 (0.36, 1.10)	1.05 (0.68, 1.64)
ISS	1.08 *** (1.07, 1.10)	Not Applicable	Not Applicable	Not Applicable

See pages 49 - 106 for financial disclosure information.

Age Predicts Ambulatory Status Following Periprosthetic Distal Femur Fracture

John Ruder, MD[1]; Gavin Hart, MD[1]; Bryan Springer, MD[2]; Madhav Karunakar, MD[1]
[1]Carolinas Medical Center Charlotte, North Carolina, USA;
[2]OrthoCarolina Hip and Knee Center, Charlotte, North Carolina, USA

Purpose: Treatment options for periprosthetic distal femur fractures include open reduction and internal fixation (ORIF) and distal femoral replacement (DFR). The purpose of this study was to evaluate the complications and functional recovery (ambulatory status, living situation, mortality) in patients undergoing operative treatment (DFR and ORIF) of periprosthetic distal femur fractures.

Methods: A retrospective review of 58 patients with distal femoral periprosthetic fractures treated with either ORIF or DFR was conducted. Outcomes included complications, discharge disposition, ambulatory status and living situation at 1 year, and 1-year mortality. Outcomes at 1 year were also compared between patients older and younger than 85 years of age.

Results: 58 patients with a mean age of 80 years (range, 61-95) met inclusion criteria. The mean follow-up was 29.5 months (range, 5-81). Patients undergoing DFR were significantly older than those who underwent ORIF (83 vs 78, $P < 0.01$). The 1-year mortality rate was 20.6%. There was no difference between groups with respect to mortality, complications, discharge disposition, or ambulatory status and living situation at 1 year. Patients who lost the ability to ambulate at 1 year were significantly older than patients who maintained the ability to ambulate (87.5 vs 76.4 years, $P < 0.05$). Patients over the age of 85 were more likely to lose the ability to ambulate and to live in a skilled nursing facility at 1 year ($P < 0.01$).

Conclusion: Distal femoral periprosthetic fractures have a high morbidity and mortality. Age at time of injury, not treatment rendered, is predictive of functional outcomes with periprosthetic distal femur fractures.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Geriatric Distal Femur Fracture: 1 in 3 Chance of Death or Nonunion Surgery at 1 Year

Gele Moloney, MD; Tiffany Pan, MD; Carola Van Eck, MD; Devan Patel, BS;
Ivan Tarkin, MD
University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, USA

Background/Purpose: Fractures of the distal femur occur commonly in elderly patients after low-energy trauma. The purpose of our study was to investigate rates of mortality and nonunion following open reduction and internal fixation (ORIF) of low-energy distal femur fractures in a geriatric population. In addition, we sought to quantify the length of inpatient hospitalization and discharge disposition to better understand the impact of this injury on the health-care system.

Methods: After obtaining IRB approval we retrospectively reviewed patients aged 60 and above who sustained a low-energy distal femur fracture (AO/OTA 33) treated with ORIF using laterally based locked plating at three affiliated institutions from 2004 through 2014. Primary outcomes included death, symptomatic nonunion, and reoperation to promote union. Age-adjusted Charlson Comorbidity Index (CCI) was calculated based on comorbidities documented in the electronic medical record. Length of stay was calculated and discharge disposition was recorded.

Results: 176 patients were included in the final analysis. *Mortality:* 30-day, 90-day, and 1-year mortality were 6% (11 patients), 11% (20 patients), and 25% (44 patients) respectively. Significant predictors of 1-year mortality included increased age (82 ± 9 vs 76 ± 9, P <0.001), increased CCI (4.5 ± 2.5 vs 3.3 ± 2.1, P <0.02), and increased age-adjusted CCI (7.2 ± 2.3 vs 5.4 ± 2.2, P <0.001). *Nonunion:* In 99 patients alive and with 1-year follow-up there were 24 symptomatic nonunions identified (24%); 21 were treated with reoperation, either with revision ORIF or conversion to distal femoral replacement. Age (71 ± 8 vs 75 ± 8, P >0.05), CCI (2.7 ± 2.1 vs 3.7 ± 2.3, P >0.05), and age-adjusted CCI (5.5 ± 2.4 vs 5.9 ± 2.4, P >0.05) were not significant predictors of nonunion. Development of surgical site infection was associated with a sixfold increase in development of nonunion. *Length of Stay/Disposition:* The postoperative length of hospital stay averaged 8.1 days (SD 6.6 days). Additionally, 154 patients (87%) were discharged to a skilled nursing facility (SNF).

Conclusion: The low-energy geriatric distal femur fracture occurs in a frail, elderly population and is associated with significant mortality and risk for nonunion. In our series, 65 patients (36%) underwent reoperation for nonunion or died within 1 year of fracture. Increased age and comorbidities are associated with death at 1 year, but not nonunion. Development of surgical site infection is a significant risk factor for nonunion. Additionally, with the increasing emphasis on providing cost-effective health care, the financial burden associated with long inpatient hospitalizations and postacute SNF placement in the vast majority of patients should be acknowledged.

See pages 49 - 106 for financial disclosure information.

Being Admitted to Hospital with a Hip Fracture at the Weekend: Is There a Difference in Mortality?

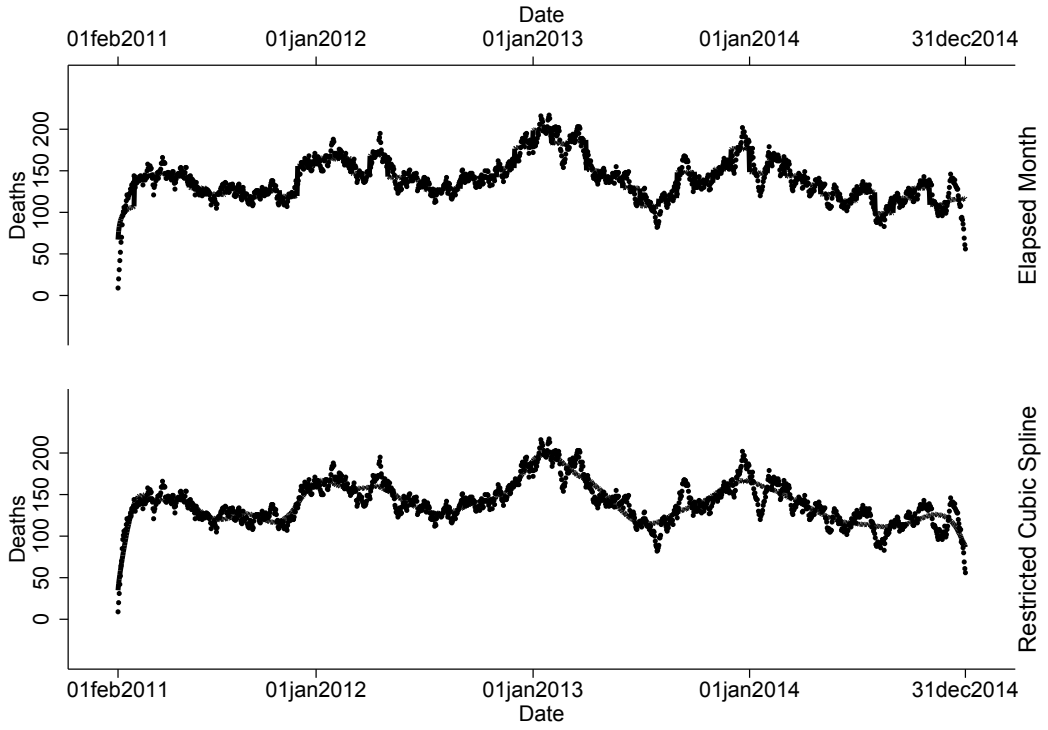
Adrian Sayers, MSc MSC(Dist) PG Dip BSc(Hons)[1]; Michael WhiteHouse, PhD, MD[1]; Timothy Chesser, FRCS[2]
[1] Musculoskeletal Research Unit, University of Bristol, Bristol, UNITED KINGDOM;
[2]Department of Trauma & Orthopaedics, Southmead Hospital, Bristol, UNITED KINGDOM

Background/Purpose: Recent publications suggest that there is an increase in 30-day mortality in patients admitted to hospital at the weekend. However, these findings have not been universally accepted, with much criticism from health-care professionals, statisticians, and epidemiologists with regard to inadequate case mix adjustment, and failures to consider the complexities of resource provision in the statistical model. Using data prospectively collected by a National Hip Fracture Database, we aimed to explore the association between the times of admission, surgery, and discharge, inpatient stay, and 30-day mortality in a large register of patients.

Methods: Using data from 237,001 patients between February 1, 2011 and December 31, 2014, we explored the association between time of admission, surgery, inpatient stay, and discharge with 30-day mortality in patients with hip fractures using logistics and Poisson regression. We adopted a progressive temporal case mix adjustment strategy when investigating time of admission, surgery, and discharge, adjusting for preadmission characteristics (fracture type, ASA [American Society of Anesthesiologists] grade, abbreviated mental test score, pathological fracture, mobility, sex, age, preadmission location), nonsurgical interventions (falls assessment, multidisciplinary team meeting), and surgical interventions (anesthetic type, operation type). We conducted extensive sensitivity analyses allowing for different seasonal specifications (month indicators, elapsed months, Fourier series, restricted cubic splines) and investigated the effect of missing data using a multiple imputation model. Results from logistic regression models are reported as odds ratios (ORs). When investigating the association between inpatient stay and 30-day mortality, we adopted a stratified (by age and sex) time-series approach using Poisson regression; results are interpreted as incidence rate ratios (IRRs).

Results: Day of admission and surgery were crudely associated with mortality. However, the association between day of admission and mortality was attenuated after adjusting for the effect of day of surgery. In parsimonious models, Sunday surgery was associated with a 10% increase in odds of death at 30 days (OR 1.095, 95% CI [1.044,1.150], $P = 0.0001$), surgery more than 24 hours from admission was associated with a 9% increase in odds of death at 30 days (OR 1.089, 95% CI [1.053, 1.126], $P \leq 0.0001$), but out of hours surgery was not associated with increased mortality (OR 1.015, 95% CI [0.945, 1.091], $P = 0.68$). Day of discharge from hospital prior to 30 days was not associated with any increase in the risk of deaths ($P > 0.05$). During the inpatient stay, seasonality dominates the association within inpatient mortality (Figure 1). However, weekends were associated with a lower incidence of death than weekdays (IRR 0.990, 95% CI [0.982, 0.998], $P = 0.01$).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.



Conclusion: Despite recent statements to the contrary, weekend admissions are not associated with increased mortality in patients with hip fracture. It appears that surgical provision (Sunday trauma list and surgery within 24 hours of admission) is the dominating modifiable risk factor that is associated with short-term mortality. Furthermore, the small reduced incidence of death during the inpatient stay at weekends after hip fracture is suggestive of at least equivalent care to that of weekdays.

See pages 49 - 106 for financial disclosure information.

Minimally Displaced Femoral Neck Fractures in the Elderly: Is a Simple Pinning Surgery Better Than Hemiarthroplasty?

Jon Hedgecock, MD[1]; John Gorczyca, MD[1]; Catherine Humphrey, MD[2]; Kyle Judd, MS, MD[1]; Gillian Soles, MD[3]; John Ketz, MD[3]
[1]*University of Rochester, Rochester, New York, USA;*
[2]*University of Rochester Medical Center, Rochester, New York, USA;*
[3]*University of Rochester Medical Center, Pittsford, New York, USA*

Background/Purpose: Minimally or nondisplaced fractures of the femoral neck (OTA 31 B1 and B2) fractures have historically been treated with percutaneous pinning. Hemiarthroplasty and total hip arthroplasty have been reserved for displaced fractures, and have yielded good results with minimal perioperative complications. The current study evaluates and defines the failure rate of internal fixation for nondisplaced or minimally displaced femoral neck fractures in patients older than 60 years of age and attempts to identify radiographic or clinical parameters that may predict treatment failure.

Methods: From January 2012 to January 2015 all OTA 31 B1 and B2 fractures that were treated using either CPT code 27325 (percutaneous fixation) or 27236 (open treatment) were included. Patients younger than age 60, displaced fractures (OTA type 31-B3), and those treated with hemiarthroplasty were excluded. Operative notes for all patients were reviewed in detail to determine the exact operative treatment. If reduction was carried out, the type was noted, as well as presence or absence of operative capsulotomy. Pre- and postoperative radiographs were examined, with preoperative fracture classification, displacement, and angulation noted. Patients' medical comorbidities were recorded. Treatment failure was defined as fracture collapse of >2 cm, implant failure (including screw cutout), nonunion, osteonecrosis, and revision surgery. If revision surgery was performed, the type was noted. Rates of the outcome variables were reported as percentages.

Results: 234 nondisplaced or minimally displaced OTA type 31-B fractures were identified. In 27% of patients a treatment failure was noted. 46% of fractures with treatment failure were those other than the valgus-impacted type (OTA 31-B1). In 43% of treatment failures, angulation <10° was noted on the preoperative lateral radiograph. Fracture collapse was noted in 78% of patients in which a complication was noted. Mean time period between surgery and when complication noted was 5.5 months. Two-thirds of cases with a complication required a revision operation. Revision operations included implant removal (26%), conversion to arthroplasty (41%), and revision reduction and fixation (33%). Individual medical comorbidities were not associated with the presence or absence of a treatment failure.

Conclusion: Elderly patients with nondisplaced or minimally displaced femoral neck fractures treated with internal fixation had a relatively high rate of treatment failure, many of which required revision surgery. In this patient population, it is desirable to minimize the risk of revision surgery, while allowing for immediate postoperative weight bearing. Hip replacement surgery may be a beneficial option in the treatment of these fractures. How-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

ever, further studies are needed to elucidate which parameters could potentially be used to predict treatment failure in this patient group.

See pages 49 - 106 for financial disclosure information.

Prevention of Hip Fracture:
An Analysis of "Preadmission" and Opportunity for Intervention

Sarah Pierrie, MD; Christine Churchill, MA; Joshua Patt, MD, MPH;
Rachel Seymour, PhD; Madhav Karunakar, MD
Carolinas Medical Center, Charlotte, North Carolina, USA

Background/Purpose: Hip fractures are associated with significant morbidity and mortality among older adults. While considerable literature exists on the injury burden, loss of independence, and mortality following hip fracture, little attention has been paid to primary or secondary prevention in the acute care setting in this medically comprised population. The purpose of this study was to describe the incidence of and reasons for emergency department (ED) visits or inpatient hospitalizations in the 12 months prior to admission for hip fracture in order to identify opportunities for intervention.

Methods: A retrospective study of patients aged 55+ with hip fractures treated in our hospital over a 1-year period was performed. Medical records were reviewed for patients who experienced one or more "preadmissions," defined as ED visits (excluding those that led to admission) and inpatient admissions for the year prior to the hip fracture. Demographic characteristics, reason for visit, interventions, discharge disposition, and complications were documented.

Results: 157 patients with an average age of 78.4 years (range, 55-100) were treated for a hip fracture at an urban academic trauma center during a 1-year period. 66% were women and 34% were male. 45% (N = 70) were admitted to the hospital in the year prior. Of these, 39% (N = 27) visited the ED (N = 13 with 2+ visits), 37% (N = 26) had at least one inpatient stay (N = 18 with 2+), and 24% (N = 17) had both an ED encounter and inpatient stay in the 365 days prior to the hip fracture. 50% of "preadmissions"—35% (N = 15) of ED visits and 24% (N = 10) inpatient admissions—were due to either mechanical or syncopal falls. The remainder presented for medical issues, including altered mental status (16%, N = 11), shortness of breath (19%, N = 13), and chest pain (13%, N = 9). 75% of patients presented with an exacerbation of an existing medical illness.

Conclusion: 45% of hip fracture patients presented for emergency or inpatient care in the year prior to the injury, presenting an opportunity for intervention. While medical issues are more common, 50% sought care related to a fall. Targeting these patients with programs such as falls education, in-home safety evaluations, and balance training might prevent future fragility fracture.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Geriatric Hip Fractures, Cognitive Impairment, and Undiagnosed Urinary Tract Infections

Christine Churchill, MA[1]*; Rachel Seymour, PhD*[2]*; Joshua Patt, MD, MPH*[2]*; Madhav Karunakar, MD*[2]
[1]*Carolinas HealthCare System, Charlotte, North Carolina, USA;*
[2]*Carolinas Medical Center, Charlotte, North Carolina, USA*

Background/Purpose: Cognitive impairment has been found to be associated with an increased risk of falls among older adults. While comanagement of these geriatric patients with the medicine service has been shown to lead to improved outcomes and lower cost, the orthopaedic surgeon is often left with primary responsibility for patient care. The aim of this study is to identify risk factors for falls and compare outcomes of older adults presenting with or without cognitive impairment who underwent surgical treatment for a low-energy hip fracture at a Level I trauma center.

Methods: 255 patients (women >55 years; men >60 years) with a hip fracture were treated during an 18-month period (May 2, 2011-November 29, 2012). Patient demographic and hospitalization data collected included: age, cognitive status, urinary tract infection diagnosis, and inpatient complications (ie, renal insufficiency/failure, delirium, hypoxia, pneumonia, pulmonary embolism, surgical site infection, deep vein thrombosis, myocardial infection, cerebrovascular accident, urinary tract infection, bleeding complications, reoperation and death). Mantel Haenszel X^2 *P* values and *t* tests were calculated to determine for statistical significance ($P < 0.05$).

Results: Among the 255 patients admitted with low-energy hip fracture for the 18-month period, 30% (N = 77) presented with a diagnosis consistent with cognitive impairment (ie, dementia, Alzheimer's disease, Lewy body, vascular dementia). The average age of those with cognitive impairment was 82.8 years while the average age of those without cognitive impairment was 73.9 years ($P < 0.001$). 23% of cognitively impaired patients had urinary tract infections (UTIs) compared to 9% of those without cognitive impairment ($P = 0.0014$ and 0.0019). However, 83% of the UTIs were preexisting condition as they were diagnosed within a day of admission. The cognitively impaired older adults were less likely to be diagnosed within 1 day of admission to the hospital compared to those without cognitive impairment (50% and 66%). 75% of cognitively impaired patients experienced complications versus 63% of those without cognitive impairment ($P = 0.0647$). 31% of cognitively impaired experienced delirium compared to 14% of those without cognitive impairment.

Conclusion: The cognitively impaired older adults were more likely to present to the hospital with undiagnosed UTIs. There were no significant differences in the overall inpatient complication rates between the two groups; however, cognitively impaired patients were more likely to experience modifiable complications such delirium. The findings highlight an opportunity to address the issue of undiagnosed UTI in the cognitively impaired older adult population as it is a risk factor for falls. Based on these findings, systematic assessment of cognitive status on admission to identify patients with cognitive impairment may improve patient care. UTI diagnosis at admission in the cognitively impaired patient is im-

See pages 49 - 106 for financial disclosure information.

perative in early treatment and also reducing the burden of unreimbursed cost of treating Medicare patients to the hospital. Diagnosis of UTI at admission is necessary since it is one of the Medicare and Medicaid unreimbursed costs of treatment if not diagnosed at admission. In the absence of an environment with comanagement of geriatric fracture patients, the orthopaedic surgeon can reduce exposure by requesting these tests. The recognition of the most common complications will also allow clinicians to create focused clinical pathways to help decrease complications in this cognitively impaired cohort.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Ambulatory Ability Diminishes Following Lower Extremity Fractures in the Geriatric Population

***Adam Driesman, BA**; Loveita Raymond, MD; Hesham Saleh, BS;*
Sanjit Konda, MD; Kenneth Egol, MD;
New York University Hospital for Joint Diseases, New York, New York, USA

Background/Purpose: One of the most important treatment goals after lower extremity injury is return to normal ambulation. It has been shown consistently throughout the literature that geriatric patients who sustain a hip fracture have approximately a 50% probability of regaining their preinjury ambulation status. However, no studies have examined the rate that patients need additional assistive devices to ambulate on a daily basis after lower extremity fractures. The purpose of this study is not only to determine the frequency of requiring a new assistive device after lower extremity fractures, but also evaluate which fractures resulted in the most long-term ambulation disability.

Methods: At a single Level I trauma center from June 2014 to August 2015, 476 orthopaedic and trauma surgery patients age ≥65 years were enrolled in a prospective registry. On initial evaluation, patients' demographics, injury characteristics, and functional status, including baseline ambulatory status and use of an assistive device, were collected. Patients were examined in the outpatient setting or contacted via telephone interviews to ascertain if they were currently using a new assistive device and what they estimated was the percentage of return to their baseline. Only patients who had sustained a lower extremity fracture (hip, femur, knee, tibia/fibula, foot/ankle), were >65 years old, and had at least 6 months follow-up from their initial injury were included in this study. Univariate examination was performed using Pearson's X^2 analysis for nominal variable and ANOVA (analysis of variance) when comparing means between multiple groups, with significance set at $P < 0.05$.

Results: Of the 239 patients contacted, 110 had sustained a lower extremity fracture. The study population was an average age of 78.1 ± 11.1 years and was followed up for an average of 300 ± 125 days. There were no significant differences noted between fracture types regarding their ambulation devices both before and after their injury (Table 1). It should be noted that patients who had hip fractures were significantly less likely to be community ambulators, even while 63% of this population were using an assistive device at this time. 66.4% of patients were using a new assistive device after their lower extremity injury (either from none to one or from one to another). No significant differences was seen in the rate of additional need of a device when comparing operative versus nonoperative treatment (66.7% vs 64.7%, $P = 0.88$). While only 31 patients (28.4%) stated that they returned to their functional baseline, 54 (49.1%) were able to walk outside and 52 (47.3%) did not need any help with their daily life activities.

Conclusion: Approximately 65% of patients in this study required an assistive device at least 6 months after their lower extremity fracture. There was no significant difference related to fracture location or operative versus nonoperative treatment. These results should be used to advise patients on ambulatory expectations after a lower extremity fracture.

See pages 49 - 106 for financial disclosure information.

Table 1

Fracture Location	Hip	Femur	Knee	Tibia/Fib	Foot/Ankle	P-value
Number of Patients	64	17	6	6	17	
Pre-injury Characteristics						
Community Ambulators	64.4%	69.2%	100.0%	75.0%	81.2%	0.01
Use of Assistive Device	47.5%	38.5%	0.0%	25.0%	31.2%	0.18
Dependence on Others	61.0%	61.5%	100.0%	75.0%	75.0%	0.33
Post-injury Characteristics						
% return to baseline	63.6%	62.4%	77.5%	61.7%	72.7%	0.58
Additional Assistive Device	68.8%	58.8%	50.0%	83.3%	64.7%	0.72

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

CT Evaluation of Osteopenia Correlates with Thoracolumbar Fracture Incidence

Anna Miller, MD, FACS[1]*; Mona Saffarzadeh, MS*[2]*; R. Hightower, BA*[2]*; Joel Stitzel, PhD*[3]*; Ashley Weaver, PhD*[3]

[1]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA;*
[2]*Biomedical Engineering, Wake Forest University School of Medicine, Winston-Salem, North Carolina, USA;*
[3]*Virginia Tech-Wake Forest University Center for Injury Biomechanics, Winston-Salem, North Carolina, USA*

Purpose: Diagnosis of osteoporosis from CT scan without the need for additional dual-energy x-ray absorptiometry (DXA) imaging could economically and logistically improve care for trauma patients. Our purpose was to quantify bone mineral density (BMD) in seriously injured motor vehicle crash (MVC) occupants using phantom-less CT scans and to correlate BMD with age, fracture incidence, and osteopenia diagnoses.

Methods: CT scans in this study were collected from the Crash Injury Research and Engineering Network (CIREN) database, a National Highway Traffic Safety Administration program that investigates serious injuries resulting from MVCs. Data were gathered from 873 occupants (372 male, 501 female) from 8 CIREN centers. Subjects were at least 15 years old and skeletally mature. A validated, phantom-less CT calibration method to calibrate BMD in the L1-L5 vertebral body trabeculae was applied to all subject CT scans. In this method, the fat and muscle Hounsfield unit (HU) values were linearly regressed against known fat and muscle values (-69 and 77 mg/cc, respectively) to establish a conversion for L1-L5 HU measurements to mg/cc. CT-measured lumbar BMD <145 mg/cc is indicative of osteopenia using a published threshold. CIREN occupant lumbar BMD in mg/cc was correlated with age, documented osteopenia comorbidities and the incidence of vertebral (cervical, thoracic, lumbar), rib, sternum, and other fractures.

Results: Of these 873 occupants, 11% (92 occupants) were documented in CIREN with osteopenia as a comorbidity based on previous diagnosis from medical history or DXA. Of these 92 occupants, 42% (39) had ≥145 mg/cc BMD, suggesting possible misclassification in CIREN. Of the 134 occupants classified as osteopenic in BMD analysis, 60% were not documented as osteopenic in CIREN, suggesting undiagnosed osteopenia; 40% were correctly classified. Age was negatively correlated with BMD ($P \leq 0.0001$) for both males and females. Despite the occupants with <145 mg/cc BMD having a significantly lower mean crash speed than the occupants with≥145 mg/cc (34.1 vs 43.4 km/h, $P = 0.0001$), they were more likely to have fractures. These observations suggest a correlation between low BMD on phantom-less CT and the risk of vertebral fracture. Occupants with <145 mg/cc BMD sustained an average 2.1 additional rib/sternum fractures (2.3 vs 4.4 rib/sternum fractures, $P \leq 0.0001$). Analysis of vertebral fracture incidence in lumbar, thoracic, and cervical regions revealed that a greater proportion of occupants with <145 mg/cc BMD sustained thoracolumbar vertebral body fractures, with 24% of occupants with <145 mg/cc BMD sustaining fractures compared to 17% of occupants with ≥145 mg/cc BMD. The difference between these two proportions of occupants was statistically significant ($P = 0.043$, Fig. 1). A greater proportion of occupants with <145 mg/cc BMD also sustained lumbar (16%

See pages 49 - 106 for financial disclosure information.

vs 13%) and thoracic (10% vs 6%) vertebral body fractures, but the differences were not statistically significant (Fig. 1).

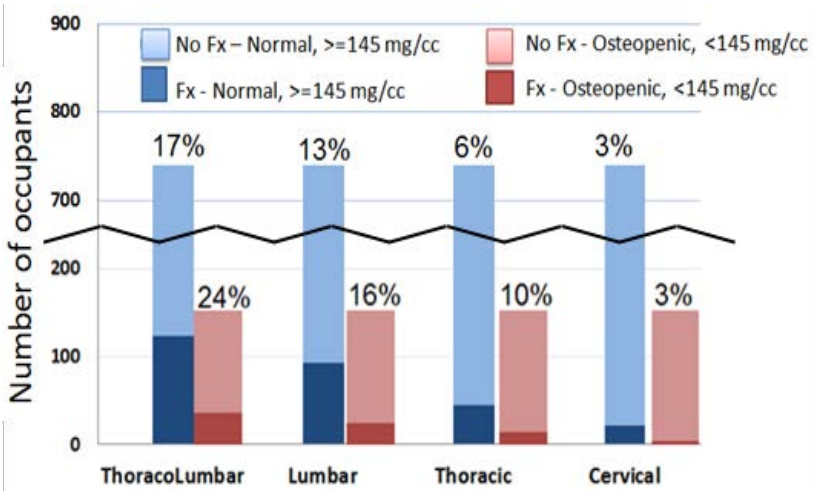


Figure 1. Proportions of vertebral fractures compared between the occupants with >=145 mg/cc and <145 mg/cc lumbar BMD values shown in blue and red bars respectively. The dark-colored bars represent the number of occupants with vertebral fractures stacked with light-colored bars representing the occupants with no fracture. The percentages represent the proportion of occupants with fracture in a specific vertebral region.

Conclusion: Low bone quality is a critical factor in determining the causation of injury and is associated with an increased number of rib/sternum fractures and a greater incidence of thoracolumbar, thoracic, and lumbar vertebral fractures in this study. Recent guidelines for post-fragility fracture treatment in the United States require osteopenia evaluation using DXA. The phantom-less technique could potentially be used in place of DXA in the future for osteopenia classification of patients with extant CT scans. This would result in decreased health-care costs and the elimination of additional radiation exposure. This phantom-less technique can be broadly applied to assess patient bone quality for clinical studies related to MVC, falls, and aging.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

3D Navigation Reduces Radiation Exposure and Operative Time in Lumbopelvic Fixations

Martin Hoffmann, MD*; Thomas Schildhauer, MD*
BG-University Hospital Bergmannsheil, Ruhr Universität Bochum, Bochum, GERMANY

Background/Purpose: Management of unstable sacral fractures has evolved from non-operative treatment to relatively rigid internal fixation. Multidirectional instability of the posterior pelvic ring and lumbopelvic junction may be stabilized by lumbopelvic fixation. This technique decreases the load to the sacrum and sacroiliac (SI) joint and transfers axial loads from the lumbar spine directly onto the ilium, which allows early full weight bearing and therefore reduces prolonged immobilization. One of the keystones for lumbopelvic fixation is the placement of the iliac screws. The iliac screws are directed from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine (AIIS). The optimal osseous corridor for iliac screw placement requires multiple posteroanterior and lateral views with additional obturator outlet and obturator inlet views. Obtaining the correct views results in increased operating room (OR) times, fluoroscopy times, and radiation exposure of the patients and OR personnel. The purpose of this study was to evaluate if a better intraoperative visualization of bony structures utilizing a 3-dimensional (3D) navigation system can reduce operative time, fluoroscopy time, and radiation exposure.

Methods: From one academic trauma center, 44 consecutive patients were retrospectively identified as having been treated with lumbopelvic fixation between July 2011 and June 2015 (4 years). Of these, 10 patients were excluded because of only a unilateral triangular fixation. 34 patients (61.8% female) met the inclusion criteria. Patients had an average age of 58.9 years (range, 18-87 years). Lumbopelvic implants (USS II, DePuySynthes) were inserted as described by Schildhauer. A passive optoelectronic navigation system (Brainlab) was utilized for navigated iliac screw placement. Surface registration of L4 was performed for the matching procedure. To compare groups, demographics were assessed, and operative time, fluoroscopic time, radiation, and screw malpositioning were delineated.

Results: During the study period, 24 patients underwent bilateral lumbopelvic fixation utilizing conventional fluoroscopic imaging alone and 10 patients underwent the procedure with 3D navigated iliac screw placement. No differences were found between the two groups regarding age (60.3 vs 55.6 years; $P = 0.553$), body mass index (BMI 25.65 vs 25.17 kg/m^2; $P = 0.808$), gender (62.5% vs 60% females; $P = 0.891$), or length of hospital stay (39 vs 26 days; $P = 0.089$). Comparing screw length and diameter, the median was 110 mm and 8 mm, respectively in both groups. Utilization of 3D navigation led to a fluoroscopy time reduction of more than 50% (3.47 vs 8.32 min; $P = 0.004$) resulting in a significantly reduced radiation (4980 vs 2665 $Gy*cm^2$; $P = 0.032$). Operative time was reduced in the navigation group (177 vs 234 min; $P = 0.028$) despite the necessity of additional surface referencing.

Conclusion: Fixation of sacral fractures continues to be challenging due to complex local anatomy. Especially in severe comminuted sacral fractures lumbopelvic fixation provides superior stability and allows immediate weight bearing. For iliac screws, identifying the correct entry point and angle of implantation in all planes requires detailed anatomic

See pages 49 - 106 for financial disclosure information.

knowledge and multiple radiographic views. In the current study, 3D navigation helped to reduce operative time and fluoroscopy time resulting in a significant reduction of radiation exposure for the patient and OR personnel.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Anterior versus Posterior Approaches for Odontoid Fracture Stabilization in Patients Older Than 65 Years: 30-Day Morbidity and Mortality

Joseph Patterson, MD[1]; David Sing, BS[2]; Bobby Tay, MD[2]; ***Alexander Theologis, MD[1]***
[1]University of California San Francisco, San Francisco, California, USA;
[2]University of California San Francisco Orthopaedic Surgery, San Francisco, California, USA

Background/Purpose: Surgical stabilization of odontoid fractures is superior to nonoperative management in geriatric patients. How elderly patients with odontoid fractures fare after anterior and posterior approaches, however, is not well defined. The purpose of this study is to compare 30-day perioperative clinical outcomes of surgical odontoid stabilization by an anterior or posterior operative approach in elderly patients.

Methods: Retrospective review of the prospectively collected American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database (2005-2013). Elderly patients (greater than 65 years) with odontoid fractures who underwent odontoid stabilization via anterior or posterior approaches were identified by ICD-9/CPT codes. Exclusion criteria included concomitant subaxial spine surgery, instrumentation noncontiguous with the atlantoaxial interval, and combined approaches. Baseline demographics and perioperative details were compared. Adverse events, mortality, reoperation, discharge, and readmission rates within 30 days of operation were compared using bivariate and multivariate generalized linear regressions.

Results: 141 patients (male 81, female 60; average age: 77.8 ± 6.5 years; anterior approach 48, posterior approach 93) were analyzed. Patients scheduled to have a posterior approach had significantly more nonunions preoperatively and higher body mass index (BMI). Operative times for posterior surgeries were significantly longer. Age, comorbidities, functional dependence, time to surgery, and length of hospital stay were similar between groups. There were no significant differences in the relative risk (RR) of the composite outcome of "any adverse event" after adjusting for differences in baseline characteristics. Patients who underwent an anterior approach were more likely to have an unplanned hospital readmission (RR = 8.95, 95% CI 2.21-36.29, $P = 0.002$) and have significantly more revision operations (RR = 19.51, 95% CI 2.49-152.62, $P = 0.005$) than patients who had a posterior operation.

Conclusion: An anterior approach for odontoid fracture stabilization in patients ≥65 years old is associated with shorter operative times and greater relative risks of unplanned readmissions and revision operations within 30 days of surgery relative to a posterior approach.

See pages 49 - 106 for financial disclosure information.

Treatment of Unstable Dorsal Distal Radius Fractures: The Dorsal Plate Revisited

Adam Driesman, BA[1]*; Nader Paksima, DO, MPH*[1]*; Julie Johnson, MD*[2]*;*
Christopher Kim, BS[1]*; Kenneth Egol, MD*[1]
[1]*New York University Hospital for Joint Diseases, New York, New York, USA;*
[2]*University of Pittsburgh, Pittsburgh, Pennsylvania, USA*

Purpose: Dorsal distal radius plates have provided stable internal fixation of displaced fractures of the wrist. However, a significant number of extensor tendon problems have been reported in the first-generation designs. Newer, lower-profile dorsally applied plates have been developed to try to address these complications. The purpose of this study is to determine the functional outcome and complication rate following next-generation, low-profile dorsal plating for unstable fractures of the distal radius.

Methods: A standard protocol and approach to the treatment of distal radius fractures was agreed upon by 2 surgeons. Those indicated for surgery were treated with either a volar locked plate or a dorsal locked plate based upon fracture pattern. Radiographic and clinical examination findings were gathered for initial presentation and follow-up visits after surgery. Those with less than 6 months' clinical follow-up, incomplete radiographic follow-up, and any other concomitant fixation of the distal radius with the exception of Kirschner wires were excluded. Outcomes were evaluated at the time of latest follow-up with use of the QuickDASH, an abbreviated version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, 10-point visual analog scale (VAS), range of motion, and osteoarthritis (OA) scale for arthritis.

Results: Of the 799 open reduction and internal fixations of the distal radius from 2007 to 2015, 34 fractures in 33 patients (4%) were treated with a low-profile dorsal locking plate (DP) by two orthopaedic surgeons. The mean age of the population was 44 years and average time to follow-up was 13.4 months. All fractures in the DP group united by an average by 3.7 months. There were no instances of loss of reduction, infection, malunion, or nonunion. The mean score of the QuickDASH questionnaire was 38 points. Average visual analog scale (VAS) pain score at latest follow-up was 2.2/10. Nine patients (26%) required hardware removal, one of which was due to extensor tendon rupture (3%).

Conclusion: Dorsal locked plating of distal radius fractures with newer low-profile implants is a viable option for a small subset of patients with unique fractures types, such as the dorsal rim shear type fractures. Surgeons should not fear the use of the dorsal distal radius plate. When called for, these implants provide excellent fixation but are at an increased risk for tendon irritation that may require removal.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Nonbridging External Fixation versus Volar Locked Plating for Distal Radial Fracture Fixation

Lewis Gray, Medical Student; ***Andrew Duckworth, MBChB, BSc, MRCSEd, MSc, PhD****;*
Nicholas Clement, MRCSEd, PhD; Charles Court-Brown, MD, FRCSEd;
Margaret McQueen, MD, FRCS
Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh,
Edinburgh, UNITED KINGDOM

Purpose: Nonbridging external fixation (NBEF) and volar locked plating (VLP) are recognized techniques in the management of distal radial fractures, but with no comparative data currently available. The aim of this study was to compare the early complications, and the longer-term functional outcomes, of NBEF versus VLP for fractures of the distal radius.

Methods: We identified from a prospective database all patients with a fracture of the distal radius managed using either NBEF or VLP. Partial articular fractures and intra-articular fractures requiring open reduction were excluded. Demographic data, fracture classification, management, complications, and subsequent surgeries were recorded. The primary short-term outcome measure was complications, determined using a combination of prospective and retrospective note review. The primary long-term functional outcome measure was the Patient Rated Wrist Evaluation (PRWE).

Results: There were 202 patients with a mean age of 58 years (range, 17-88) and 160 (79%) were female. A fall from standing height accounted for 82% (n = 165) of all injuries, with one or more comorbidities in 53% (n = 106) of patients and a mean body mass index (BMI) of 25 kg/m^2 (range, 15-39). There were 139 (69%) OTA type-A fractures and 63 (31%) type-C. There were 156 patients who underwent NBEF and 46 VLP. The overall rate of complications was comparable between the two groups (32.1% NBEF vs 17.4% VLP; P = 0.053), with the higher rate for NBEF associated with an increased rate of superficial infection (19.2% vs 0%; P <0.001). Neurological complications were more frequent following VLP (8.7% vs 1.3%; P = 0.029), with the majority (n = 5) acute carpal tunnel syndrome. At a mean of 4 years (range, 3.6-4.6; n = 88) postinjury there was no significant difference in the PRWE (P = 0.252), QuickDASH (an abbreviated version of the Disabilities of the Arm, Shoulder and Hand [DASH])(P = 0.444), or overall satisfaction (P = 0.105) between the two groups.

Conclusion: NBEF and VLP have a comparable complication rate following distal radius fracture fixation, with superficial pin site infection associated with NBEF and neurological complications more frequent following VLP. In the longer term there is no patient-reported functional advantage for either technique. Given the increased costs associated with VLP and with no longer-term advantage found, NBEF may be a more cost-effective option for managing these fractures.

See pages 49 - 106 for financial disclosure information.

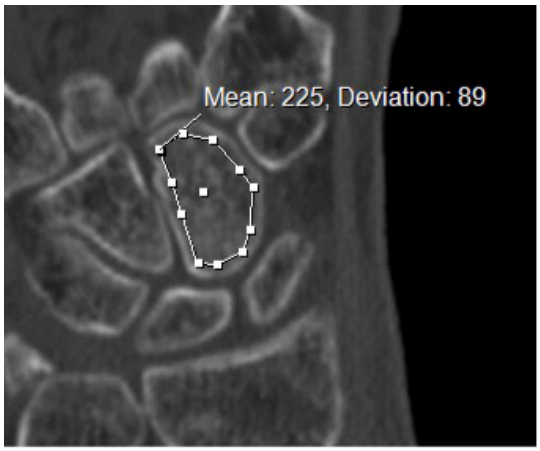
Using Hounsfield Units to Assess Osteoporotic Status on Wrist CT Scans: Comparison with Dual X-Ray Absorptiometry

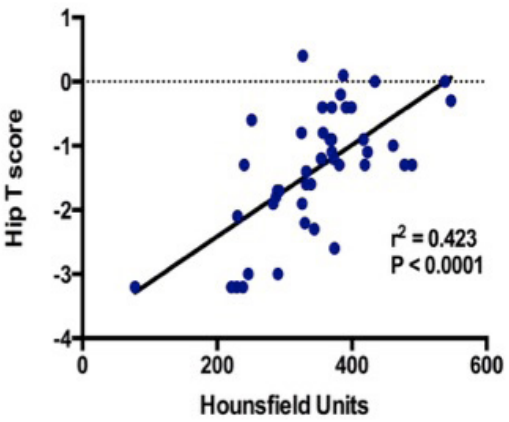
Elizabeth Gausden, MD[1]*; Christine Johnson, MD*[2]*; Andrew Weiland, MD*[2]*; Joseph Lane, MD*[2]*; Joseph Schreiber, MD*[2]
[1]*Hospital for Special Surgery-Cornell, New York, New York, USA*
[2]*Hospital for Special Surgery, New York, New York, USA*

Purpose: Rates of evaluation and treatment for osteoporosis following distal radius fragility fractures remain low. As a subset of patients with these fractures undergo diagnostic CT scan of the wrist, utilizing bone mineral density (BMD) measurements available with this imaging can be used to detect osteopenia or osteoporosis. This information may consequently prompt intervention to prevent a subsequent fracture. The purpose of this study was to determine if Hounsfield unit (HU) measurements at the wrist correlate with BMD measurements of the hip, femoral neck, and lumbar spine, and to assess the ability of these HU measurements to detect osteoporosis of the hip.

Methods: 45 female patients with distal radius fractures who underwent CT scan and dual x-ray absorptiometry (DXA) scan as part of the management of their wrist fracture were identified. The region of interest (ROI) tool in Sectra IDS7 PACS (picture archiving and communication system) was utilized to calculate HU values within the capitate. A two-tailed Pearson *r* analysis was used to assess the correlation between HU and BMD and T-scores. A threshold cutoff value of HU that optimized sensitivity and specificity was identified using a receiver operating characteristic curve.

Results: Within our institution, 907 distal radius fractures were identified on CT scans, but only 50 of these patients (45 female) underwent DXA scans within 12 months of the fracture (5.5%). Interobserver reliability of the measurement of HU at the capitate was excellent (r = 0.918; P <0.0001). HU values were positively correlated with BMD as measured at the hip (r^2 = 0.406, P <0.0001), femoral neck (r^2 = 0.475, P <0.0001), and lumbar spine (r^2 = 0.225, P = 0.001). An HU threshold of 307 in the capitate optimized sensitivity (86%) and specificity





The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

(94%) for discerning patients with osteoporosis, as defined as a T-score below -2.5, from patients with a normal T-score. Patients with mean HU capitate values below this threshold were significantly more likely to be osteoporotic (odds ratio = 14.6, $P = 0.0013$).

Conclusion: The results of this study demonstrate that a patient's bone quality can be inferred based on a diagnostic imaging study that may already be available. As HU values measured by wrist CT correlate with BMD as determined by DXA, orthopaedic surgeons have another tool for determining the patients at high risk who require further evaluation and intervention for osteoporosis.

See pages 49 - 106 for financial disclosure information.

The Epidemiology of Fracture Nonunion in 18 Human Bones: Analysis of a Payer Database that Includes ~90.1 Million Patients

Robert D. Zura, MD[1]; Ze Xiong, MS[2]; Thomas Einhorn, MD[3]; J. Tracy Watson, MD[4]; Robert F. Ostrum, MD[5]; Michael Prayson, MD[6]; Gregory J. Della Rocca, MD, PhD, FACS[7]; Samir Mehta, MD[8]; Zhe Wang, MS[9]; R. Grant Steen, PhD[10]

[1]*Louisiana State University Health Science Center, New Orleans, Louisiana, USA;*
[2]*North Carolina State University, Raleigh, North Carolina, USA;*
[3]*Boston University Medical Center, Boston, Massachusetts, USA;*
[4]*St. Louis University Dept. of Ortho Surgery, Saint Louis, Missouri, USA;*
[5]*UNC Department of Orthopaedics, Chapel Hill, North Carolina, USA;*
[6]*Wright State Orthopaedic Surgery, Dayton, Ohio, USA;*
[7]*University of Missouri School of Medicine, Columbia, Missouri, USA;*
[8]*Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, USA;*
[9]*North Carolina State University, Raleigh, North Carolina, USA;*
[10]*Bioventus LLC, Durham, North Carolina, USA*

Purpose: The rate of nonunion is generally accepted as 5% to 10% of all fractures. Nonunion risk is related to the severity of injury and/or surgical tactics used for fixation, but nonunion is not fully explained by these factors alone. Certain patient factors are modifiable, which could potentially have a strong impact on patient care, perioperative decision making, and patient counseling. We test a hypothesis that fracture characteristics and patient-related risk factors assessable by the clinician at presentation can predict the risk of fracture nonunion.

Methods: This was an inception cohort study in a large payer database of patients in the United States. Patient-level health claims for medical and drug expenses were compiled for approximately 90.1 million patients. Study inclusion was limited to patients with a coded bone fracture in calendar year 2011. The final database collated 257 patient variables for each fracture. Variables included patient demographic descriptors, treatment procedures as per CPT codes, comorbidities as per ICD-9 codes, and drug prescriptions as per National Drug Code Directory (Red Book) codes. Continuous enrollment in the database was required for 12 months after fracture, to allow sufficient time to capture a nonunion diagnosis. Logistic regression was used to calculate odds ratios (ORs) for variables associated with nonunion.

Results: Among 313,256 fractures in 18 bones, the nonunion rate was 4.7%. Elevated nonunion risk was associated with a more complex fracture (eg, open fracture, multiple fractures), high body mass index, smoking, and alcoholism. Females had more fractures, but males were more prone to nonunion. Multivariate ORs for nonunion are generally small (<2.0), which may explain why nonunion has been so hard to predict. Fracture complexity is a key determinant, but nonunion rate also varies with fracture location: scaphoid, tibia + fibula, and femur are most likely to suffer nonunion. Nonunion ORs were significantly increased for risk factors including: number of fractures, use of NSAIDs (nonsteroidal anti-inflammatory drugs) + opiates, operative treatment, open fracture, anticoagulant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

use, rheumatoid + osteoarthritis, opioid use, diabetes, anticonvulsant use, osteoarthritis, high-energy injury, osteoporosis, male gender, smoking, benzodiazepine use, insulin use, vitamin D deficiency, antibiotic use, obesity, and diuretic use (all, multivariate P <0.001). Surprisingly, nonunion risk associated with opioid use accrued largely to patients who were using opioids prior to fracture, rather than to patients who took opioids to treat pain secondary to fracture.

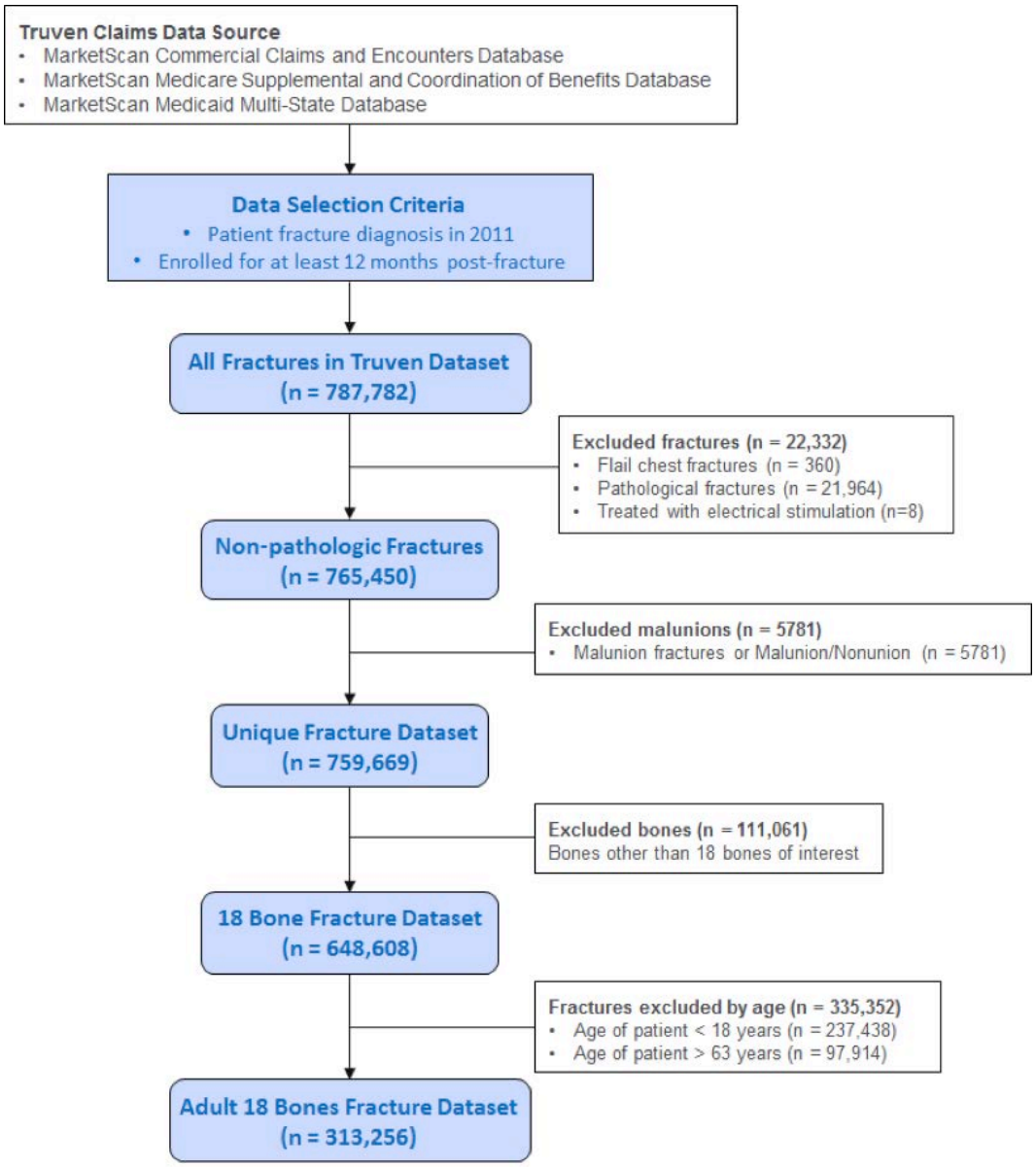


Figure 1. CONSORT diagram showing how the analytic sample was assembled.

See pages 49 - 106 for financial disclosure information.

Conclusions: Nonunion is a function of fracture complexity, fracture location, medication use, and disease comorbidity. The interplay of risk factors is complex, but it may become possible to predict nonunion. Certain medications that have a significant impact on fracture nonunion can be modified in the perioperative period to minimize risk of nonunion. Chronic opioid exposure is a strong risk factor for nonunion.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Prospective Evaluation of Opioid Use After Distal Radius Fracture Surgery: Understanding What Affects Consumption

Joseph O'Neil, MD[1]; Mark Wang, MD, PhD[1]; ***Asif Ilyas, MD, FACS***[2]
[1]*Rothman Institute / Jefferson, Philadelphia, Pennsylvania, USA*
[2]*Rothman Institute / Jefferson, Wayne, Pennsylvania, USA*

Background/Purpose: Postoperative pain management and opioid consumption following distal radius fracture repair surgery (DRF ORIF) may be influenced by a number of variables including fracture type, patient demographics, and anesthetic type. Overprescribing postoperatively potentially introduces excess opioids vulnerable to diversion and abuse. In order to optimize postoperative opioid dosage and better understand opioid consumption following DRF ORIF, a prospective study was undertaken with the hypothesis that opioid consumption would be lower with regional anesthesia, but higher with worsening fracture classification and various patient demographics.

Methods: All patients undergoing DRF ORIF were consecutively enrolled over a 6-month period. Information collected included patient demographics, fracture type, surgical technique, anesthesia type, amount and type of narcotic prescribed, number of pills taken, reason for stopping, and adverse events. Statistical analysis was performed.

Results: A total of 98 patients were eligible for inclusion in the study (average age of 58 years), consisting of 79 females and 19 males. Prior to morphine equivalent conversion, average opioid pill consumption was 15 pills and the average amount prescribed was 29 pills. Anesthesia type consisted of 45 patients with general anesthesia (GEN) and 53 with regional anesthesia (REG) with a single shot peripheral nerve block. The mean amount of opioid consumption calculated via morphine equivalence was 58.5 mg (range, 0-280 mg) for a mean of 4.8 days (range, 0-16 days) after surgery. Opioid consumption in the GEN group was 59.2 compared to 58.5 in the REG group ($P > 0.05$). Opioid consumption based on fracture classification consisted of mean morphine equivalence of 57.7, 60.3, and 62.0 for fractures with AO Class A, B, and C, respectively ($P > 0.05$). Analysis of patient demographics found that there was an inverse relationship between age and opioid use ($P < 0.05$). Similarly, there was a trend toward a higher opioid consumption among self-pay / Medicaid patients ($P > 0.05$).

Conclusion: Patients following DRF ORIF were routinely overprescribed opioids by approximately double than actually consumed postoperatively. Opioid consumption was equivalent irrespective of type of GEN or REG anesthesia. Worsening fracture classification demonstrated a trend toward increasing opioid consumption. In terms of patient demographics, opioid consumption decreased with increasing age. However, patients who were self-pay or had Medicaid were more likely to consume a greater amount of opioids. Surgeons should take these findings into account when prescribing postoperative opioids in order to avoid overprescribing.

See pages 49 - 106 for financial disclosure information.

Do You Know When Your Open Fractures Actually Receive Antibiotics and What May Cause a Delay? An Analysis at a Level I Trauma Center

*Robert Steffner, MD[1]; **Justin Lucas, MD**[2]; Gannon Kennedy, MD[3]; Philip Wolinsky, MD[2];*
[1]Columbia University Medical Center New York, New York, USA;
[2]UC Davis Medical Center, Sacramento, California, USA;
[3]New York Medical College, New York, New York, USA

Purpose: Early administration of antibiotics is an essential component of treatment of open fractures. Studies recommend that antibiotics should be given within 3 hours of injury in order to minimize the infection risk. Some experts suggest that administration within 1 hour should be the current benchmark. Although the literature emphasizes the importance of prompt antibiotic administration, few studies have examined if patients with open fractures are actually receiving antibiotics within an acceptable time frame or what factors contribute to a delay in administration. We hypothesized that there was significant variability in the time to administration of the initial dose of antibiotics for patients with open fractures at our institution and there were identifiable factors associated with delays.

Methods: This was a retrospective chart review of patients with open fractures treated at a single Level I trauma center over two separate time intervals. The second interval was included to determine the effects of an intervention initiated by our Emergency Department (ED) to improve the delay to initial antibiotic administration for patients with open fractures. Patient charts with CPT codes 11010, 11011, and/or 11012 were included. We then excluded those with: (1) open hand or spine fractures, (2) transfers from another institution, and (3) those who received antibiotics prior to arrival to our ED. A total of 209 patients in the preintervention group and 38 patients in the postintervention group were then reviewed and appropriate data were collected.

Results: 73% of our patients received antibiotics within 3 hours of presentation to our ED. This was not improved after the ED intervention. Several factors affected time to antibiotics: (1) The service placing the antibiotic order had a significant influence on both the time to order (P <0.0001) and time to administration of antibiotics (P <0.0001). Patients who had antibiotics ordered by an ED physician had their antibiotics ordered and administered the fastest. Antibiotics ordered by the orthopaedic service had the longest delay to order placement and administration. (2) Whether or not a patient was a "coded" trauma and the level of the trauma activation also had a significant effect on when a patient's antibiotics were ordered and administered (P = 0.0332). Patients who had the most intense level of trauma code activation (911) and those who were uncoded traumas were more likely to have a delay (911: antibiotic order average of 105 min, antibiotics administration average of 183 min; uncoded: antibiotic order average of 85 min, antibiotics administration average of 47 min) (Table 1). (3) Time to operative debridement: patients who went to the operating room in less than 6 hours had a time to antibiotic order of 52 minutes and time to administration of 115 minutes; those greater than 6 hours had a time to antibiotic order of 92 minutes and time to administration of 157 minutes (P = 0.0113). A comparison of pre- and postintervention data showed a trend toward increasing time for both the mean time to antibiotic order (32% longer, P = 0.248) and the mean time to antibiotic administration (38% longer, P =

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

0.118) after changes were initiated in the ED.

Table 1. Effect of trauma code activation level on the timing of the antibiotic order and antibiotic administration

Trauma Code Level	Time from ED arrival to antibiotic order (minutes) p = 0.0332	Odds Ratio (95% CI)	Time from ED arrival to antibiotic infusion (minutes)
No Activation	85	1.89 (0.67-5.12)	147
933	59	-----	101
922	86	1.17 (0.46-2.98)	158
911	105	3.33 (1.30-8.53)	183

Conclusion: 27% of patients with open fractures treated at our Level I trauma center did not receive antibiotics within 3 hours of presentation to the ED. Those at risk of receiving delayed antibiotics included: (1) the most severely injured trauma patients, (2) the least severely injured patients with low-grade open fractures triaged as uncoded traumas, (3) patients with antibiotics ordered by anyone other than an ED physician, and (4) patients undergoing operative debridement more than 6 hours after presentation to the ED.

See pages 49 - 106 for financial disclosure information.

Radiographic Characteristics of Volar Barton Distal Radius Fractures

Michael Daly, MD, MSc[1]; Taylor Horst, MD[2]; Chaitanya Mudgal, MD[3];
[1]Massachusetts General Hospital, Harvard Combined Orthopaedics Residency Program, Boston, Massachusetts, USA;
[2]Massachusetts General Hospital, Division of Hand and Upper Extremity, Boston, Massachusetts, USA;
[3]Massachusetts General Hospital Boston, Massachusetts, USA

Purpose: This study has three purposes: (1) to critically analyze fracture geometry on preoperative CT scans of surgically treated volar Barton distal radius fractures, (2) to determine the frequency of the presence of a dorsal cortical break (fracture line extending through the dorsal cortex of the metaphysis of the distal radius), and (3) to assess whether the presence of a dorsal cortical break is associated with age or gender.

Methods: We retrospectively reviewed the medical records of all patients with distal radius fracture treated surgically by a single fellowship-trained orthopaedic hand surgeon between January 2007 and January 2015 at a large, academic tertiary care center. Patients 18 years of age and older with a volar Barton distal radius fracture (OTA 23-B3 or OTA 23 type C) were included if they had a preoperative CT scan and underwent surgery (CPT codes 25608 or 25609). We examined CT scans and recorded the number of fracture fragments (including the shaft fragment), characteristics of the volar piece (presence of a longitudinal split, % involvement of the scaphoid and/or lunate facets as measured from the volar articular rim), presence of central articular depression, and whether there was a dorsal cortical break and, if present, the location of the dorsal cortical break as measured from the dorsal articular rim (Fig. 1). Our main outcome measure was dorsal cortical break versus no dorsal cortical break; our main predictor was age. We analyzed baseline variables using nonparametric bivariate statistics for unadjusted comparisons.

Results: Of 194 patients treated operatively by a single surgeon over an 8-year period, we identified 26 adult patients (mean age, 49 years; 69% female) who sustained a volar Barton distal radius fracture and had a preoperative CT scan available for analysis. All 26 (100%) were treated with precontoured volar plates; 1 patient was treated with both a precontoured volar plate and a supplemental radial-sided plate. Including the shaft as a fragment, 20 (76%) had 3 or more discrete fracture fragments. When analyzing radiographic characteristics of the volar fracture fragment by itself, we found 13 (50%) had a longitudinal split. The main fracture line of the volar piece starts within the radiocarpal joint, involving an average of 44.2% of the scaphoid fossa (Fig. 1A) and 12.8% of the lunate fossa (Fig. 1B) as measured from the volar rim of the distal radius. The main fracture line of the volar piece extends proximally, exiting an average of 20.7 mm from the volar articular margin of the distal radius (Fig. 1C). On sagittal CT reconstructions, depression of the central articular surface was evident in 18 patients (69%) (Fig. 1D). 19 fractures (73%) had a dorsal cortical break. Of those with a dorsal cortical break, the fracture line exited the dorsal metaphyseal cortex an average of 10.4 mm from the dorsal articular rim of the distal radius (Fig. 1E). Comparing those with and without a dorsal cortical break, there was no difference in age (51 ± 20 years versus 42 ± 20 years, odds ratio [OR] 1.02 [95% CI 0.98-1.07],

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

$P = 0.29$, Wilcoxon rank sum test) or gender (68% vs 57% female, OR 0.61 [95% CI: 0.07-5.67], $P = 0.66$, Fisher's exact test).

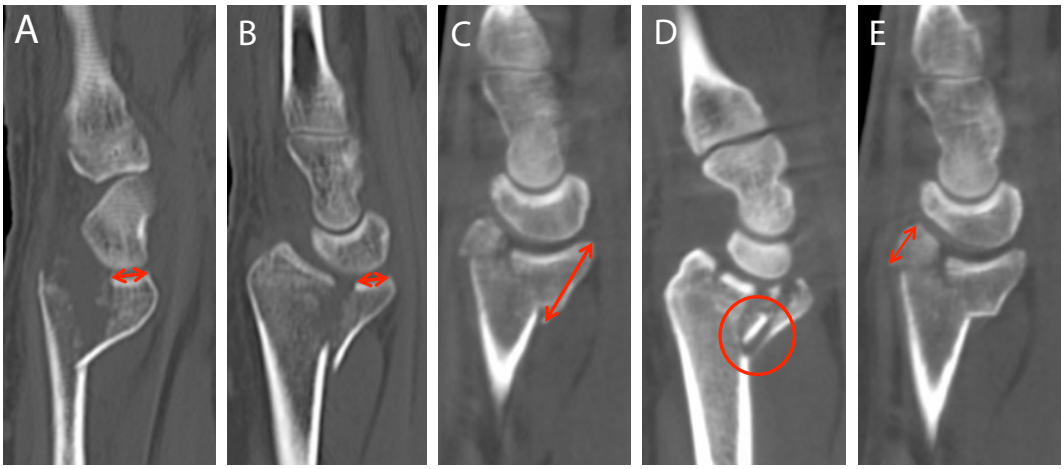


Figure 1. Radiographic characteristics of volar Barton distal radius fractures on preoperative CT scans. The main fracture line of the volar piece starts within the radiocarpal joint, involving variable amounts of the scaphoid fossa **(A)** and/or lunate fossa **(B)** as measured from the volar articular rim of the distal radius. **(C)** Maximal length of the main volar fragment. **(D)** Articular depression. **(E)** Dorsal cortical break — when present, we measured the distance from the dorsal cortical break to the dorsal articular rim of the distal radius.

Conclusion: The majority (73%) of patients with surgically treated volar Barton distal radius fractures in our series had a dorsal cortical break, which occurred an average of 10.4 mm from the dorsal articular rim of the distal radius. The presence of a dorsal cortical break was not statistically associated with age or gender, suggesting these fracture patterns may not be associated with osteoporosis as previously postulated by Harness et al in 2004. Our findings expand and refine our understanding of the radiographic pathoanatomy of volar Barton fractures of the distal radius, and suggest further study is warranted.

See pages 49 - 106 for financial disclosure information.

ORIF versus Radial Head Arthroplasty for the Treatment of Radial Head Fractures in a Young Active Population

*Nicholas Kusnezov, MD[1]; **Emmanuel Eisenstein, MD**[1]; Justin Mitchell, DO[2]; Kelly Kilcoyne, MD[2]; Brian Waterman, MD[2];*
[1]William Beaumont Army Medical Center/Texas Tech University Health Sciences Center, El Paso, Texas, USA;
[2]William Beaumont Army Medical Center, El Paso, Texas, USA

Purpose: Radial head arthroplasty (RHA) compares favorably to open reduction and internal fixation (ORIF) for the treatment of radial head fractures in a young active military population.

Methods: A retrospective electronic medical record review was performed of the Military Health System (M2) database for CPT codes 24665 (ORIF) and 24666 (RHA), between 2010 and 2015. Procedure miscoding or patients with insufficient follow-up (ie, <2 years) were excluded. Multiple variables including demographics, ipsilateral versus contralateral injury with respect to dominant handedness, junior or senior rank, age, gender, fracture classification based on Mason classification scheme (OTA 21-B2), associated dislocation (OTA 20-A, OTA 20-B), concomitant coronoid fracture (OTA 21-C1.2), coronoid fixation, associated ulna fracture (Monteggia variant, 21-B3), lateral ulnar collateral ligament (LUCL) reconstruction, other concomitant injury, and heterotopic ossification (HO) prophylaxis were studied with regard to range of motion (ROM), ability to return to military duty and deployment, complications and revisions, as well as final DASH (Disabilities of the Arm, Shoulder and Hand) scores. Multivariable analysis was performed to assess for the influence of specific risk factors on stated end points.

Results: There were 67 patients who underwent 69 ORIFs and 10 patients who underwent RHA available for review. Average patient age was 31 years (SD 8.1) with a mean follow-up time of 3.4 years (range, 2-5.8). 22 patients had an associated dislocation and 14 had an associated coronoid fracture with 6 undergoing coronoid fixation. Average extension was 8.7° (SD 9.9), flexion 132° (SD 12), pronation 80° (SD 16), and supination 73° (SD 23). 90% of patients in both groups were able to return to active duty. Deployment data were available for 24 patients with 75% being able to deploy postoperatively. Functional end points did not significantly differ between ORIF and RHA. Coronoid fracture was significantly associated with decreased supination (P <0.05), while secondary coronoid fixation predicted improved pronation and supination (P <0.05). Dislocation, coronoid fracture, and LUCL reconstruction were associated with a significantly increased rate of sustaining one or more complications (P <0.05), while dislocation and need for LUCL reconstruction independently predicted revision surgery (P <0.05). DASH scores were available for 14 ORIF patients with an average of 18, and for 5 RHA patients with an average of 13.

Conclusion: Arthroplasty and ORIF are viable options for treating radial head fractures in a young active population. With 90% of service members able to return to full duty after radial head fracture, increased complexity of the fracture or requirement for arthroplasty due to nonreconstructable fracture pattern does not affect the ability to have a functional upper

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

extremity. Increased fracture complexity as measured by coronoid fracture has a negative effect on ROM, with fixation of the fracture associated with improved ROM. However, dislocation, coronoid fracture, and LUCL reconstruction (as markers of increased fracture severity and complexity) are associated with increased complications. Dislocation and LUCL reconstruction are associated with increased need for revision surgery, again as surrogates for injury severity. While the optimal treatment of radial head fractures, especially more complex injury patterns, is still debatable, it is reassuring to know that in a young active population with high upper extremity demands both treatment options provide good results, and thus one should not be overly concerned with providing arthroplasty as an option in young patients due to nonreconstructable radial head fractures.

See pages 49 - 106 for financial disclosure information.

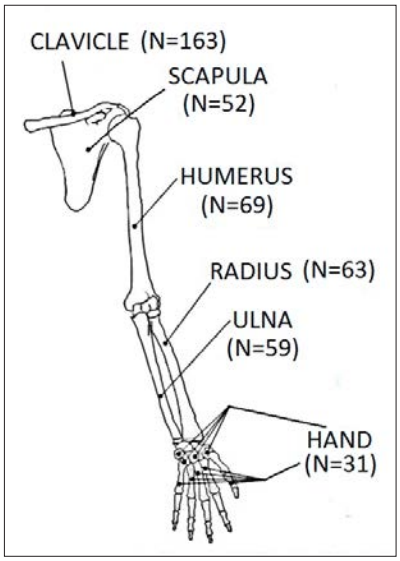
Side-Impact Collisions Increase Proximal Upper Extremity Injuries

Andrew Usoro, BA[1]*; Ashley Weaver, PhD*[2]*; Eric Barnard, BS*[1]*; Anna Miller, MD, FACS*[3]
[1]*Wake Forest School of Medicine, Winston-Salem, North Carolina, USA;*
[2]*Virginia Tech-Wake Forest University Center for Injury Biomechanics, Winston-Salem, North Carolina, USA;*
[3]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA*

Purpose: Motor vehicle collisions (MVCs) remain a major cause of morbidity and mortality in the United States. While much research has focused on injuries in frontal impact MVCs, few studies have examined the injury patterns and severity of upper extremity injuries in side-impact collisions. This study sought to further characterize upper extremity injuries in side-impact MVCs.

Methods: We reviewed 3089 total upper extremity injuries involving 756 participants from the National Highway Traffic Safety Administration's Crash Investigation Research and Engineering Network from 1995-2012. Data on the occupant and injury included: age, gender, weight, belt status, injury description, and injury source, defined as the structural component of the car that caused injury. Exclusion criteria were: those not wearing a seatbelt at the time of injury or unknown belt status; those who sustained frontal, rear impact, or rollover collisions; and crashes with undocumented primary direction of force or change in velocity (Δv). All injuries were categorized into distinct anatomic locations. Injuries were initially stratified by type and distribution. Statistical analysis of the data included descriptive statistics. The same analysis was done for gender stratification.

Results: Of the 3089 upper extremity injuries, most were soft-tissue injuries (83.4%), including abrasions, lacerations, and contusions. The majority of non-soft-tissue injuries were fractures (86.1%), with the clavicle being the most common fracture (n = 163). The incidence of fractures decreased with location distally down the arm. There was no association between injury location and type with gender, age, height, or weight. The left B-pillar, the interior structural support of the car, was the most common injury source (62.3% of all injuries, 51% of fractures). In addition, pillars caused 100% of nerve, burn, and degloving injuries. Neither airbags nor seatbelts caused injury.



Conclusion: Our study sought to characterize the distribution of upper extremity injuries in side-impact collisions and demonstrated that side-impact collisions increase proximal upper extremity injury incidence preferentially over distal upper extremity injuries. This differs from prior studies of frontal impact collisions that demonstrate a greater incidence of distal injuries of the upper extremity. Since we have shown that the majority of these upper extremity injuries are from

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

the left B-pillar and interior surface, we recommend further research on pillar structure safety and improved vehicle performance. Limiting upper extremity injury will potentially improve functional outcomes and return-to-work in side-impact crash survivors.

See pages 49 - 106 for financial disclosure information.

Reliability of Unilateral Clavicle Radiographs versus Panoramic Shoulder Girdle Radiographs in Evaluating Midshaft Clavicle Fracture Shortening

Ryan Ponton, MD*; Andrew Johnson, MD; Patrick Morrissey, MD; Dean Asher, MD; David Dromsky, MD; Kevin Kuhn, MD*
Naval Medical Center San Diego, San Diego, California, USA

Background/Purpose: A relative indication for surgical treatment of midshaft clavicle fractures is shortening of the fracture greater than 1.5-2.0 cm. Previous studies suggest that this degree of shortening impairs shoulder function by decreasing muscular strength and endurance; however the optimal radiographic projection for measuring clavicle shortening has not been established. The purpose of this study was to compare the interobserver and intraobserver reliability of measuring clavicle shortening on a standard unilateral clavicle series versus a panoramic shoulder girdle series (bilateral clavicles on the same cassette).

Methods: After IRB approval, a single institution PACS (Picture Archiving and Communication System) was queried from 1 June 2014 and searched back in time until the sample size was reached. Statistical power analysis demonstrated a sample size of 30 would be sufficient for comparison. Inclusion criteria were patients with a midshaft clavicle fracture that were older than 18 years, had no prior clavicle trauma or surgery, and had both unilateral and panoramic shoulder girdle series performed within 1 week of injury. Two musculoskeletal radiologists, 2 fellowship-trained orthopaedic trauma surgeons, and 2 senior orthopaedic residents evaluated both a unilateral clavicle series and a panoramic shoulder girdle series for fracture shortening. Two weeks after initial evaluation, the same individuals reviewed the same films again to measure clavicle shortening. An intraclass correlation coefficient (ICC) and its confidence interval (CI) were calculated to determine interobserver reliability. The average difference between the 2 time points with 95% CI was calculated to determine intraobserver reliability for each of the unilateral clavicle films and the panoramic shoulder girdle films. The imaging methods were tested statistically by a test of correlation of the two correlation coefficients' data.

Results: The average age of the patients in this study was 28.8 years old. 20 of the 30 (67%) fractures were comminuted. Overall, intraobserver reliability for measuring clavicle shortening was higher with the panoramic shoulder girdle films compared to the unilateral clavicle films ($P = 0.02$). Reliability for each observer was higher with use of the panoramic shoulder girdle film, with 4 of the 6 (67%) observers demonstrating a statistically significant difference. Similarly, interobserver reliability for measuring clavicle shortening was significantly higher with the panoramic shoulder girdle film ($P < 0.01$). Significantly higher inter- and intraobserver reliability was observed in comminuted fracture patterns ($P < 0.01$) compared to simple fracture patterns.

Conclusion: To our knowledge, no prior study has compared the reliability of measuring clavicle shortening in the acute setting on unilateral versus panoramic shoulder girdle films. Our study demonstrated a more reliable measure of shortening using the panoramic shoulder girdle films. This reliability was demonstrated in both inter- and intraobserver measurements. When evaluating midshaft clavicle fracture shortening, clinicians should consider obtaining panoramic shoulder girdle films.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Clavicle Nonunion Repair 2016: What Can Patients Expect?

Nina Fisher, BS*; Adam Driesman, BA; Michael Spurling, BS; Sanjit Konda, MD; Kenneth A. Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Background: While surgical fixation of clavicle fractures has gained popularity and has been well studied, there is little information available on the functional outcomes of patients treated surgically for clavicular nonunions. The purpose of this study was to compare the long-term functional status of patients treated surgically for a clavicular nonunion with patients treated either operatively or non-operatively for an acute clavicle fracture.

Methods: Twenty consecutive patients treated by a single surgeon for a clavicle fracture nonunion using a standard algorithm were identified. Patients were evaluated radiographically and functionally using the Short Musculoskeletal Functional Assessment (SMFA) at routine time-points (pre-operatively, and at 3 months, 6 months, 12 months, and greater than 12 months post-operatively). For comparison of outcomes, acute clavicle fractures were identified from an EMR query from 2011 to 2015 of a single orthopaedic surgeon using the ICD-9 codes for clavicle fractures. All patients who had been treated for an acute clavicle fracture either operatively or non-operatively were contacted for long-term follow-up to assess their current functional status using the SMFA. Chart review was also completed to determine time to healing. SMFA scores were compared between groups only at the long-term follow-up time point. Multivariate analysis was performed using a one-way ANOVA for continuous variables and Pearson's chi-squared analysis for categorical variables.

Results: Twenty-seven patients who sustained an acute clavicle fracture were available. Eighteen (66.7%) patients were treated operatively (average age of 39.06±16.3) and 9 (33.3%) were treated non-operatively (average age of 40.00±18.444.2). Of the patients who were treated for a clavicle nonunion, 18 (90%) patients were originally treated non-operatively. The average age of the clavicle nonunion group was 44.1. The average follow-up interval was 28 months for the nonunion patients and 34 months for the acute fracture patients. There were no significant differences between clavicle nonunion, operative, and non-operative patients in terms of age, gender, BMI, smoking status, education level, marital status, life activity status, or energy of injury. The average time to healing was 4.4±4.1 months for nonunions, 4.93±3.5 months for operative patients, and 3.80±2.5 months for non-operative patients ($p = .817$). There was no significant difference in SMFA or pain scores between nonunion patients and acute fracture patients ($p = .167, .156$).

Conclusions: Patients who are treated surgically for clavicular nonunions ultimately regain a similar functional status as patients who are treated either operatively or non-operatively for an acute clavicle fracture who heal acutely. Orthopaedic surgeons can counsel patients who develop a clavicle nonunion that they will not be debilitated from this injury in the long-term.

See pages 49 - 106 for financial disclosure information.

Gunshot Fractures of the Forearm Are Bad Actors!

*Paul Tornetta III, MD[1]; **David Veltre, MD**[1]; Peter Krause, MD[2]; Mary George, MD[3]; Heather Vallier, MD[4]; Mai Nguyen, MD[5]; Michael Reich, MD[6]; Lisa K. Cannada, MD[7]; Michael Eng, BS[7]; Anna Miller, MD, FACS[8]; Alexandra Goodwin, MD[8]; Hassan R. Mir, MD[9]; Charles Clark, MD[9]; Benjamin Sandberg, MD[10]; Jerald Westberg, BA[11]; Reza Firoozabadi, MD, MA[12]*

[1]*Boston University Medical Center Boston, Massachusetts, USA;*
[2]*LSUHSC, New Orleans, Louisiana, USA;*
[3]*Louisiana State University, New Orleans, Louisiana, USA;*
[4]*Metrohealth Medical Center, Cleveland, Ohio, USA;*
[5]*MetroHealth System, Cleveland, Ohio, USA;*
[6]*Case Western Reserve University, Cleveland, Ohio, USA;*
[7]*Saint Louis University, St. Louis, Missouri, USA;*
[8]*Wake Forest Baptist Hospital, Winston-Salem, North Carolina, USA;*
[9]*Florida Orthopaedic Institute, Temple Terrace, Florida, USA;*
[10]*University of Minnesota, Dept of Orthopaedic Surgery, Minneapolis, Minnesota, USA;*
[11]*Hennepin County Medical Center, Minneapolis, Minnesota, USA;*
[12]*Harborview / University of Washington, Seattle, Washington, USA*

Purpose: Gunshot fractures are common in urban centers. Gunshot fractures of bones with good soft-tissue cover have low infection rates, such as the femur and humerus. The forearm, however. has less coverage, particularly over the ulna, which may place these injuries at higher risk for infection. The current study sought to evaluate a large series of gunshot fractures of the forearm to determine the complication rates and what factors may lead to infection, nonunion, or compartment syndrome.

Methods: We performed a retrospective analysis of a consecutive series of gunshot forearm fractures at 8 trauma centers. Data abstracted included: age, gender, ISS, number of gunshot wounds (GSWs) total and to the forearm, bone fractured, and side of injury, fracture pattern and location, energy of GSW, nerve or vascular injury, antibiotics, disposition of bullet, the presence of bullet fragmentation, and the amount of bone loss (estimated by length and % circumference). Outcomes assessed were infection, compartment syndrome, and nonunion.

Results: 157 patients (87% male, aged 18-68 [average 30]) had 159 forearms fractures (84 L; 75 R). The average number of GSWs sustained to the body was 3, and to the forearm was 1.2. There were 56 isolated radius, 76 isolated ulna, and 27 both-bone fractures. 85% of fractures were comminuted, 40% were proximal, 60% had bullet fragmentation, and 30% had a retained bullet. Neurovascular injury was common with 39% having a nerve injury and 20% having an arterial injury (Figure). Follow-up was to union or diagnosis of nonunion and averaged 862 days. 7 patients (8%) developed a compartment syndrome. There were 16 (10%) infections (11 deep, 5 superficial) and 19 patients (12%) developed a nonunion (5 radius, 10 ulna, 4 both). Deep infection was more common in the ulna (8 deep, 3 superficial) than the radius (2 deep, 3 superficial). Four of the infections occurred in both-bone fractures, all of which were of the ulna. Vascular injury correlated with compartment syn-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

drome ($P = 0.003$) but not with infection or nonunion. Proximal fracture location was not associated with compartment syndrome, contrary to prior studies. Bullet fragmentation correlated with infection of both radius and ulna fractures ($P = 0.002$) and all infections occurred in comminuted fractures. Ulnar infection was associated with more distal fractures with less soft-tissue cover ($P = 0.02$) and with bone loss ($P = 0.0001$) while radial infection correlated with median or anterior interosseous nerve (AIN) injury ($P = 0.004$ and $P = 0.04$) and with a dorsal approach being used ($P = 0.03$). Nonunion of the radius was associated with nerve injury and bone defect size (26 mm x 80% vs 12 mm x 30%; $P < 0.0001$). Nonunion of the ulna was associated with infection ($P = 0.0003$) and also with bone defect size (29 mm x 75% vs 11 mm x 27%; $P < 0.0001$).

VASCULAR INJURIES'		
At Least One Vascular Injury	32	20.1%
Brachial Artery	8	5.0%
Radial Artery	16	10.1%
Ulnar Artery	14	8.8%
NERVE INJURIES		
Any Nerve Injury	63	39.6%
Radial Nerve	26	16.4%
Ulnar Nerve	37	23.3%
Median Nerve	19	11.9%
Anterior Interosseous Nerve	10	6.3%
Posterior Interosseous Nerve	14	8.8%

Conclusion: Gunshot fractures of the forearm are serious injuries that carry a higher infection (10%) and much higher nonunion rates (12%) than blunt injuries. Ulnar-sided infection was more common and more commonly deep. This may be related to the poor coverage of the ulna predisposing to wound problems. Bones that were more directly hit, represented by a comminuted pattern with bullet fragmentation and bone loss, predisposed patients to complications. Infections occurred only in comminuted patterns and were associated with bullet fragmentation while increased bone loss predisposed to nonunion. Gunshot fractures of the forearm are bad actors and patients should be counseled regarding the high complication rate. In particular, the ulna is at particular risk for infection if not well covered. Further work will be needed to determine if operative measures should be taken to treat bone loss.

See pages 49 - 106 for financial disclosure information.

Positional Change in Displacement of Midshaft Clavicle Fractures: An Aid to Preoperative Evaluation

Ehsan Jazini, MD[1]*; Awais Malik, BS*[2]*; Xuyang Song, MD*[2]*; Herman Johal, MD MPH*[3]*; Nathan O'Hara, MHA*[2]*; Gerard Slobogean, MD*[2]*; Joshua Abzug, MD*[4]
[1]*University of Maryland, Baltimore, Maryland, USA;*
[2]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[3]*McMaster University, Hamilton, Ontario, CANADA;*
[4]*University of Maryland School of Medicine, Timonium, Maryland, USA*

Background/Purpose: The majority of midshaft clavicle fractures are treated nonsurgically; however, shortening or horizontal displacement greater than 20 mm has been shown to be associated with worse functional outcomes and is considered a potential surgical indication. It has been suggested that the upright position may result in a dynamic increase in fracture displacement during the healing process. Since an upright radiograph mimics the position of the limb during nonsurgical treatment, it is important to determine if it is associated with increased fracture displacement, which may alter treatment decision making. We sought to evaluate whether there is a change in fracture displacement based on patient position.

Methods: A retrospective review of 80 consecutive patients with displaced midshaft clavicle fractures between December 2006 and June 2013 was performed at a Level I trauma center. Vertical and horizontal displacements of each fracture were measured by four reviewers on supine, semi-upright, and/or upright chest radiographs. The effect of patient position (supine, semi-upright, upright) on fracture displacement was calculated using a mixed effects linear regression model. Patients were coded as categorical variables and included as random effects in the model. The proportion of patients that have a horizontal displacement greater than 20 mm in supine versus upright was compared using a Fisher's exact test.

Results: Four observers completed measurements with interclass correlation coefficients of 0.957 (95% CI: 0.946-0.966) and 0.926 (95% CI: 0.909-0.941) for vertical and horizontal displacements, respectively. Mean vertical displacement was 9.42 mm (95% CI: 8.07-10.77 mm) in the supine position, 11.78 mm (95% CI: 10.25-13.32 mm) in the semi-upright position, and 15.72 mm (95% CI: 13.71-17.72 mm) in the upright position. Horizontal displacement was -0.41 mm (95% CI: -2.53 to 1.70 mm) in the supine position, 2.11 mm (95% CI: -0.84 to 5.07) in the semi-upright position, and 4.86 mm (95% CI: 1.66-8.06 mm) in the upright position. Using a mixed effects linear regression model, we determined that change in position from supine to upright significantly increases both vertical and horizontal fracture displacements (P <0.001). When placed in the upright position, the proportion of patients that met surgical indications (horizontal displacement >20 mm) was three times greater when compared to the supine position: upright 17.65% versus supine 5.88% (P = 0.06). Positional changes in fracture displacement were not associated with body mass index, age, or gender.

Conclusion: Our results demonstrate that patient position is associated with significant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

changes in fracture displacement. Over three times more patients meet surgical indications (horizontal displacement >20 mm) when placed in the upright position compared to the supine position. We recommend upright chest radiographs be obtained to evaluate midshaft clavicle fracture displacement as this represents the physiologic stress across the fracture when considering nonsurgical management.

See pages 49 - 106 for financial disclosure information.

Is Minimally Invasive Plate Osteosynthesis Helpful in the Fixation of 2-Part Proximal Humerus Fractures Compared to Open Plating?

Joon-Woo Kim, MD, PhD[1]; Chang-Wug Oh, MD, PhD[1]; Jong-Keon Oh, MD, PhD[2]; Kyeong-Hyeon Park, MD[1]
[1]Kyungpook National University Hospital, Daegu, SOUTH KOREA;
[2]Korea University Guro Hospital, Seoul, SOUTH KOREA

Purpose: Although 2-part fractures of the proximal humerus are usually treated conservatively, open reduction and plate osteosynthesis (ORPO) is generally used when operation is needed. Recently, minimally invasive plate osteosynthesis (MIPO) is favored with its excellent fracture healing and functional recovery. We performed a comparative study between ORPO and MIPO for the treatment of 2-part proximal humeral fractures to discover the differences of radiologic and functional outcomes.

Methods: From 2007 to 2013, 41 fractures were fixed with a Philos plate (DePuy Synthes) in our institution. Excluding 5 cases that were lost to follow-up, 36 (AO/OTA A2, 4; A3, 32) were enrolled in this study. 17 (mean 52.6 years; range, 23-72) patients underwent ORPO through a deltopectoral approach, and 19 (mean 58.7 years; range, 20-80) patients underwent MIPO through a deltoid-splitting approach. There was no obvious individual difference between two groups in either age (**Purpose:** Although 2 part fractures of proximal humerus are usually treated conservatively, open reduction and plate osteosynthesis (ORPO) is generally used when operation is needed. Recently, minimally invasive plate osteosynthesis (MIPO) is favored with its excellent fracture healing and functional recovery. We performed a comparative study between ORPO and MIPO for the treatment of 2 part proximal humeral fractures to discover the differences of radiologic and functional outcomes.

Methods: From 2007 to 2013, forty-one fractures were fixed with a Philos plate (Depuy Synthes, Paoli, PA, USA) in our institution. Excluding 5 cases that lost to follow-up, 36 (AO-OTA A2: 4, A3: 32) were enrolled in this study. Seventeen (mean 52.6 years, range, 23-72) patients underwent ORPO through deltopectoral approach, and 19 (mean 58.7 years, range, 20-80) patients underwent MIPO through deltoid splitting approach. There was no obvious individual difference between two groups in either age ($P = 0.255$, Mann-Whitney test) or fracture types ($P = 0.906$, X^2 test). Radiologic results were evaluated by union, time to union, and alignment. Functional outcome was assessed by using Constant score and UCLA score. Radiation exposure time and operative time were also appraised.

Results: Union was achieved in all cases. The mean time to union was 15.6 weeks in the ORPO group and 14.9 weeks in the MIPO group ($P = 0.465$, Mann-Whitney test). The mean neck shaft angle was 137.8° in ORPO group and 133.8° in MIPO group ($P = 0.102$, Mann-Whitney test). There were 3 cases of malunion (ORPO: 1, MIPO: 2). With respect to the functional outcome, mean Constant score was 78.4 in ORPO group and 75.6 in MIPO group ($P = 0.619$, Mann-Whitney test) and mean UCLA score was 28.8 in ORPO group and 27.9 in MIPO group ($P = 0.560$, Mann-Whitney test). The mean radiation exposure time was 18.2 seconds in ORPO group and 38.5 seconds in MIPO group ($P < 0.001$, Mann-Whitney test).

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

The mean operative time was 145.9 minutes in ORPO group and 109.7 minutes in MIPO group (P <0.001, Mann-Whitney test).

Conclusion: This study revealed that 2-part fractures of the proximal humerus had high union rate and excellent functional outcome with both ORPO and MIPO techniques. Taking the disadvantages into account, ORPO took longer operative time and MIPO had longer radiation exposure time.

See pages 49 - 106 for financial disclosure information.

Nonunion After Clavicle Osteosynthesis: High Incidence of Infection

Elizabeth Gausden, MD[1]*; Jordan Villa, MD*[2]*; Stephen Warner, MD, PhD*[2]*; Mariya Redko, MD*[2]*; Andrew Pearle, MD*[2]*; Dean Lorich, MD*[3]*; David Helfet, MD*[2]*; David Wellman, MD*[2]
[1]*Hospital for Special Surgery-Cornell, New York, New York, USA;*
[2]*Hospital for Special Surgery, New York, New York, USA;*
[3]*New York Presbysterian Hospital, New York, New York, USA*

Purpose: There is scant literature regarding nonunions in clavicle fractures (OTA 15) following osteosynthesis. As the incidence of operative treatment of clavicle fractures is increasing, it is important to elucidate the etiologies of major complications. We investigated a series of nonunions following primary osteosynthesis of clavicle fractures in order to identify potential causes of failure. We hypothesized that a large portion of clavicle nonunions following surgical intervention would be infected.

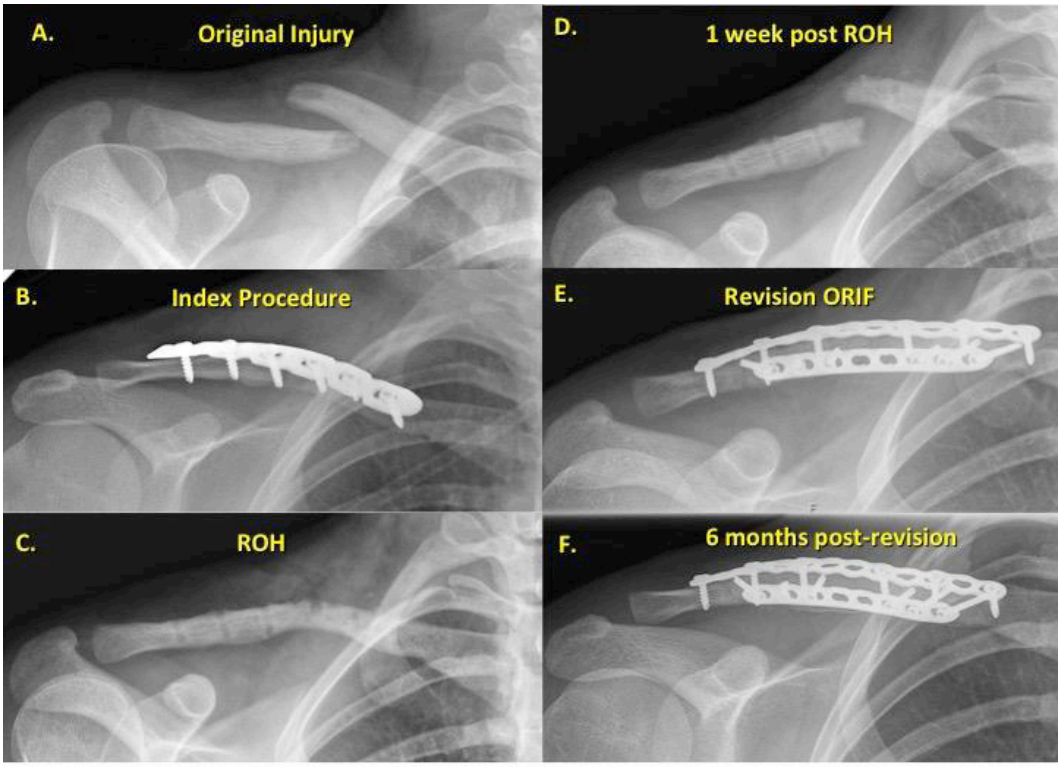
Methods: We performed a retrospective review of nonunion cases following clavicle osteosynthesis that were referred to the orthopaedic trauma service at our institution. The cases were identified using our institutional orthopaedic trauma surgery database. Data were collected to define patient characteristics, comorbidities, and concomitant injuries. Radiographs were reviewed for original method of fixation and evidence of implant failure. In addition, microbiologic data from cultures obtained during the revision surgery were analyzed. We performed revision osteosynthesis in a single stage using a double plate technique. A 2.7-mm reconstruction locking plate is applied superiorly and a 2.4-mm LCP (locking compression plate) is applied anteroinferiorly. When possible, interfragmentary fixation was applied. Iliac crest bone graft was used when a cortical defect or shortening was present. Antibiotics were added to the postoperative regimen if cultures were positive. Postoperative radiographs were reviewed and assessed for union.

Results: Clinical and radiographic follow-up was available for 20 cases. The average age was 44 years (±13 years). There was an average 14.6 months (range, 4-30 months) between the index procedure and the revision surgery for nonunion. In four cases (20%) the nonunions were diagnosed radiographically after the hardware was removed from the primary osteosynthesis (Fig. 1). In 9 cases (45%) there was catastrophic hardware failure that prompted the revision surgery. In the 18 cases in which cultures were taken, 16 of the 18 (89%) had positive cultures that were treated as infections with a prolonged course of antibiotics. 14 of these patients' cultures grew *Propioinibacterium acnes*, one grew *Enterococcus faecalis* in addition to *P. acnes*, one grew *Staphylococcus auriculares* in addition to *P. acnes*, and two grew *Streptococcus epidermis*. Average clinical follow-up was 30 months and the average radiographic follow-up was 26 months. No patients required revision following the nonunion surgery. All infections were treated with a single-stage revision and a course of intravenous or oral antibiotics. All cases with radiographic follow-up achieved union.

Conclusion: There is a high rate of positive cultures in cases of nonunion following osteosynthesis of the clavicle. Data from our cohort of patients suggest the etiology of midshaft clavicle nonunions often results from a combination of suboptimal mechanical fixation and latent infection. Our treatment protocol of superior and anterior plating, interfragmentary

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

fixation, bone grafting, and appropriate antimicrobial treatment for latent infections has resulted in 100% union rate in the revision setting.



See pages 49 - 106 for financial disclosure information.

Clinical and Radiographic Outcomes of 67 Consecutive Humeral Shaft Fractures Treated with Plate Osteosynthesis Through a Triceps-Sparing Posterior Approach

Elizabeth Gausden, MD[1]*; Alexander Christ, MD*[2]*; Stephen Warner, MD, PhD*[2]*; Ashley Levack, MD, MAS*[2]*; Andrew Nellestein, BS*[3]*; Dean Lorich, MD*[3]
[1]*Hospital for Special Surgery-Cornell, New York, New York, USA;*
[2]*Hospital for Special Surgery, New York, New York, USA;*
[3]*New York Presbyterian Hospital, New York, New York, USA*

Background/Purpose: The optimal treatment for humeral shaft fractures continues to be debated and likely depends on several injury- and patient-related factors. The triceps-sparing posterior approach to the humerus offers several intuitive advantages, including the ability to visualize and protect the radial nerve, access to a flat diaphyseal surface for plate fixation, adequate exposure for application of two orthogonal plates, and visualization of distal humerus for metaphyseal fixation and avoidance of the olecranon and coranoid fossa. In the current investigation, we sought to determine the clinical and radiographic outcomes following plate fixation of humeral shaft fractures utilizing the triceps-sparing posterior approach to the humerus. We hypothesized that this technique would result in a high rate of union and a low rate of secondary nerve palsies as the approach provides ample visualization of the fracture as well as the radial nerve.

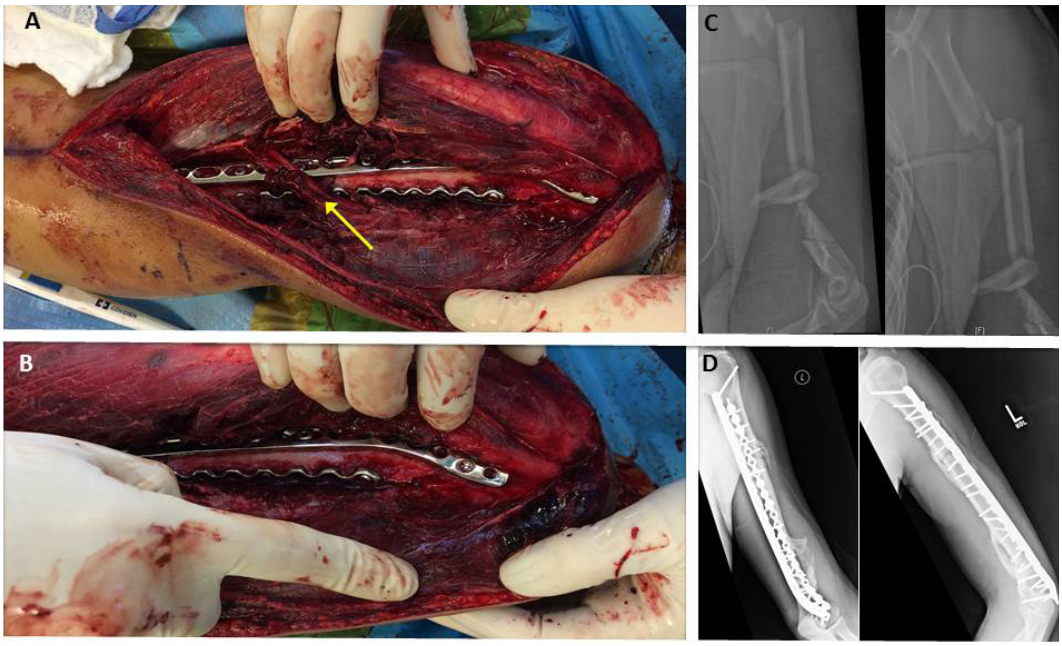
Methods: A retrospective review from a single surgeon's cases at one institution was performed collecting demographics, operative reports, clinical follow-up, and radiographs from a consecutive series of humeral shaft fractures (OTA 12-A, 12-B, or 12-C) treated with plate fixation between 2005 and 2014. All cases were treated via a posterior, triceps-sparing approach for open reduction and fixation using a 3.5-mm extra-articular locking compression (LCP) distal humerus plate (DePuy Synthes) in combination with a 3.5-mm reconstruction plate (Fig. 1). Postoperative radiographs were assessed for angular deformity and time to union. Clinical outcomes, including range of motion and strength testing, were also reviewed.

Results: Four of the 67 patients were lost to follow-up before their 6-week follow-up. In the remaining 63 patients with radiographic follow-up, the average radiographic time to union was 15.5 ± 11.1 weeks and there was 1 case of delayed union (1.6%). There were no cases of malunion and no instances of implant failure. 17 of 67 patients (25.4%) presented with a primary radial nerve palsy following injury, and 14 of the 17 of the preoperative radial nerve palsies fully resolved at an average of 7 months following injury. Two additional patients developed radial nerve palsies postoperatively (2 of 67, 3.0%). One of the patients with postoperative nerve palsy had a full recovery, and the other was lost to follow-up after 6 months. By the time of the latest clinical follow-up appointment, 50 of 61 patients (82.0%) had full range of motion of the elbow, symmetrical to the contralateral, uninjured side.

Conclusion: This is a large consecutive series of humeral shaft fractures treated with locked compression plating through the posterior approach by a single surgeon. The results of this study indicate that using the triceps-sparing posterior approach to the humerus is an

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

effective technique that achieves a high union rate and a low incidence of secondary radial nerve palsy.



See pages 49 - 106 for financial disclosure information.

Patient Outcomes Following Transolecranon Fracture-Dislocations

Justin Haller, MD[1]; Daphne Beingessner, MD[2]
[1]Harborview Medical Center, Seattle, Washington, USA;
[2]Harborview Medical Center, Orthopaedics, Seattle, Washington, USA

Background/Purpose: Transolecranon fracture-dislocation occurs after a high-energy traumatic injury to the elbow. By definition, these fractures occur with a complex fracture through the olecranon that is accompanied with anterior translation of the forearm relative to the humerus. In the past, there have been only small case series describing this injury pattern. Based on current case series, patient outcomes after transolecranon fracture-dislocation are associated with low rates of reoperation and reasonable function. However, given the small size of these series, it is unknown how well patients actually recover from this injury. The purpose of this investigation is to describe fracture characteristics and assess patient outcome following transolecranon fracture-dislocations.

Methods: Patients with combined fracture-dislocations of the proximal radius and ulna (OTA 21 and all subgroups) from January 2005 through December 2014 were identified in our prospectively collected orthopaedic trauma registry. All radiographs were reviewed to identify patients with transolecranon fracture-dislocations that were treated at a single Level I trauma center. Patients were excluded if they died during their initial hospital course, had incomplete radiographs, or were skeletally immature. Medical records were reviewed for demographic data including age, gender, and mechanism of injury. Fracture pattern, associated fractures around the elbow, and soft-tissue injury were assessed on preoperative imaging and from the operative report. At final follow-up, range of motion (ROM), additional surgical procedures, and any complications were recorded. Final ROM was recorded after additional procedures to improve motion (capsular release, heterotopic ossification [HO] excision, etc). Radiographs at final follow-up were assessed for presence of HO and presence of joint degeneration using the Broberg and Morrey classification.

Results: During this period, there were 671 proximal radius and ulna fractures treated at our facility. 59 patients were identified as having a transolecranon fracture-dislocation. Four patients died during their hospital course and 17 patients had less than 1-year follow-up. The remaining 38 patients had a mean follow-up of 23 months (range, 12-117 months). There were 58% male patients with a mean age of 44 years (range, 19-77 years). The most common mechanism was motor vehicle accident (42%), followed by fall from height (24%) and ground level fall (13%). 14 patients had open injuries, with 3 Type 1 open fractures, 4 Type 2 open fractures, 5 Type 3A open fractures, 1 Type 3B open fracture, and 1 Type 3C open fracture. Nine patients had an associated radial head fracture, 27 patients had associated coronoid fracture, 5 patients had associated ligamentous injury, and 9 patients had associated distal humerus fracture. Mean time to radiographic union was 16 weeks (range, 7-48 weeks). At final follow-up, mean extension was 19° (range, 0-80) and mean flexion was 122° (range, 45-145) for a mean arc of motion of 102° (range, 0-130). Overall, 21 patients had a second operation whereas only 6 patients had isolated plate removal. Ten patients had nerve palsy (10 ulnar, 1 radial, and 1 median) and all underwent repeat surgery for nerve decompression. Five patients (13%) developed infection and required surgical ir-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

rigation and debridement with a course of antibiotics. 23 patients developed HO, and 8 patients underwent HO excision. 17 patients developed radiographic arthrosis with the majority (14/17) having Grade 2 or 3 changes. Ultimately, two patients underwent elbow arthrodesis, one patient developed an ankylosed elbow, and one patient underwent total elbow arthroplasty.

Conclusion: Transolecranon fracture-dislocation is a devastating injury with high rates of postoperative complications. Additionally, we observed high rates of HO and posttraumatic arthrosis in our patient cohort. Based on our series, patients should be counseled on the possibility of restricted motion, additional surgery, and overall poor prognosis that occurs after these injuries.

See pages 49 - 106 for financial disclosure information.

Is Time to Surgery in the Fixation of Diaphyseal Humeral Fractures a Risk Factor in the Development of Iatrogenic Radial Nerve Palsy?

Kristin Shoji, MD[1]*; Marilyn Heng, MD*[2]*; Mitchel Harris, MD*[1]*; Mark Vrahas, MD*[2]*; Michael Weaver, MD*[1]
[1]*Brigham and Women's Hospital, Boston, Massachusetts, USA;*
[2]*Massachusetts General Hospital, Boston, Massachusetts, USA*

Purpose: A radial nerve palsy is the most common peripheral nerve injury associated with diaphyseal humerus fractures. It may occur during the injury itself or iatrogenically following fracture fixation. While some factors have been associated with iatrogenic radial nerve palsies, such as distal location of the fracture, to our knowledge no study has evaluated the timing of surgery as it relates to the risk of developing a radial nerve palsy. The purpose of this study is to determine if time from injury to surgical approach to the humerus is associated with the risk of iatrogenic radial nerve palsy. The null hypothesis is that time is not correlated with the risk of radial nerve palsy.

Methods: We performed a retrospective study of all patients treated for either an acute diaphyseal humerus fracture or a humeral nonunion at 2 Level I trauma centers between December 2001 and February 2015. Exclusion criteria were preoperative radial nerve palsy, concomitant brachial plexus or spinal injury preventing accurate assessment of the etiology of the radial nerve palsy, ipsilateral hemiplegia, cognitive impairment precluding the ability to participate in a physical examination, and traumatic ipsilateral upper extremity amputations. The medical record was reviewed and patients were contacted and interviewed in cases where the medical record was incomplete.

Results: 325 patients were included in the study. The overall risk of iatrogenic radial nerve palsy was 7.7% (25/325). Time to surgery was not significantly associated with the occurrence of a radial nerve palsy. In a multiple variable analysis, when comparing patients treated within 4 weeks to those treated in 4-8 weeks ($P = 0.41$), 8-12 weeks ($P = 0.94$), and over 12 weeks ($P = 0.20$), there were no significant associations. While not significant, there was an overall trend toward a decrease in the risk of radial nerve palsy in fractures and or nonunions treated 3 months or longer following the initial injury. Independent risk factors for iatrogenic radial nerve palsy included distal location of fracture ($P = 0.04$, odds ratio [OR] 3.71) and previous fixation ($P = 0.03$, OR 3.80). Age ($P = 0.49$), sex ($P = 0.71$), body mass index ($P = 0.06$), Charlson comorbidity index ($P = 0.74$), nonunion ($P = 0.59$), open injury ($P = 0.16$), fracture class ($P = 0.75$), and use of a block by anesthesia ($P = 0.50$) were not associated with iatrogenic radial nerve palsies. Of the 25 iatrogenic nerve injuries, 22 recovered fully with expectant management, 1 was lost to follow-up, and 2 required either nerve graft or tendon transfers.

Conclusion: Time to surgery does not appear to be a risk factor for developing an iatrogenic radial nerve palsy. We had initially hypothesized that a delay in surgery may make the exposure more difficult due to scar tissue and callus formation. Despite this anecdotal experience, there does not appear to be an increased risk in waiting to perform surgery on

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

humerus fractures. Patients with distal fractures, and those who have previous fracture implants, are at increased risk for iatrogenic nerve radial palsy.

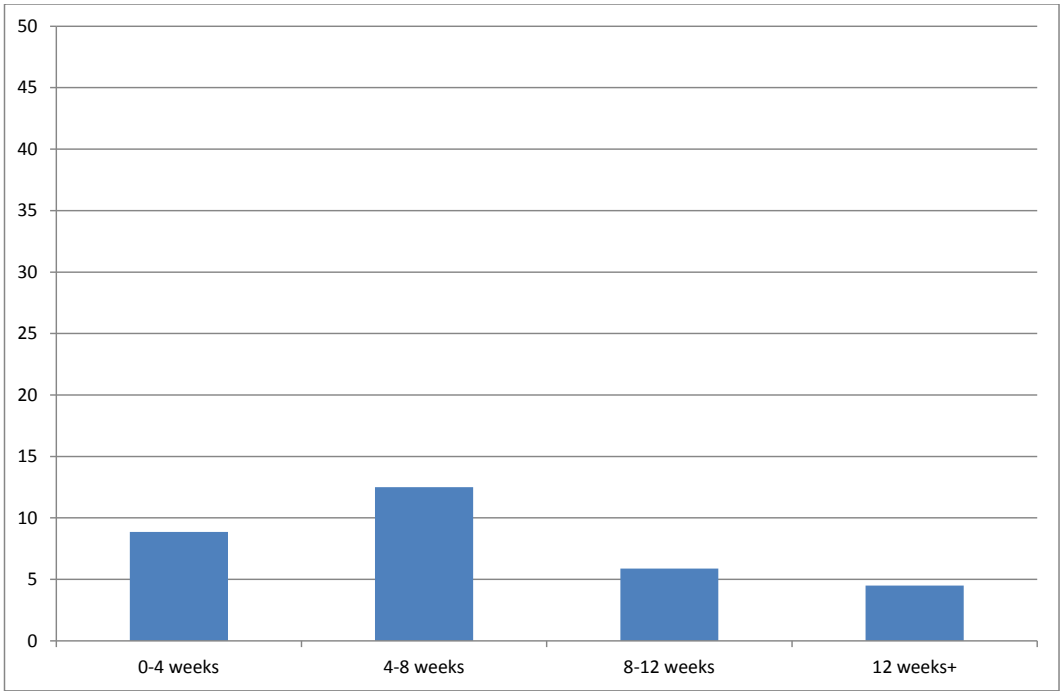


Figure 1. Percent of patients who developed an iatrogenic radial nerve palsy following fixation of a humeral shaft fracture grouped by weeks from injury to surgery.

See pages 49 - 106 for financial disclosure information.

Quality of Life After Plating of Midshaft Clavicle Fractures

Rens van der Linde, MD*; Sven van Helden, MD, PhD*
Isala Klinieken, Zwolle, NETHERLANDS

Background/Purpose: The clavicle is the most commonly fractured bone in the human body. Clavicular fractures occur mostly due to traffic accidents or sport injuries. Most often the fracture site lies in the middle third of the clavicle (81%). Surgical treatment often consists of open reduction and internal fixation (ORIF) using plates. A lot of research has been has been done into functional outcome after operative treatment. However, not much is known about the quality of life after operation in this, mostly young, population. Therefore we investigated the quality of life ≥1 year after plating for midshaft clavicular fractures.

Methods: Patients 16 to 65 years of age with a midshaft clavicular fracture who underwent surgical treatment in our hospital with ORIF between January 2006 and December 2014 were included in this study. Information about the course of treatment and postoperative complications was extracted from the hospitals records. Furthermore, all eligible patients were approached by phone and asked if they wanted to participate in the online survey. Primary outcome was quality of life ≥1 year after operation (measured using the Short Form 36 [SF-36], ranging from 0 [worst health possible] to 100 [best health possible] and the EuroQol [EQ]-5D-5L, ranging from 0 [death] to 1.0 [best possible health imaginable]). Secondary outcomes were postoperative complications, reoperation rate, patient satisfaction, and functional outcome (measured using the Disabilities of the Arm, Shoulder and Hand questionnaire [DASH], ranging from 0 [no disability] to 100 [severe disability]). Statistical analyses was performed using the Student *t* test and the X^2 test. Results with $P < 0.05$ were considered to be significant.

Results: We included 164 patients who underwent surgery for a midshaft clavicle fracture (mean age and SD 44.9 ± 15.1 years; table); 101 patients completed the online survey. The mean physical and mental SF-36 scored were 54.0 ± 7.3 and 52.3 ± 9.9, the EQ-5D-5L score was 0.87 ± 0.16, and the average DASH was 8.45 ± 13.8. In seven cases there was failure of the osteosynthesis material (OSM), five patients developed an infection, and two patients suffered from neuropraxia. Less common complications were thoracic outlet syndrome, refracture, and nonunion, all occurring in one patient. Overall, 77 patients underwent a reoperation. Isolated removal of the plate was the leading cause of reoperation (80.5%), followed by failure of the OSM (9.1%) and infection of the OSM (5.2%). Furthermore, we found a strong correlation between the functional outcome and the quality of life ($P < 0.001$).

Conclusion: Patients who received operative treatment for a midshaft clavicle fracture have a good quality of life, and a good functional outcome. Also, following plating for a midshaft clavicle fracture one in ten patients developed a complication. Almost half of the patients underwent a reoperation, with isolated implant removal as the most common procedure. Furthermore, there is a strong relationship between functional outcome and quality of life.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

TABLE 1. Patient and Fracture Characteristic Research Cohort		
Characteristics	Total n=164	%
Sex		
Female	38	23,2
Male	126	76.8
Age *(mean ± SD)*	44.9 ± 15.1	NA*
Age cohort *(16 to 30:31 to 45:46 to 65)*	38/38/88	23.2/23.2/53.7
Fractured side		
Left	80	48.8
Right	83	50.6
Left & right	1	0.6
Fracture characteristics		
Displaced†	132	81.5
Comminuted‡	94	58.3
Shortened§	77	47.0
Delayed union¶	31	18.9
Non-union¶	5	3.0
Skin at risk	19	11.6

* NA indicates not applicable †In 2 cases there was no x-ray or description by the radiologist available (n=162). ‡ A comminuted fracture was defined as a fracture which consisted of ≥ 3 fracture parts (OTA classification B2.1-3.3). § A shortened fracture was defined as ≥ 20mm or more than one shaft width shortening. ¶ Delayed union and non-union/pseudoarthrosis were defined as a fracture which, prior to operation, had not adequately healed after 3 and 6 months respectively.

See pages 49 - 106 for financial disclosure information.

The Proximal Humerus Outcome Score at 1 Year (POSY) Predicts Which Patients Have Poor Functional Outcomes Following Operative Fixation

Nina Fisher, BS*; Sanjit Konda, MD; Adam Driesman, BA; Hesham Saleh, BS; Sarah Yukelis, HSD; Kenneth Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: The ability to predict long-term outcomes following surgical fixation of proximal humerus fractures would help identify patients at risk of poor functional outcomes, for whom more aggressive treatments (i.e. shoulder arthroplasty) or more aggressive post-operative intervention may provide benefit. The purpose of this study was to develop a simple score based on preoperative data that can accurately predict functional outcomes for patients following operative management of proximal humerus fractures.

Methods: Over a 12-year period, 202 surgically treated proximal humerus fractures treated at a single institution were prospectively enrolled in an IRB approved database. Fractures were classified using the OTA and Neer fracture classification. All patients underwent operative fixation with locking plate and screw fixation via a standard protocol. At routine intervals, radiographic outcomes were assessed via plain radiographs and functional outcome was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH). A post-operative time point of one year or greater was chosen as the predictive target of maximal functional outcome. Inclusion criteria was any patient with a minimum of 1-year functional outcome score. Patients were assigned to the poor outcome cohort if their SMFA score at that time point was greater than 10 points above the mean DASH score. Logistic regression was used to build a predictive formula for cohort membership using $p<0.15$ and an area under the receiver operator characteristic curve (AUROC) value was calculated to define the overall predictive capacity.

Results: A total of 151 (74.8%) patients with an average age of 61.08±13.9 met the inclusion criteria and were included in this analysis. The mean follow-up interval was 20 months and the mean DASH score was 21.93±21.9. There were 36 OTA 11-A, 55 OTA 11-B, and 57 OTA 11-C fracture types. Older age ($p = .045$), BMI ($p = .026$), age-adjusted CCI ($p = .001$), Caucasian race ($p = .012$), college degree ($p < .0005$), employed ($p < .0005$), and worker's compensation case ($p = .001$) were found to be significant predictors of poorer outcome. Fracture classification and number of fracture parts (Neer classification) were not found to be predictors of poor outcome. The significant predictors were used to create a final formula through logistic regression which predicted the probability of a poor outcome (Nagelkerke R Square = .420; Hosmer and Lemeshow = .469; AUROC = .847 (CI: 0.769-0.926). Of the 6 predictor variables, only age, worker's comp, and CCI were statistically significant. Education was only statistically significant when comparing patients with high school and postgraduate degrees. Once each patient was assigned a score, two cutoff values were defined that divided the cohort into three groups. Patients with a score lower than 20% were classified as low risk, with 6 (9.1%) of patients having a poor outcome. Patients between 20% and 50% were at intermediate risk, with 10 (31.3%) of patients having a poor outcome. High-risk patients had a score above 50%, as 18 (72.0%) of these patients had a poor outcome.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1. Logistic Regression Predicting Poor Outcome Group Membership

	Sig.	Odds Radio	95% CI for Odds Radio	
Age	.465	0.978	.921	1.038
BMI	.334	1.039	.961	1.124
Age Adjusted CCI	.099	1.497	.927	2.417
Caucasian Race	.089	2.823	.854	1.172
College Degree	.068	2.897	.923	1.084
Employed	.040	4.202	1.067	16.550
Worker's Compensation Case	.015	22.820	1.829	284.764
Constant	.711	.443	---	---

Conclusions: The POSY score is a tool that can predict functional outcome at 1 year or greater following surgical intervention for a proximal humerus fracture. Patients who score above 50% are considered at high risk for a poor functional outcome. These patients should be targeted to either discuss alternative treatment options prior to surgery or be indicated for more aggressive rehabilitation following surgical intervention. In the era of value-based care, the POSY score may be used to direct resource utilization while improving outcomes.

See pages 49 - 106 for financial disclosure information.

Minimally Invasive Plate Osteosynthesis for Displaced Midshaft Clavicular Fractures

Iain Elliott, MD*; William Uffmann, MD; Zachary Working, MD; Erik Kubiak, MD*
University of Utah Department of Orthopaedics, Salt Lake City, Utah, USA

Purpose: Traditionally, when displaced midshaft clavicle fractures are treated with open reduction and internal fixation, a longitudinal incision is placed anteriorly or superiorly over the clavicle for reduction and fixation. This approach puts both cutaneous nerves and clavicular periosteal blood supply at risk. We hypothesized that minimally invasive plate osteosynthesis (MIPO) of the clavicle would result in low complication rates and be a reasonable treatment option for displaced midshaft clavicle fractures. MIPO involves plating the clavicle with a precontoured plate applied via a medial or lateral saber or vertical incision.

Methods: All patients with closed, midshaft clavicle fractures that underwent MIPO by a single surgeon at a Level I trauma center from 2007-2015 were reviewed. All patients with follow-up of a minimum of 6 weeks were included. Patient demographics and presence or absence of smoking and diabetes were recorded. The initial fracture displacement and angulation was recorded from preoperative radiographs. Reoperation for any reason was recorded.

Results: A total of 51 patients who underwent MIPO for displaced midshaft clavicle fractures were available for review. Six patients had no follow-up and were excluded from our analysis leaving 45 total patients. Average age was 34.8 years. Average radiographic follow-up was 40.3 weeks. Average shortening at presentation was 24 mm, with average displacement 31 mm. Cycling was the most common cause of clavicle fracture in this cohort (n = 16, 36%), followed by motor vehicle crashes including ATV accidents (n = 8, 18%) and falls (n = 8, 18%). Three patients underwent reoperation (n = 3, 6.7%), one for infection (n = 1, 2.2%), and two for symptomatic hardware removal (n = 2, 4.4%). There were no reoperations for nonunion or malunion in our cohort. The patient who presented with an infection did so 24 months after her index procedure.

Conclusion: Minimally invasive plate osteosynthesis is a viable option for displaced midshaft clavicle fractures, with only three patients undergoing reoperation at an average follow-up of 40 weeks.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Reoperation After Open Reduction and Internal Fixation of Olecranon Fractures

Theodoros H. Tosounidis, MD, PhD[1]*; Nikolaos Davarinos, MD*[1]*;*
Nikolaos Kanakaris, MD, PhD[2]*; Peter V. Giannoudis, MD, FRCS, MBBS, BS*[2]*,*
[1]*Leeds General Infirmary, Major Trauma Centre, Leeds, UNITED KINGDOM;*
[2]*Leeds Teaching Hospitals NHS Trust, Academic Department of Trauma and Orthopaedics, Leeds General Infirmary, Leeds, UNITED KINGDOM*

Purpose: The vast majority of olecranon fractures require internal fixation (plating or tension band wiring) with favorable outcomes. Nevertheless, the exact prevalence of complications after their surgical fixation remains obscure. We sought to determine whether there is a difference in reinterventions after surgical fixation of olecranon fractures with either plating (PL) or tension band wiring (TBW). Our null hypothesis was that there would be no difference.

Methods: After IRB approval, 778 patients treated surgically for an acutely displaced olecranon fracture between 2007-2013 were identified and reviewed retrospectively at a minimum of 24 months follow-up (FU). Fractures were divided into two cohorts according to the surgical fixation method: plate and tension banf wiring. Inclusion criteria included adult patients >16 years of age, who had sustained isolated olecranon fracture. Exclusion criteria were children, patients with complex elbow injuries, incomplete data records, and loss to FU. Group analysis included demographics (age, gender), mechanism of injury, fracture characteristics, laterality, method of fixation, complications, time from index surgery to reoperation, and reason for reoperation. Fisher exact test, *t* test, and odds ratio were used for statistical analysis.

Results: In total 237 patients with a mean age of 58 years (range, 16-95) met the inclusion criteria. 112 (47.25%) were in the PL group and 125 (52.75%) in the TBW group. No differences in demographics, type of fracture, laterality, time to reoperation, or length to FU existed between groups. 38 revision operations were carried out (22 and 16 in the PL and TBW groups, respectively). The reasons for revision were: 26 cases for removal implants for skin irritation and/or superficial infection, 1 case for nonunion, and 11 cases for fixation failure. The overall odds ratio for a revision operation was similar among the two groups.

Conclusion: This Level III therapeutic retrospective comparative study indicates that there is no difference in the reoperation rates after surgical fixation of olecranon fractures treated either with PL or TBW. The most common cause for reintervention was soft-tissue irritation.

See pages 49 - 106 for financial disclosure information.

Significant Osteolysis Following Press-Fit Radial Head Prosthesis: Comparison Between Two Different Implants

Nathan Haile, MD[1]; Michael Brennan, MD[2]; Daniel Stahl, MD[1]
[1]Baylor Scott & White Health Care - Texas A&M Health Science Center, Temple, Texas, USA
[2]Scott and White Memorial Hospital, Temple, Texas, USA

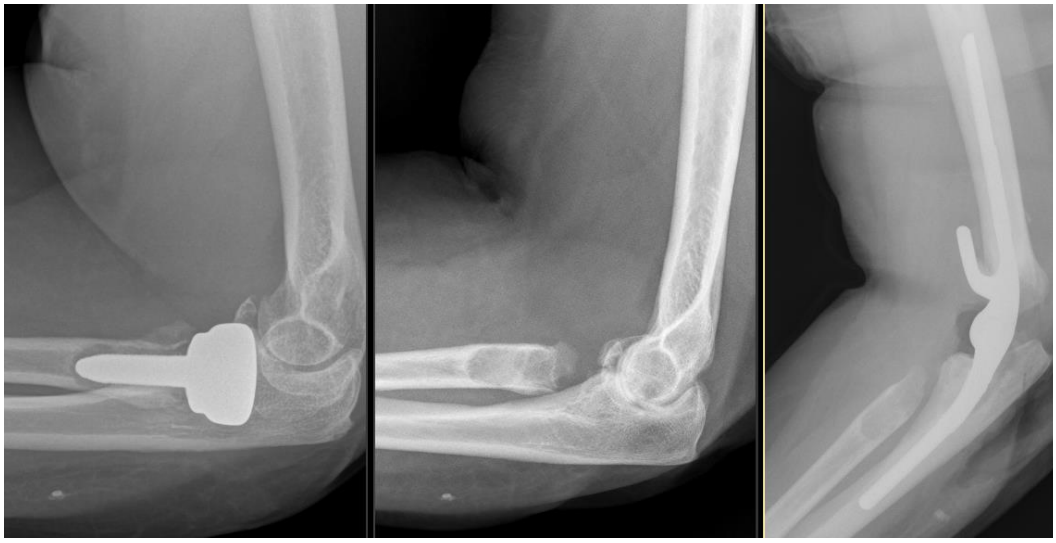
Background/Purpose: Radial head arthroplasty is a common treatment for comminuted radial head and radial neck fractures that are not amenable to reduction and fixation. Reported outcomes have been satisfactory with a common complication being loosening of the prosthesis. However, the clinical significance of this finding has not been delineated. The objective of this study was to review the radiographic outcomes of all radial head prostheses placed at one Level I trauma center and to compare the rate of periprosthetic lucency, osteolysis, periosteal reaction, and the need for reoperation between two implants.

Methods: This is a retrospective radiographic review of all patients who received a radial head arthroplasty for fracture of the radial head or radial neck from January 2010 to December 2015. Intraoperative radiographs and final follow-up radiographs were evaluated by two fellowship-trained orthopaedic trauma surgeons. The number of periprosthetic lucent zones as described by Popovic and the incidence of osteolysis and periosteal reaction were recorded. The results were further analyzed to compare the incidence of these findings in two different implants. Furthermore, the electronic medical record was utilized to determine the need for reoperation including removal of the prosthesis.

Results: From January 2010 to December 2015, 40 press-fit radial head prostheses were implanted into 39 patients. 14 elbows in 14 patients received the Synthes Radial Head Prosthesis, and 26 elbows in 25 patients received the Biomet ExploR Prosthesis. The average number of lucent zones was 2.88 in the Biomet implant and 4.64 in the Synthes implant ($P = 0.32$). The rate of osteolysis was 8% in the Biomet implant and 64% in the Synthes implant. This met statistical significance ($P = 0.0004$). The rate of periosteal reaction was similar in both implants, Biomet with 20% and Synthes with 36% ($P = 0.45$). There were 4 reoperations in the patients who received the Synthes and 3 operations in patients who received the Biomet implant. Two of the reoperations involving the Biomet implant were unrelated to implant stability, and the implant was retained. All other reoperations involved removal of the prosthesis. The incidence of reoperation involving removal of the prosthesis met statistical significance (P value: 0.10). One patient with the Synthes implant went on to total elbow arthroplasty.

Conclusion: Radial head arthroplasty remains a viable treatment option in the setting of irreparable radial head and radial neck fractures. However, complications including osteolysis, periosteal reaction, and need for reoperation can occur. Specifically, the Synthes press-fit modular radial head implant should be used with caution.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.



See pages 49 - 106 for financial disclosure information.

Outcomes Are Similar for Acute versus Delayed Surgical Treatment of Displaced Diaphyseal Clavicle Fractures

Robert Westermann, MD[1]; Ben Kopp, BS[1]; Michael Willey, MD[2]
[1]University of Iowa Hospitals and Clinics, Iowa City, Iowa, USA
[2]The University of Iowa, Iowa City, Iowa, USA

Background/Purpose: The management of displaced diaphyseal clavicle fractures has changed over recent years. Classically, surgical intervention was reserved for fractures that failed conservative treatment resulting in nonunion or malunion. Recent randomized trials suggest clinical benefits to acute operative management. As a result more surgeons are recommending acute fixation of displaced diaphyseal clavicle fractures. There is a lack of literature comparing outcomes and surgical complications of acute clavicle fracture fixation to late fixation of nonunion or malunion. Combined with known rates of nonunion with conservative treatment, this information would allow surgeons to better inform patients about the outcomes with delayed treatment of these injuries.

Methods: According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a systematic review was conducted. Studies reporting outcomes following acute and delayed clavicle fracture surgical fixation were identified in PubMed, CINAHL, EMBASE, sportDiscus (EBSCO), and Cochrane Central Register of Controlled Trials databases. Distal and medial clavicle fracture reports were excluded. Studies that failed to report timing to surgery were also excluded. All clavicle fixation methods were included. Cohorts were classified as "delayed surgery" when diagnoses of nonunion or malunion were cited as indications for surgery.

Results: After review, 27 studies met inclusion criteria, reporting outcomes of 1018 patients. Fracture union was reported in all studies and was similar between acute (97.6%) and delayed (95.4%) surgical groups ($P = 0.83$). There were 16 studies that reported Constant scores at final follow-up. The mean Constant score for acute surgery was slightly higher than delayed surgery (91.1 vs 87.9); however, this did not reach significance ($P = 0.31$). Reoperation was common, and data were reported in 19 studies. Reoperation rates were similar after acute and delayed surgery (22.5% vs 26.7%) most commonly for implant removal. Reported complications were more common after acute surgery (30.5%) than in delayed surgery (8.5%). The most common complications reported were surgical wound site irritation or numbness (17.4% in acute, 6.2% in delayed), implant failure or bending (3.9% in acute, 1.1% in delayed), and superficial infection (2.6% in acute, 0.0% in delayed). Overall, there were fewer complications in the delayed surgery group ($P = 0.01$).

Conclusion: We found that good outcomes can be expected after both acute clavicle fracture surgery and delayed surgery to address nonunion or malunion. Patient-reported outcomes were slightly higher after acute surgery; however, this did not reach significance. Reported complications rates for delayed surgical intervention were consistently lower than for acute fixation of these injuries. Surgeons may counsel patients that a trial of nonoperative management for diaphyseal clavicle fractures will likely not have a significant impact on union or clinical outcome with surgical intervention. Lower rates of surgical complications may be seen with delayed treatment.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Surgical Fixation of Nonunion of Clavicle Fractures Is Associated with Higher Rates of Short-Term Complications Compared to Primary Fixation

*Braden McKnight, BS[1]; **Nathanael Heckmann, MD**[2]; J. Hill, BS[1]; William Pannell, MD[1]; Lakshmanan Sivasundaram, BS[1]; Amir Mostofi, MD[3]; Reza Omid, MD[1]; George Hatch III, MD[1]*
[1]Keck School of Medicine of University of Southern California, Los Angeles, California, USA;
[2]University of Southern California, Department of Orthopaedic Surgery, Los Angeles, California, USA;
[3]Huntington Memorial Hospital, Los Angeles, California, USA

Purpose: When selecting patients for primary surgical fixation of midshaft clavicle fractures (OTA/AO 15.2) physicians must weigh the risks of surgery against the risk of nonunion following nonoperative management. Relatively little is known about the perioperative complication rates of primary surgical fixation and even less is known of those rates after surgical fixation for nonunion. The purpose of the current study was to establish the perioperative complication rates of surgical fixation for nonunion of midshaft clavicle fractures and contrast them to a comparative cohort of acute clavicle fractures.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ASC NSQIP) database was queried in order to identify patients who had undergone open reduction and internal fixation of midshaft clavicle fractures between 2007 and 2013. Patients were stratified by operative indication: acute fracture or nonunion. Patient characteristics and 30-day complication rates were compared between the two groups using univariate and multivariate analyses.

Results: A total of 1215 patients who underwent surgical management of a midshaft clavicle fracture were included in our analysis. Of these, 1006 (82.8%) were acute fractures and 209 (17.2%) were nonunions. Patients undergoing surgical fixation for nonunion had a higher rate of total complications compared to those with an acute fracture (5.3% vs 2.3%; $P = 0.035$). After correcting for age, sex, body mass index, smoking status, diabetes, and other comorbidities, patients with a nonunion were over twice as likely to experience any complication (odds ratio [OR] 2.29; 95% CI, 1.05 to 5.00; $P = 0.037$) and over three times as likely to experience a wound complication (OR 3.22; 95% CI, 1.02 to 10.20; $P = 0.046$) compared to acute fractures.

Multivariate Analysis of Postoperative Complications by Operative Indication*

	Odds Ratio (95% CI)	P Value
Total complications		
Acute Fracture	Ref.	
Nonunion	2.29 (1.05-5.00)	0.037
Wound complication		
Acute Fracture	Ref.	
Nonunion	3.22 (1.02-10.20)	0.046
Reoperation		
Acute Fracture	Ref.	
Nonunion	0.84 (0.21-3.25)	0.797

*Variables with P < .20 on univariate analyses were included in each respective multivariate analysis.

Conclusion: Patients undergoing surgical fixation for a midshaft clavicle nonunion are at an increased risk of 30-day total complications and wound complications compared to pa-

See pages 49 - 106 for financial disclosure information.

tients undergoing primary surgical fixation. This provides additional evidence supporting primary surgical fixation in patients with a high likelihood of nonunion, as it may obviate the risk of surgical complications.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Diminished Elbow Range of Motion Does Not Affect Functional Outcomes in Operatively Treated Supracondylar Humerus Fractures: A Prospective Study

*Justin Ernat, MD[1]; **Anthony I. Riccio, MD**[2]; R. Lane Wimberly, MD[2]; David Podeszwa, MD[2]; Christine Ho, MD[3]*
[1]Tripler Army Medical Center Honolulu, Hawaii, USA;
[2]Texas Scottish Rite Hospital for Children, Dallas, Texas, USA;
[3]Children's Medical Center, Dallas, Texas, USA

Background/Purpose: Although elbow stiffness is a commonly reported complication following the operative treatment of pediatric supracondylar humerus fractures, the relationship between ultimate range of motion and functional outcomes has never been studied prospectively in this patient populaiton. The purpose of this study is to prospectively evaluate the relationship between elbow range of motion (ROM) and functional outcomes in children with supracondylar humerus fractures (SCHFX) using validated outcomes measures.

Methods: An IRB-approved prospective enrollment of consecutive patients with operative SCHFX was performed over a 3-year period. Elbow ROM and carrying angles for operative and nonoperative extremities were documented at final follow-up, and functional outcome was assessed using the Pediatric Outcomes Data Collection Instrument (PODCI) and the QuickDASH (an abbreviated version of the Disabilities of the Arm, Shoulder and Hand [DASH]) outcome measure. Patients were stratified by arc of motion differences between the operative and nonoperative elbow. Paired Student's *t* test and ANOVA (analysis of variance) were used to compare arc of motion to functional outcome scores.

Results: 752 patients were enrolled during the study period. 62 (average age 5.4 years) completed functional outcome measures and had complete ROM data at final follow-up (average 13 weeks; range, 10-31 weeks). Average flexion-extension arc was 136° in the operative extremity (-1.4° extension, 135° flexion) versus 146° in the nonoperative side (-4.3° extension, 142° flexion), which was significantly different (P <0.0001). There were no differences at final follow-up between the operative and nonoperative extremities in average pronation-supination arc (162° vs 163°) or average carrying angle (5.3° vs 5.5°). There were no statistically significant differences in PODCI or QuickDASH scores between those achieving <90% flexion/extension arc of the nonoperative side when compared to those with ≥90%, nor for those operative elbows with >1 standard deviation difference from the nonoperative side in flexion/extension arc versus those within 1 standard deviation. Due to the lack of statistically significant differences in outcome measures between these groups, controlling for other injury parameters such as patient age, fracture classification, neurologic injury, and vascular abnormality was not necessary.

Conclusion: While operatively treated SCHFX may result in an average 10° decrease in flexion/extension arc of motion, this did not affect functional outcomes in this cohort.

See pages 49 - 106 for financial disclosure information.

Perfusion Assessment with Near Infrared Spectroscopy (NIRS) in Pediatric Supracondylar Humeral Fractures: Can NIRS Detect the Poorly Perfused Extremity?

Brian Scannell, MD[1]; Brian Brighton, MD, MPH[2]; Kelly Vanderhave, MD[1]; Rachel Seymour, PhD[1]; Steve Frick, MD[3]
[1]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[2]*Carolinas Healthcare System/Levine Children's Hospital, Charlotte, North Carolina, USA;*
[3]*Nemour's Children Hospital, Orlando, Florida, USA*

Purpose: Near infrared spectroscopy (NIRS) measures the percentage of hemoglobin oxygen saturation in microcirculation. It has been used to identify poor perfusion in adults. The purpose was to determine baseline perfusion values with NIRS in pediatric forearms distal to a supracondylar humeral fracture (SCHF) and compare this to uninjured forearms. Additionally, we wanted to determine whether NIRS detected differences in perfusion between extremities presenting with a normal pulse and those without a palpable pulse ("perfused, pulseless").

Methods: Over a 10-month period, consecutive patients with an SCHF needing operative fixation were approached for consent. Participants had NIRS pads placed on the injured and uninjured volar forearm. Data were continuously collected but blinded to the surgeon. Monitoring was performed pre- and postoperatively on each forearm. Distal pulses, Doppler signal, pulse oximetry measurements, and motor/neurological function were recorded pre-/postoperatively. Data were also collected on 20 controls without injuries.

Results: 71 patients with mean age of 6 years (range, 2-10) had complete data collected. There were 55 type III fractures, 10 type II fractures, and 6 type IV fracture. 8 patients with type III fractures did not have a palpable pulse at presentation (perfused, pulseless). 20 controls were slightly older, with a mean age of 7.2 years (range, 3-11). Controls had a mean tissue oxygenation of 80% (range, 61-94). In the SCHFd with a pulse (n = 63), the mean tissue oxygenation during the entire study period was significantly higher in the injured forearm, 89.6%, compared to the uninjured forearm, 82.6% (P <0.001). Preoperatively there was no difference between the injured (83.8%) and uninjured (82.7%) forearms. Postoperatively, the mean tissue oxygenation was significantly higher in the injured forearm, 89.2% versus 81.7% (P <0.01). In the injured side forearms, there was a significant increase in mean tissue oxygenation from pre- to postoperative (P = 0.004). We found no correlation between oxygen saturation measured by pulse oximetry and NIRS monitoring of the volar forearm. Data were collected on 8 "perfused, pulseless" patients. There was a decreased mean tissue oxygenation seen in the injured side forearms (72.4%) compared to the uninjured forearms (86.8%). The injured forearms preoperatively had a mean tissue oxygenation of only 71.7%, but did improve to 82.4% postoperatively.

Conclusion: Children presenting with an SCHF and a palpable pulse had a significant increase in tissue oxygenation of the ipsilateral forearm measured by NIRS, as compared to the contralateral uninjured forearm. In children without a pulse, NIRS values were lower than controls preoperatively and did not reach the hyperemia levels seen in the palpable pulse group. NIRS is an objective measurement of distal perfusion and can assess/monitor perfusion after SCHF in "perfused, pulseless" patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Pediatric and Adolescent Calcaneal Fractures

Christiane Kruppa, MD[1]; Marcel Dudda, MD[2]; Debra Sietsema, PhD[3]; Tyler Snoap, BS[4]; Thomas Schildhauer, MD[1]; Clifford B. Jones, MD[3]
[1]BG-University Hospital Bergmannsheil, Ruhr University, Bochum, GERMANY;
[2]University Hospital Essen, Essen, GERMANY;
[3]The CORE Institute Phoenix, Arizona, USA;
[4]Michigan State University/CHM, Grand Rapids, Michigan, USA

Purpose: Calcaneal fractures in children and adolescents are rare. Whereas in children most fractures show no articular involvement, fractures in adolescents often occur with similar patterns as in adults and require operative stabilization. The purpose of this study was to analyze calcaneal fracture patterns, treatment, and radiographic outcome.

Methods: Between 2002 and 2011, 48 consecutive pediatric patients with 50 fractures of the calcaneus were retrospectively analyzed concerning fracture pattern and treatment. Age averaged 12.1 years (range, 1-18) in 26 (54%) boys and 22 (46%) girls. 22 children (46%) were <13 years old (average 6.7 years; range, 1-12) and 26 children (54%) were ≥13 years old (average 16.3 years; range, 13-18). Three fractures (6%) were open. Fractures were classified according to Schmidt and Weiner as 25 type 1, 1 type 2, 4 type 3, 3 type 4, 13 type 5 (6 Tongue-type and 7 Joint-depression), and 4 unclassifiable fractures. 29 (58%) were non-operatively treated and 21 (42%) operative. The data of 19 children with 21 fractures were available for a follow-up analysis > 6 months in terms of union, infection, range of motion, pain, arthrosis, and arthrodesis.

Results: 86% (19) fractures in children <13 years were extra-articular. 90% (20) were non-operatively treated. 79% of children ≥13 years had intra-articular fractures with operative treatment in 68% (19). Only two (15.4%) of 13 compression fractures of the subtalar joint occurred in the younger group. Average preoperative Böhler angle in Type 5 fractures was 11° (range, -28° to 26°). Average postoperative Böhler angle was 30° (range, 22-44). Average age in children with follow-up >6 months was 14.7 years (range, 5-18). One (5%) non-union occurred, no wound infection was observed. Weight bearing as tolerated averaged after 10.5 weeks (range, 0-32). Range of motion with dorsiflexion averaged 18° (range, 0-30) and plantar flexion 40° (range, 30-50). Five (24%) had <50% subtalar motion. Six (29%) reported pain on final follow-up with one taking NSAIDs (nonsteroidal anti-inflammatory drugs) regularly. Two (10%) required orthotic shoe wear. Two (9.5%) showed mild subtalar arthrosis signs on final follow-up radiograph 30 months after fracture and two (10%) required subtalar fusion for severe symptomatic arthrosis 9 and 1 year after a type 5 fracture.

Conclusion: Whereas calcaneal fractures in children often have no articular involvement and do not require operative treatment, calcaneal fractures in adolescents often have similar fracture patterns as adults and require open reduction and internal fixation to restore the joint surface and Böhler angle. Long-term complications such as arthrosis requiring arthrodesis are present in these patients.

See pages 49 - 106 for financial disclosure information.

Comparison of Flexible Intramedullary Nailing and Plating Techniques for Treatment of Pediatric Midshaft Femur Fractures in Children Ages 5-11 Years

Jerad Allen, MD; Kevin Murr, MD; Ferras Albitar, BS; Cale Jacobs, PhD; Ryan Muchow, MD
University of Kentucky College of Medicine, Lexington, Kentucky, USA

Background/Purpose: Current AAOS clinical practice guidelines for pediatric femoral shaft fractures indicate flexible intramedullary nails for children 5-11 years old; however, growing evidence suggests these fractures may be treated with open or submuscular plating techniques as well. The purpose of this study was to directly compare estimated blood loss, operative time, and fluoroscopy time between flexible intramedullary nailing and plating techniques used in 5-11-year-old children with middle-third femur fractures based on length stability. We hypothesized that estimated blood loss, operative time, and fluoroscopy time would be greater with plate fixation.

Methods: We retrospectively identified all pediatric middle-third femur fractures treated with flexible nails, submuscular plating, or open plating between 2004 and 2014. Clinical data analyzed included patient age, body mass index (BMI), ISS, side of injury, presence of open fracture, length stability (stable or unstable), estimated blood loss, operative time, fluoroscopy time, major complications, and length of stay. Major complications were defined as: unplanned reoperation, malunion requiring operative treatment, leg-length discrepancy >2 cm, or nonunion. The estimated blood loss, operative time, fluoroscopy time, open fracture prevalence, and length stability were compared between the three fixation methods using paired *t* tests or Fisher's exact test as appropriate.

Results: There were 65 middle-third femur fractures in 63 patients included in this study (age = 8.7 ± 2.0 years; 43 male, 20 female; 27 left-sided injuries, 38-right sided; BMI = 18.2 ± 3.54 kg/m^2). Flexible nail fixation was the most common technique utilized (50/65 [77%]) followed by open and submuscular plating (15/65 [23%]). The two plating methods were grouped together for analysis as differences in estimated blood loss, operative time, and fluoroscopy time were not significant ($P = 0.1$, $P = 0.51$, and $P = 0.17$, respectively). There was no statistical difference in ISS ($P = 0.92$) or length of stay ($P = 0.79$) between fixation techniques. Individual fracture characteristics, being open or length unstable, were not found to be significant between the two fixation groups ($P = 0.566$ and $P = 0.214$, respectively). Comparing operative variables, there was a significantly increased operative time (2.5 vs 1.6 hours, $P = 0.007$) and a notably greater estimated blood loss (79.0 vs 40.1 mL, $P = 0.057$) for the plating technique compared to flexible nails. Fluoroscopy time was not statistically significant between the two fixation methods (flexible nailing 2.5 vs plating 3.3 minutes, $P = 0.21$). One complication occurred in the flexible nail group (1/50 [2%]) consisting of an unplanned reoperation to revise a nail tenting the skin and one complication occurred in the plating group (1/15 [8%]) consisting of a leg-length discrepancy of 2.1 cm.

Conclusion: Midshaft femur fractures in children 5-11 years old may be successfully treated with flexible intramedullary nailing or open/submuscular plating, regardless of length stability. However, a greater estimated blood loss and operative time were seen in plating

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

techniques. Increased radiation exposure, measured in fluoroscopy time, was equal between the groups despite our original hypothesis. To our knowledge, this study represents the first direct comparison of the common fixation methods specifically for midshaft femur fractures and favors the use of flexible intramedullary nailing based on decreased blood loss and operative time.

See pages 49 - 106 for financial disclosure information.

The Use of the Semi-Sterile Technique for Closed Reduction and Percutaneous Pinning of Upper Extremity Fractures in Pediatric Patients

Karan Dua, MD[1]*; Charles Blevins, BS*[1]*; Joshua Abzug, MD*[2]
[1]*University of Maryland School of Medicine, Baltimore, Maryland, USA*
[2]*University of Maryland School of Medicine, Timonium, Maryland, USA*

Background/Purpose: Closed reduction and percutaneous pinning (CRPP) is commonly utilized for pediatric upper extremity fractures. The technique is traditionally performed following full surgical prep and draping, which can be inefficient and wasteful of materials. The semi-sterile technique has been shown to have no difference in infection or complication rates when utilized for pediatric supracondylar humerus fractures. The purpose of this study was to compare the use of the semi-sterile technique versus the full prep and drape technique for CRPP procedures of all pediatric upper extremity fractures.

Methods: A retrospective review was conducted of all pediatric patients who underwent CRPP of an upper extremity fracture. There was a gradual transition from utilizing the full prep and drape technique to the semi-sterile technique. Demographic data, fracture type and location, and length of pin fixation were recorded. Qualities of intraoperative care were assessed including average length of surgery, room set-up time, and room cleaning time. Additionally, parameters of postoperative care were recorded including average length of follow-up and complication rates. Simple statistics and unpaired *t* tests were performed.

Results: 224 patients were reviewed including 162 in the semi-sterile group and 62 in the full prep group. The average length of surgery was 32 minutes (range, 11-110) in the full prep group compared to 26 minutes (range, 7-69) in the semi-sterile group ($P = 0.007$). The average room set-up time in the full prep group was 20.1 minutes compared to 18.4 minutes in the semi-sterile group (Table 1). Furthermore, the average operating room cleaning time in the full prep group was 18.8 minutes compared to 16.8 minutes in the semi-sterile group. When assessing the set-up time, procedure time, and clean-up times together, the combined average times were 71.1 minutes in the full prep group and 61.3 minutes in the semi-sterile group, for a difference of 9.8 minutes. The average time to pin removal was 27.5 days (range, 5-76). The average length of follow-up was 68 days (range, 15-365) with patients being followed on average for 37 days after pin removal. Two complications in the full prep group occurred including one pin tract infection and one physeal arrest.

Conclusion: The semi-sterile technique is a safe and cost-effective alternative that should be used when performing CRPP of all pediatric upper extremity fractures. The full prep technique increases operating room time and medical waste, and therefore should not be utilized given the effectiveness of the semi-sterile technique.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1: Intraoperative Data

Category	Full-Prep: Average Time (mins)	Semi-Sterile: Average Time (mins)
Room Set-Up	20.13	18.38
Time Patient in the Room	62.98	52.17
Prep Time	5.77	5.37
Anesthesia Time	62.00	52.00
Procedure Time	32.10	26.06
Clean Time	18.84	16.82
Set-Up + Clean Time	38.97	35.20
Set-Up + Procedure Time + Clean Time	**71.07**	**61.26**

See pages 49 - 106 for financial disclosure information.

Percutaneous versus Open Reduction and Fixation for Tillaux and Triplane Fractures: A Multicenter Study

William Zelenty, MD[1]*; Richard Yoon, MD*[1]*; Lior Shabtai, MD*[2]*; Paul Choi, MD*[2]*; David Martin, MD*[3]*; B. Horn, MD*[4]*; David Feldman, MD*[5]*; Norman Otsuka, MD*[6]*; David Godfried, MD*[1]

[1]*New York University Hospital for Joint Diseases, New York, New York, USA;*
[2]*Children's Hospital Los Angeles, Los Angeles, California, USA;*
[3]*Children's National Washington, District of Columbia, USA;*
[4]*Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA;*
[5]*Paley Institute, West Palm Beach, Florida, USA;*
[6]*Montefiore Children's Hospital, New York, New York, USA*

Purpose: For Tillaux and triplane ankle fractures, treatment via both open and percutaneous techniques has been described. The literature contains supportive evidence for both techniques, leaving no general consensus on which is superior when it comes to minimizing residual gap or preventing growth disturbance. In this study, we present a multicenter initiative comparing the two techniques in a large, cohort comparison.

Methods: Four academic pediatric orthopaedic centers participated in this retrospective cohort comparison study. Two cohorts were formulated dependent on operative technique: percutaneous (PERC) or open reduction (OPEN). Inclusion criteria included all healthy, adolescent children undergoing operative fixation for either Tillaux or triplane ankle fractures with minimum 1-year follow-up. Data collected included age, gender, body mass index (BMI), diagnosis, time to surgery, operative technique, initial displacement, residual gap, and/or any radiographics signs of growth disturbance.

Results: A total of 68 patients met inclusion criteria and were included for analysis. The OPEN group consisted of 52 patients, while the PERC group consisted of 16 patients. There were no significant differences in age, gender, BMI, or diagnosis between the two cohorts. While results exhibited a significantly higher initial displacement in the OPEN group (4.4 ± 2.2mm vs 2.7 ± 1.9mm, $P = 0.01$), there was no significant difference in residual gap at final follow-up. Furthermore, at final radiographic follow-up, there were no significant differences in the presence of growth arrest.

Conclusion: Despite a significantly higher initial displacement in the OPEN group, a seemingly higher-energy injury did not yield any significant differences in residual gap or growth disturbances at final follow-up. In this multicenter study, both techniques yielded desired results; however, prospective, controlled comparisons are required to truly delineate a difference.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Comparable Outcomes Between Length Stable and Unstable Pediatric Femur Fractures Treated with Flexible Intramedullary Nailing

Devon Nixon, MD*; Sami Mardam-Bey, MD; Lauren Davis, MPH; J. Eric Gordon, MD*
Washington University in St. Louis, St. Louis, Missouri, USA

Purpose: Pediatric femur fractures are common injuries in school-age children. Various fixation options exist for definitive management with flexible intramedullary nailing (IMN) a popular choice. However, controversy exists regarding the use of flexible IMN in length unstable fracture patterns with reports of increased complications including early femoral shortening and leg-length discrepancy (LLD). The purpose of our study was to further explore length stability in pediatric femur fractures in an expanded data set, hypothesizing no differences in outcomes between stable and unstable fractures.

Methods: All pediatric femoral fractures treated with flexible IMN from January 1, 2006 to December 31, 2012 at a tertiary-care institution were identified. Pathologic fractures were excluded. Fracture characteristics were based on review of injury films and categorized as either length stable or unstable using previously described criteria. Length stable fractures had transverse or short oblique patterns. Length unstable fractures had either comminution or long oblique patterns where the obliquity length was greater than twice the shaft diameter at the level of the fracture. Outcome measures included postoperative complication rates, elective hardware removal rates, early femoral shortening, and LLD. Complications included nonunion and/or malunion necessitating reoperation, clinically significant LLD requiring surgical intervention, infection, and/or repeat surgery prior to complete fracture healing (<3 months from initial surgery). Early length stability was assessed by measuring the change in femoral shaft length between initial postoperative radiographs. Additionally, we identified a subset of patients with full-length, standing radiographs and compared leg-length inequalities between stable and unstable populations.

Results: We identified 106 patients for analysis (63 stable and 43 unstable fractures). Complications necessitating further surgery were seen in 8 of 63 stable fractures (12.7%) including malunion (n = 3), nonunion (n = 1), LLD (n = 2), and early reoperation prior to fracture healing (n = 2). Of the 43 unstable femur fractures, 5 patients (11.6%) experienced complications including refracture (n = 1) and early reoperation prior to fracture healing (n = 4). There was no difference in complication rates between groups (P >0.1). Hardware removal rates were similar between stable and unstable populations (77.8% vs 65.1%, respectively; P >0.1). There was no difference (P >0.1) in femoral shaft length between initial postoperative visits with stable (average 0.13 mm, n = 56) and unstable (average 0.18 mm, n = 38) patients. Leg-length discrepancies were similar (P >0.1) between stable (n = 30) and unstable (n = 18) groups (average 7.1 vs 5.33 mm, respectively) at an equivalent time from index surgery to standing examination (544 vs 578 days, respectively).

Conclusion: Based on data here, unstable femur fractures are not at increased risk for more complications, higher elective implant removal rates, early femoral shortening, or LLD. Flexible IMN likely remains a viable treatment option for length unstable pediatric femur fractures.

See pages 49 - 106 for financial disclosure information.

Can Trauma Surgeons' Subjective Intraoperative Conclusions on Patients' Bone Quality Be Trusted?

Ole Brink, MD, PhD, MPA[1]; Randi Tei, RN[2]; Bente Langdahl, MD, DMSc[3]
[1]Aarhus University Hospital, Aarhus, DENMARK;
[2]Deparment of Endocrinology, Aarhus University Hospital, Aarhus, DENMARK;
[3]Deparment of Endocrinology, Aarhus University Hospital, Aarhus, DENMARK

Background/Purpose: How are my bones; do I have osteoporosis? Orthopaedic trauma surgeons are occasionally asked this question. A response from a medical doctor often has a major impact on the patients, but how valid is the surgeon's answer? The purpose of this study was to validate trauma surgeons' estimation of bone quality and conclusions as to whether a patient undergoing surgery for a fracture has osteoporosis or not.

Methods: Trauma surgeons were asked immediately after performing fracture surgery to evaluate the quality of the bone on a 10-cm visual analog scale (VAS) ranging from very poor to extremely high bone quality. The surgeons were also asked if they would answer "osteoporosis," "not osteoporosis," or "not able to answer" if the patients asked for their status of osteoporosis. Within 3 months after surgery all patients were invited to undergo dual x-ray absorptiometry (DXA) for measuring bone mineral density. Receiver operating characteristic (ROC) curves were used as diagnostic tools to describe the accuracy of VAS score against prevalence of osteoporosis based on DXA or bone status category: normal, osteopenia, or osteoporosis. Nonparametric methods were used to calculate area under the ROC curves, and DXA outcome was binary. An area between 0.7-0.8 represents a fair test and from 0.6-0.7 represents a poor test.

Results: 53 patients were included in this study and evaluated by 13 trauma surgeons. Location of fracture varied between distal radius (24%), hip (19%), ankle (19%), lower leg (15%), and forearm (15%).

Area under the ROC curve measuring accuracy of VAS as diagnostics tool for osteoporosis was 0.698 and for diagnosing a status of osteopenia or osteoporosis the area under the curve was 0.727. Using a cut point on the VAS scale 4 cm or less as diagnostics for osteoporosis, the sensitivity was 84%, the specificity 42%, and 75% were correctly classified. Using the same cut point of 4 cm for diagnosing osteopenia or osteoporosis from the VAS scale the sensitivity was 93%, specificity 27%, and 45% were correctly classified. In 15 cases (28%) the surgeons were not able to conclude if osteoporosis was present or not. The positive predictive value of the surgeons' conclusion of osteoporosis was 50% and the negative predictive value was 83%. If surgeons' conclusion of osteoporosis was used as a surrogate for any abnormal low bone density (osteopenia or osteoporosis), the positive predictive value raised to 86%.

Conclusion: The trauma surgeon's intraoperative experiences and conclusions concerning a patients bone quality can be trusted to some degree. The positive predictive value of surgeons' conclusions of abnormal bone quality is high. The VAS scale has been found to be a simple tool to identify patients with potential abnormal bone quality who might need further diagnostics with DXA scans.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

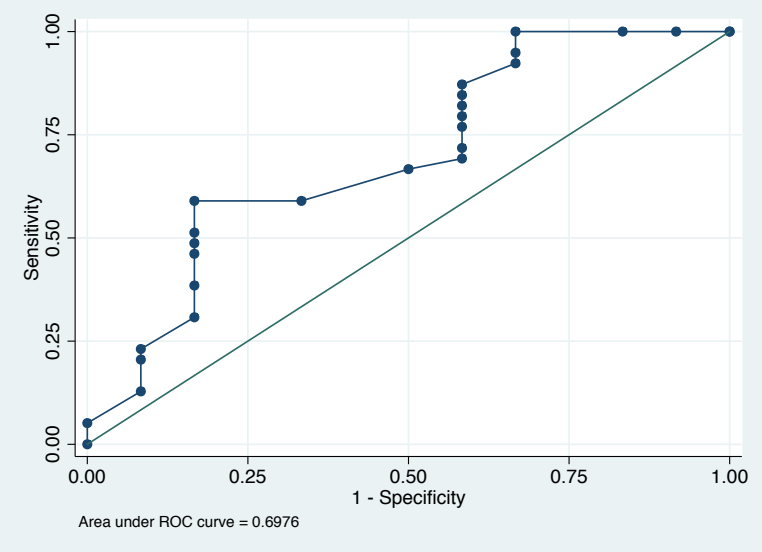


Figure 1 A) Osteoporis

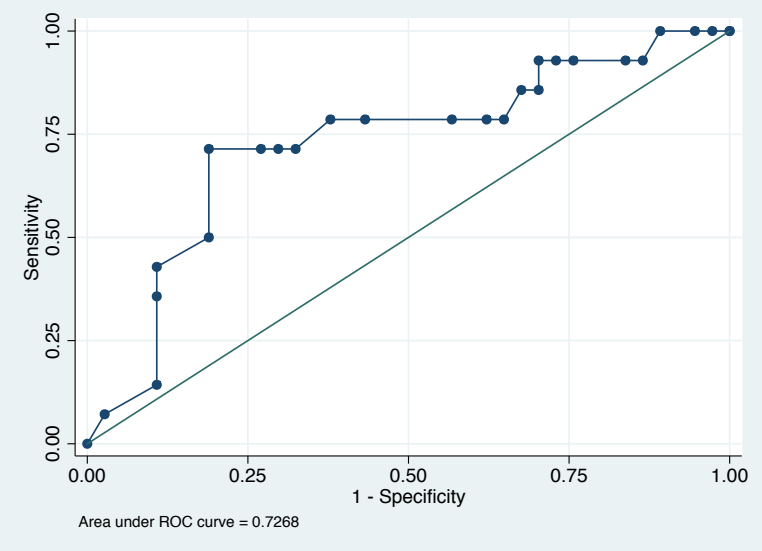


Figure 1 B) Osteopenia or Osteoporosis

Figure 1 A & B:
ROC curves shows characteristics of VAS scale as diagnostic test for (A) osteoporosis & (B) osteopenia or osteoporosis.

See pages 49 - 106 for financial disclosure information.

Results Following Surgical Intervention for Fracture Nonunions: Does Diabetes Predict Poor Outcomes?

Nina Fisher, BS*; Adam S. Driesman, BA; Sanjit R. Konda, MD; Kenneth A. Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: Diabetes mellitus has become an increasingly prevalent in our healthcare system, and will affect approximately 439 million adults worldwide by 2030. Diabetes mellitus has been known to affect bone quality, leading to increased fracture risk and, is associated with increased risk of nonunion following a fracture. However, there is little evidence which gives insight as to the long-term outcomes of diabetic patients who are treated surgically for fracture nonunion. The purpose of this study was to examine the functional outcomes of diabetic patients who were treated for a nonunion, and compare their functional outcomes against matched controls.

Methods: Three hundred and thirty-three patients who were surgically treated for a fracture nonunion were followed prospectively. Sixty-one (18.3%) patients carried a diagnosis of diabetes mellitus (either type 1 or type 2). This cohort was paired with 61 matched controls based on age, gender, and location of fracture nonunion. All fracture nonunions were treated surgically in a similar manner. Patients were evaluated for union with radiographs and function using the Short Musculoskeletal Functional Assessment (SMFA) at baseline (pre-operatively) and at 3 months, 6 months, 12 months, and greater than 2 years post-operatively. Patients were also assessed at these time points for healing and any complications. Univariate analysis was performed using independent t-tests for normally distributed continuous variables and the Mann Whitney U test for non-normally distributed continuous variables, with significance set at $p < .05$. Pearson's chi-squared analysis was used for categorical variables.

Results: The diabetic group was composed of 29 females and 32 males, with an average age of 58.2. In each group, there were 17 upper extremity nonunions and 43 lower extremity nonunions. The average length of time of long-term follow-up was 37.7 months for the diabetic group and 41.7 months for the non-diabetic group. The average time to heal for the diabetic group was by 6.7 months and by 6.5 months for the non-diabetic group ($p = 0.764$). Additionally, there was no difference in the complication rate between the groups. Distributions of SMFA scores for diabetic and non-diabetic patients were similar at baseline, 3 months and 6 months post-operatively, as assessed by visual inspection. SMFA scores at 12 months and long-term were normally distributed, and there was no significant difference in SMFA scores between the groups at either time point. Diabetic patients saw a 13.2 reduction in mean SMFA score from baseline to long-term follow-up while non-diabetics had a reduction of 18.5.

Conclusions: The comorbidity of diabetes mellitus does not lead to significantly worse functional outcomes following surgical treatment for a fracture nonunion. Although patients with diabetes mellitus are at a higher risk for developing a nonunion following an acute fracture, comparison with matched controls demonstrates that diabetes mellitus has little impact on the healing that occurs after surgical revision for fracture nonunions. Orthopaedic surgeons should counsel diabetic patients that they can expect a similar return to function and time to healing as non-diabetic patients if undergoing this treatment.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Women in Orthopaedic Fellowships: How Does the OTA Do?

Lisa K. Cannada, MD
Saint Louis University, Saint Louis, Missouri, USA

Purpose: The American Academy of Orthopaedic Surgeons (AAOS) has made a concerted effort to increase diversity in the field. Currently, 15% of orthopaedic residents are females. Most residents are completing advanced training in orthopaedics, and the number of applicants to orthopaedic fellowships often exceeds the number of available positions. With the current emphasis on increasing diversity, especially in terms of gender, the purposes of this study are to report subspecialty selection for females as well as fellowship match rate for female trauma applicants over the past 5 years.

Methods: Three organizations currently run the nine fellowship matches in orthopaedic surgery. The hand match is through the National Resident Matching Program and includes orthopaedic, general, and plastic surgery residents. The American Shoulder and Elbow Society (ASES) administers its own match. Trauma, foot and ankle, pediatrics, spine, sports, and adult reconstruction/tumor use the San Francisco Match (SF Match). We reviewed all applicants who submitted rank lists as well as which applicants matched in all subspecialties through the SF Match and ASES from 2010 to 2014. X^2 analysis was used to compare the values between gender for match rate and subspecialty for all data.Significance was set at $P < 0.05$.

Results: Our results indicate that females represent 9% (38/441) of all trauma fellowship applicants and 11% (37/345) of all matched trauma fellowship applicants. The match rate for trauma was 97% (37/38) for females and 76% (308/403) for males. In the past 5 years, all females applying for a trauma fellowship matched except one. Overall, the female applicants to the orthopaedic fellowships we evaluated had a higher chance of fellowship matching compared with males (females: 320/335 [96%]; males: 2696/3325 [81%]; $P < 0.001$). When evaluating total number of women matching in each subspecialty, pediatric orthopaedic surgery had the highest percentage of females who matched (44%), followed by foot and ankle (17%), shoulder (12%), trauma (12%), sports (11%), adult reconstruction/tumor (6%), and spine (4%).

Conclusion: We found that females match at a higher rate than males in orthopaedic trauma fellowship training. For trauma, there was only one female who did not match over the 5-year period. The overall match rate for females is significantly higher than males in orthopaedic fellowships. The OTA has made an effort over the past 10 years to offer females interested in trauma both mentoring and networking with the Kathryn Cramer Luncheon, among other opportunities. This can be a model for other societies in the recruitment of females in fellowship training.

See pages 49 - 106 for financial disclosure information.

A Comparative Study of Intermittent Indigenous Negative Pressure Wound Therapy and Conventional Gauze Dressing of Contaminated Soft Tissue Injuries in Cases of High Energy Trauma

Rakesh Kumar, MBBS, MS(ORTHO)[1]; Devwart Kaushik, MBBS, MS(ORTHO)[2]
[1] Sawai ManSingh Medical College and Attached Hospitals, Jaipur, INDIA;
[2] Sports Injury Center, Safdarjung Hospital, New Dehli, INDIA

Background/Purpose: In the 21st century, with the emergence of high-speed transportation systems, a trauma patient commonly presents with large degloving injury, a compound fracture or severe crushing of soft tissues. After stabilizing skeletal injuries, management of soft-tissue injuries in high-energy trauma has proved unsatisfactory despite various wound management modalities available. A renewed interest has been seen in negative pressure wound therapy (NPWT) recently in orthopaedic trauma patients, but the cost remains a limiting factor in developing nations. The present study compared a low-cost indigenous negative pressure wound therapy (iNPWT) to conventional gauze dressings in high-energy soft-tissue trauma at a tertiary care center.

Methods: This prospective study was conducted from September 2012 to November 2014. The IRB approved all procedures. An ethical clearance was obtained from the ethical society of our institution. Out of all patients presenting due to high-energy trauma with open fractures/ soft-tissue injuries (n = 243), a total of 104 patients (101 men, 3 women) who fulfilled the inclusion criteria were enrolled. Among 104 patients, test (ie, iNPWT group [50 patients; mean age, 35 years; age range, 15-75 years]) and control (ie, control group [54 patients; mean age, 31.7 years; age range, 8-65 years) were compared in terms of (1) total number of dressings needed, (2) time from injury to definitive management, (3) length of hospitalization, (4) number of operations to close wounds, (5) rate of infection, and (6) other wound complications. χ^2 test and Fisher's exact test (whenever applicable) were used to observe an association between the qualitative data and outcome variables. Unpaired *t* test and Mann-Whitney test were used for analysis of the quantitative data. A *P* value of less than 0.05 was considered statistically significant.

Results: Total number of dressings (mean) in test and control were 3.44 and 19 respectively ($P < 0.001$). Comparing infection versus no infection in the two groups, difference was statistically significant ($P < 0.05$). Total time between injury and wound coverage (12.5 vs 21.35 days) as well as hospitalization duration (17.26 versus 23.81 days) was significantly less in test ($P < 0.05$). Single procedure was sufficient for closure in test in >90% patients ($P < 0.05$).

Conclusion: The use of iNPWT in patients presenting with soft-tissue injuries due to high-energy trauma results in improved wound healing compared to conventional gauze dressings, reflected by reduced duration of hospitalization and a significantly smaller number of dressings required until coverage of the wound compared to conventionally treated wounds.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Risk for Delayed Diagnosis of Orthopaedic Injury in the Polytrauma Patient: An Observational Epidemiological Study

Lattisha Rowe, MD*; Daniel Jupiter, PhD; Nikoletta Carayannopoulos, DO; Ronald W. Lindsey, MD*
University of Texas Medical Branch, Galveston, Texas, USA

Purpose: Evaluation of the polytrauma patient is a demanding task and, despite trauma protocols, missed injuries still occur. The objective of this study was to determine incidence and risk factors for orthopaedics-related delayed diagnoses in polytrauma patients.

Methods: Patient charts from January 1, 2000 through December 31, 2014 in the trauma registry of a Level I trauma center were reviewed to identify patients who met our study inclusion criteria, ie, admission for greater than 24 hours and an ISS >15. We determined the incidences of delayed diagnosis of injury according to the type and anatomic location of the injury; delayed diagnosis was defined as injury noted after the primary survey and 24 hours after admission. For delayed diagnosis of orthopaedic injury, we used *t* test/ANOVA (analysis of variance) or X^2/Fisher's exact test to assess the relationship between incidence and the potential risk factors of age, sex, race, ISS, Glasgow Coma Scale (GCS) score, ICU length of stay, intubation status, mechanism of injury, total injuries and fractures, resident daily shift change, and the beginning versus end of the academic year.

Results: The inclusion criteria were met by 2247 patients. Delayed diagnosis of an injury of any type occurred in 121 of them. A delayed-diagnosis orthopaedic injury occurred in 101 patients (4.5%), who accounted for 83.5% of those with delayed diagnosis of any type. Among the 101 patients, 27.8% had two or more orthopaedics-related delayed diagnoses. Scapula and tibial plateau fractures were the most common orthopaedics-related delayed diagnoses in the upper (18.2%) and lower (21.9%) extremities, respectively. Delayed orthopaedic diagnoses occurred largely in motor vehicle collisions in white males aged 31-50 years, although mechanism of injury, race, sex, and age were not significant predictors of delayed diagnosis. ISS, GCS, intubation on arrival, and days in the ICU were also not significant risk factors. There was no difference in delayed orthopaedic diagnosis incidence for the beginning versus end of the academic year or during resident shift change. However, as the number of delayed diagnoses incurred per patient increased there was a concomitant increase in associated injuries and fractures. Patients with delayed orthopaedic diagnosis had on average 11.4 concomitant injuries and 6.7 fractures.

Conclusion: In our population, most of the delayed diagnoses in polytrauma patients were orthopaedic in nature. Risk for delayed diagnosis of orthopaedic injury in these patients was significantly associated with total number of concomitant injuries and fractures.

See pages 49 - 106 for financial disclosure information.

Novel Application of Exhaled Carbon Monoxide Monitors: Smoking Cessation in Orthopaedic Trauma Patients

Paul Matuszewski, MD[1]*; Timothy Costales, BS*[1]*; Timothy Zerhusen, BS*[2]*; Max Coale, BA*[2]*; Robert V. O'Toole, MD*[3]
[1]*University of Maryland, Baltimore, Maryland, USA;* [2]*R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[3]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA*

Background/Purpose: Smoking is associated with increased complications in fracture care, including increased infection rate, wound healing difficulties, and perioperative morbidity. Recent data demonstrate that trauma patients may be more interested in quitting than the general public. Physician-assisted quit rates approach 6%, which is not much better than the unassisted quit rate of 3%. Nationally based quitline (1-800-Quit-NOW) referral, however, results in a quit rate approaching 30-40%. An exhaled carbon monoxide (CO) monitor is an inexpensive (~20 US$ per use), quick (<1 min), and easy-to-use tool to assess smoking status. Use of an in-office exhaledCO monitor in orthopaedic trauma patients may enhance interest in smoking cessation and increase referral to a quitline. We hypothesize that the use of a CO monitor will increase willingness to quit smoking, and increase patient referral to the national quitline when compared to standard of care.

Methods: We prospectively approached 134 patients at their first postoperative clinic visit for participation in our study; 124 (93%) participated. Current smokers were defined as those having smoked more than 1 cigarette in the last 6 months (including those who had recently quit). A 21-question survey was administered to each patient with questions relating to demographics, smoking habits, and interest in quitting smoking. The survey addressed the smoking patients' readiness to quit by measuring the previously defined transtheoretical stage of change and a 10-point Likert scale describing willingness to quit today. At survey conclusion, exhaled CO was measured with results explained in a standardized fashion (Pico+ Smokerlyzer, Bedfont Scientific). After exhaled CO was explained, stage of change and willingness to quit was reassessed. Additionally, a yes/no/no change question asking if the CO reading increased their willingness to quit was administered. Wilcoxon signed rank sum test and logistic regression was utilized to determine primary outcome (readiness to quit, increase in stage of change). Linear regression and multiple regression models were utilized to determine relationship of exhaled CO and other outcome variables.

Results: 95% of respondents were regular smokers (46% up to ½ pack/day, 49% ≥1 pack/day smokers). Use of the exhaled CO monitor

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

increased willingness to quit in 70% (95% CI .600-.785) of participants still smoking, and increased willingness to quit on average, .83 points on a 10-point Likert scale (95% CI .599-1.067) (P <0.001). 15% of patients modified their stage of change towards quitting. 40% of patients after exhaled CO monitor requested referral to the quitline (compared to participant-reported 4% presurvey referral to a cessation programs, P <0.001). Anecdotally, most participants were very interested in the device and their reading, expressing concern with their result. The value of exhaled CO was not associated with any measured outcomes.

Conclusion: The use of an exhaled CO monitor increased the willingness to quit in 70% of patients, but the effect size was relatively small (.83 points on a 10-point Likert scale). However the use of the CO monitor resulted in a large increase (40% vs 6% baseline) in referral to the national quitline. Use of a quitline typically increases the chance of smoking cessation by 10 times the baseline rate, suggesting that this finding may be clinically important.

See pages 49 - 106 for financial disclosure information.

Can the AAOS/OTA Hip Fracture Skills Simulator Measure Your Surgical Skill? Construct Validation of a Computer-Based Force-Feedback Simulation Platform

Matthew Christian, MD[1]*; Cullen Griffith, MD*[2]*; Carrie Schoonover, BS*[1]*; Max Coale, BA*[3]*; Timothy Zerhusen, BS*[3]*; Nathan O'Hara, MHA*[4]*; R. Henn, III, MD*[5]*; Robert V. O'Toole, MD*[6]*; Marcus F. Sciadini, MD*[1]

[1]*University of Maryland/R. Adams Cowley Shock Trauma Center, Department of Orthopaedics, Baltimore, Maryland, USA;*

[2]*Shock Trauma Orthopaedics, Baltimore, Maryland, USA;*

[3]*R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;*

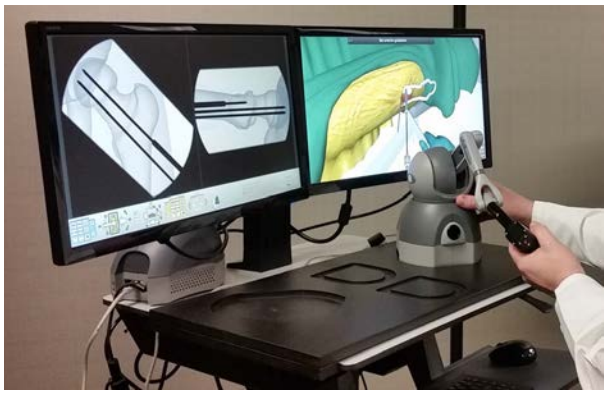
[4]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*

[5]*University of Maryland Department of Orthopaedics, Baltimore, Maryland, USA;*

[6]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA*

Background/Purpose: Surgical simulation training is well-established in scope-assisted surgery. Recent interest in increasing the role of surgical simulation in the training of orthopaedic residents has led to the development by the AAOS and OTA with an industry partner of a computer-based force-feedback simulation platform designed to teach motor skills associated with percutaneous, fluoroscopically guided procedures. This study seeks to validate this platform by determining if it is capable of differentiating between novice, intermediate, and experienced practitioners based upon defined metrics measured and recorded by the program during motor skills exercises. Our hypothesis was that the simulator would differentiate between users of different experience levels.

Methods: With IRB approval, 48 volunteer participants were recruited including medical students (Group I, n = 15), junior orthopaedic residents (Group II, PGY [postgraduate year] 2-3, n = 9), senior orthopaedic residents (Group III, PGY 4-5, n = 10), and attending orthopaedic surgeons and fellows (Group IV, n = 14). Each participant performed the task of placing 3 guidewires (inverted triangle construct) in a valgus-impacted femoral neck fracture (OTA 31-B1) using the simulator. After a basic introduction to the simulator, each participant completed the task of placing the 3 pins. Performance metrics included pin distance to defined ideals at inferior, anterior, and posterior femoral neck, distance to the femoral head articular surface, simulated fluoroscopy time, overall time to task completion, and distance to ideal starting point on lateral cortex. Unpaired *t* tests were used to compare the groups.



Results: The more experienced surgeons (Groups II, III, IV) outperformed the novices (Group I) on 12 of the 17 measured variables (number of fluoroscopy shots, distance of all 3 guidewires to joint surface,

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

distance of guide wires to cortex, distance of starting point on lateral cortex to ideal, and parallelism of wire placement; $P < 0.05$). Time to completion, fluoroscopy time, and number of wire penetrations of the joint surface for each of the 3 pins was similar between groups ($P > 0.05$).

Conclusion: This study demonstrates construct validity of the AAOS/OTA Hip Fracture Simulator in its ability to distinguish between novice and experienced surgeons for 12 of the 17 measured parameters ($P < 0.05$), implying that that the simulator measures elements of surgical skill specific to this task. A valid computer-based simulation platform capable of simulating both fluoroscopic images as well as tactile feedback during percutaneous procedures, without exposure to ionizing radiation to patients or surgeons, has the potential to improve surgical education in orthopaedic trauma by facilitating the tracking of performance and evaluation of novel teaching techniques via computer-based skills assessment. This initial validation is encouraging in terms of potential for this system to have utility in orthopaedic education.

See pages 49 - 106 for financial disclosure information.

The Use of Titanium Mesh Cage in Reconstruction of Segmental Long Bone Defects: A Multicenter Study

Naftaly Attias, MD[1]*; Ahmed Hagag, MD, PhD*[2]*; Rick Gehlert, MD*[3]
[1]*St. Joseph's Hospital, Phoenix, Arizona, USA;*
[2]*Texas Tech University, El Paso, Texas, USA;*
[3]*University of New Mexico HSC, Albuquerque, New Mexico, USA*

Purpose: The treatment of segmental long bones defects after trauma, atrophic nonunion, or after radical debridement for infection is challenging. The options include vascularized fibular graft, distraction osteogenesis through bone transport, or acute shortening combined with lengthening, Masquelet technique, and allograft. There is no ideal option that can fit every patient. The decision making varies according to patient's preference, the size of the defects, and the surgeon's surgical skill set. The aim is to report the use of titanium mesh cage in reconstruction of posttraumatic segmental bone defects.

Methods: This retrospective study was approved by the IRBs at two institutions. Our patients' database was reviewed for patients with posttraumatic bone defects. The study included patients with posttraumatic segmental bone defects due to fractures with bone loss, atrophic nonunion, and after radical debridement for infection. We only included patients treated with titanium mesh cages (Synthes) for segmental bone defects. The study period was between 2007 and 2014. The medical records and radiographs were reviewed. Medical records were reviewed for patients' demographics (age, side of injury, and gender), the anatomic location, mechanism of injury, initial treatment, classification of open fractures, length of segmental defect (cm), time from injury to bony reconstruction (months), time of external fixator removal to bony reconstruction, length of used cages (cm), past surgical history and the need for secondary procedures after the index surgery, and the time from injury to last follow-up. The study excluded patients who were treated with other treatment options rather that titanium mesh cages. Complications encountered during surgery and postoperative treatment course were recorded. The radiographs were reviewed for size of bone defect and alignment at last follow-up.

Results: A total of 17 patients were available for the study. The mean age at surgery was 35 years (range, 17-61). The majority of the study population are male (13; females, 4/17). The anatomic bony segments were: tibia 8/17, femur 5/17, radius 2/17, and humerus 1/17. Motor vehicle collision (MVC) was the most common mechanism of injury (10/17); other mechanisms of injury included gunshot wound (GSW) 5/17, crush injury 1/17, and unknown mechanism 1/17. All patients received initial surgical treatment before definitive index procedure. Irrigation and debridement (I&D) with external fixator application was the most common initial treatment (11/17). Other forms of initial treatment were initial internal fixation (6/17: plate 3 and intramedullary nail [IMN] 3). Antibiotics cement spacer was used in three patients (3/17). Soft-tissue reconstruction was necessary in the majority of patients (13/17). The average time of patients' presentation after initial injury was 15 months (range, 2-110). The external fixators were removed before definitive reconstruction to allow healing of pin sites. The range of time between external fixator removal and definitive bony reconstruction was between 2 and 9.5 weeks. The intraoperative cultures were

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

negative (12/17), positive (3/17), and not taken (3/17). The average length of segmental bone defect was 8 cm (range, 2.2-13 cm). The average length of titanium mesh cage was 8 cm (range, 2-13 cm). The average time between the time of injury and last follow-up was 43 months (range, 6-118). There were no intraoperative complications. The postoperative complications included: residual limb length discrepancy (LLD) 3/17; residual deformity (1/17); nerve palsy (5/17); common peroneal palsy (4/17: postinjury [2] and postoperative [2]); postinjury radial nerve palsy (1/17); hardware loosening or failure (2/17); recurrent infection (3/17); wound dehiscence required reconstruction (1/17); and chronic patellofemoral knee pain (1/17). All patients healed clinically and radiographically.

Conclusion: The use of titanium mesh cages is a viable alternative option for reconstruction of segmental bone defects. The procedures does not require a special surgical skill set compared to distraction osteogenesis or vascularized fibular graft. The procedure can be performed by general trauma orthopaedic surgeons. The cages can be combined with internal fixation (plates or nails) to provide structural support. Bone grafting around the cages is possible to improve bone biology. Eradication of infection is mandatory for successful outcome.

See pages 49 - 106 for financial disclosure information.

Does Low Vitamin D Lead to More Fracture Complications?

Brett D. Crist, MD[1]; Blake Bodendorfer, MD[2] Gregory J. Della Rocca, MD, PhD, FACS[1]; David Volgas, MD[3]; James Stannard, MD[4]
[1]University of Missouri School of Medicine, Columbia, Missouri, USA;
[2]Georgetown University, Washington, District of Columbia, USA;
[3]University of Missouri, Columbia, Missouri, USA;
[4]Missouri Orthopaedic Institute, Columbia, Missouri, USA

Purpose: Our aim was to determine if a low serum 25-hydroxy (OH) vitamin D is associated with a higher complication rate in fracture patients.

Methods: A retrospective review was done of all orthopaedic trauma patients over 20 months to identify fracture patients with an initial and repeat 25-OH vitamin D serum level. During this time, the orthopaedic trauma service's protocol was that all patients managed operatively had an initial 25-OH vitamin D level. Unless contraindicated, all patients received daily vitamin D3 and calcium replacement. Those who were found to be deficient or insufficient were also given a weekly high-dose vitamin D2 for 8 weeks. Repeat serum 25-OH vitamin D levels were performed between 2 and 3 months after surgery. The cohorts were separated by initial serum 25-OH vitamin D level. The primary outcomes were fracture and wound healing. Only complications requiring surgical interventions were evaluated. *T* tests, one-way ANOVA (analysis of variance), and Fisher's exact tests were used to determine statistical significance (**Purpose:** To determine if a low serum 25-OH vitamin D is associated with a higher complication rate in fracture patients.

Methods: A retrospective review was done of all orthopaedic trauma patients over 20 months to identify fracture patients with an initial and repeat 25-hydroxy (OH) vitamin D serum level. During this time, the orthopaedic trauma service's protocol was that all patients managed operatively had an initial 25-OH vitamin D level. Unless contraindicated, all patients received daily vitamin D3 and calcium replacement. Those that were found to be deficient or insufficient were also given a weekly high dose vitamin D2 for 8 weeks. Repeat serum 25-OH vitamin D levels were performed between 2 and 3 months after surgery. The cohorts were separated by initial serum 25-OH vitamin D level. The primary outcomes were fracture and wound healing. Only complications requiring surgical interventions were evaluated. T-tests, one-way ANOVA, and Fisher's Exact tests were used to determine statistical significance ($P < 0.05$).

Results: 201 patients were identified who had initial and repeat vitamin D levels. Out of 201 patients, 81 (40.3%) were initially deficient, 88 (43.8%) insufficient, and 32 were normal (15.9%). Therefore 169/201 (84.1%) patients were considered to have a low initial serum 25-OH vitamin D level. 15/201 (7.5%) of patients required orthopaedic procedures for fracture and wound healing complications and 13/15 (87%) had a low initial vitamin D and 8/15 (53.3%) remained low after supplementation. Overall, however, there were no significant differences in serum 25-OH vitamin D levels between those patients that had fracture or wound healing complications (15/201) and those without complications (186/201) when comparing the initial vitamin D level (mean 22.5 ng/mL vs 22.8; $P = 0.92$,

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

power) and the repeat level (mean 33.3 ng/mL vs 32.9 ng/mL; $P = 0.91$, power = 0.8) respectively.

Conclusion: Although the prevalence of low vitamin D is high in orthopaedic trauma patients, there does not appear to be a correlation between the initial and/or repeat serum 25-OH vitamin D level and risk of fracture or wound healing complications requiring surgical intervention.

See pages 49 - 106 for financial disclosure information.

Δ Socioeconomic Status and Trauma Center Care:
An Analysis of a Custom NTDB Dataset

Erik McDonald, BS[1]; ***Saam Morshed, MD***[2]
[1]*University of California San Francisco, San Francisco, California, USA*
[2]*UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA*

Purpose: While trauma centers (TCs) confer a mortality benefit for patients with traumatic injury, the degree to which socioeconomic status (SES) modifies this relationship is unknown. We hypothesized that subjects with higher SES would experience a greater mortality benefit of being treated at a TC compared to subjects with lower SES.

Methods: A custom dataset from the National Trauma Data Bank (NTDB) was obtained for years 2008-2012 that linked the subject's home zip code to the median household income (MHI) reported by the US Census for that corresponding zip code, which was used as a marker of SES. The MHI was broken into deciles. Subjects between 18-65 years of age with ISS >15 were included. Only subjects with blunt or penetrating injuries were included while subjects with burns were excluded. Subjects who were transferred into or out of a facility were also excluded. TCs were defined as Level I or II TCs while non-trauma centers (NTCs) were defined as Level III, IV, or lower. Statistical analyses were performed to evaluate how MHI modified the relationship between mortality following trauma using stratified univariate analyses as well as multivariate logisitic regression techniques using propensity score analysis. The propensity score controlled for a subject's probability of being triaged to a TC based on age, gender, injury severity, need for mechanical ventilation, total Glascow Coma Score, systolic blood pressure <90 mmHg, insurance status, race/ethnicity, and blunt/penetrating injury. Inverse probability weighting using the propensity score was used to adjust for confounding, while an interaction term between TC and MHI was included to evaluate potential effect modification between the variables. A P <0.20 of the interaction term was considered significant.

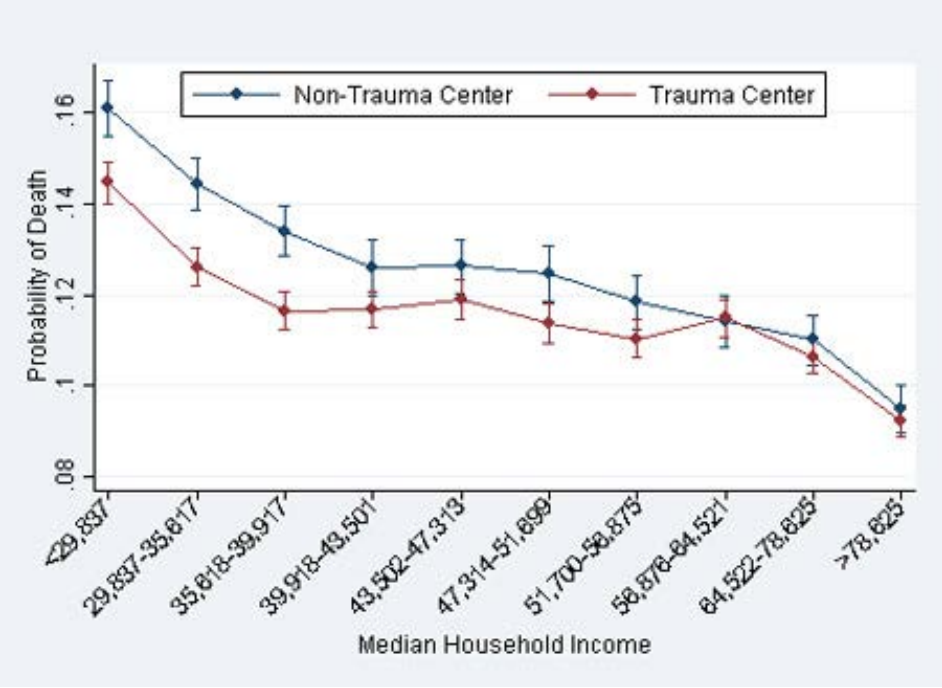
Results: 227,245 subjects were included in the univariate analysis. Stratifying subjects by MHI revealed that subjects from lower SES were more likely to be younger, male, have Medicare/Medicaid, have a systolic blood pressure <90 mmHg, require a ventilator, experience a penetrating injury, and have a Glascow Coma Score <8. Subjects from a lower MHI were also more likely to be treated at an NTC and die. The unadjusted analysis revealed that patients treated at a TC had 0.90 (95% CI 0.89-0.92) times the odds of mortality compared to NTC. There was a linear trend of a decreasing probability of death with an increasing MHI (Figure, left). While this trend persisted in the multivariate, propensity score model, there was no difference observed in mortality between TC and NTC (Figure, right).

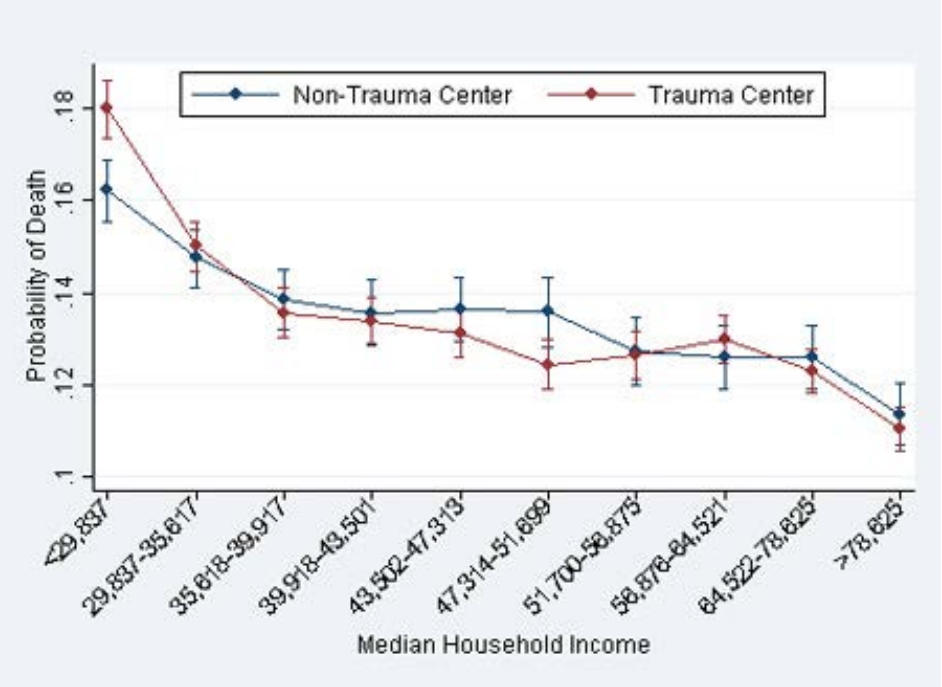
Conclusion: Subjects from lower SES experience higher mortality following trauma compared to subjects from higher SES. While the unadjusted analysis suggested subjects from lower SES experienced a greater mortality benefit of TC compared to NTC, this association did not persist in multivariate models, suggesting that the association between mortality and TC is not modified by SES in those models. Subjects from low SES have higher mortality after trauma compared to those from high SES. Univariate analysis suggests low SES

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

subjects experience a greater mortality benefit of TC care. The types of injuries, level of care, and outcomes subjects experienced was associated with SES.





See pages 49 - 106 for financial disclosure information.

Surgical Site Infections in Patients with Type III Open Fractures: Comparing Antibiotic Prophylaxis with Cefazolin Plus Gentamicin versus Piperacillin/Tazobactam

Peter Shorten, MD[1]*; Scott Wasilko, MD*[2]*; Jenessa Redfern, Pharm D*[1]*; Meghan Groth, Pharm D*[1]*; Wesley McMillian, Pharm*[1]*; Jesse Chlebeck, MD*[1]*; Craig Bartlett III, MD*[1]
[1]*University of Vermont Medical Center, Burlington, Vermont, USA;*
[2]*University of Vermont Medical Center, Gainesville, Vermont, USA*

Background/Purpose: Infections after open fractures remain problematic, with rates as high as 50% reported for Gustilo Anderson Type III (GAIII) injuries. Administration of prophylactic antibiotics in the setting of open fractures is a cornerstone of treatment and in GAIII open fractures has historically consisted of a cephalosporin and aminoglycoside, the latter of which has a significant side-effect profile, including ototoxicity and nephrotoxicity. The purpose of this analysis is to report on a single institution's results on surgical site infections (SSIs) utilizing a novel antibiotic prophylaxis regimen, piperacillin/tazobactam, in the treatment of Gustilo Anderson Type III open fractures.

Methods: A retrospective review of all patients over 18 years of age with GAIII open fractures who presented to a single Level I trauma center between 2004 and 2012 was performed. All patients were initially treated by an on-call team comprised of an orthopaedic attending surgeon and orthopaedic resident(s) utilizing accepted practices. These included early antibiotic administration, early and adequate debridement within 6-8 hours when possible, dead space management, and soft-tissue management. While only one-third of cases were initially staffed by an orthopaedic traumatologist, ultimately all were managed by one of two full-time orthopaedic traumatologists. Patients were stratified into two groups: those who received cefazolin and gentamicin (group CG; 2004-2009) and those who received piperacillin/tazobactam (group PT; 2009-2012) as antibiotic prophylaxis for open fractures. Patient data were collected from hospital records, including GA classification, OTA fracture classification, age, sex, diabetes, smoking history, ISS, and duration of antibiotic administration. The primary outcome measure was SSI at 1 year, with secondary outcome measures of SSI at 30 days, nonunions, mortality and rehospitalization at 1 year.

Results: 766 patients presented with open fractures over the study time period, 134 of whom were identified with GAIII open fractures. 72 patients met inclusion criteria--37 (51%) in group CG and 35 (49%) in group PT. Loss to follow-up prior to 1 year (35.5%, n = 22) and prophylactic antibiotics used outside of the studied medications (35.5%, n = 22) were the most common reasons for exclusion. There was no difference in GAIII subtypes, OTA classification, age, incidence of diabetes, smoking status, ISS, or duration of antibiotic therapy between groups. While there was no statistically significant difference in SSI at 30 days between groups, the rate was higher in the cefazolin plus gentamicin group (21.6% vs 11.4%; $P = 0.246$). The 1-year SSI rate was 32.4% (12/37) and 31.4% (11/35) for group CG and PT, respectively ($P = 1.000$). There were also no significant differences in the rates of nonunion at 1 year (28.9% group CG vs 14.3% group PT; $P = 0.130$), death at 1 year (2.6% group CG vs 0.0% group PT; $P = 0.334$), and rates of rehospitalization related to the initial

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

injury (37.8% group CG vs 31.4% group PT; $P = 0.715$) between groups. Two separate post hoc analyses of 8 patients followed for a minimum 30 days but less than 1 year and of 9 patients with uninfected nonunions (which might indicate the presence of a culture-negative infection) also found no differences in infection rates.

Conclusion: Piperacillin/tazobactam provides equivalent infection prophylaxis for Gustilo Anderson Type III open fractures when compared to the current gold standard, a cephalosporin and aminoglycoside combination. With its ease of use as a single agent, superior safety profile, and superior bone penetration, piperacillin/tazobactam should be considered as an option for antibiotic prophylaxis in patients with Type III open fractures.

See pages 49 - 106 for financial disclosure information.

What Do Orthopaedic Trauma Patients Value in Venous Thromboembolism Prevention? Results of a Prospective Discrete Choice Experiment

Bryce Haac, MD[1]*; Nathan O'Hara, MHA*[1]*; Theodore T. Manson, MD*[2]*; Deborah Stein, MD*[1]*; Herman Johal, MD, MPH*[3]*; Renan Castillo, PhD*[4]*; Robert V. O'Toole, MD*[5]*; Gerard Slobogean, MD*[6]

[1]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[2]*R. Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;*
[3]*McMaster University, Hamilton, Ontario, CANADA;*
[4]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA;*
[5]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA;*
[6]*University of Maryland, Baltimore, Maryland, USA*

Purpose: Limited scientific evidence to determine the most efficacious venous thromboembolism (VTE) prophylaxis regimen in orthopaedic trauma has led to widespread variability in prescribed regimens. Understanding patient preferences toward the costs, complication profile, and route of administration is imperative in an era of patient-centered health care. This study used a discrete choice experiment (DCE) to determine patient preferences regarding VTE prophylaxis and quantify risk-benefits tradeoffs.

Methods: This prospective study enrolled adult orthopaedic trauma patients indicated for VTE prophylaxis from a Level I trauma center. Participants completed a DCE survey containing 10 hypothetical VTE prophylaxis comparisons with varied attributes. Multinomial logit modeling was used to determine relative preferences and acceptable trade-off estimates for a 1% reduction in VTE complications or side effects. Subgroups were investigated for preference heterogeneity.

Results: Of the 232 enrolled participants (mean age, 47.9 years; 56.9% male), patients most strongly valued a reduction in risk of death by pulmonary embolism (PE) (mean utility, 4.57; P <0.0001), distantly followed by a reduction in the risk of VTE (mean utility, 0.25; P <0.0001), wound complications (mean utility, 0.07; P <0.0001), and bleeding complications (mean utility, 0.05; P <0.0001). Patients preferred oral pills over subcutaneous injections (mean utility, 0.16; P <0.0001) but were willing to change their preference in favor of injections with a 6.98% absolute reduction in the risk of bleeding complications requiring transfusion, a 4.53% absolute reduction in the risk of wound complications requiring reoperation, and a 1.27% absolute reduction in risk of VTE requiring therapeutic anticoagulation. In contrast, only a 0.07% absolute reduction in risk of death due to PE was needed to change patients' route preference. Underlying patient characteristics, including sex, ethnicity, and type of injury, were associated with heterogeneity in VTE prophylaxis preferences.

Conclusion: Orthopaedic trauma patients prefer VTE prophylaxis by oral pill and are most concerned about the risk of death due to PE when choosing a regimen. The findings of this study are the first to document patient preferences with trade-off estimates, as well as heterogeneity in patient preferences, in this important area of ongoing debate.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table 1 Relative preferences of orthopaedic trauma patients to prevent VTE

Attribute	Level	Mean Marginal Utility	P-Value
Route	Take oral pill over injection	6.7	<.0001
Side Effects	Avoid bruising on leg	1.9	0.4362
	Avoid stomach pain	2.0	-
Bleeding complications	Reduce risk by 1%	1.0	<.0001
Wound complications	Reduce risk by 1%	1.4	<.0001
Blood clot	Reduce risk by 1%	4.5	0.0011
Death due to PE	Reduce risk by 1%	86.1	<.0001

VTE = venous thromboembolism, PE =pulmonary embolism

See pages 49 - 106 for financial disclosure information.

Is the Caprini Score Predictive of VTE Events in Orthopaedic Fracture Patients?

*Paul Tornetta III, MD; **Jesse Dashe, MD**; Robert Parisien, MD;*
Anthony De Giacomo, MD, MS; Matthew Pina, BS; Lauren Roberts, BS
Boston University Medical Center, Boston, Massachusetts, USA

Background/Purpose: The Caprini Score stratifies the risk of venous thrombotic and embolic (VTE) events based on patient factors, injuries, and treatments. This score accurately predicts VTE events in many patient populations; however, it has not been adopted in orthopaedic trauma as it lacks stratification of lower extremity fractures, all of which are placed into one high-risk group. The purpose of this study was to explore the validity of the Caprini Score in orthopaedic patients with fractures and to determine if the lack of stratification had any influence on the predictive model.

Methods: All patients with lower extremity fractures from 2002 to 2015 at a single institution were included. Exclusion criteria were: <18 years old, able to bear weight immediately, and follow-up less than 30 days postinjury. Data collected included the Caprini Score, fracture classification, length of follow-up, DVT (deep vein thrombosis) chemoprophylaxis, and VTE events (DVT and /or PE [pulmonary embolism) diagnosed with objective testing. To examine whether stratification would improve the model, we identified a high-risk group (pelvic and acetabular fractures) and a low-risk group (isolated foot and ankle fractures). Receiver operating characteristic (ROC) curves of the Caprini Scores were generated for all patients and the high and low-risk groups. Patients were prophylaxed based on protocols that changed over the 13 years, but in general, high-risk patients were treated with warfarin or low molecular-weight heparin and others with aspirin or nothing.

Results: We reviewed 848 patients (499 M; 349 F) aged 18-93 years (average 43.7) with an average body mass index of 29 kg/m^2. There were 300 high-risk patients and 548 in the low-risk group with no differences in the demographics between the groups. Average follow-up was 288 days. There were 33 (3.9%) VTE events. VTE events were more common in the high-risk group (8%: 9 DVT, 15 PE) than in the low-risk group (1.6%: 8 DVT, 1 PE) (P = 0.0001). The cutoff that best predicted VTE events based on the ROC curves was 12 (c = 0.74) in the high-risk group, 11 (c = 0.79) in the low-risk group, and 12 (c = 0.83) overall. The table displays the sensitivity, specificity, positive predictive value, and negative predictive value for the respective groups.

Conclusion: We sought to evaluate the validity of the Caprini Score in orthopaedic fracture patients. Specifically, we were interested if a single assignment of one value (5) in the score was appropriate for patients with high and low-risk fractures (pelvis/acetabulum vs foot and ankle). As expected, we found a lower rate of VTE in the low-risk group, but the Caprini prediction model was not significantly different for the two groups. These data suggest that with current chemoprophylaxis, stratification of orthopaedic high and low-risk fractures does not influence the model, likely as different prophylaxis was given based on the assumed risk of the type of fracture. Most importantly, these data confirm that patient factors play a large role in the development of VTE events independent of injury type. The Caprini Score may help to identify these patients who may require increased protection.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Table #1

	Caprini Cutoff	Sensitivity	Specificity	PPV	NPV	c-statistic
High risk group	12	100%	48.6%	13.9%	100%	0.74
Low risk group	11	88.9%	68.8%	4.6%	99.7%	0.79
All patients	12	90.6%	73.9%	12%	99.5%	0.83

PPV=positive predictive value, NPV=negative predictive value

See pages 49 - 106 for financial disclosure information.

Operative Treatment of Rib Fractures in Flail Chest Injuries: A Meta-Analysis and Cost-Effectiveness Analysis

Eric Swart, MD[1]*; Joseph Laratta, MD*[2]*; Gerard Slobogean, MD*[3]*; Samir Mehta, MD*[4]
[1]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[2]*Columbia University, New York, New York, USA;*
[3]*University of Maryland, Baltimore, Maryland, USA;*
[4]*Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, USA*

Background/Purpose: Flail chest is a common injury sustained by patients who suffer from high-energy blunt chest trauma, and results in severe respiratory compromise due to altered mechanics or respiration with paradoxical chest wall motion. Historically treatment has been supportive, with patients treated with pain control and respiratory assistance, usually in the form of mechanical ventilation. However, there has been increased interest in operative fixation of these injuries with the intention of restoring the mechanical integrity of the chest wall and several studies have shown that ventilation requirements and pulmonary complications may be decreased with operative intervention. The purpose of this study was to conduct a cost-effectiveness analysis, supported by systematic review and meta-analysis, to evaluate if the respiratory benefits and decreased ventilator support after fixation is enough to justify the additional cost requirements of operative fixation and perioperative complications.

Methods: This was a two-part study in which we initially conducted a systematic review and meta-analysis of the current literature evaluating outcomes after operative fixation of flail chest injuries. Major outcome measures investigated included ICU stay/ventilator requirements, total hospital length of stay, perioperative complications, pneumonia, tracheostomy, and mortality. The results from that analysis were then applied to a decision-analysis model comparing the costs and outcomes of operative fixation versus nonoperative treatment of flail chest injuries. Clinical outcome measures were determined from our meta-analysis, and health utility states and costs were derived from existing literature and Medicare costs. The validity of the results were tested using multiway sensitivity analysis within literature-reported ranges.

Results: Operative treatment decreased mortality, pneumonia, and tracheotomy (risk ratios of 0.41, 0.45, and 0.37 respectively), as well as time in ICU and total length of stay (3.2 and 2.9 days, respectively). For the base case in the economic model (a polytrauma patient suffering a flail chest injury), operative fixation was the dominant strategy (decreased total cost and increased quality of life), decreasing total cost by $801 and improving quality-adjusted life years by 5.82 per case. These results were maintained for all ranges tested in sensitivity analysis, as long as overall surgical complication rate stayed below 27%.

Conclusion: Surgical fixation of rib fractures sustained from flail chest injuries decreases ICU time, mortality, pulmonary complications, and hospital length of stay, and results in improved health care-related outcomes at a net decreased cost. These results are sensitive to overall complication rates, and operations should be conducted by surgeons or combined surgical teams comfortable with both thoracic anatomy and exposures as well as with the principles and techniques of internal fixation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

See pages 49 - 106 for financial disclosure information.

Table 1 – Results of Literature Review and Meta-Analysis

		Number of patients		Ventilator Time [days]				ICU LOS [days]				Hospital LOS [days]				Mortality		Pneumonia		Tracheostomy	
		ORIF	Non-Op	ORIF		Non-Op		ORIF		Non-Op		ORIF		Non-Op		Op	Non-Op	Op	Non-Op	Op	Non-Op
Study	LoE			Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Inc	Inc	Inc	Inc	Inc	Inc
Ahmed et al.[29]	3	26	38	3.9	*4.3*	15.0	*6.4*	9.0	*3.9*	21.0	*5.3*					0.08	0.29	0.15	0.50	0.12	0.37
Althausen et al[30].	3	22	28	4.1	*4.7*	9.7	*7.4*	7.3	*4.2*	9.7	*6.1*	11.9	*6.5*	19.0	*8.8*			0.05	0.25	0.14	0.39
Balci et al.[31]	3	27	37	3.1	*1.8*	7.2	*5.8*					18.3	*7.6*	19.3	*6.9*	0.11	0.27			0.00	0.19
de Moya et al.[32]	3	16	32	7.0	*8.0*	6.0	*10.0*	9.0	*8.0*	7.0	*10.0*	18.0	*12.0*	16.0	*11.0*			0.31	0.38		
Doben et al.[13]	3	10	11	8.2	*6.9*	18.0	*11.9*	12.5	*6.2*	15.3	*9.8*	21.6	*9.6*	28.5	*14.1*	0.00					
Granetzny et al.[28]	1	20	20	2.0	*4.9*	12.0	*8.8*	9.6	*4.4*	14.6	*7.3*	11.7	*6.8*	23.1	*10.4*	0.10	0.15	0.10	0.50		
Granhed et al.gran[10]	3	60	153	2.7	*2.8*	9.0	*3.2*									0.03		0.00			
Jayle et al.[9]	3	10	10	3.1	*5.2*	5.9	*9.4*	9.0	*4.3*	12.3	*8.5*	21.7	*7.8*	32.3	*19.3*			0.40	0.30		
Karev et al.[33]	3	40	93	2.3	*0.6*	6.3	*1.2*									0.23	0.46	0.15	0.34		
Kim et al.[34]	3	18	45													0.06	0.22				
Marasco et al.[11]	1	23	23	6.3	*3.5*	7.5	*5.4*	13.5	*3.0*	18.7	*4.1*					0.00	0.04	0.48	0.74	0.39	0.70
Nirula et al.[35]	3	30	30	6.5	*1.3*	11.2	*2.6*	12.1	*1.2*	14.1	*2.7*	18.8	*1.8*	21.1	*3.9*						
Tanaka et al.[36]	1	18	19	10.8	*3.4*	18.3	*7.4*	16.5	*7.4*	26.8	*13.2*							0.22	0.89	0.28	0.79
Teng et al.[37]	3	32	28	14.0	*3.9*	20.0	*7.4*	8.7	*3.5*	15.2	*6.1*	17.1	*5.4*	22.4	*8.8*			0.13	0.43		
Voggenreiter et al.[38]	3	20	22	18.8	*20.3*	27.2	*27.8*									0.15	0.36	0.25		0.32	
Xu et al.[39]	3	17	15	10.5	*3.7*	13.7	*4.4*	15.9	*5.0*	19.6	*5.0*					0.00	0.07	0.59	0.93	0.12	0.40
Heterogeneity (I^2)				81%				63%				44%				0%		40%		0%	
Meta-analysis effect size (SD)				5.26 days (± 0.92 days)				3.81 days (± 0.82 days)				2.88 days (± 0.61days)				RR 0.41 (± 0.09)		RR 0.45 (± 0.06)		RR 0.37 (± 0.08)	
Effect size using only level 1 studies				6.03 days (± 2.74 days)				6.84 days (± 2.48 days)				3.01 days (± 0.73 days)				RR 0.56 (± 0.57)		RR 0.39 (± 0.09)		RR 0.46 (± 0.11)	

ORIF = open reduction internal fixation. Non-Op = patients treated non-operatively with standard of care. LoE = Level of Evidence. Avg = Average value. SD = Standard Deviation. Inc = Incidence rate. RR = risk ratio

Misuse of Opioid Medications in Orthopaedic Postoperative Patients

***Anup Gangavalli, MD*[1]*; Ajith Malige, BS*[2]*; George Terres; Saqib Rehman, MD*[3]*; Chinenye Nwachuku, MD*[1]
[1]*St. Luke's Hospital, Bethlehem, Pennsylvania, USA;*
[2]*Temple/St. Lukes University Medical School, Bethlehem, Pennsylvania, USA;*
[3]*Temple University Hospital, Moorestown, New Jersey, USA*

Background/Purpose: Appropriate pain management in postoperative patients is always evolving, with increasing scrutiny on the upward trend in the use of opioids as analgesics. Unfortunately, this increased use coupled with the introduction of high-dose, extended release formulations has increased opportunities for addictive illicit use. This study examines three conditions: the distribution of patients who believe they are not being prescribed enough pain medication, patients who use prescribed opioid medications at a higher than recommended dose, and patients who take additional opioid medications in addition to their prescribed analgesics. These conditions were stratified by age, employment, income, education, illicit drug use, pain interference with activities of daily living, and anatomical surgical site. We believe that opioid medication misuse is prevalent in the orthopaedic population and can be predicted by certain factors. We hope this study will provide orthopaedists with the trends they need to develop more effective pain regimens for their patients.

Methods: This survey based study was conducted at two Level I trauma centers representing both an urban and suburban community, over a 10-month period. 182 patients between the ages of 18 and 89 years who underwent surgical intervention for fractures involving the pelvis, long bones, or peri-articular regions of the knee, ankle, elbow, and wrist were asked to participate. The questionnaire aimed to identify trends in opioid medication misuse and sources of obtaining extra opioid medications. Data were analyzed using simple descriptive statistics and X^2 or Fisher's exact tests to determine significance of association between the three aforementioned conditions and general demographic factors with significance set at $P < 0.05$.

Results: Overall, 19.2% of patients (n = 35) believed that their surgeon did not prescribe them enough pain medication. Among them, unemployed patients ($P < 0.01$), low-income patients making less than $12,000 a year ($P = 0.01$), and self-reported illicit drug users ($P < 0.01$) were more likely to report that their surgeon did not prescribe them enough pain medication. 12.6% of patients (n = 23) admitted to using pain medications at a higher dose than prescribed. Unemployed patients ($P = 0.04$), lower-income patients ($P = 0.04$), patients who were not High School graduates or GED recipients ($P = 0.03$), and patients admitting to illicit drug use ($P < 0.01$) were also more likely to report using pain medications at a higher dose than prescribed. Finally, 33.5% of patients (n = 61) admitted to using other pain medications in addition to their prescribed analgesics. Within this group, 9.3% of patients (n = 17) admitted to using other opioid pain medications that were not prescribed, with only unemployed patients ($P = 0.01$) and self-reported illicit drug users ($P < 0.01$) more likely to use nonprescribed opioid pain medications. Four patients reported obtaining these additional opioids from other doctors, 1 reported buying analgesics "off the street,"

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

5 reported obtaining these medications from family or friends, and 7 patients declined to indicate a source.

Conclusion: There are several groups of patients who are found to be at risk for misusing opioid pain medications. Awareness of these demographics may best serve orthopaedists in their efforts to devise a successful pain regimen and minimize potential patient harm from the adverse effects of opioids. Additionally, surgeon awareness of additional opiate sources may also help engender safer prescription practices.

See pages 49 - 106 for financial disclosure information.

Ultra Low-Dose CT Scan (REDUCTION Protocol) for Extremity Fracture Evaluation Is as Safe and Effective as Conventional CT: An Evaluation of Quality Outcomes

Abraham Goch, BS; Sanjit Konda, MD; Kenneth Egol, MD
New York University Hospital for Joint Diseases, New York, New York, USA

Purpose: With an estimated 29,000 future cancers possibly related to CT performed on an annual basis in the United States, there exists a need to properly identify the correct dosing of radiation necessary for diagnosis of extremity fractures. A Reduced Effective Dose Using Computed Tomography In Orthopaedic Injury (REDUCTION) protocol for fracture evaluation was previously demonstrated to yield equivalent diagnostic information to conventional CT scanning. This study seeks to assess clinical and hospital quality outcomes of patients receiving this imaging protocol.

Methods: After IRB approval, a retrospective chart review was conducted for consecutive patients receiving the REDUCTION protocol, beginning in August 2014 until present. 31 patients who received this protocol for traumatic fracture evaluation and had surgery for their fracture were compared to a comparable cohort of 40 patients who previously received conventional CT scanning and underwent fracture surgery at our academic medical center. Estimated effective radiation doses were calculated and compared using Digital Imaging and Communications in Medicine (DICOM) information from all included studies. Patient outcomes included time to union, complications, 30-day readmission, reoperation, and length of stay. Univariate and multivariate analyses were conducted to identify significant differences between cohorts (significance designated as $P < 0.05$).

Results: Patient characteristics between cohorts were not significantly different with respect to injury types, mechanism, age, gender, laterality, body mass index, and comorbidities. Mean clinical follow-up was 8.4 months. Mean estimated effective dose for all REDUCTION scans was 0.18 mSv as compared to 1.55 mSv for the conventional CT cohort ($P = 0.026$). Outcomes including time to union, complications, readmission, reoperation, and length of stay were not significantly different between groups (Table 1).

CT Scan Protocol	REDUCTION N=31	CONVENTIONAL N=40	P value
Average Time to Union (weeks)	13 ± 4	14 ± 4	0.32
Complications	3 (9.7%)	5 (12.5%)	0.09
Readmission (30 day)	1 (3.2%)	1 (2.5%)	0.52
Reoperation	2 (6.5%)	4 (10.0%)	0.11
Length of Stay (days)	3.8 + 2.7	4.5 + 3.3	0.15

Conclusion: The REDUCTION protocol represents an ultra low-dose CT scan developed for minimizing radiation exposure to patients presenting with traumatic fractures. This protocol resulted in an approximate ninefold reduction in radiation exposure. No difference in clinical or hospital quality outcomes was detected between patients who received

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

this protocol as compared to those receiving automated dose CT scans. The REDUCTION protocol is a safe and effective method of performing CT scans for extremity fractures and should become the standard of care for CT scans of extremity fractures.

See pages 49 - 106 for financial disclosure information.

Hypovitaminosis D: Which Guidelines for Baseline Supplementation Should Be Followed?

Brett Schiffman, BA*; Hobie Summers, MD; Mitchell Bernstein, MD; Frank DiSilvio, BS; Sarah Foyil, MD; William Lack, MD*
Loyola University Medical Center, Maywood, Illinois, USA

Background/Purpose: Hypovitaminosis D is prevalent among orthopaedic trauma patients and is a risk factor for fragility fractures as well as bone healing complications. There are two major sets of guidelines that address what level of baseline vitamin D supplementation is appropriate, but they differ significantly in their recommendations. The Institute of Medicine recommends 400 IU daily while the Endocrine Society recommends a higher dose (2000 IU daily). The objectives of this study were to prospectively evaluate risk factors for hypovitaminosis D in an orthopaedic trauma population and to determine the level of baseline supplementation associated with normal vitamin D levels at presentation.

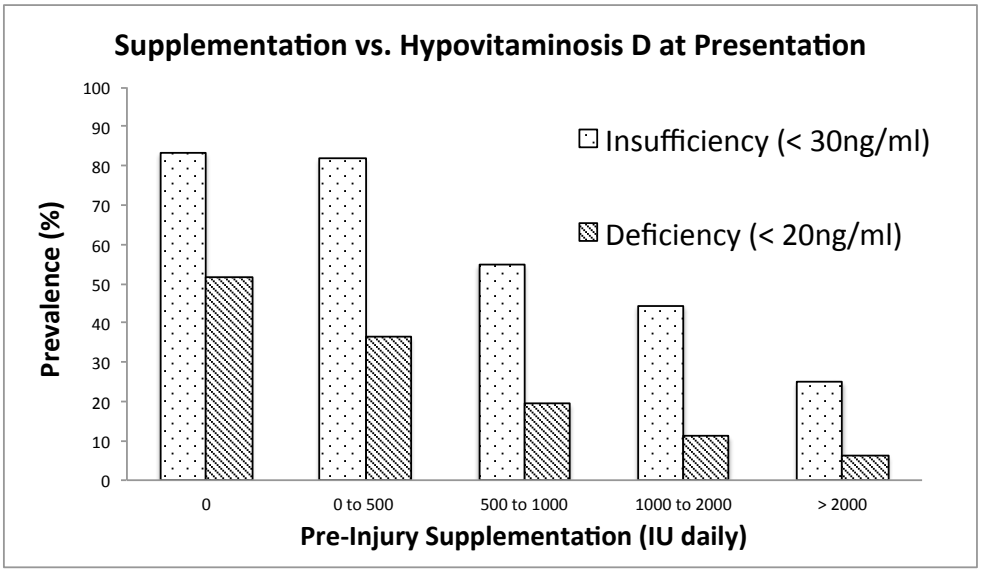
Methods: A prospective observational study was performed in patients undergoing operative treatment for orthopaedic trauma at a Level I trauma center (January to December, 2014). Levels of 25-hydroxy vitamin D (25-OH D) were obtained for 259 patients. Patient and injury characteristics were recorded including age, sex, race, insurance, smoking, body mass index (BMI), comorbidities, preinjury supplementation, and low versus high-energy mechanism. Prevalence of insufficiency (25-OH D <30 ng/mL) and deficiency (25-OH D <20 ng/mL) were determined. Univariate analyses of patient and injury characteristics determined associations with hypovitaminosis D and multivariate logistic regression analysis assessed for independent associations.

Results: Among 259 patients, 191 (73.7%) were vitamin D insufficient and 109 (42.1%) were deficient. 52 patients (20.1%) were receiving preinjury supplementation (200 to 5000 IU daily). Supplementation was more common over age 70 (36 of 99, 36.6%) than below age 70 (17 of 159, 10.7%), P <0.0001. Univariate predictors of hypovitaminosis D included lack of preinjury supplementation, non-white race, younger age, female sex, non-Medicare insurance, smoking, obesity, Charlson Comorbidity Index <2, and high-energy mechanism. On multivariate analysis only preinjury supplementation (odds ratio [OR] 0.33, 95% CI 0.16-0.71, P = 0.004) and non-white race (OR 4.58, 95% CI 1.94-10.79, P = 0.001) were independently associated with hypovitaminosis D. The 25-OH D level demonstrated a dose-dependent association with baseline vitamin D supplementation. Among those on supplementation, the prevalence of insufficiency was 9 of 11 (81.8%) for <500 IU daily, 17 of 31 (54.8%) for 500 to 1000 IU daily, 8 of 18 (44.4%) for 1000 to 2000 IU daily, and 4 of 16 (25%) for >2000 IU daily. Deficiency (25-OH D <20 ng/mL) was 4 of 11 (36.4%) for <500 IU daily, 6 of 31 (19.4%) for 500 to 1000 IU daily, 2 of 18 (11.1%) for 1000 to 2000 IU daily, and 1 of 16 (6.3%) for >2000 IU daily.

Conclusion: Lack of preinjury supplementation and non-white race were independently associated with hypovitaminosis D, which was highly prevalent in the population. Although baseline vitamin D supplementation was infrequent, when present at a sufficient dose it was associated with a very low level of hypovitaminosis D. Given hypovitaminosis

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

D remained prevalent for supplementation less than 1000 IU daily, baseline supplementation consistent with recommendations from the Endocrine Society (2000 IU daily) appears most effective in this population.



See pages 49 - 106 for financial disclosure information.

Regional Decolonization Minimizes Surgical Site Infection in Orthopaedic Trauma

Daniel Schmitt, MD*; Hobie Summers, MD; Mitchell Bernstein, MD; Megan Rodts, BS; William Lack, MD*
Loyola University Medical Center, Maywood, Illinois, USA

Background/Purpose: *Staphylococcus aureus* (SA) colonization is of particular importance in orthopaedics due to the use of implants, as it is the most common etiology of surgical site infection (SSI). Specifically, methicillin-resistant SA (MRSA) colonization has been associated with high rates of SSI after surgeries utilizing metal implants. Preoperative decolonization protocols such as chlorhexidine gluconate showers are recommended prior to joint arthroplasty procedures for decolonization of SA and other skin flora, but these protocols can be impractical in the orthopaedic trauma patient. Our aim was to determine if SSI could be minimized through the use of a regional decolonization procedure prior to orthopaedic trauma surgery.

Methods: We conducted a prospective observational study of adults undergoing open orthopaedic trauma surgery over 1 year at an urban academic Level I trauma center. Exclusion criteria were preexisting infection, age <18 years, percutaneous procedures, nontraumatologist surgeon, insufficient follow-up, and unknown MRSA status. All patients underwent regional decolonization consisting of chlorhexidine and alcohol mechanical scrub of the operative extremity prior to prep and drape. Patient, injury, and surgical characteristics were recorded and patients were followed for diagnosis of deep SSI. Data were analyzed using X^2 test with significance for P values <0.05.

Results: Inclusion criteria were satisfied for 468 trauma cases, for 13 of which the patient was positive for MRSA nasal carriage (2.8%). Deep SSI was identified in 4/468 cases (0.85%). Of the four infections, one returned positive cultures for MRSA, one returned positive cultures for methicillin-sensitive SA, one returned positive cultures for *Serratia marcescens*, and one returned cultures positive for multiple non-Staphylococcus species. One of 13 MRSA positive patients (7.7%) and 3/454 MRSA negative patients (0.66%) had a postoperative deep SSI. Notably, 9 of 13 patients (69.2%) who were MRSA positive did not receive antibiotic prophylaxis adequately covering MRSA. Of the 468 trauma cases for which inclusion criteria were met, there were 51 open fractures consisting of 6 Type I fractures, 8 Type II fractures, 22 Type IIIA fractures, 13 Type IIIB fractures, and 2 Type IIIC fractures. One of 13 Type IIIB fractures and 1 of 2 Type IIIC fractures were complicated by deep SSI. Additionally, there were 24 revision cases for nonunion as well as one revision for malunion, none of which were complicated by deep SSI.

Conclusion: We report a low rate of deep SSI (0.85%) in open orthopaedic trauma procedures, including open fracture and revision cases. This is in contrast to previous reports of SSI rates ranging from 2.5% to 4.2% in orthopaedic trauma. Causality cannot be proven in this observational cohort study; however, the practice of preoperative regional decolonization deserves further study. We recommend consideration of this low-risk, efficient process as part of a multimodal effort to minimize SSI in orthopaedic trauma patients.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

A Cost Analysis of Irrigation Methods for Open Fractures: Are High-Pressure and Very Low-Pressure Delivery Devices Equivalent?

Jesse Chlebeck, MD*; Michael Blankstein, MD; Thomas Kristiansen, MD; Craig Bartlett III, MD; Patrick Schottel, MD*
University of Vermont Medical Center, Burlington, Vermont, USA

Background/Purpose: Timely irrigation and debridement of open fractures is currently considered the standard of care. While no definitive guidelines exist, irrigation with multiple liters of fluid using either very low-pressure gravity flow tubing or higher-pressure pulsatile lavage devices is commonplace. Recently, a multicenter, randomized controlled trial of open extremity fractures found that the delivery pressure of the irrigation solution had no effect on reoperation rate at 12 months for infection, wound-healing, or bone-healing problems. With neither delivery device showing clinical superiority, we performed a cost analysis of two commonly used irrigation devices. We hypothesized that gravity flow tubing would overall be costlier due to longer irrigation time.

Methods: Two irrigation delivery devices were used in our study. For very low-pressure gravity flow irrigation we used transurethral resection flexible irrigation tubing (Hospira) and for high-pressure irrigation the InterPulse pulsatile lavage device (Stryker). Both delivery methods are commonly used by our orthopaedic trauma service for the irrigation of open fractures. Three different irrigation quantities were tested: 3 L, 6 L, and 9 L. Each 3-L bag of fluid was placed on an IV pole extended to a height of 8 feet. All irrigation was performed at a height of 4 feet with a Y-connector when more than one bag of irrigation was tested. Each of the two devices were used to irrigate with the three different quantities of irrigation fluid. The total time for all of the irrigation fluid to completely run through the irrigation device was recorded. Five separate trials were performed. Our institution's cost for each irrigation device as well as current operating room and anesthesia charges were obtained from our operating room administration and recorded.

Results: The very low-pressure gravity flow irrigation was significantly faster on average than the high-pressure delivery device for all fluid quantities tested: 9 L - 373 versus 530.2 seconds; 6 L – 229.6 versus 364 seconds; and 3 L – 134.4 versus 171.4 seconds. The gravity flow tubing was more than 2 minutes faster than the pulsatile device for irrigation of both 6-L and 9-L quantities. At our institution, gravity flow tubing costs $9.94 and the pulsatile device is $41.67. Typical operating room charges were found to be $63.00 per minute and average anesthesia costs are $122.00 per 15-minute block. Therefore, the cost of irrigating an open fracture was less expensive with gravity flow tubing resulting in a cost savings of $157.73 per 6-L and 9-L case and $31.73 for 3-L cases. Over an 8-year period at our institution we treated an average of 50 open fracture cases per year requiring 6 L or 9 L of irrigation and 50 cases requiring 3-L irrigation. Therefore, exclusively using very low-pressure gravity flow tubing instead of a pulsatile lavage device would save our institution approximately $9473 per year.

Conclusion: Very low-pressure gravity flow irrigation was found to not only cost less but irrigate faster than a pulsatile device. Using our institution's current operating room, anesthesia, and irrigation device costs, we estimated that converting exclusively to use of gravi-

See pages 49 - 106 for financial disclosure information.

ty flow irrigation would save our trauma center a modest $9473 per year. Our findings may not be applicable to other institutions depending on the structure of operating room and anesthesia charges as well as negotiated device costs. Ultimately, based on our findings of only nominal cost savings, we believe that the choice of irrigation device should be at the discretion of the surgeon depending on the particular circumstances of each open fracture case.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Factors Associated with Patient-Initiated Phone Calls After Orthopaedic Trauma Surgery

Abdurrahman Kandil, MD[1]; Michael Hadeed, MD[1]; Vandan Patel, BS[1]; Feredun Azari, BS[1]; Avery Morrison, BS candidate[2]; Wendy Novicoff, PhD[1]; Seth R. Yarboro, MD[2];
[1]University of Virginia Health System, Charlottesville, Virginia, USA;
[2]University of Virginia, Charlottesville, Virginia, USA

Background/Purpose: Patient telephone calls after surgery may place significant burden on clinic personnel. As our health-care system moves toward outcome-based medicine with greater emphasis on patient satisfaction, improving safety, efficiency, and communication at the time of discharge is paramount. After discharge, patients rely on information from perioperative counseling and written discharge instructions. If this information is inadequate or unclear, or an unanticipated issue arises, a phone conversation may be required to address the issue. By analyzing the content of these phone calls, one may begin to understand deficiencies in the discharge process. To our knowledge, no study has examined this topic. The purpose of this study is threefold: to (1) determine the incidence of calls in the immediate postoperative period, (2) identify the reasons for patient calls, and (3) identify significant risk factors for patient calls.

Methods: This is a retrospective chart review of all surgeries performed at our institution by the orthopaedic trauma division from January 1, 2014 through December 31, 2014. Demographic, operative and perioperative variables, and the reason for phone calls were recorded. The primary outcome was whether or not a patient made a telephone call within the first 14 days postoperatively. Exclusion criteria included patients who died during the hospitalization and subsequent surgeries in patients with more than one surgical encounter. Univariate statistical analysis was performed using the two-sample Student *t* test and X^2 test (depending on type of variable) with significance set at a *P* value <0.05. Binary logistic regression was used to determine which variables were predictive of patients calling after discharge.

Results: A total of 751 patients underwent orthopaedic trauma surgical procedures in our study. 26% of patients (n = 194) made a phone call within 14 days after surgery, while 74% (n = 557) did not. A total of 62% of patients called at some point after their surgery. The most common reasons for phone calls were pain control (22%), bathing/dressing/wound questions (19%), discharge medication questions (9%), home health nursing questions (8%), and clarification of weight-bearing status or activity restriction (5%). Risk factors associated with making a phone call within 14 days postoperatively include shorter hospital length of stay (LOS), nonHispanic ethnicity, married patients, ASA (American Society of Anesthesiologists) score of 2, discharge to home (with or without home health nursing), and outpatient procedure (*P* <0.05). There was a trend toward increased phone calls for patients who were smokers (*P* = 0.12), although this was not statistically significant. There was no difference in age, gender, number of allergies, number of medical comorbidities, employment status, disability status, Workers' Compensation status, and narcotic use between the groups. A multivariate analysis using binary logistic regression showed that shorter LOS (odds ratio [OR] = 1.06, CI 1.02 to 1.09) and discharge to home (OR = 2.4, CI = 1.20 to 4.88) were independent risk factors for more telephone calls, whereas Hispanic

See pages 49 - 106 for financial disclosure information.

ethnicity (OR = 0.04, CI = 0.00 to 0.79) and widowed marital status (OR = 0.25, CI = 0.09 to 0.72) were independent risk factors for fewer calls.

Variable	Phone call placed within 14 days	No phone call placed within 14 days	P-value
Age (Mean±SD)	49.3±15.9	49.8±18.4	0.744
Length of stay (Mean±SD)	**3.4±4.5**	**5.9±8.3**	**0.000**
Number of allergies (Mean±SD)	1.0±1.6	1.0±1.6	0.624
Number of comorbidities (Mean±SD)	3.3±3.6	3.6±4.0	0.293
Gender	Female = 41.2% Male = 58.8%	Female = 45.2% Male = 54.8%	0.342
Smoking status	Yes = 29.9% No = 70.1%	Yes = 24.2% No = 75.8%	0.117
Ethnicity	Black = 10.8% White = 86.1% Hispanic = 1.0% Asian = 1.0% Other = 1.1%	Black = 11.6% White = 83.2% Hispanic = 3.6% Asian = 0.2% Other = 1.4%	0.422
Marital status	**Single = 26.8%** **Married = 47.9%** **Divorced = 22.2%** **Widowed = 3.1%**	**Single = 34.8%** **Married = 38.2%** **Divorced = 16.9%** **Widowed = 10.2%**	**0.001**
Employment status	Not employed = 40.2% Employed = 51.0% Not listed = 8.8%	Not employed = 46.1% Employed = 45.9% Not listed = 8.8%	0.366
Insurance type	Medicaid = 5.7% Medicare = 20.6% Private = 49.0% Uninsured = 17.0% Not listed = 7.7%	Medicaid = 6.6% Medicare = 27.6% Private = 42.1% Uninsured = 18.5% Not listed = 5.2%	0.183
Workers' Compensation status	Yes = 7.2% No = 1.0% Not listed = 91.8%	Yes = 6.1% No = 1.1% Not listed = 92.8%	0.862
Disability	Yes = 13.4% No = 80.9% Not listed = 5.7%	Yes = 15.1% No = 82.1% Not listed = 2.8%	0.207
History or current narcotic use	Yes = 52.1% No = 47.9%	Yes = 52.2% No = 47.8%	0.983
American Society of Anesthesiologists (ASA) Score	**1 = 11.9%** **1E = 1.5%** **2 = 56.7%** **2E = 5.7%** **3 = 22.7%** **3E = 0.5%** **4 = 1.0%** **4E = 0.0%**	**1 = 11.8%** **1E = 0.9%** **2 = 46.7%** **2E = 3.6%** **3 = 28.4%** **3E = 4.1%** **4 = 3.8%** **4E = 0.7%**	**0.003**
Discharge destination	**Home = 75.8%** **Home with Home Health = 10.8%** **Rehab = 5.7%** **SNF = 7.7%** **LTAC = 0.0%**	**Home = 62.9%** **Home with Home Health = 5.2%** **Rehab = 17.4%** **SNF = 13.4%** **LTAC = 1.1%**	**0.000**
Inpatient (IP) vs. Outpatient (OP) status	**IP = 53.1%** **OP = 46.9%**	**IP = 63.3%** **OP = 36.7%**	**0.013**

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Conclusions: More than one-fourth of patients undergoing orthopaedic trauma surgery call the surgeon's clinic or office before their first follow-up appointment. Our study identified common reasons and risk factors for phone calls after orthopaedic trauma surgery. Ultimately, we hope to use these data to optimize communication at the time of discharge to improve efficiency, patient care, and patient satisfaction.

See pages 49 - 106 for financial disclosure information.

Body Composition and its Effect on the Badly Injured

David Bryson, MBChB, MRCS; Katie Rollins, MBBS;
Dileep Lobo, MBBS, MS, DM, FRCS, FACS, FRCP; ***Ben Ollivere, FRCS Tr+Orth****;*
Queens Medical Centre, Nottingham, UNITED KINGDOM

Background/Purpose: Trauma is the leading cause of death in the under-35-year-olds and carries an even greater burden of life-long morbidity. The inception of the Major Trauma System in the United Kingdom has cut mortality greatly and in the East Midlands has reduced the chances of death from major injury by 30% over the past 2 years. Much of this improvement has been in the prevention of early deaths. Many patients still die from the Systemic Inflammatory Response Syndrome (SIRS) due to a latter burden associated with an excessive inflammatory response ("Second Hit" phenomenon). Body composition analysis has been validated as a predictor of outcome in a number of types of cancer, and more specifically skeletal muscle changes (myosteatosis and sarcopenia) have been linked to cancer survival. This study sought to examine the association, if any, between body composition and survival in trauma patients.

Methods: We retrospectively analyzed 44 consecutive patients with admitted to a single Level I major trauma centre. All patients had sustained blunt multisystem trauma and all underwent a full trauma CT scan on arrival. Using validated cross-sectional CT analysis, we determined the body composition (presence of sarcopenia and myosteatosis) for each of the patients. Data on ISS, lactate, duration of hospital admission, and mortality were collated from the trauma database.

Results: The mean age of patients was 48.70 years (SD 23.53) with a mean ISS of 9.85 (SD 8.91). Patients stayed on average 9 days. There were three deaths in the cohort (6.8%). Overall mean skeletal muscle Hounsfield Unit (HU) was 42.23 (SD 9.29). 18 of the 44 patients were sarcopenic; the mean age was 55.6 years. There was a positive correlation between sarcopenia and mortality but this did not reach statistical significance ($P = 0.052$). There was no correlation between sarcopenia and ISS, initial lactate levels, or length of stay. Ten patients were myosteatotic; there was a significant difference in age between patients who were myosteatotic and those who were not ($P < 0.001$). The three patients who died were myosteatotic (3/10) which was statistically significant ($P = 0.009$). There was no difference between patients who were myosteatotic and those who were not with respect to ISS, lactate, or length of stay. Overall mean HU density was significantly lower in those who died ($P = 0.003$).

Conclusion: Trauma deaths rank as one of the biggest global health-care challenges of the century. We have identified for the first time that body composition is associated with survival in trauma patients. Deaths from the "Second Hit" phenomenon are poorly understood. Given that the SIRS response is a metabolically mediated response, it is not implausible to suggest that body composition may play a role in influencing outcome. The results of this study suggest that body composition may influence the Second Hit phenomenon and represents a novel observation.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Coagulopathy Is Associated with Complications in Polytrauma Patients Undergoing Fracture Fixation

Daniel Verhotz, 3rd Year Medical Student[1]*; Benjamin Childs, BS*[2]*; Timothy A. Moore, MD*[3]*; Heather Vallier, MD*[1]
[1]*MetroHealth Medical Center, Cleveland, Ohio, USA;*
[2]*MetroHealth System, Cleveland, Ohio, USA;*
[3]*MetroHealth System, Shaker Heights, Ohio, USA*

Purpose: Coagulopathy, secondary to hemorrhage, and potentially aggravated by preexisting factors, is a contributor to morbidity and mortality in trauma patients. However, the relationship between coagulopathy and outcomes in trauma patients is poorly defined. This study evaluates coagulopathy determined by routine laboratory studies as a predictor of complications in multiply injured trauma patients with orthopaedic injuries. We hypothesized that routine laboratory indicators of coagulopathy on presentation and perioperatively would be associated with complications.

Methods: Laboratory and clinical data were prospectively collected for 375 consecutive, skeletally mature patients with unstable spine, pelvis, and/or femur fractures and injury to at least one other system, with minimum ISS of 16, treated over 30 months. 263 men (70.1%) and 112 women were included with mean age 39.9 years and mean ISS 26.9. They underwent a total of 540 surgical procedures during the initial hospitalization, including both orthopaedic (n = 495) and nonorthopaedic (n = 45) operations. Coagulopathy was defined as international normalized ratio (INR) of ≥1.3, prothrombin time (PT) of ≥14.1, partial thromboplastin time (PTT) of ≥36, or platelet count of <100,000/μL. Complications were compared for patients with coagulopathy within 8 hours of injury (n = 68) versus those with normal coagulation parameters (n = 307). Binary logistic regression was used to determine odds ratios (ORs) of complications with worsening measures of coagulopathy. Adjudicated complications included pneumonia (PNA), acute respiratory distress syndrome (ARDS), acute renal failure (ARF), multiple organ failure (MOF), deep vein thrombosis (DVT), pulmonary embolism (PE), wound infection, sepsis, and death.

Results: 68 patients (18.1%) were coagulopathic within 8 hours of injury, with 56 (82.3%) having INR ≥1.3, 54 (79.4%) having PT ≥14.1, 22 (32.4%) having PTT ≥36, and 22 (32.4%) having platelet count <100K. For coagulopathic patients, the mean highest INR within 8 hours of injury was slightly lower than the highest INR at anytime (see table). The highest INR occurred within the first 8 hours in 47% of coagulopathic patients, with 13.3%, 7.2%, 22.9%, 8.4%, and 1.2% occurring from 8 to 16 hours, 16 to 24 hours, 24 to 36 hours, 36 to 48 hours, and greater than 48 hours after injury, respectively. There were similar findings for the highest mean PT and PTT. The lowest mean platelet values were highest within 8 hours of injury. Coagulopathic patients had higher ISS (38.4 vs 24.3, P <0.001) and more abdominal injuries (51% vs 22%), especially liver lacerations (32% vs 9.1%). Mean age and number of head and chest injuries were similar between groups. 56% of coagulopathic patients and 27% of patients with normal coagulation studies developed at least one complication (P <0.001), with more PNA (17.7% vs 8.5%, P = 0.023), ARF (8.8% vs 2.0%, P = 0.003), ARDS (4.4% vs 1.3%, P = 0.116), MOF (4.4% vs 0%, P <0.006), infection (16.2% vs

See pages 49 - 106 for financial disclosure information.

6.2%, *P* <0.001), and death (14.7% vs 2.3%, *P* <0.001) in the coagulopathic group. Although binary logistic regression showed that between admission and 8 hours pH, base deficit, platelet, PT, and INR were predictors of complications individually; after controlling for age and ISS there was no statistical significance. As the hospital course extended, measures of coagulopathy were still not statistically significant predictors of complications when controlled for age and ISS.

Conclusion: Coagulopathy occurred in 18% of our patients and was more frequent with abdominal injuries, which may generate large amounts of hemorrhage. Coagulopathy was associated with higher rates of all measured complications. Although coagulopathy is associated with complications, increasing measures of coagulopathy were not predictive of complications when controlled for age and ISS. Further study is needed to determine whether more aggressive early correction of coagulopathy should be incorporated into existing resuscitation protocols. Additionally, more specific diagnostic techniques, such as thromboelastography, may be helpful in individualizing treatment.

For Coagulopathic Patients (n=68):

INR	Mean Max	SD	N
0 to 8 hrs	1.482	0.411	68
8 to 16 hrs	1.274	0.406	46
16 to 24 hrs	1.254	0.176	37
24 to 36 hrs	1.394	0.191	35
36 to 48 hrs	1.326	0.221	34
> 48 hrs	1.257	0.193	23
Any time	1.557	0.399	68
PT			
0 to 8 hrs	15.765	2.952	66
8 to 16 hrs	14.339	4.821	46
16 to 24 hrs	14.143	2.040	37
24 to 36 hrs	15.874	2.243	35
36 to 48 hrs	15.118	2.585	34
> 48 hrs	14.222	2.366	23
Any time	18.054	4.800	68
PTT			
0 to 8 hrs	33.703	9.913	64
8 to 16 hrs	29.000	3.857	33
16 to 24 hrs	29.077	2.226	26
24 to 36 hrs	30.167	5.205	18
36 to 48 hrs	30.467	4.734	15
> 48 hrs	31.200	5.473	10
Any time	35.627	9.826	67
PLT	**Mean Min**	**SD**	**N**
0 to 8 hrs	137.439	66.892	66
8 to 16 hrs	124.593	50.518	59
16 to 24 hrs	120.690	36.063	58
24 to 36 hrs	115.983	36.504	60
36 to 48 hrs	107.750	35.603	52
> 48 hrs	105.925	34.675	53
Any time	86.779	34.231	68

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Infection Rates of Isolated Low-Energy Extremity Gunshot Injuries

Mai Nguyen, MD[1]*; Jeffrey O'Donnell, BS*[1]*; Jonathan Savakus, BS*[1]*; Nicholas Prayson, BA*[1]*; Michael Reich, MD*[2]*; Dominic Grimberg, BS*[1]*; Joseph Golob, Jr., MD*[1]*; Amy McDonald, MD*[1]*; John Como, MD, MPH*[1]*; Heather Vallier, MD*[3]
[1]*MetroHealth System, Cleveland, Ohio, USA;*
[2]*Case Western Reserve University, Cleveland, Ohio, USA;*
[3]*Metrohealth Medical Center, Cleveland, Ohio, USA*

Purpose: Extremity involvement is common among non-fatal gunshot wounds (GSWs). Despite their frequency, no standard treatment algorithms exist regarding the administration of antibiotics in this population. The goals of the study were (1) to determine the incidence of infection in isolated low-velocity GSWs to the extremity, presenting to an urban trauma center, and (2) to develop an institutional guideline for antibiotic treatment of these injuries.

Methods: A retrospective review of a prospectively collected database was performed at a Level I trauma center. 502 consecutive, skeletally mature patients with isolated extremity GSWs were treated over 4 years. Treatment was recorded including type and duration of antibiotics and details of operative and nonoperative management. Superficial and deep (defined as requiring intravenous antibiotics or surgical debridement) infections and complications were evaluated.

Results: There were 469 lower extremity injuries (79.2%) and 123 upper extremity injuries (20.8%) in 502 patients. Mean age was 30.4 ± 11.6 years, and 95.0% of patients were male, 27.1% had multiple injuries, and 54.4% had associated fractures. 69% received prophylactic antibiotics, most commonly a first-generation cephalosporin (90.0%). Age, gender, and injury location were similar between the groups that did and did not receive antibiotic prophylaxis. In patients with follow-up for wound assessment, 437 patients (87.1%), the overall infection rate was 5.72% (25/437 patients) and deep infection rate was 1.14% (5/437 patients). Regarding soft-tissue-only injuries, antibiotic prophylaxis lowered the rate of infection versus no antibiotics (2.08% vs 10.13%, $P = 0.04$); however, multiple doses of antibiotic did not reduce the rate of overall infection further when compared to a single dose (5.31% vs 3.85%, $P = 1.00$). There was no difference in deep infection with or without antibiotic prophylaxis (0% vs 2.53%, $P = 0.20$) in soft-tissue-only injuries. No deep infections occurred in patients with nonoperatively treated fractures, regardless of antibiotic administration (0/112 patients); 31 (27.7%) of these patients did not receive antibiotic prophylaxis. All operatively treated fractures (n = 150) received antibiotic prophylaxis, after which the overall infection rate was 8.00%, and the deep infection rate was 2.00%.

Conclusion: Infection after low-energy extremity GSWs is infrequent. In nonoperatively treated fractures and in soft-tissue injuries without fracture, a single dose of intravenous antibiotics in the emergency room appears to be safe and cost-effective, with no discernible advantage to additional antibiotics or surgical debridement. Fractures treated operatively with fixation and perioperative antibiotic prophylaxis also have a low rate of infection.

See pages 49 - 106 for financial disclosure information.

The Role of Dedicated Musculoskeletal Urgent Care Centers in Reducing Cost and Improving Access to Orthopaedic Care

Peter L. Althausen, MD, MBA; Justin Walker, MD; Austin McPhillamy, MD
Reno Orthopaedic Clinic, Reno, Nevada, USA

Purpose: Over the past few years the United States has seen the rapid growth of dedicated musculoskeletal urgent care centers owned and operated by individual orthopaedic practices. Our hypothesis is that such centers can safely improve orthopaedic care for ambulatory orthopaedic injuries, decrease volume for overburdened emergency rooms (ERs), reduce wait times, and significantly decrease the cost of care while improving access to orthopaedic specialists.

Methods: In June of 2014, our practice opened the first dedicated orthopaedic urgent care in the region staffed by physician assistants and supervised by orthopaedic surgeons. Data were collected during the first year of operation from both our center and the local trauma center ER to assess a variety of clinical and economic outcomes. Data on patient wait times, time to an appointment with an orthopaedic specialist, and cost of visit were recorded. Basic demographic information, payer status, and diagnosis were also obtained. The effect on total ER and hospital surgical volume was recorded and the economic effect on our practice was calculated.

Results: During the 12 months of study, 12,722 patients were treated in our urgent care. The average urgent care wait time was 23 minutes compared to 194 minutes in hospital ER. Total visit time was 43 minutes in the urgent care and 318 minutes in the hospital ER. Time to being seen by an orthopaedic specialist was 1.2 days for urgent care patients compared to 5.2 days for ER patients. The average cost of an urgent care visit was $210 compared to a $3200 ER charge. Overall wait times for nonorthopaedic patients in the ER decreased 73 minutes. Hospital surgical case volume did not change over the period of study and the orthopaedic census remained stable. Urgent care start-up, marketing, administration, and supply costs totaled $1,654,242. Revenue from E&M (evaluation and management), imaging, DME (durable medical equipment), and casting totaled $2,577,707.

Conclusion: Dedicated musculoskeletal urgent care clinics operated by orthopaedic surgery practices can be extremely beneficial to patients, physicians, and the health-care system. They clearly improve access to care while decreasing overall health-care costs. In addition, they can be financially beneficial to both patients and orthopaedic surgeons alike without cannibalizing local hospital surgical volumes.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Patient Perceptions of the Use of Medical Marijuana in the Treatment of Musculoskeletal Trauma

Michael Weaver, MD[1]*; Marilyn Heng, MD*[2]*; Robert Lucas, BA*[1]*; Mark Vrahas, MD*[2]*; Mitchel Harris, MD*[1]
[1]*Brigham and Women's Hospital, Boston, Massachusetts, USA;*
[2]*Massachusetts General Hospital, Boston, Massachusetts, USA*

Background/Purpose: There has been significant debate in the United States about the utility of medical marijuana. Despite federal laws limiting the sale and distribution of marijuana there are now 23 states that allow the prescription of marijuana for the treatment of medical conditions. A recent study demonstrated a decrease in opioid-related deaths in states with medical marijuana laws. It has been our anecdotal experience that since the legalization of marijuana in our state that there have been a significant number of patients who inquire about its use in managing postinjury and postsurgical pain. To our knowledge there are no studies evaluating the perceptions of the musculoskeletal trauma population with regard to the utility of using marijuana in the management of postinjury and postoperative pain. The goals of this study were to: (1) evaluate musculoskeletal trauma patients regarding their perception of the usefulness of marijuana in the treatment of postinjury pain and anxiety, (2) determine if patients feel that marijuana reduces their need for opioid pain medications, and (3) determine if there is a relationship between anxiety, pain catastrophizing, and symptoms of posttraumatic stress disorder (PTSD) and marijuana use during injury recovery.

Methods: We performed a prospective study of patients treated for a musculoskeletal injury in the trauma clinics of 2 Level I trauma centers in a state with recently legalized medical marijuana. Our practice does not prescribe marijuana nor does it endorse its use. A convenience sample of patients was collected from our orthopaedic trauma clinics. Inclusion required at least one musculoskeletal injury that had occurred between 1 and 6 months prior to their clinic visit. 264 patients were approached to complete a questionnaire, and 249 patients completed the questionnaire yielding a response rate of 94.3%. The survey consisted of basic demographic and injury questions as well as questions about the patients' perceptions of the validity of the use of marijuana in the treatment of medical conditions in general and pain specifically. We also asked patients about marijuana use during their recovery and whether they felt that it reduced their symptoms of pain and anxiety, and if they felt it reduced their opioid use. The Patient Reported Outcomes Measurement Information System (PROMIS) Anxiety Short Form 4, the Pain Catastrophizing Scale, and the Breslau Short Screening Scale for DSM-IV (Diagnostic and Statistical Manual of Mental Disorders) PTSD were also administered.

Results: There were 249 responses to the survey. Median age was 55 (range, 18-93). 46% (115) were female. 224 (90%) of patients reported an isolated injury, while 25 (10%) had multiple injuries. 180 (72%) required surgery to treat their injury. The majority of patients, 204 (82%), believed that marijuana is useful as a medication, while 30 (12%) were unsure and 15 (6%) felt that it was not. In addition, the majority of patients felt that marijuana could be used to treat both pain 195 (78%) and anxiety 156 (63%). 88% of people (n = 218)

See pages 49 - 106 for financial disclosure information.

reported they would be comfortable discussing medical marijuana with their health-care provider. Of the 249 patients who responded, 40 (16%) reported using marijuana following their injury. Of these, 36/40 (90%) believed that it reduced symptoms of pain and 33/40 (83%) believed that it reduced the amount of opioid pain medication they required to manage their pain. Marijuana use during injury recovery was associated with a worse PROMIS Anxiety score (mean nonuser 49.1 vs user 53.6, $P = 0.01$). There was no difference in the Pain Catastrophizing Scale in marijuana nonusers and users (mean 16.4 vs 18.9, $P = 0.28$). There was no difference in the number of patients with clinically significant PTSD (score = 4) in nonusers compared to users of marijuana (40/209 vs 6/40, $P = 0.69$).

Conclusion: The role of medical marijuana in managing postinjury and postoperative symptoms of pain and anxiety is poorly understood. The vast majority of patients in this study believed that medical marijuana is a valid treatment and that it does have a role in reducing postinjury and postoperative pain. Further, in the subset of patients who used marijuana following their injury, they indicated that it helped alleviate symptoms of pain and reduced their level of opioid intake. Current use of marijuana was associated with higher PROMIS anxiety scores. Scores for pain catastrophizing and PTSD were similar between current marijuana users and nonusers. Further study into the utility of medical marijuana in the orthopaedic trauma population is warranted.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Prehospital Antibiotic Prophylaxis for Open Fractures: Practicality and Safety

William Lack, MD[1]*; Anna Bickers, BA*[2]*; Jonathan Studnek, PhD*[3]*; Rachel Seymour, PhD*[2]*; Madhav Karunakar, MD*[2]

[1]*Loyola University Medical Center, Maywood, Illinois, USA;*
[2]*Carolinas Medical Center, Charlotte, North Carolina, USA;*
[3]*MEDIC, Charlotte, North Carolina, USA*

Purpose: Early antibiotic administration has been associated with a significant decrease in infection following open fractures. However, antibiotics are most effective within an hour of injury when many patients are still being transported for care. There is limited evidence that antibiotics may be safely administered for open fractures when being transported by helicopter. No such data exist for ground emergency medical services (EMS) transport of patients with open fractures. Our purpose was to determine if ground transport paramedics could identify open fractures and safely administer antibiotic prophylaxis during transport.

Methods: We performed a prospective observational study between January 1, 2014 and May 31, 2015 of all trauma patients being transferred to a Level I trauma center by a single ground EMS agency. After a single training session, paramedics assessed patients during transport for the presence of an open extremity fracture. If such a fracture was noted the patient was then indicated for antibiotic prophylaxis with 2 g IV cefazolin. Exclusion criteria included penicillin allergy, higher priority patient care tasks, and remaining transport time insufficient for administration of antibiotics. The identification of an open fracture and administration of antibiotics were recorded in the electronic patient care report. Patient demographics, associated injuries, priority level (1 = life-threatening injury, 2 = potentially life-threatening injury, 3 = non-life-threatening injury), and timing of transport and antibiotic administration were also recorded.

Results: Paramedics identified 60 patients during the study period for whom they suspected an open fracture. The patient's clinical status and transport time allowed for administration of antibiotic prophylaxis for 26 patients (43.3%). Administration of antibiotics did not differ by priority level ($P = 0.818$), with 39% (N = 9) of priority 1, 48% (N = 12) of priority 2, and 42% (N = 5) of priority 3. 16 of 60 patients (26.7%) initially identified as open fractures were later determined to have open soft-tissue injuries that did not communicate with an underlying fracture. 19 patients (31.7%) had isolated fractures, 34 patients (56.7%) had between 2 and 8 fractures, and 7 (6.7%) had only soft-tissue injuries. There were no allergic reactions to antibiotic administration. There were no documented injuries to paramedics related to antibiotic administration.

Conclusion: Paramedics were able to administer prehospital antibiotic prophylaxis for a substantial portion of the identified patients without any complications for patients or providers. Given the limited training provided prior to implementation of the antibiotic prophylaxis protocol, it is likely that further development of this initial training will lead to even higher rates of prehospital antibiotic administration for open fractures.

See pages 49 - 106 for financial disclosure information.

Rib Fracture Fixation in a Major Trauma Center:
Outcomes Following Fixation with the MatrixRIB Contoured Plate System

Rebecca Russell, BMedSci[1]; Samuel Walters, MBBS[1];
Tanvir Khan, BSc(Hons), MBBS, MRCS(Eng)[1]; Avishek Das, MRCS(Eng)[1];
Daren Forward, MD[2]; Christopher Moran, MD, FRCS[3];
Ben Ollivere, FRCS (Ortho), MD, MBBS, MA[4]
[1]University of Nottingham, Nottingham, UNITED KINGDOM;
[2]Nottingham University Hospitals, Nottingham, UNITED KINGDOM;
[3]Queens Medical Centre, Nottingham University Hospitals, Nottingham, UNITED KINGDOM
[4]Queens Medical Centre, Nottingham, UNITED KINGDOM

Purpose: Thoracic injury accounts for 25% of all trauma deaths, with rib fractures being the most common thoracic injury. There is growing evidence in support of managing these injuries operatively to achieve anatomical correction and fixation of the chest wall, but there are few reports of the outcomes in patients managed using the MatrixRIB system. We aimed to assess the survival and clinical outcomes following surgical rib fixation using the MatrixRIB system.

Methods: We conducted a retrospective analysis of prospectively collected national audit data and patient records from our institution, a major trauma center. Consecutive patients who had undergone surgical rib fixation using the MatrixRIB system over a 3-year period (September 2012-August 2015) were identified and verified using hospital information systems and imaging software to review pre- and postoperative chest imaging. These were matched to patients who had sustained similar injuries, and were managed nonoperatively. Matching was performed on the basis of Abbreviated Injury Scale (AIS) for Chest, ISS, gender, age, and date of admission. Injuries were verified to include rib fractures using hospital information systems. The primary outcome measure was 30-day mortality. Secondary outcomes collected during latest follow-up included quality of life (EuroQol 5 Dimensions 5 Levels [EQ-5D-5L]), pain (visual analog scale [VAS]), functional capacity (UCLA Activity Score), return to work, and satisfaction.

Results: 56 patients had undergone rib fixation at our institution during the time period. These were matched to 89 patients managed nonoperatively. There was a significant difference in 30-day mortality in the fixed patients (1/56) compared to the nonfixed patients (11/89) ($P = 0.0253$). Questionnaire data were available for 33 patients in the fixed group, with a mean follow-up time of 16.7 months (range, 3-39 months). The EQ-5D-5L responses for quality of life showed that 69.7% of patients had "none/slight" difficulties with mobility, and no patients reported extreme pain or being unable to mobilize. In terms of ability to self-care, 84.85% reported none/slight difficulties and only one patient (3.03%) reported being unable to self-care. In terms of pain experienced, 69.70% of patients reported none/slight pain or discomfort on EQ-5D-5L. On the VAS, 45.16% of patients reported no/mild pain (VAS pain score of 0-3), while only 16.13% of patients reported severe pain (VAS score of 7-10).

Conclusion: Mortality was significantly lower in patients who underwent rib fixation sur-

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

gery using the MatrixRIB system. Quality of life was sustained and most patients were free from major discomfort at the time of follow-up, indicating acceptable outcomes for patients following this procedure.

See pages 49 - 106 for financial disclosure information.

Δ Health-Related Quality of Life Following Operative Management of Open Fractures

*Brad Petrisor, MD[1]; **Kyle Jeray, MD[2]**; Sheila Sprague, PhD[3]; Paula McKay, BSc[3]; Gordon Guyatt, MD[3]; Stephen D. Walter, BSc, ARCS, PhD[3]; Emil H. Schemitsch, MD[4]; Susan Liew, MD[5]; Diane Heels-Ansdell, MSc[3]; Sun Makosso-Kallyth, PhD[3]; Mohit Bhandari, MD, FRCSC, PhD[6]; FLOW Investigators*
[1]Hamilton General Hospital, Hamilton, Texas, USA;
[2]Greenville Health System University Medical Center, Greenville, South Carolina, USA;
[3]McMaster University, Hamilton, Ontario, CANADA;
[4]St. Michael's Hospital, Toronto, Ontario, CANADA;
[5]The Alfred Hospital, Melbourne, Victoria, AUSTRALIA;
[6]MacOrtho Research, Hamilton, Ontario, CANADA

Purpose: Open fractures are common and debilitating injuries yet there are little data on the health-related quality of life and function following operative management. The recently completed FLOW (Fluid Lavage of Open Wounds) trial was a multicenter, blinded, randomized controlled trial, using a 2 × 3 factorial design that evaluated irrigation solution (soap vs normal saline) and irrigation pressure (very low vs low vs high) in patients with open fracture wounds. The FLOW primary analysis of 2447 patients found soap to have a significantly higher reoperation rate than saline and found no differences between the irrigation pressures evaluated. Using the FLOW data, we sought to describe health-related quality of life and function for patients in the year following their open fracture.

Methods: Patients enrolled in the FLOW study completed the Short Form-12 (SF-12) and the EuroQol-5 Dimensions (EQ-5D) at baseline (preinjury recall) and at 2 and 6 weeks, and 3, 6, 9, and 12 months postfracture. Using the standardized scoring method, we calculated the Physical Component Score (PCS) and the Mental Component Score (MCS) of the Short Form (SF)-12. The PCS and MCS are expressed on a scale from 0 to 100 with a minimally important difference of 5 points. EQ-5D results are expressed as a utility score on a scale from 0 to 1 with a minimally important difference of 0.03. The mean scores for the SF-12 PCS, SF-12 MCS, and EQ-5D were plotted over time for all patients and separately by treatment group. We conducted a multilevel Cox proportional hazards regression analysis with three levels (center, patient, and time of follow-up).

Results: We did not find any significant differences between soap and saline and between the three irrigation pressure groups on the SF-12 PCS, SF-12 MCS, and EQ-5D ($P > 0.5$). Patients had not returned to their preinjury function at 12 months for any of the three functional outcomes ($P < 0.001$). Patients' SF-12 PCS score at 12 months was 10.15 (95% CI 9.51-10.79) points lower than their preinjury score and their SF-12 MCS score was 2.66 (95% CI 2.01-3.31) points lower than their preinjury score. Patients' utility scores were 0.15 (95% CI 0.14-0.16) lower at 12 months than preinjury.

Conclusion: Similar to the findings of the FLOW primary analysis, there were no differences between irrigation pressures in the SF-12 and EQ-5D. The significant effect of irrigation solutions in our primary analysis was not found in the health-related quality of life and

Δ OTA Grant

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

functional outcomes. This may be a result of generic instruments used not being sensitive enough to capture differences due to reoperation or this may be due to reoperations not having a large impact on general quality of life and physical function. Patients sustaining open fractures had not returned to their pr-injury status at 12 months postfracture, as demonstrated by the clinically significant lower SF-12 PCS and utility scores.

See pages 49 - 106 for financial disclosure information.

Antibiotics Selection for Open Fractures: Is the Current Regimen Still Applicable?

*James Moss, MD[1]; **Patrick Bergin, MD**[2]; Matthew Graves, MD[2]; William Replogle, PhD[2]; Vuong-Iam Pham, MD[2]; James Brown, BS[2]; Clay Spitler, MD[2]*
[1]Mississippi Sports Medicine and Orthopaedic Center, Jackson, Mississippi, USA;
[2]University of Mississippi Medical Center, Jackson, Mississippi, USA

Background/Purpose: Open fractures have proven to be a difficult problem to treat and have an increased risk of infection and other healing complications. They usually occur from a high-energy mechanism and can be associated with differing degrees of soft-tissue injury, bony injury, and contamination. The purpose of this study is to analyze the efficacy of our present open, long bone fracture antibiotic regimens, identify a preferred antibiotic combination for gram-positive/gram-negative coverage, and analyze risk factors for infection after open fractures.

Methods: 622 patients were identified as having open, long bone fractures between January 2008 and December 2012. Infections were defined as positive cultures during surgical debridement after definitive wound closure. Efficacy profiles were calculated for cefazolin and gentamicin (our current regimen) as well as any antibiotic tested at least 20% of the time. Antibiotic sensitivities for each organism were collected and analyzed. Patient factors, injury characteristics, and treatment options were analyzed to determine risk factors for infection.

Results: 90 patients (15%) had positive intraoperative cultures at surgical debridement. 170 organisms were identified. Cefazolin was 50% effective, but it was only tested in 5% of gram-positive infections. We therefore assessed all beta-lactam or cephalosporin antibiotics as a surrogate for class efficacy. These were effective 59% of the time. Gentamicin was tested 94% of the time for gram-negative infections with 94% sensitivity. Vancomycin was the most effective antibiotic for gram-positive organisms (96% sensitivity). Gentamicin was most effective for gram-negative infections (94% sensitivity). Male gender, Gustilo-Anderson type, diabetes, and days to closure were independently predictive of infection in a multivariate model.

Conclusion: Based on this analysis, our present antibiotic regimen may be insufficient for treatment of open, long bone fractures. A modification of our current regimen may be necessary. A regimen of vancomycin/gentamicin should be considered.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Using PROsetta Stone to Translate PROMIS Depression Scores for Meaningful Use in Orthopaedic Trauma

Amanda Spraggs-Hughes, BS, MA[1]*; William M. Ricci, MD*[1]*; Michael Gardner, MD*[2]*; Christopher McAndrew, MD, MSc*[1]
[1]*Washington University in St. Louis, St. Louis, Missouri, USA;*
[2]*Stanford University Department of Orthopaedic Surgery, Redwood City, California, USA*

Background/Purpose: PROMIS (Patient Reported Outcomes Measurement Information System) assessments provide clinicians with valid and reliable outcome instruments with low patient burden. Due to the novelty of administering the assessments in clinical populations, many of the PROMIS domains have not yet been interpreted for meaningful use in directing clinical care. The PROsetta Stone project is an NIH (National Institutes of Health)-funded initiative tasked with developing "cross-walks" to translate PROMIS scores into comparable scores from commonly used legacy instruments. The primary aim of this study was to translate PROMIS Depression scores collected in an orthopaedic trauma outpatient clinic to Patient Health Questionnaire-9 (PHQ-9) depression severity levels utilizing the PROsetta Stone. The secondary aim was to examine the translated scores in a diverse orthopaedic trauma population to develop future treatment strategies for depression after orthopaedic trauma.

Methods: In 2015, the orthopaedic surgery department of a Level I trauma center implemented a new check-in process for patients that included the collection of the PROMIS CAT (Computer Adaptive Test) Depression assessments. IRB approval was obtained after a pilot period to retrospectively collect the PROMIS Depression scores along with basic patient demographic data. The PROsetta Stone cross-walk was utilized to stratify the PROMIS scores by PHQ-9 depression severity levels (Table 1). Descriptive statistics were used to analyze and report on the PROMIS Depression scores and translated PHQ-9 severity levels.

Results: PROMIS Depression scores were collected for 810 insured patient visits to the orthopaedic trauma faculty during an 11-week pilot period. The mean age was 54 years and 53.5% of the sample was male. The mean PROMIS Depression score was 48.5, which is just below the population mean of 50. Figure 1 demonstrates the breakdown of translated PROMIS Depression to PHQ-9 severity levels for this sample. The PHQ-9 proposed treatment actions recommend initiating depression treatment for PROMIS Depression scores of ≥59.9 including immediate initiation of pharmacotherapy intervention for PROMIS ≥65.8. Based on these guidelines, 9.5% of patients presenting to an outpatient orthopaedic trauma clinic should be treated for depression and 4.2% meet criteria for immediate initiation of pharmacotherapy.

Conclusion: Translation of PROMIS Depression scores into the depression severity levels of the PHQ-9 allowed determination of patients in need of further evaluation and treatment for depressive symptoms. While the overall mean PROMIS score of this cohort was near the population mean, nearly 14% of our patients met PHQ-9 criteria for initiation of depression treatment or beginning pharmacotherapy. By utilizing the severity strati-

See pages 49 - 106 for financial disclosure information.

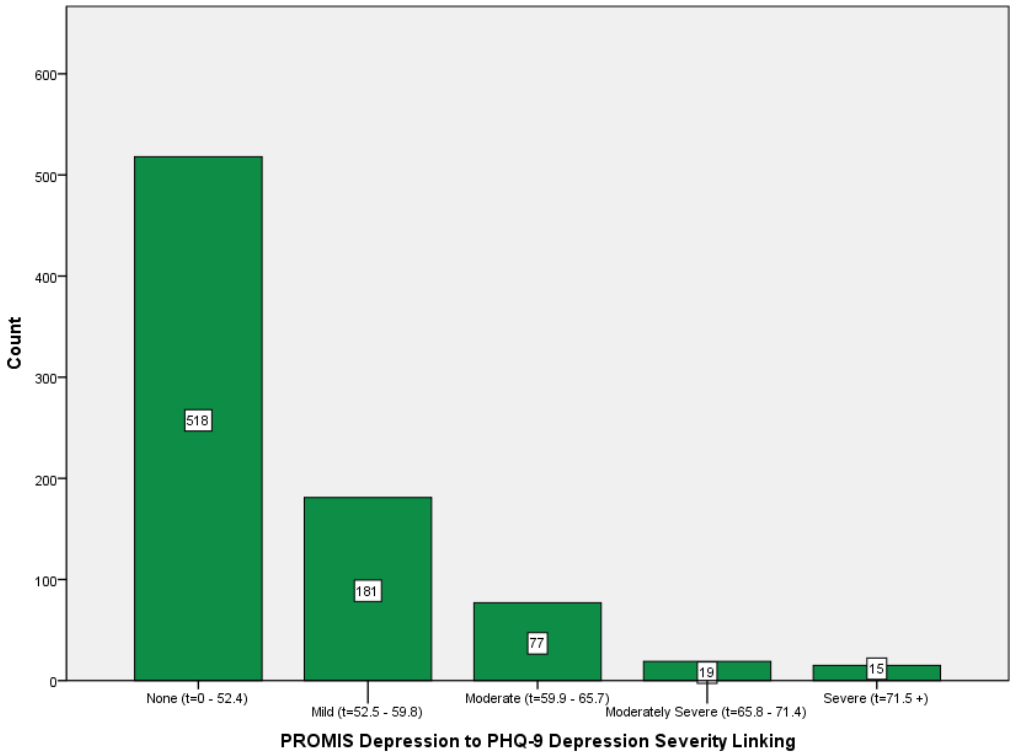
fication of the commonly used PHQ-9, PROMIS Depression scores can be interpreted for appropriate and timely treatment of depression in orthopaedic trauma patients. Future directions could include the creation of Collaborative Care Models to aid in the treatment of depression in orthopaedic trauma patients.

Table 1. PROsetta Stone translation of PROMIS Depression t-scores to PHQ-9 depression severity levels

PROMIS Depression t-score	PHQ-9 Score	PHQ-9 Depression Severity	PHQ-9 Proposed Treatment Actions*
0 – 52.4	1 to 4	None	None
52.5 – 59.8	5 to 9	Mild	Monitor and repeat PHQ-9 at next appointment
59.9 – 65.7	10 to 14	Moderate	Initiate treatment planning
65.8 – 71.4	15 to 19	Moderately Severe	Immediate pharmacotherapy
71.5 +	20 to 27	Severe	Immediate pharmacotherapy plus expedited referral

*Adapted from Kroenke, K. & Spitzer, RL. (2002). The PHQ-9: A new depression and diagnostic severity measure. *Psychiatric Annals,* 32, 509-521.

Figure 1. The sample distribution of translated PROMIS Depression to PHQ-9 severity levels. For each category the PHQ-9 severity is provided with the associated PROMIS Depression scores in parentheses.



The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Pilot Study of Effect of Real-Time Dosimetry on Surgeon Radiation Exposure During Operative Repair of Femur and Pelvis Fractures

Ryan Duffy, MD*; Eleni Berhaneselase, BA; Saam Morshed, MD*
UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA

Purpose: Intraoperative use of fluoroscopy has increased in orthopaedic surgery. Real-time dosimetry during procedures has been associated with reductions in radiation exposure during fracture surgery. The purpose of this pilot randomized trial is to estimate a sample size required to test effectiveness of real-time dosimetry in reducing surgeon radiation exposure.

Methods: We conducted a prospective randomized controlled trial of adults undergoing operative treatment of fractures of the femoral shaft, proximal femur, acetabulum, and pelvis at a Level I trauma center. Participants in this study included attending orthopaedic surgeons, fellowship orthopaedic trauma surgeons, and resident orthopaedic surgeons. The unit of randomization was the patient, with all participants randomized to either the blind group (BG), where participants were blinded to exposure levels, or the aware group (AG), where participants had visual access to exposure levels.

Results: Of the 44 eligible operations, 22 were randomized to the BG and 22 to the AG. There were no differences in average age, body mass index (BMI), or OTA fracture class between the two treatment groups. Overall mean surgeon exposure in the AG was lower than the BG (mean 88.8 μSv, SD 96.5; and mean 134.7 μSv, SD 172.7, respectively); however, mean difference did not achieve statistical significance (P = 0.28). Proximal femur fractures had the highest mean surgeon radiation exposure for blind group and aware group (mean 157.4 μSv, SD 211.9; and mean 101.1 μSv, SD 128.1, respectively). Additionally, there was no significant difference between the study groups when mean surgeon exposure was adjusted for patient BMI, patient radiation exposure, number of fluoroscopic images, or fluoroscopy duration. In order to achieve a false discovery rate of 5% and power of 80%, 140 subjects would need to be randomized to each treatment group in order for the mean reduction in exposure found in the AG to reach statistical significance.

Conclusion: Although our data did not demonstrate the efficacy of real-time visualization, a 34% reduction in mean exposure endorses previously reported reductions associated with this modality. Further research with a larger sample size, that we are now able to estimate with these data, will allow us to determine the true impact of knowledge of exposure levels in real time on surgeon dosing during fluoroscopy-intensive fracture surgery.

See pages 49 - 106 for financial disclosure information.

Table 1. Mean surgeon radiation exposure by fracture location and treatment group

Femur Fracture	Mean Radiation Exposure (µSv) Blind Group (SD)	Mean Radiation Exposure (µSv) Aware Group (SD)	Mean Difference (µSv) Blind – Aware (95% CI)	P
Femur	143.0 (182.6)	96.7 (111.2)	46.2 (-56.4 - 148.9)	0.37
Pelvis	88.2 (90.7)	67.7 (35.5)	14.4 (-191.7 - 220.5)	0.81
Total	134.7 (172.7)	88.8 (96.5)	45.9 (-39.3-131.0)	0.28

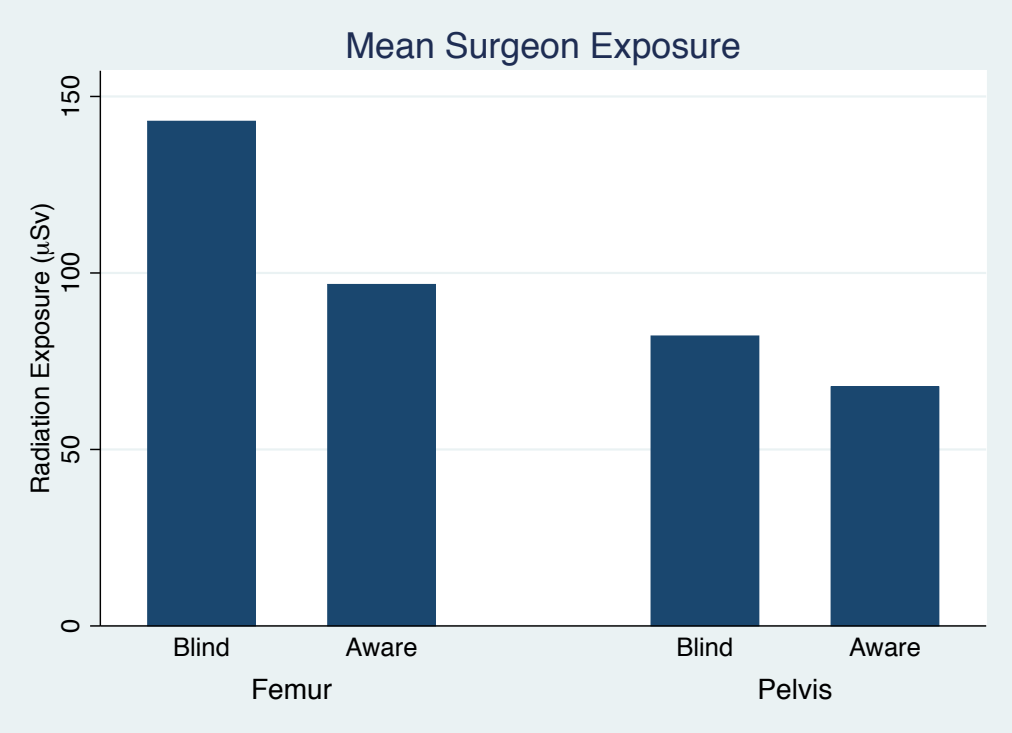


Figure 1. Mean surgeon radiation exposure for fracture location

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Patient Perceptions of Physician Reimbursement in Orthopaedic Trauma Surgery

Jane Liu, MD[1]*; Robert Keller, MD*[1]*; William Hakeos, MD*[1]*; Stuart Guthrie, MD*[2]*; Joseph Hoegler, MD*[1]
[1]*Henry Ford Hospital, Detroit, Michigan, USA;*
[2]*Henry Ford Hospital System, Detroit, Michigan, USA*

Background/Purpose: The rising cost of medical care in the United States is a matter of concern for both patients and providers. Medicare reform drives a large part of the discussion, and in recent years physician reimbursement has been reduced as part of the effort to decrease cost. Previous studies examining payment perception of reimbursement in elective orthopaedic spine surgery and total joint replacement have found that patients vastly overestimate physician reimbursement from Medicare for common procedures. Trauma patients typically have different socioeconomic characteristics than elective orthopaedic patients and may hold a different view of how much physicians should be reimbursed. Our present study surveys the orthopaedic trauma clinic to gain data on public opinion regarding physician reimbursement.

Methods: IRB approval was obtained for this study. Patients who presented to the orthopaedic trauma clinic at Henry Ford Hospital Main Campus (Detroit, MI) between August 1, 2015 and January 31, 2016 were approached to complete a 28-question anonymous survey regarding physician reimbursement. Demographic data were obtained including age, sex, whether the patient had undergone surgery, level of education, household income, and insurance type. The patients then answered questions regarding whether they felt physicians were overpaid and how health-care costs should be decreased. They were then asked how much they felt physicians should be reimbursed for operative fixation of bimalleolar ankle fractures and femur fractures. They were also asked to guess how much Medicare actually reimbursed for operative fixation of these two fractures and whether physicians should be compensated for additional subspecialty training.

Results: 202 surveys were completed. 114 (56%) respondents were female and 88 (43.6%) had undergone some type of orthopaedic procedure. 105 patients (56% of respondents) had a household income less than $50,000 per year. 76 patients (39% of respondents) were Medicare or Medicaid patients. When asked what they felt was a reasonable amount for physicians to be reimbursed for a bimalleolar ankle fracture, 86 patients (42.5%) responded with an average amount of $18,695.50. The remainder of survey respondents did not venture a guess, stating they had no frame of reference to judge reimbursement. 79 patients (39%) responded with a guess of what Medicare actually reimbursed for fixation of bimalleolar ankle fracture with an average of $7458.20. When asked what they felt was a reasonable amount for physicians to be reimbursed for a femur fracture, 84 patients (41.2%) responded with an average of $16,389.30. 78 patients (38.6%) responded with a guess of what Medicare actually reimbursed for fixation of femur fracture with an average guess of $7847.70. 90 patients (54%) felt that orthopaedic surgeons were reimbursed somewhat low or very low for the standard Medicare reimbursement for open reduction and internal fixation of a bimalleolar ankle fracture. 69 patients (44%) felt that orthopaedic surgeons were reimbursed somewhat low or very low for the standard Medicare reimbursement for open

See pages 49 - 106 for financial disclosure information.

reduction and internal fixation of a femur fracture. 115 patients (70% of respondents) felt that physicians with additional subspecialty training should be reimbursed higher than those without. 4 patients (2% of respondents) felt that the best way to reduce US health-care cost was to reduce physician reimbursement; the remainder of participants who responded felt reducing insurance company reimbursement, drug and device reimbursement, or hospital reimbursement were the best option to reduce health-care spending (54%, 31%, and 13%, respectively). Patients who had undergone previous surgery of any kind responded with a higher value when asked what they thought a reasonable reimbursement amount was for fixation of a bimalleolar ankle fracture. There was no difference among either income level or education level whether participants felt physicians were overpaid, whether physician salary should be cut, salaries linked to outcome, or the best way to lower the cost of US health care. The amount that patients stated they would be willing to pay out of pocket was not related to education level or income level, but instead insurance type. Patients with a PPO (preferred provider organization) answered approximately $4864.60, patients with an HMO (health maintenance organization) answered $1831.00, while patients with Medicare answered $303.50 and patients with Medicaid answered $1057.70.

Conclusion: Health-care reform is a difficult problem to address due to multifactorial contributors to cost and lack of transparency in billing. Our survey demonstrates that most patients lack a reference range to venture a guess regarding Medicare reimbursement. Those who do guess vastly overestimate.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Patient-Specific Injury Score Is a Better Predictor of Outcome Than ISS in Multiply Injured Patients

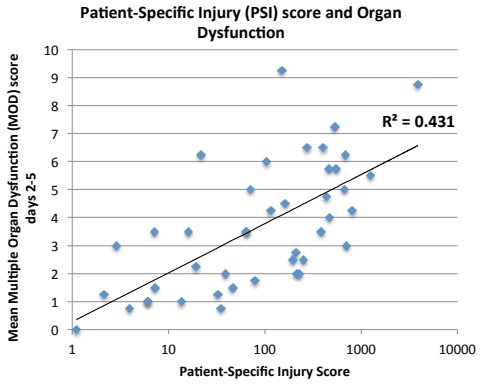
*Greg Gaski, MD[1]; Kenaz Bakdash, BS[2]; **Cameron Metzger, BS**[2]; Tyler McCarroll, BS[2]; Andrew Cutshall, BS[2]; Scott Steenburg, MD[2]; Todd McKinley, MD[1]*
[1]IU Health - Methodist Hospital, Indiana University School of Medicine, Indianapolis, Indiana, USA;
[2]Indiana University School of Medicine, Indianapolis, Indiana, USA

Purpose: Current injury scoring systems in trauma have limited prognostic value and are relatively nonspecific. The most frequently employed method to estimate injury burden is the ISS. The ISS has been criticized for underestimating multiple injuries within the same region and offers no guidance in treatment due to the retrospective nature of its calculation. Multiply injured patients (MIPs) sustain both mechanical and ischemic components of tissue injury. Precise methods of quantifying the injury burden may allow clinicians to better predict clinical trajectories, complications, and aid in guiding treatment such as the timing of staged orthopaedic interventions. Several recent retrospective studies of critically injured patients employing patient-specific injury measurement techniques found significant correlations between the initial magnitude of both mechanical and ischemic tissue injury and subsequent organ dysfunction. This investigation expands on this concept and evaluates the utility of a Patient-Specific Injury (PSI) score, which incorporates mechanical and ischemic tissue injury, in predicting organ dysfunction in a prospective cohort of multiply injured patients. We hypothesized that PSI scores, in comparison to ISS, would demonstrate improved correlation to organ dysfunction, multiple organ failure (MOF), and nosocomial infection (NI).

Methods: 54 consecutive MIPs ages 18-55 admitted to the ICU or taken straight to the operating room were evaluated. 4 patients declined participation and 2 additional patients had incomplete imaging, leaving 48 patients eligible for the study. Whole-body patient-specific mechanical tissue damage was quantified using a novel index termed the Tissue Damage Volume (TDV) score. TDV score calculates a volume (cm^3) of every injury sustained by a patient based on measurements made from admission CT scans of the head/neck, chest, abdomen, pelvis/retroperitoneum, and axial skeleton. Ischemic tissue injury was characterized by integrating elevated values of shock index (SI) (SI = HR/SBP [heart rate/systolic blood pressure]; SI >0.9 is a validated marker of hypoperfusion) over the initial 24 hours after injury to yield a patient-specific metric termed Shock Volume (SV). Patient-specific metabolic response was measured by calculating the difference of the minimum pH for 0-24 and 24-48 hours after injury from normal (7.40). TDV, SV, and pH deviation were integrated into a PSI score (TDV + [SV x 5] x pH deviation). The primary outcome was organ dysfunction as depicted by mean Marshall Multiple Organ Dysfunction (MOD) score on days 2- 5 (predictive of prolonged ICU admission). We also determined the presence of MOF using the MOD score criteria and the presence of NI (CDC [Centers for Disease Control and Prevention] criteria). PSI scores were compared to ISS for correspondence to mean MOD scores with linear regression. Student's *t* test was employed to compare PSI scores and ISS between groups that did or did not develop MOF and NI.

See pages 49 - 106 for financial disclosure information.

Results: PSI scores demonstrated better correlation to organ dysfunction (r^2 = 0.431) in comparison to ISS (r^2 = 0.151) as measured by the MOD score on days 2 through 5 (Fig. 1a and 1b). Mean PSI was elevated 4.7 times in patients who developed MOF versus those who did not (755.3 vs 159.7; P <0.01) (Fig. 1c). Mean PSI was 3 times higher in patients who acquired an NI (459.6 vs 143.7; P = 0.03) (Fig. 1d). There was no difference in the mean ISS of patients who developed MOF and those who did not. (34.8 vs 28.5; P = 0.13). Patients who developed NI had a higher mean ISS (35.9 vs 25.2; P <0.01).



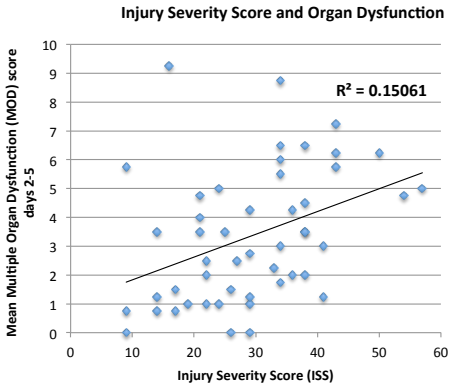


Figure 1a and 1b. The PSI score demonstrated better correlation with organ dysfunction (days 2-5) compared to ISS (r^2= 0.431 vs. r^2= 0.151).

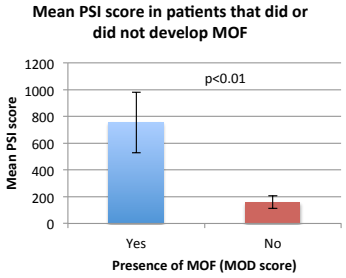


Figure 1c. The mean PSI score was nearly 4.7 times higher in patients that developed MOF (MOD score) compared to those that did not develop MOF.

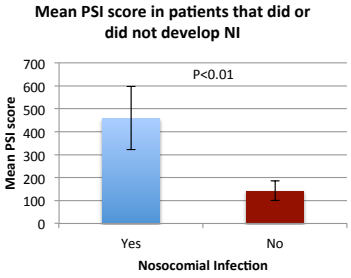


Figure 1d. The mean PSI score was over 3 times higher in patients that acquired NI compared to those that did not acquire NI.

Conclusion: This prospective investigation demonstrates that patient-specific metrics of tissue injury better determine how the overall injury burden affects meaningful clinical phenotypes compared to traditional measures such as ISS. PSI provides early identification of patients at risk of complications such as NI and MOF. This prospective study outlines a novel approach to injury assessment via precision medicine techniques in MIPs in an attempt to stratify patients at risk of complicated clinical courses. The described techniques continue to be refined and require more rigorous study in a larger population of trauma patients before clinical application. Future studies should analyze and incorporate immunologic dysregulation after trauma.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Δ 90-Day Postoperative Narcotic Use Following Hospitalization for Orthopaedic Trauma

Nina Fisher, BS*; Shay Bess, MD; Dana Cruz, MD; Sanjit Konda, MD; Philipp Leucht, MD, PhD; Kenneth Egol, MD*
New York University Hospital for Joint Diseases, New York, New York, USA

Background/Purpose: Narcotic abuse is a growing problem within our society, and can act as a barrier in providing adequate postoperative pain management. In order to effectively care for patients, orthopaedic surgeons must be aware of which patients are at a higher risk for developing drug-seeking tendencies. The purpose of this study was twofold. First we sought to analyze narcotic use in the 90-day postoperative period for orthopaedic trauma injuries and compare those to other patients undergoing elective orthopaedic procedures. Secondly, we examined if patient-reported pain scores during hospitalization are correlated with increased narcotic use during the 90-day postoperative period.

Methods: An electronic medical records (EMR) query was performed between 2012 and 2015 at one institution using DRG (diagnosis-related group) codes for spine, adult reconstruction, and trauma procedures. Demographics, length of stay (LOS), all pain scores recorded during LOS, and all narcotic pain medication prescribed in the 90 days following discharge were collected. Only patients who were prescribed postoperative narcotics within our institution's EMR were available for analysis. Narcotic pain medication was converted to morphine equivalents for comparison purposes. Multivariate analysis was performed using a one-way ANOVA (analysis of variance) for continuous variables and Pearson's X^2 analysis for categorical variables.

Results: 5030 patients across three orthopaedic cohorts had complete information available for analysis of 90-day narcotic use. 1578 were spine surgery patients (average age 61.1), 2923 were joint replacement patients (average age 64.9), and 529 were trauma patients (average age 61.0). Spinal patients had the longest LOS, highest mean pain reported during LOS, and were prescribed the most morphine in the 90-day postoperative period. However, trauma patients did not differ significantly from spinal patients in terms of LOS ($P = 0.161$) and the total morphine prescribed in the 90-day postoperative period ($P = 0.543$). There was no significant correlation between the mean patient-reported pain score during LOS and amount of narcotics prescribed in the 90-day postoperative period ($r = 0.150$) across all three orthopaedic specialties or within solely orthopaedic trauma patients ($r = 0.115$). Orthopaedic trauma patients were grouped into the following cohorts: hip and femur (191 patients); tibia, fibula, ankle, humerus, and knee (205 patients); polytrauma (9 patients); and other, including shoulder, elbow, hand, wrist, and foot (124 patients). There were no significant differences in the amount of morphine prescribed in the 90-day postoperative period between the orthopaedic trauma cohorts ($P = 0.425$).

Conclusion: Overall, pain levels during admission do not directly influence narcotic use in the 90-day postoperative period. However, while trauma patients do not report as much pain in the immediate postoperative period as spinal patients, they receive larger amounts of morphine equivalents in the 90-day postoperative period. Orthopaedic trauma sur-

Δ OTA Grant
See pages 49 - 106 for financial disclosure information.

geons should be aware that their patients will require increased levels of narcotics following discharge compared to other orthopaedic specialties, and are thus at a higher risk of developing narcotic dependency.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Transcutaneous Endoprosthetic Reconstruction of Devastating Lower Limb Military and Terrorist Blast Injuries

Kevin Tetsworth, MD[1]; Munjed Al Muderis, FRACS, FRCS (Ortho), MB, ChB[2]; Vaida Glatt, PhD[3]
[1]*Royal Brisbane Hospital, Brisbane, Queensland, AUSTRALIA;*
[2]*School of Medicine Sydney, University of Notre Dame, Australia Bella Vista, New South Wales, AUSTRALIA;*
[3]*Institute of Health and Biomedical Innovation, Brisbane, Queensland, AUSTRALIA*

Background/Purpose: Military-type blast injuries from improvised explosive devices (IEDs), unfortunately, all too often result in truly devastating lower extremity injuries, and in many instances it is not possible to reconstruct biologically. The associated gross destruction of the extremities frequently results in lower limb amputations, with soft tissues and bone obliterated by the force of the explosion. Moreover, these injuries are often bilateral, and are notoriously difficult to fit with prostheses because of a short skeletal residuum, dense adherent scars, and heterotopic bone. Osseointegration provides a revolutionary strategy for management of these amputees, using a transcutaneous porous-coated titanium endoprosthetic device. The primary objective here was to describe our experience using osseointegration as the definitive reconstruction strategy following amputations resulting from military-type blast injuries, including preliminary assessment of the safety and efficacy of the procedure in this challenging cohort of patients.

Methods: This is a case series of 10 patients who had sustained military or terrorist blast injuries resulting in lower extremity amputations. The study groups comprised 10 males and 0 females, aged 23-67 years (mean 37). Principal outcome measures included: Questionnaire for persons with a Trans-Femoral Amputation (Q-TFA), Short Form Health Survey 36 (SF-36), Six Minute Walk Test (6MWT), Timed Up and Go (TUG), and K-levels. Adverse events were recorded including infection, revision surgery, fractures, and implant failures.

Results: Clinical outcomes were obtained pre- and postoperatively from 10 to 30 months, with a mean follow-up of 16 months. Compared to the mean preoperative values with socket prostheses, the mean postoperative values for all five validated outcome measures were improved. The postoperative Q-TFA global score (40.69 ± 6.46 to 78.13 ± 4.44, P = 0.0003) and the SF-36 physical component summary (42.16 ± 2.83 to 47.90 ± 3.34, P = 0.2) were both superior to the preoperative values, although for the SF-36 this did not achieve significance because of the limited sample size. K-levels improved in 9 patients, and remained unchanged in 1 patient; no patient had a reduction in their K-level (X^2 = 14.624, df = 2, P = 0.0007). The 6MWT (102 ± 56.17 to 437 ± 60.61, P = 0.0017) and the TUG (14.34 ± 3.33 to 8.74 ± 1.46, P = 0.11) were also dramatically improved; for the 6MWT this is a 330% increase, and the TUG was decreased 39%. This difference was significant for the 6MWT, but not the TUG, again most likely because of the small sample size. These patients were often completely disabled, with 4 participants wheelchair bound preoperatively, and could not perform the TUG and 6MWT; however, all 4 were able to do so after osseointegrated reconstruction, and their postoperative values were comparable to those of the prosthetic users who were ambulatory preoperatively. A total of 6 participants were adverse event-

See pages 49 - 106 for financial disclosure information.

free, There were episodes of minor infection in 3 patients, and all of these responded to oral antibiotics. Refashioning of the soft-tissue residuum was performed on 1 patient electively; 1 periprosthetic fracture occurred due to increased activity, and was successfully stabilized without the need to revise the implant.

Conclusion: Our experience in this small series suggests osseointegration may be considered a highly effective strategy for the definitive reconstruction of amputees resulting from military-type blast injuries. Despite having tremendous difficulties using a socket-mounted prosthetic limb, their functional levels were much improved after osseointegrated reconstruction. These findings have very important implications for the definitive reconstruction and rehabilitation of those veterans who have undergone an amputation as a result of military combat blast injuries.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Sleep Disturbance Following Orthopaedic Trauma: Does it Predict Future Physical Functioning?

Renan Castillo, MD[1]; CAPT (ret) Michael J. Bosse, MD[2]; Saam Morshed, MD[3]; Thomas F. Higgins, MD[4]; Kristin Archer, PhD[5]; Julie Agel, ATC[6]; Albert Wu, MD[1]; Robert V. O'Toole, MD[7]; Anthony Carlini, MS[1]; Katherine Frey, RN, MPH[1]; Rachel Kirk, BS[1]; Stephen Wegener, PhD[8]; (Consortium) METRC, NA[1]
[1]John Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA;
[2]Carolinas Medical Center, Charlotte, North Carolina, USA;
[3]UCSF/SFGH Orthopaedic Trauma Institute, San Francisco, California, USA;
[4]University Orthopaedic Center, Salt Lake City, Utah, USA;
[5]Vanderbilt University Medical Center, Nashville, Tennessee, USA;
[6]Harborview Medical Center, Seattle, Washington, USA;
[7]University of Maryland, Shock Trauma, Baltimore, Maryland, USA;
[8]Johns Hopkins, Baltimore, Maryland, USA

Purpose: Following trauma, patients experience a variety of psychologic and somatic symptoms, as well as poor long-term functional outcomes. While sleep disturbances appear to play a role in several trauma-related conditions, including posttraumatic stress disorder and traumatic brain injury, little is known about the association of sleep with functional outcomes after orthopaedic trauma. The goal of this analysis is to describe the extent and severity of sleep disturbances 3 and 6 months following orthopaedic injury and document the relationship between sleep disturbance at 3 months and subsequent physical function measured at 6 months.

Methods: A total of 486 orthopaedic trauma patients treated at academic trauma centers were interviewed at 3 months following an orthopaedic injury (including open and closed tibia, calcaneus, pilon, ankle and foot fractures, and below-knee amputees). Of these patients, at the time of this submission 308 had also been followed up at 6 months posttrauma. The National Institutes of Health Patient Reported Outcomes Measurement Information System (PROMIS) framework is designed to improve measurement of patient-reported outcomes with greater quality and precision while reducing respondent burden using Computer Adaptive Testing (CAT) techniques. PROMIS instrument scores are normalized to the general US population. Domains are scored on a 0 to 100 scale, standardized to a mean of 50 and a standard deviation of 10. Participants were assessed using the PROMIS sleep disturbance (Sleep) and physical function (PF) domains at both 3 and 6 months. In the PROMIS PF scale, lower numbers indicate greater physical function limitations, while in the PROMIS Sleep scale, higher numbers indicate greater sleep disturbance. A multiple variable linear regression analysis was conducted to estimate the relationship between Sleep at 3 months and PF at 6 months, as we would expect sleep disturbances to be manifest in an extended period of diminished function. Covariates included PF at 3 months, patient demographics (age, sex, race, and education) and injury characteristics (polytrauma, head AIS [Abbreviated Injury Scale] >2, and Gustilo III open fractures (vs lower-severity injuries).

Results: The mean Sleep score for this group was 56.2 (SD 7.7) at 3 months and 55.2 (SD

See pages 49 - 106 for financial disclosure information.

7.0) at 6 months. The mean PF score for this group was 31.7 (SD 7.5) at 3 months and 36.2 (SD 7.9) at 6 months, indicating significant physical function limitations in this population. Thus, the mean Sleep scores were far closer to population means than the PF scores. Among 85 participants (18% of the sample) who had 3-month Sleep scores more than 1 SD above population norms, mean 6-month PF scores were 32.8 (SD 6.0), compared to 37.1 (SD 8.1) among the 386 participants with 3-month Sleep scores within 1 SD of population norms (Student's *t* test *P* value <0.001). After adjustment for demographics, severity, and PF at 3 months, a one-point increase in Sleep at 3 months was associated with a 0.11 point decrease in PF at 6 months (95% CI: -0.207, -0.004; $P = 0.043$).

Conclusion: Despite a well-documented elevated prevalence of sleep disturbances in numerous other trauma populations, the prevalence in this broad orthopaedic trauma population was only moderately higher than population norms. However, there was a significant relationship between 3-month sleep disturbance and poorer 6-month physical function, suggesting that, as has been seen in other patient populations, poor sleep is associated with worse outcomes for orthopaedic trauma patients. The magnitude of the observed effect was modest, and it is unclear if it was clinically as well as statistically significant in this longitudinal dataset. While these data do not provide definitive evidence for sleep as a major driver of outcomes, it supports the need for further research to determine if interventions to improve sleep could improve the health of this population.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Extended Use of Opioids After Orthopaedic Trauma Is More Closely Associated with Psychosocial than Injury Factors

Cullen Griffith, MD[1]*; Peter Berger, BS*[1]*; Timothy Costales, BS*[2]*; Max Coale, BA*[3]*; Timothy Zerhusen, BS*[3]*; Kerry Campbell, BS*[2]*; Renan Castillo, PhD*[4]*; Robert V. O'Toole, MD*[5]
[1]*R Adams Cowley Shock Trauma Center, Baltimore, Maryland, USA;*
[2]*University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[3]*R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[4]*Johns Hopkins School of Public Health, Baltimore, Maryland, USA;*
[5]*University of Maryland, Shock Trauma, Baltimore, Maryland, USA*

Background/Purpose: Extended opioid use after orthopaedic trauma places patients at risk for dependency, addiction and even overdose. There is currently very limited understanding of what combination of patient or injury factors, if any, predispose patients to longer duration of opioid medications. We set out to identify the most significant psychological, sociodemographic, and injury characteristics associated with prolonged opioid use.

Methods: Our study group consisted of 183 patients treated at a Level I trauma center for orthopaedic injuries who were prospectively enrolled and completed surveys during routine follow-up of their injuries. Patient demographics included mean age of 46, 61% male, high-energy mechanism of 68% and mean time from injury of 60 days (range, 41-97). A single interview was completed between 6-12 weeks postinjury. Patients completed validated instruments, including the Patient Health Questionnaire (PHQ)-9 for depression, Brief Pain Inventory (BPI), Positive Affect, Pain Catastrophizing Scale (PCS), FAST, Alcohol Use Disorders Identification Test (AUDIT), and Drug Abuse Screening Test (DAST)-10. Additionally we reviewed the medical record to collect 13 other patient factors hypothesized to contribute to persistent opioid use, including specific injury location, length of hospitalization, and ISS. Our primary outcome measure was self-reported use of opiate medications past the 6-week mark from injury. Bivariate and multiple variable logistic regression analyses were used to assess the independent association between each factor and extended opioid use.

Results: Opiate use beyond 6 weeks from injury was very common in this population (55%). Six risk factors for prolonged opiate use were identified: education level of high school graduate or lower (odds ratio [OR] 2.1; 95% CI: 1.0, 4.2; $P = 0.05$), length of initial hospital stay (OR 1.1 per day; 95% CI: 1.0, 1.2; $P = 0.02$), an injury mechanism of fall from height (OR 3.3; 95% CI: 1.2, 8.8; $P = 0.02$), opioid use 3 months prior to injury (OR 3.6; 95% CI: 1.1, 11.5; $P = 0.03$), Brief Pain Inventory (BPI) pain interference (OR 1.2 per point on a 10-point scale; 95% CI: 1.0, 1.4; $P = 0.03$), and Pain Catastrophizing Rumination (OR 1.1 per point on a 16-point scale; 95% CI: 1.0, 1.2; $P = 0.05$). To provide some context for the Rumination score, we note that the difference between the participants at the 25th and 75th quantiles for this measure was 9 points, resulting in a 2.5-fold increase in the odds of extended use. Similarly, the difference between the participants at the 25th and 75th quantiles for pain interference was 6 points, resulting in a 3-fold increase in the odds of extended use. Finally, the difference between the participants at the 25th and 75th quan-

See pages 49 - 106 for financial disclosure information.

tiles for length of stay was 5 days, resulting in a 65% increase in the odds of extended use.

Conclusion: In contrast to expectations, we found that few factors associated with more severe injuries (and therefore presumably longer duration of pain) were independent predictors of extended opiate use. Instead we found that psychological factors such as pain catastrophizing, psychsocial factors such as educational background, and prior opioid use were the most important predictors of continuing to use opioids 6 weeks postinjury. These findings suggest that strategies aimed at identifying patients with psychosocial profiles that place them at risk for extended use may be more important than focusing on patients with higher-energy injuries. Further research is needed to examine the overlap between predictors of extended use and chronic use of opioids, and whether interventions targeting these factors in the early phase of recovery may yield reductions in dependency, addiction, and overdose.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Clinical and Economic Impact of Generic Implant Use at a Level II Trauma Center

Peter L. Althausen, MD, MBA; Austin McPhillamy, MD; Taylor Gurnea, BS; Alistair Moody, BS; Justin Walker, MD
Reno Orthopaedic Clinic, Reno, Nevada, USA

Background/Purpose: In the current health care environment there has been increased awareness in the availability and effectiveness of generic orthopaedic implants, and their contribution to cost containment while maintaining clinical benefit and patient safety. The economic impact of widespread use of generic orthopaedic implants as a cost containment strategy between the hospital, surgeon, and patients cannot be understated. The purpose of this study is to expand the understanding quantitatively of the financial cost savings utilizing these implant designs as well as to examine the outcomes/complications associated with the use of these versus traditional implants.

Methods: Following approval by the IRB, the orthopaedic traumatologists at our institution adopted the use of generic volar locking distal radius, clavicle, proximal humerus, distal tibia, ankle, and proximal tibial plateau plates. Despite a much lower cost, these constructs were biomechanically tested as equivalent to major implant company products prior to the initiation of the project. Review of our trauma database identified patients with displaced distal radius, clavicle, proximal humerus, ankle, pilon, and tibial plateau fractures that met operative criteria treated with generic implants. These patients were compared to patients treated in a similar manner from years prior with conventional implants. Chart review was undertaken to obtain basic demographic variables such as age, sex, and fracture classification. Operative records were analyzed to identify any intraoperative complications, operative time, and estimated blood loss. Hospital charts were examined to compare rates of deep infection and need for repeat surgery including hardware removal. Clinic charts were assessed to identify cases of infection, malunion, nonunion, or need for repeat surgery. Radiographs were reviewed by an author not involved in the clinical care of the patient to record fracture type, hardware loosening, healing, loss of reduction, and malunion or nonunion. Hospital financial records were appraised to determine operative implant costs.

Results: We had a total of 533 patients treated with generic constructs. 128 patients with operatively managed distal radius fractures, 51 patients treated operatively with tibial plateau fractures, 123 patients with clavicle fractures, 38 patients with proximal humerus fractures, and 193 total patients with ankle and pilon fractures were identified in the study group. There were no significant differences in age, sex, or fracture type between generic and conventional groups and no difference in operative time, estimated blood loss, or complication rate was observed. No increase in postoperative infection rate, hardware failure, hardware loosening, malunion, nonunion, or need for hardware removal was noted. Overall our hospital realized a significant reduction in implant costs, resulting in a total savings of $428,310.

Conclusion: Use of generic implants has been a successful endeavor at our institution. Hospital implant costs decreased significantly without any associated increase in compli-

See pages 49 - 106 for financial disclosure information.

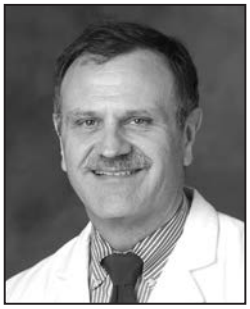
cation rate or change in radiographic outcome. Generic implant usage has the potential to markedly reduce operative costs in a manner similar to the generic pharmaceutical industry. This has profound implications for the treatment of trauma patients. As long as quality products are utilized, patient care is unaffected and cost savings can be realized. A portion of savings from such a change can be reinvested in the hospital trauma program to support OTA/AAOS position statement guidelines and positively affect the cost of fracture implants in the future.

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

See pages 49 - 106 for financial disclosure information.

ORTHOPAEDIC TRAUMA ASSOCIATION ORGANIZATION

2016 BOARD OF DIRECTORS



Steven A. Olson, MD
President

William M. Ricci, MD
President Elect

David C. Teague, MD
2nd President Elect

Brendan M. Patterson, MD
Chief Financial Officer

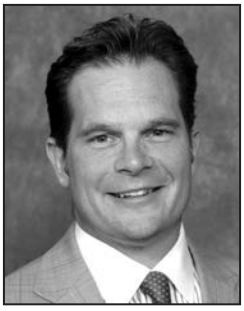
Heather A. Vallier, MD
Secretary

Theodore Miclau, III, MD
Immediate Past President

ORTHOPAEDIC TRAUMA ASSOCIATION ORGANIZATION

2016 BOARD OF DIRECTORS, continued

Ross K. Leighton, MD
2nd Past President



Michael T. Archdeacon, MD
Member-at-Large

Clifford B. Jones, MD, FACS
Member-at-Large

Nirmal C. Tejwani, MD
Member-at-Large

Robert V. O'Toole, MD
Annual Program

ORTHOPAEDIC TRAUMA ASSOCIATION ORGANIZATION

NOMINATING
(Elected Committee)
Theodore Miclau (Chair 2017 Slate)
Gregory Della Rocca
Edward Harvey
Samir Mehta
Emil Schemitsch

MEMBERSHIP
(Elected Committee)
Kyle Jeray (Chair)
Emily Benson
Gilbert Ortega
Hans-Christoph Pape
George Russell

ANNUAL MEETING ARRANGEMENTS
Jean-Claude G. D'Alleyrand
(National Harbor, MD 2016 Local Host)

ANNUAL PROGRAM
Robert O'Toole (Chair)
Michael McKee (Co-Chair)
Gregory Della Rocca
David Hak
Thomas Higgins
Stephen Kottmeier
Gilbert Ortega
David Sanders
Gerard Slobogean
Basic Science Sub-Committee
Chair (*ex officio*): Edward Harvey
Coding Course
Chair (*ex officio*): Paul Appleton

Basic Science Sub-Committee
Edward Harvey (Chair)
Mohit Bhandari
Joseph Borrelli Jr
Aaron Nauth
Todd McKinley
Emil Schemitsch
Research Committee Chair (*ex officio*):
Brett Crist

BY-LAWS & HEARINGS
James Stannard (Chair)
Chad Coles
Eric Meinberg

CLASSIFICATION
Craig Roberts (Chair)
Andrew Evans
Roman Hayda
Matthew Karam
Daniel Stinner
Nirmal Tejwani
Gregory Zych
Julie Agel (Presidential Consultant)
James Kellam (Presidential Consultant)
J Lawrence Marsh (Presidential Consultant)

DISASTER MANAGEMENT PREPAREDNESS
Christopher Born (Chair)
Roman Hayda
Christiaan Mamczak
Usha Mani
Ken Nelson
Eric Pagenkopf
Philip Wolinsky
COT Rep (*ex officio*):
James Ficke

EDUCATION
Robert Ostrum (Chair)
Martin Boyer
Dan Horwitz
Utku Kandemir
Samir Mehta
Marrku Nousiainen
Marcus Sciadini
OKO Member (*ex officio*):
Thomas DeCoster
Resident Member (*ex officio*):
Jennifer Leighton, MD
PA Member (*ex officio*):
Dan Coll

Education Sub-Committee
Toni McLaurin – RCFC, Chair
Marcus Sciadini – RCFC, Co-Chair
David Weiss – Spring RCFC Chair
Jason Lowe – Spring RCFC Co-Chair
Philip R Wolinsky – RATTC, Chair
Nirmal Tejwani – RATTC, Co-Chair
Michael Gardner – AAOS/OTA Course, Chair
Kyle Jeray – AAOS/OTA Course, Co-Chair

Education Sub-Committee, continued
Kenneth Koval – Resident Syllabus
Update Project Director - Phase I
Clifford Jones – Resident Syllabus
Update Project Director - Phase II
Lisa Cannada – Resident Syllabus
Update Project Director - Phase III
Roy Sanders – JOT Editor

EVIDENCE BASED QUALITY, VALUE, SAFETY
William Obremskey (Chair)
Jaimo Ahn
Chad Coles
Cory Collinge
Gudrun Mirick
Arvind Nana
Paul Tornetta, III
Michael Zlowodzki
COT Rep (*ex officio*):
Philip R Wolinsky

FELLOWSHIP & CAREER CHOICES
Lisa Taitsman (Chair)
Madhav Karunakar
Dirk Leu
Frank Liporace
Jason Nascone
Michael Prayson
Roy Sanders
Brad Yoo
David Zamorano
Presidential Consultant:
J. Tracy Watson
Fellow Member:
Yelena Bogdan

Fellowship Match Compliance Sub-Committee
Gregory Schmeling (Chair)
Animesh Agarwal
Robert Probe
Jason Roberts
Dan Schlatter

FINANCE AND AUDIT
Brendan Patterson, CFO, Chairman
David Hak (past CFO)
Douglas Dirschl

FUND DEVELOPMENT
Steven Morgan (chair)
Barry Davis
John France
Ed Perez
Michael Sirkin
Rena Stewart
J. Tracy Watson
OTA CFO (*ex officio*):
Brendan Patterson
Research Chair (*ex officio*):
Brett Crist
Timothy Bray (Presidential Consultant)

HEALTH POLICY & PLANNING
Doug Lundy (Chair)
John Campbell
Alex Jahangir
Clifford Jones
Gerald Lang
Samir Mehta
Manish Sethi
Todd Swenning
Bruce Ziran
EBQVS Liaison (*ex officio*):
Chad Coles
COT Chair (*ex officio*):
Philip R Wolinsky
(*ex officio*): Bruce Browner

HUMANITARIAN
Saqib Rehman (Chair)
Rick Coughlin
Rachel Reilly
Edward Rodriguez
Peter Trafton
Pat Yoon
Disaster Management Chair (*ex officio*):
Christopher Born
Lewis Zirkle (Presidential Consultant)

INTERNATIONAL RELATIONS
Peter Giannoudis (Chair)
Ney Amaral
Fernando DeLaHuerta
Toan Le
Amir Matityahu
Cyril Mauffrey
Hans-Christoph Pape
Toney Russell (Presidential Consultant)

MILITARY
MAJ Daniel Stinner (USA) (Chair)
Lt. COL Wade Gordon (USAF)
COL(R) Roman Hayda
CDR Kevin Kuhn (USN)
Lt. COL Christopher LeBrun (USAF)
LCDR Christopher Smith (USN)
CAPT William Todd (USN, Hospital Ships)
MAJ Eric Verweibe (USA)

PRACTICE MANAGEMENT
Paul Appleton (Chair)
Lisa Cannada
Anthony Infante
Adam Kaufman
James Krieg
Frank Liporace
Brent Norris
Presidential Consultants:
Brad Henley
William Creevy

PUBLIC RELATIONS
Jeffrey Smith (Chair)
Miguel Daccarett
Josh Gary
Alex Jahangir
Mark Lee
Jason Lowe
Hassan Mir
Lori Reed
Jason Sansone

Ad Hoc
OrthoInfo Project Team
Bob Dunbar and Jason Lowe (Chairs)

Newsletter
Hassan Mir (Editor, appointed 2012)
Josh Gary (Co-editor)

RESEARCH
Brett Crist (Chair)
Romney Andersen
Donald Anderson
Timothy Bhattacharyya
Victor De Ridder
Reza Firoozabadi
Michael Gardner
Kelly LeFaivre
Saam Morshed
David Ring
Andrew Trenholm
Emil Schemitsch

Strategic Research Initiative
Gregory Della Rocca (Chair)
Brett Crist
Edward Harvey
Todd McKinley
Theodore Miclau
Steven Olsen
Robert O'Toole

ORTHOPAEDIC ORGANIZATIONAL LIAISONS
AAOS Board of Specialty Societies
David Teague – Presidential Line Rep
Hassan Mir – Communications
David Lundy – Health Policy
Robert Ostrum – Education
Brett Crist – Research
Lisa Taitsman – BOS Match Oversight Committee OTA Rep
Kathleen Caswell – ED Representative

ACS COT (American College of Surgeons Committee on Trauma)
COT Orthopaedic Members
Philip R Wolinsky (Chair)
Gregory Della Rocca
James Ficke
Mark McAndrew
Langdon Hartsock
M. Bradford Henley
Clifford Jones
Mark McAndrew
Anna Miller
Bruce Ziran
Doug Lundy – OTA Rep to the ACS Advisory Council for Surgery
Bill DeLong and Jeff Anglen – ACS Board of Governors

Other Orthopaedic Liaison Positions
Bruce Browner – OTA Liaison to USBJDI
Andrew Schmidt – EWI Civilian Rep Co-Chair (2016 – 2017)

PROJECT TEAMS
AO / OTA Collaboration
Ted Miclau (Chair)

Database Project Team
Doug Lundy (Chair)

ORTHOPAEDIC TRAUMA ASSOCIATION

IN MEMORIAM

OTA remembers the following members who have made contributions to OTA's organizational missions, to education, to the practice of orthopaedics, and to the science of musculoskeletal trauma research.

Robert William Bucholz, MD (2016)
Dallas, Texas

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2016-2017 Academic Year Fellowship Program Awards:

Allegheny General Hospital, Pittsburgh, PA
Daniel T. Altman, MD, Director

Carolinas Medical Center, Charlotte, NC
Madhav Karunakar, MD, Director

Georgia Orthopaedic Trauma Institute, Macon, GA
Lawrence X. Webb, MD, Director

Harborview Medical Center, Seattle, WA
David P. Barei, MD, Director

Hospital for Special Surgery, New York, NY
David L. Helfet, MD, Director

Hughston Orthopaedic Trauma Service (HOTS), Columbus, GA
John C. P. Floyd, MD, FACS, Director

IU Methodist Orthopaedic Trauma Fellowship, Indianapolis, IN
Anthony T. Sorkin, MD, Director

Mass Gen Hosp Brigham & Womens, Boston, MA
Michael Weavers, MD, Director

OrthoIndy, Indianapolis, IN
Timothy Weber, MD, Director

R Adams Cowley Shock Trauma Center, Baltimore, MD
Robert V. O'Toole, MD, Director

Regions Trauma Center/Univ. of Minnesota Orthopaedic, St. Paul, MN
Peter A. Cole, MD, Director

Reno Orthopaedic Trauma Fellowship, Reno, NV
Timothy Bray, MD, Director

San Diego Trauma Fellowship, San Diego, CA
Jeffrey M. Smith, MD, Director

Tampa General Hospital, Tampa, FL
Roy Sanders, MD, Director

University of California (Davis) Medical Center, Sacramento, CA
Mark A. Lee, MD, Director

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2016-2017 Academic Year Fellowship Program Awards:

University of California, San Diego, San Diego, CA
Alexandra K. Schwartz, MD, Director

University of California, San Francisco, San Francisco, CA
Theodore Miclau, MD, Director

University of Miami/Jackson Memorial Medical Center, Miami, FL
Gregory Zych, DO, Director

University of Missouri, Columbia, MO
Brett D. Crist, MD, Director

University of Texas Health Science Center at Houston, Houston, TX
Timothy S. Achor, MD, Director

Vanderbilt University Medical Center, Nashville, TN
Cory Collinge, MD, Director

York Hospital, York, PA
Thomas DiPasquale, DO, FACOS, FAOAO, Director

Awards made possible by

COTA/Stryker, Smith & Nephew, DePuy-Synthes, and **Medtronic**

CONGRATULATIONS

2015-2016 OTA Fellowship Graduating Class:

Kevin Carlile, MD and **Jessica Gordon Kingsberg, MD**
Allegheny Health Network, Pittsburgh, PA
Daniel T. Altman, MD, Director

Mai Nguyen, MD
Case Western Reserve Medical School, MetroHealth Medical Center, Cleveland, OH
John H. Wilber, MD, Director

Daniel Lim Tayag, MD
Georgia Orthopaedic Trauma Institute, Navicent Health, Macon, GA
Lawrence X. Webb, MD, Director

Hans Peter Van Lancker, MD, FRCSC and **Amir Khoshbin, MD, MSc, FRCSC**
Harvard Orthopaedic Trauma, Massachusetts GH
Brigham and Women's Hospital, Boston, MA
Michael Weaver, MD, Director

Isaac Fehrenbacher, MD and **Matthew Cavallero, MD**
IU Methodist Orthopaedic Trauma Fellowship, Indianapolis, IN
Anthony T. Sorkin, MD, Director

Gregory Charles Strohmeyer, MD
Orthopaedic Trauma Surgeons of Northern California, Carmichael, CA
Paul Gregory, Jr. MD, Director

Christopher Sanford, MD
Penn State University, College of Medicine, Hershey, PA
J. Spence Reid, MD, Director

Heather Woodin, MD
Sonoran Orthopaedic Trauma Surgeons, Scottsdale, AZ
Anthony S. Rhorer, MD, Director

David Weatherby, MD, BS, FRCSC and **Chad Beck, MD**
University of California, Davis Medical Center, Sacramento, CA
Mark A. Lee, MD, Director

Paul Clay Baldwin, MD
Orlando Regional Medical Center, Orlando, FL
George Haidukewych, MD, Director

2015-2016 OTA Fellowship Graduating Class, continued

George Ochenjele, MD, **Ida Leah Gitajn, MD**, **Cullen K. Griffith, MD**, **Roman Natoli, MD, PhD** and **Anthony Ding, MD**
University of Maryland, R. Adams Cowley Shock Trauma Center, Baltimore, MD
Robert V. O'Toole, MD, Director

Seth Gengler, DO
University of Miami, Jackson Memorial Medical Center, Miami, FL
Gregory Zych, MD, Director

Emily Wagstrom, MD and **John Kampa, MD**
University of Minnesota, Hennepin County Medical Center, Minneapolis, MN
David C. Templeman, MD, Director

Daniel Hesse, MD and **Evgeny Arkadyevich Dyskin, MD, PhD**
University of Minnesota, Regions Hospital, St. Paul, MN
Peter A. Cole, MD, Director

Austin McPhilamy, MD
University of Nevada School of Medicine,
Reno Orthopaedic Trauma Fellowship, Reno, NV
Timothy Bray, MD, Director

Seth Hall Criner, MS, DO
University of New Mexico Hospital, Albuquerque, NM
Thomas A. DeCoster, MD, Director

Ari David Amitai, MD
University of Rochester, Orthopaedic Trauma Fellowship, Rochester, NY
Kyle Judd, MD, Director

Sean Barrett Kuehn, MD
University of Tennessee - Campbell Clinic, Memphis, TN
John C. Weinlein, MD & Matthew I. Rudloff, MD, Directors

Jeffrey J. Sunblad, MD
University of Tennessee/Erlanger Health Systems, Chattanooga, TN
Peter J. Nowotarski, MD, Director

John Christian Hagedorn II, MD,
Cory Czajka, MD and **Ryan Metri Taylor, MD**
University of Texas Health Science Center, Houston, TX
Timothy S. Achor, MD, Director

2015-2016 OTA Fellowship Graduating Class, continued

Jonathan Barnwell, MD
University of Texas, Parkland Hospital & Health System, Dallas, TX
Adam J. Starr, MD, Director

Justin Haller, MD, **Michael Githens, MD**, **Matthew Robert Garner, MD** and **Timothy Bruce Alton, MD**
University of Washington, Harborview Medical Center, Seattle, WA
David P. Barei, MD, Director

Caroline Anne Tougas, MD, BS
USC Keck School of Medicine, LAC, Los Angeles, CA
Jackson Lee, MD, Director

Jeffrey MacLean, MD, MS and **Norele Jean Cutrera, MD**
Vanderbilt University Medical Center, Nashville, TN
William T. Obremskey, MD & Cory A. Collinge, MD, Directors

Christopher D. Parks, MD
Washington University School of Medicine/Barnes-Jewish Hospital, Saint Louis, MO
William M. Ricci, MD, Director

Gary Updegrove, MD, Eric Swart, MD and **Paul Edward Matuszewski, MD, BS**
Carolinas Medical Center, Charlotte, NC
Madhav Karunakar, MD, Director

David Hampton, MD
Cedars Sinai Medical Center, Los Angeles, CA
Donald A. Wiss, MD, Director

Mani Kahn, MD, MPH, MS
Duke University Medical Center, Durham, NC
Rachel Reilly, MD, Director

Christopher Beiser, DO, **David Galos, MD, BA** and **David Rion, MD**
Grant Medical Center, Columbus, OH
Benjamin C. Taylor, MD, Director

Paul William Perdue, Jr, MD, **Yelena Bogdan, MD** and **Gele Moloney, MD**
Hospital for Special Surgery, New York, NY
David L. Helfet, MD, Director

2015-2016 OTA Fellowship Graduating Class, continued

Aaron Schrayer, MD
Hughston Orthopaedic Trauma Service
John C.P. Floyd, MD, FACS

Adam Cota, MD, FRCSC
OrthoIndy, St. Vincent Hospital, Indianapolis, IN
Timothy G. Weber, MD, Director

Kenneth Koury, MD
Rutgers, New Jersey Medical School, Newark, NJ
Mark C. Reilly, MD, Director

Christopher Vitale, DO
San Diego Trauma Fellowship, San Diego, CA
Jeffrey M. Smith, MD, Director

Thomas Revak, DO
St. Louis University, Saint Louis, MO
J. Tracy Watson, MD, Director

Adam Adler, MD
Stanford University, Redwood City, CA
Michael J. Bellino, MD & Michael J. Gardner, MD, Directors

Darryl A. Auston, MD, **Michael Jason Beebe, MD** and **Jonathan H. Quade, MD**
Tampa General Hospital, Tampa, FL
Roy Sanders, MD, Director

Brian Patrick Cunningham, MD and **Nicholas Antell, MD**
University of California, San Francisco, Orthopaedic Trauma Institute, CA
Theodore Miclau, MD, Director

Stephen Stacey, MD
University of Colorado, Denver Health, Denver, CO
David J. Hak, MD, Director

Jon B. Carlson, MD, **Bryan Houseman, DO, ATC** and **Carlos Kennedy, MD**
University of Louisville, Louisville, KY
David Seligson, MD, Director

2015-2016 OTA Fellowship Graduating Class, continued

Camden Burns, MD and **Jeffery Chad Martin, DO**
University of Kentucky, Lexington, KY
Raymond D. Wright, Jr, MD

Brian Campfield, MD and **Russell Douglas Goode, MD**
University of Missouri, Columbia, MO
Brett D. Crist, MD, Director

Douglas Alexander Smith, DO
University of Oklahoma, Tulsa, Tulsa, OK
Brent L. Norris, MD & Paul R. Stafford, MD, Directors

Brandon Clark, DO
University of Pittsburgh, Pittsburgh, PA
Ivan S. Tarkin, MD & Peter Siska, MD, Directors

Christopher Holden, MD
University of Florida, Gainesville, FL
Kalia K. Sadasivan, MD

Niladri Basu, MD
Virginia Commonwealth University, Richmond, VA
Varatharaj Mounasamy, MD

Arun Aneja, MD, PhD
Wake Forest University, Winston Salem, NC
Eben A. Carroll, MD, Director

Jason Reid, DO
Wright State University, Dayton, OH
Michael J. Prayson, MD, Director

Hans Joseph, DO
York Hospital, York, PA
Thomas DiPasquale, DO, Director

AWARDS

OTA/SIGN SCHOLARSHIP

The Orthopaedic Trauma Association funds two scholarships annually for SIGN members to attend the OTA Annual Meeting. Information regarding SIGN can be found on http://signfracturecare.org.

Congratulations to the following OTA/SIGN Scholarship Winners:

2016 – ***Carlito Chee Kee Valera, JR****, Davao City, Phillipines*
Anthony Maina*, Kjabe Kenya*

JOHN BORDER, MD, MEMORIAL LECTURE

Supported in part by AO/North America and OTA
This lectureship was established to honor the memory of Dr. John Border. John Border was instrumental in the development of modern trauma care and in particular, modern orthopaedic trauma care. He was the pioneer in the concept of total care and the implications of the orthopaedic injuries on the total management of the trauma patient. He was also a surgeon scientist, using both his clinical observations and basic science research to further his patient care in Orthopaedic Trauma.

2015 – Minimally Invasive Surgery – Past, Present, Future
Christian Krettek, MD, FRACS, FRCSEd

EDWIN G. BOVILL, Jr., MD AWARD WINNER

Dedicated to Edwin G. Bovill, Jr., MD, (1918 - 1986)
Surgeon, traumatologist, educator, academician, and gentleman;
co-founder of the Orthopaedic Trauma Association.

2015 – A Multicentre RCT Comparing the InterTAN Device Versus the Sliding Hip Screw in the Treatment of Geriatric Hip Fractures: Results Depend on Preinjury Functional Level
David Sanders, MD*; Dianne Bryant, PhD; Mark MacLeod, MD; Abdel-Rahman Lawendy, MD, PhD, FRCSC; Kevin Gurr, MD; Tim Carey, MD; Christopher Bailey; Debra Bartley; Christina Tieszer, BSc, MSc; Steven Papp, MD, FRCPC; Allan Liew, MD, FRCSC; Wade Gofton, MD, FRCPC; Julia Foxall; Chad Coles, MD; Ross Leighton, MD, FRCSC, FACS; Kelly Trask, MSc; Darius Viskontas, MD; Trevor Stone, MD; Mauri Zomar; Andrew Trenholm, MD; Tracy Adams*

OTA 2016 RESEARCH GRANT AWARD RECIPIENTS

(January 1, 2016 - December 31, 2016 Grant Cycle)

CLINICAL GRANT AWARDS (up to $40,000/year, 2 year grant cycle)

Title: **The DECIPHER Study: DEterminants of Function and Clinically Important outcomes in Proximal Humerus Fractures in the Elder Population: A North American Prospective Cohort**
Principal Investigator: **Emil H Schemitsch, MD, FRCSC**
Co-Principal Investigator: **Michael D McKee, MD, FRCSC**
Awarded Funds: **$87,765** Grant Funded By: **OTA/COTA/Smith & Nephew**

BASIC RESEARCH GRANT AWARDS (up to $50,000 with $25,000/year max up to 2-year grant cycle)

Title: **Antimicrobial Blue Light Therapy for Treatment of Post-traumatic Implant-Related Infections in Orthopedics**
Principal Investigator: **Tianhong Dai, PhD**
Co-Principal Investigators: **Mark S Vrahas, MD**
Awarded Funds: **$50,000** Grant Funded By: **OTA**

Title: **The Effects of Locally Delivered Bone Marrow-Derived Cells on Fracture Healing in a Diabetic Rat Model**
Principal Investigator: **Emil H Schemitsch, MD**
Co-Principal Investigator: **Aaron Nauth, MD**
Awarded Funds: **$50,000** Grant Funded By: **OTA/DePuy Synthes**

Title: **Does Time to Administration or Duration of Treatment with the Mast Cell Stabilizer, Ketotifen Fumarate, Effect Post-traumatic Joint Contractures?**
Principal Investigator: **Prism S Schneider, MD, PhD**
Co-Principal Investigator: **Kevin A Hildebrand, MD**
Awarded Funds: **$49,991** Grant Funded By: **OTA/Zimmer**

Title: **Evaluation of Local Tissue Concentrations and Bioactivity of Vancomycin Eluted from PMMA Implants in an Ovine Fracture Healing Model**
Principal Investigator: **Thomas P Schaer, VMD**
Co-Principal Investigator: **James Krieg, MD**
Awarded Funds: **$49,800** Grant Funded By: **OTA**

2016 DIRECTED TOPIC GRANTS (up to $50,000/year, max. up to 3 year grant cycle)

Title: **Decreasing Systemic Inflammation to Improve Fracture Healing in Polytraumatized Rats**
Principal Investigator: **Todd O McKinley, MD**
Co-Principal Investigator: **Christopher H. Pape, MD**
Awarded Funds: **$117,234** Grant Funded By: **OTA**

TOTAL AWARDED: **$404,790**

2016 RESIDENT GRANT RECIPIENTS (up to $20,000)

Title: **Effect of Cryotherapy on Fracture Healing**
Principal Investigator: **Daniel Castano, MD**
Co-Principal Investigator: **Edward J Harvey, MD MSc**
Awarded Funds: **$18,390** Grant Funded By: **OTA/FOT**

Title: **Anterior Superior Iliac Spine Osteotomy Increases Surgical Exposure Through Both the Lateral and Stoppa Windows: A Cadaveric Study**
Principal Investigator: **Andrew J Sheean, MD**
Co-Principal Investigator: **Michael Beltran, MD**
Awarded Funds: **$11,010** Grant Funded By: **OTA/Smith & Nephew**

Title: **The Effect of Sirtuin-1 on Chondrocyte Progenitor Cell Activity in Acute Cartilage Injury**
Principal Investigator: **Jocelyn T Compton, MD**
Co-Principal Investigator: **J Lawrence Marsh, MD**
Awarded Funds: **$20,000** Grant Funded By: **OTA/FOT**

Title: **Biomechanical Evaluation of Augmentation Strategies for Fixation of Proximal Humerus Fractures Involving the Anatomic Neck in Osteoporotic Bone Amount**
Principal Investigator: **Austin A Pitcher, MD, PhD**
Co-Principal Investigator: **Meir Marmor, MD**
Awarded Funds: **$20,000** Grant Funded By: **OTA/FOT**

Title: **Laser Assisted Indocyanine Green Angiography as an Adjunct in the Evaluation of Skin and Soft Tissue in Closed Distal Plafond Fractures**
Principal Investigator: **Young Lu, MD**
Co-Principal Investigator: **David Zamorano, MD**
Awarded Funds: **$20,000** Grant Funded By: **OTA/FOT**

TOTAL RESIDENT GRANTS AWARDED: **$89,400**

OTA 2016 RESIDENT GRANT RECIPIENTS

(June 1, 2016 - May 31, 2017 Grant Cycle)

Grant Title: **Validation of the Radiographic Union Score for Tibial Fractures (RUST) using Medical Imaging and Biomechanical Testing in an In-Vivo Rat Model**
Principal Investigator: **Meghan C Crookshank, MD**
Co-Investigator: **Radovan Zdero, PhD**
Amount Funded: **$20,000** Grant Funded by: **OTA/DePuy Synthes**

Grant Title: **Posterior Malleolus Exposure Map and Screw Trajectory: A Cadaveric Study**
Principal Investigator: **Bradley Meulenkamp, MD, FRCSC**
Co-Investigator: **Steve Papp, MD**
Amount Funded: **$17,050** Grant Funded by: **OTA**

Grant Title: **Pro-osteogenic Effect of Aminocaproic Acid**
Principal Investigator: **Dalibel M Bravo, MD**
Co-Investigator: **Philipp Leucht, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/DePuy Synthes**

Grant Title: **Complications after Gunshot-associated Fracture Fixation in a Large Population Cohort**
Principal Investigator: **Daniel Pincus, MD**
Co-Investigator: **Hans Kreder, MD**
Amount Funded: **$18,500** Grant Funded by: **OTA**

Grant Title: **Evaluating the Utility of Lateral Elbow Radiographs in Articular Olecranon Reduction: An Anatomic and Radiographic Study**
Principal Investigator: **Jeremy F Kubik, MD**
Co-Investigator: **Christopher Martin, MD**
Amount Funded: **$5,000** Grant Funded by: **OTA**

TOTAL RESIDENT GRANTS AWARDED: **$80,500**

Mission Statement

The mission of the Orthopaedic Trauma Association (OTA) is to promote excellence in care for the injured patient, through provision of scientific forums and support of musculoskeletal research and education of orthopaedic surgeons and the public.

Vision Statement

The OTA will be the authoritative source for the optimum treatment and prevention of musculoskeletal injury, will effectively communicate this information to the orthopaedic and medical community and will seek to influence health care policy that effect care and prevention of injury.

Value Statement

The OTA is adaptable, forward thinking and fiscally responsible and is composed of a diverse worldwide membership who provide care and improve the knowledge base for the treatment of injured patients. OTA members provide worldwide leadership through education, research and patient advocacy.

Scientific Meeting Objectives

The OTA is an organization dedicated to the discovery and dissemination of knowledge and information regarding the prevention, diagnosis, and treatment of musculoskeletal injuries. This 32nd Anniversary Annual Meeting of the OTA will allow all registrants to:

- Discuss and become familiar with the most up-to-date clinical and basic science advances related to the practice of orthopaedic trauma
- Review strategies to optimize management of amputees, as well as identify the most recent innovations in amputee care
- Generate understanding of the most important emerging controversies in managing the fracture healing process, particularly in "problem" fractures
- Summarize the most recent advances in the management of femoral neck fractures and understand the current controversies in treating patients with these injuries
- Apply knowledge of clinical care, controversies, and latest developments in a host of topics related to orthopaedic trauma.

Research sessions will include: original paper presentations dedicated to specific anatomic injury and original basic science papers.

Educational objectives will be fulfilled through the presentation of scientific presentations and symposia with subsequent discussions in an open forum. Ample opportunity will be available to express common concern, share relevant experiences and provide alternative treatment approaches.

General themes of orthopaedic trauma care will also be presented by topic focused symposia, motor skills laboratories, case presentations, scientific poster presentations and technical exhibits.

The American Academy of Orthopaedic Surgeons designates this live activityfor a maximum of **20** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ACCREDITATION – CME INFORMATION

The Basic Science Focus Forum has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and the Orthopaedic Trauma Association. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **11** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The 32nd Annual Meeting of the Orthopaedic Trauma Association has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and Orthopaedic Trauma Association. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **20** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

FDA STATEMENT

Some drugs or medical devices demonstrated at this 32nd Annual Meeting may not have been cleared by the FDA or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.

Academy policy provides that "off label" uses of a drug or medical device may be described in the Academy's CME activities so long as the "off label" use of the drug or medical device is also specifically disclosed (i.e., it must be disclosed that the FDA has not cleared the drug or device for the described purpose). Any drug or medical device is being used "off label" if the described use is not set forth on the product's approval label.

DISCLAIMER

The material presented at the 32nd Annual Meeting has been made available by the *Orthopaedic Trauma Association* for educational purposes only. The material is not intended to represent the only, nor necessarily best, method or procedure appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty which may be helpful to others who face similar situations.

The Orthopaedic Trauma Association disclaims any and all liability for injury or other damages resulting to any individual attending the Annual Meeting and for all claims which may arise out of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by physician or any other person.

DISCLOSURE

The names of authors presenting the papers at the 32nd Annual Meeting are printed in **boldface**.

As an accredited provider of continuing medical education CME, the Academy and OTA are required by the Accreditation Council for Continuing Medical Education (ACCME) to obtain and share with participants of an OTA CME activity any potential conflicts of interest by faculty, program developers and CME planners.

The ACCME Standards of Commercial Support, Standard 2 states the requirements:

2.1 The provider must be able to show that everyone who is in a position to control the content of an education activity has disclosed all relevant financial relationships with any commercial interest to the provider.

2.2 An individual who refuses to disclose relevant financial relationship will be disqualified from being a planning committee member, a teacher, or an author of CME, and cannot have control of, or responsibility for the development, management, presentation or evaluation of the CME activity.

The AAOS disclosure policy requires that faculty submit all financial relationships occurring within the past 12 months that create a potential conflict.

Each participant in the Annual Meeting has been asked to disclose if he or she has received something of value from a commercial company or institution, which relates directly or indirectly to the subject of their presentations.

Authors who completed their financial disclosures have identified the options to disclose as follows:

n. Respondent answered 'No' to all items indicating no conflicts;
1. Royalties from a company or supplier;
2. Speakers bureau/paid presentations for a company or supplier;
3A. Paid employee for a company or supplier;
3B. Paid consultant for a company or supplier;
3C. Unpaid consultant for a company or supplier;
4. Stock or stock options in a company or supplier;
5. Research support from a company or supplier as a PI;
6. Other financial or material support from a company or supplier;
7. Royalties, financial or material support from publishers;
8. Medical/orthopaedic publications editorial/governing board;
9. Board member/committee appointments for a society.

An indication of the participant's disclosure appears after his/her name in the alphabetical listing along with the commercial company or institution that provided the support.

The Academy and OTA do not view the existence of these disclosed interests or commitments as necessarily implying bias or decreasing the value of the author's participation in the meeting.

Δ Indicates presentation was funded by a grant from the Orthopaedic Trauma Association.

Cameras or video cameras may not be used in any portion of the meeting.

OTA MANDATORY DISCLOSURE POLICY FOR GOVERNANCE GROUPS AND CONTINUING MEDICAL EDUCATION CONTRIBUTORS

PHILOSOPHY

In order to promote transparency and confidence in the educational programs and in the decisions of the Orthopaedic Trauma Association (hereinafter collectively referred to as "OTA"), the OTA Board of Directors has adopted this mandatory disclosure policy.

The actions and expressions of Fellows, Members, and Others providing education of the highest quality, or in shaping OTA policy, must be as free of outside influence as possible, and any relevant potentially conflicting interests or commercial relationships must be disclosed. Because the OTA depends upon voluntary service by Fellows, Members, and Others to conduct its educational programs and achieve its organizational goals, this disclosure policy has been designed to be realistic and workable.

The OTA does not view the existence of these interests or relationships as necessarily implying bias or decreasing the value of your participation in the OTA.

OBLIGATION TO DISCLOSE

Each participant in an OTA CME program or author of enduring materials, and members of the OTA Board of Directors, Committees, Project Teams or other official OTA groups (collectively "OTA governance groups"), has the obligation to disclose all potentially conflicting interests. Disclosure information is to be submitted through the AAOS on-line Disclosure Program (or other disclosure form provided and approved by the OTA Participants are responsible for the accuracy and completeness of their information. In addition, participants who disclose via the AAOS on-line Disclosure Program have an obligation to review and update their personal information in the AAOS Orthopaedic Disclosure Program at least semiannually (usually April and October). It is recommended that participants note any changes to the AAOS Orthopaedic Disclosure Program as soon as possible after they occur.

Failure of a required participant to disclose will result in the participant being asked not to participate in the OTA CME program and OTA governance groups.

A list of all participants in OTA CME programs and OTA governance groups, along with their disclosures, will be included in all meeting materials.

Participants in OTA governance groups have an obligation to indicate any potential conflicts they may have during discussions affecting their personal interests during the meeting of the OTA governance group. At each meeting of the OTA governance group, members of the group will be reminded that full disclosure must be made of any potential conflict of interest when a matter involving that interest is discussed.

The chair of the governance group shall also have the prerogative of requesting a participant to provide further information or an explanation if the chair identifies a potential conflict of interest regarding that participant. Based on the information provided in the OTA Orthopaedic Disclosure Program and/or upon a further review, the chair of the OTA governance group may determine that the participant shall:

Disclose the conflict and continue to participate fully in the OTA governance group's deliberations

Disclose the conflict, but abstain from discussing and voting on the matter; or

Disclose the conflict and leave the room until the matter has been fully discussed and acted upon.

If one of the latter two actions is taken, it should be reflected in the minutes of the OTA governance group's meeting.

Adopted: February 2011
Revised: March 2014

Orthopaedic Trauma Association
ANTITRUST POLICY
(Adopted July 2012)

Discussions at OTA meetings often cover a broad range of topics pertinent to the interests or concerns of orthopaedic surgeons. As a general rule, except as noted below, discussions at OTA meetings can address virtually any topic without raising antitrust concerns if the discussions are kept scrupulously free of even the suggestion of private regulation of the profession. However, a number of topics that might be (and have been) discussed at OTA meetings may raise significant complex antitrust concerns. These include:

- Membership admissions, rejections, restrictions, and terminations;
- Method of provision and sale of OTA products and services to non-members;
- Restrictions in the selection and requirements for exhibitors at the OTA Annual Meeting or in CME activities;
- Establishment of the professional compliance program and adoption of Standards of Professionalism;
- Collecting and distributing certain orthopaedic practice information, particularly involving practice charges and costs;
- Obtaining and distributing orthopaedic industry price and cost information;
- Professional certification programs;
- Group buying and selling; and
- Inclusions or exclusion of other medical societies in organizational activities or offerings.

When these and related topics are discussed, the convener or members of the OTA group should seek counsel from Legal Counsel.

OTA urges its Board, committees and other groups not to participate in discussions that may give the appearance of or constitute an agreement that would violate the antitrust laws.

Notwithstanding this reliance, it is the responsibility of each OTA Board or committee member to avoid raising improper subjects for discussion. This reminder has been prepared to ensure that OTA members and other participants in OTA meetings are aware of this obligation.

The "Do Not's" and "Do's" presented below highlight only the most basic antitrust principles. OTA members and others participating in OTA meetings should consult with the OTA Presidential Line and/or General Counsel in all cases involving specific questions, interpretations or advice regarding antitrust matters.

Do Nots

1. Do not, in fact or appearance, discuss or exchange information regarding:
   a. Individual company prices, price changes, price differentials, mark-ups, discounts, allowances, credit terms, etc. or any other data that may bear on price, such as costs, production, capacity, inventories, sales, etc.
   b. Raising, lowering or "stabilizing" orthopaedic prices or fees;
   c. What constitutes a fair profit or margin level;
   d. The availability of products or services;
   e. The allocation of markets, territories or patients.

2. Do not suggest or imply that OTA members should or should not deal with certain other persons or firms.
3. Do not foster unfair practices regarding advertising, standardization, certification or accreditation.
4. Do not discuss or exchange information regarding the above matters during social gatherings, incidental to OTA-sponsored meetings.
5. Do not make oral or written statements on important issues on behalf of OTA without appropriate authority to do so.

Do

1. Do adhere to prepared agenda for all OTA meetings. It is generally permissible for agendas to include discussions of such varied topics as professional economic trends, advances and problems in relevant technology or research, various aspects of the science and art of management, and relationships with local, state or federal governments.
2. Do object whenever meeting summaries do not accurately reflect the matters that occurred.
3. Do consult with OTA counsel on all antitrust questions relating to discussions at OTA meetings.
4. Do object to and do not participate in any discussions or meeting activities that you believe violate the antitrust laws; dissociate yourself from any such discussions or activities and leave any meeting in which they continue.

Special Guidelines for Collecting and Distributing Information

The collection and distribution of information regarding business practices is a traditional function of associations and is well-recognized under the law as appropriate, legal and consistent with the antitrust laws. However, if conducted improperly, such information gathering and distributing activities might be viewed as facilitating an express or implied agreement among association members to adhere to the same business practices. For this reason, special general guidelines have developed over time regarding association's reporting on information collected from and disseminated to members. Any exceptions to these general guidelines should be made only after discussion with the Office of General Counsel. These general guidelines include:

1. Member participation in the statistical reporting program is voluntary. The statistical reporting program should be conducted without coercion or penalty. Non-members should be allowed to participate in the statistical reporting program if eligible; however, if there is a fee involved, they may be charged a reasonably higher fee than members.
2. Information should be collected via a written instrument that clearly sets forth what is being requested.
3. The data that is collected should be about past transactions or activities; particularly if the survey deals with prices and price terms (including charges, costs, wages, benefits, discounts, etc,), it should be historic, i.e., more than three months old.
4. The data should be collected by either the OTA or an independent third party not connected with any one member.
5. Data on individual orthopaedic surgeons should be kept confidential.

6. There should be a sufficient number of participants to prevent specific responses or data from being attributable to any one respondent. As a general rule, there should be at least five respondents reporting data upon which any statistic or item is based, and no individual's data should represent more than 25% on a weighted average of that statistic or item.
7. Composite/aggregate data should be available to all participants – both members and nonmembers. The data may be categorized, e.g., geographically, and ranges and averages may be used. No member should be given access to the raw data. Disclosure of individual data could serve to promote uniformity and reduce competition.
8. As a general rule, there should be no discussion or agreement as to how members should adjust, plan or carry out their practices based on the results of the survey. Each member should analyze the data and make business decisions independently.

OTA GRATEFULLY ACKNOWLEDGES THE FOLLOWING EXHIBITORS FOR THEIR SUPPORT OF THE 32ND ANNUAL MEETING:

Booth #	Company Names	City, State
428	**Aap Implantate AG**	Berlin, Germany
319	**Acelity / KCI**	San Antonio, TX
333	**Acumed**	Hillsboro, OR
420	**Advanced Orthopaedic Solutions**	Torrance, CA
325	**AO Trauma North America**	Paoli, PA
401	**Arthrex Inc.**	Naples, FL
123	**BioAccess, Inc**	Baltimore, MD
440	**Biocomposites Inc.**	Wilmington, NC
415	**Bionova Medical, Inc.**	Germantown, TN
418	**Bioventus LLC**	Durham, NC
409	**Bone Foam Inc.**	Plymouth, MN
500	**Carbofix Orthopedics, Inc.**	Collierville, TN
433	**CoNextions Medical**	Sandy, UT
326	**Conventus Orthopaedics**	Maple Grove, MN
101	**Depuy Synthes**	West Chester, PA
322	**DJO, Inc.**	Vista, CA
427	**ECA Medical**	Thousand Oaks, CA
141	**Emcare Acute Care Surgery**	Dallas, TX
334	**February Point Resort Estates LTD**	Bal Harbour, FL
441	**FH Orthopedics**	Chicago, IL
339	**FORE**	Temple Terrace, FL
139	**Gannet**	Hengelo, Netherlands
332	**Gauthier Biomedical, Inc.**	Grafton, WI
423	**GPC Medical - USA**	Dallas, TX
222	**gSource, LLC**	Emerson, NJ
540	**Innomed Inc.**	Savannah, GA
233	**IntraFuse**	Logan, UT
510	**Invibio**	Conshohocken, PA
235	**Invuity Inc**	San Francisco, CA
127	**ITS**	Maitland, FL
438	**Mallinckrodt Pharmaceuticals**	Hazelwood, MO
424	**Medartis**	Exton, PA

EXHIBITORS LISTING, continued

Booth #	Company Names	City, State
338	**Medtronic Spinal and Biologics**	Memphis, TN
225	**Microware Precision Co Ltd**	Taichung City, Taiwan
221	**Mizuho OSI**	Union City, CA
508	**New Clip Technics**	Haute-Goulaine, France
133	**NuVasive Specialized Orthopedics**	Aliso Viejo, CA
502	**Orthofix**	Lewisville, TX
341	**Orthogrid Systems, LLC**	Woods Cross, UT
425	**Pacific Instruments**	Honolulu, HI
324	**Paradigm Biodevices, Inc.**	Rockland, MA
421	**Quintus Composites**	Camp Verde, AZ
232	**RTI Surgical, Inc.**	Alachua, FL
417	**Sawbones/Pacific Research Labs**	Vashon, WA
329	**Sectra**	Linköping, Sweden
234	**Shukla Medical**	Piscalaway, NJ
413	**Si-Bone, Inc.**	San Jose, CA
121	**Skeletal Dynamics**	Miami, FL
109	**Smith & Nephew, Inc.**	Cordova, TN
Offices 1, 2	**SMV Scientific**	Austin, TX
135	**Sonoma Orthopedic Products, Inc.**	Buffalo Grove, IL
119	**Starr Frame LLC**	Richardson, TX
201	**Stryker**	Mahwah, NJ
439	**Synergy Surgicalists**	Bozeman, MT
218	**The Orthopaedic Implant Company**	Reno, NV
240	**TIDI Products**	Fenton, MI
514	**TriMed, Inc.**	Santa Clarita, CA
241	**Whale Imaging**	Beijing, China
Potomac Ballroom Foyer	**Wolters Kluwer Health | Lippincott Williams & Wilkins**	Philadelphia, PA
538	**Wright Medical**	Memphis, TN
320	**X-Bolt Orthopaedics**	Bristol, United Kingdom
227	**Ziehm Imaging**	Orlando, FL
309	**Zimmer Biomet**	Warsaw, IN
323	**Zyga Technology, Inc.**	Minnetonka, MN