

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



David C. Teague, MD

President's Welcome 2019

Dear OTA Members, Guests and Associates:

Welcome to Denver and the OTA Annual Meeting 2019. On behalf of the OTA Board of Directors (BOD), we thank you for trusting us with your time, your resources and your scientific energy. We recognize that travel away from your busy work and home necessitates a choice and an endorsement of the meetings you elect to attend. We believe you have chosen well and will gain much from this week's myriad offerings.

Mike Gardner, MD, Annual Meeting Program Chair, and the committee present an amazing array of scientific, instructional and case-based discussion sessions, along with annual favorite and new pre-meeting offerings.

The BOD and the entire OTA welcome our colleagues from Argentina, this year's official guest nation. They graciously hosted small OTA contingents on two occasions over the past year. We look forward to reciprocating their hospitality and know their scientific session on Friday brings much for all of us to learn.

Our annual meeting represents the best of our OTA community. It highlights thoughtful scientific approach and brilliant, committed surgeons. The efforts of hundreds of OTA members and associates, committee members and chairs culminate in this premier annual gathering. The meeting, in turn, propels further inquiry and collaboration. It distinguishes the OTA.

Mike McKee, Heather Vallier, Mike Archdeacon, Bill Ricci and Steve Olson comprise your presidential line. Cliff Jones, Chad Coles and Phil Wolinsky represent you all as At-Large Members of the BOD. Doug Lundy, Thomas Higgins, Mike Gardner and Ted Miclau round out the current BOD roster. You would be proud to hear how actively they advocate for you and the organization in all of our deliberations.

Your Board wishes you a tremendous week. Thank you for joining us in the beautiful Front Range of the Rockies.

Respectfully,

Dave Teague, MD OTA President

com

Find a Surgeon

OTA Membership Directory available at www.ota.org. Search by name or location. 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

• Exhibits, Speaker Ready Room, Video Showcase Information	
Acknowledgments	5
OTA Legacy Society	6
Basic Science Focus Forum Program	
• Basic Science Focus Forum Program – Thursday	
International Trauma Care Forum Program	
• International Trauma Care Forum Program – Thursday	
Annual Meeting Scientific Program	
Annual Meeting Scientific Program – Thursday	
Annual Meeting Scientific Program – Friday	
Annual Meeting Scientific Program – Saturday	
Basic Science Focus Forum Abstracts	
International Trauma Care Forum Abstracts	86
• Annual Meeting Scientific Program - Paper Abstracts	123
Scientific Poster Abstracts	201
International Scientific Poster Abstracts	350
Digital Presentations	358
Alphabetical Author Listing	379
• OTA History	445
Board of Directors/Committees	447
• 2018-19 COTA Fellowship Program Awards	454
• 2018-19 OTA Fellowship Graduating Class.	457
• Awards	462
• Info-FAQs	466
Annual Meeting Objectives	
CME Information	468
Disclosure Information	469
Antitrust Policy	472
Code of Ethics	475
Conflict of Interest	476
Industry Session & Product Theater Listing	480
• Exhibitor Listing	

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

GENERAL INFORMATION

and TECHNICAL EXH	S IBITS 200 100 - 355: Exhibitor Lictiv	E Concourse Mile High
Open: Thursday	2:30 PM – 5:00 PM (Unop) 5:15 PM – 6:15 PM (Happy Hour Exhibitor Recep Sponsored by OsteoCentric Teo	tion (<i>Mile High</i>)
Friday	9:00 AM – 5:00 PM (Unopposed times: 9:00 AM - 9:30 A 12:10 PM - 1:10 PM; 2:36 PM - 3:0	M; 6 PM)
Saturday	9:00 AM – 1:45 PM (Unopposed times: 9:00 AM - 9:30 A	M; 11:41 AM - 12:41 PM)
SPEAKER READY RO	OM 4·00 PM – 6·00 PM	Room 610/612
Open: Wed. thru Sat.	6:00 AM - 6:00 PM	
OTA VIDEO SHOWC Open: Wednesday Open: Thurs. thru Sat.	ASE 12:00 PM – 5:00 PM 6:30 AM – 5:00 PM	Mile High
INTERNATIONAL RE Wednesday	CEPTION Four Seas 5:25 PM – 6:25 PM	ons Pre-function Area
Thursday	DN Ellie 6:20 PM – 8:20 PM	Caukins Opera House
WELCOME RECEPTION Thursday WOMEN IN ORTHOP KATHY CRAMER ME Friday	DN Ellie 6:20 PM - 8:20 PM AEDIC TRAUMA MORIAL LUNCHEON 12:10 PM - 1:10 PM	Caukins Opera House Room 501/502
WELCOME RECEPTION Thursday WOMEN IN ORTHOP KATHY CRAMER ME Friday NEW MEMBER LUNC Friday	DN Ellie 6:20 PM - 8:20 PM AEDIC TRAUMA MORIAL LUNCHEON 12:10 PM - 1:10 PM CHEON 12:10 PM - 1:10 PM	Caukins Opera House Room 501/502 Room 403/404
WELCOME RECEPTION Thursday WOMEN IN ORTHOP KATHY CRAMER ME Friday NEW MEMBER LUNC Friday MILITARY RECEPTIO Friday	DN Ellie 6:20 PM 8:20 PM AEDIC TRAUMA MORIAL LUNCHEON 12:10 PM 1:10 PM CHEON 12:10 PM 1:10 PM DN 5:30 PM 6:30 PM	Caukins Opera House Room 501/502 Room 403/404 License Plate Lobby
 WELCOME RECEPTION Thursday WOMEN IN ORTHOP KATHY CRAMER MEL Friday NEW MEMBER LUNC Friday MILITARY RECEPTION Friday YOGA Sponsored by Surgeon Wednesday Friday 	DN Ellie 6:20 PM – 8:20 PM AEDIC TRAUMA MORIAL LUNCHEON 12:10 PM – 1:10 PM CHEON 1:10 PM - 12:10 PM – 1:10 PM CHEON - 6:30 PM 5:30 PM – 6:30 PM 5:30 PM – 6:30 PM 5:30 PM – 6:30 PM	Caukins Opera House Room 501/502 Room 403/404 License Plate Lobby Room 102
 WELCOME RECEPTION Thursday WOMEN IN ORTHOP KATHY CRAMER ME Friday NEW MEMBER LUNC Friday MILITARY RECEPTIO Friday YOGA Sponsored by Surgeo Wednesday Friday MEDITATION Sponsored Daily (Wed Fri.) Guided (Wed Fri.) 	DN Ellie 6:20 PM – 8:20 PM AEDIC TRAUMA MORIAL LUNCHEON PM 12:10 PM – 1:10 PM CHEON 1:10 PM PM 5:30 PM – 6:30 PM onMasters 5:30 PM – 6:30 PM 5:30 PM – 6:30 PM by SurgeonMasters) 6:00 AM – 4:00 PM i.) 7:00 AM – 7:30 AM	Caukins Opera House Room 501/502 Room 403/404 License Plate Lobby Room 102 Room 102
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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.

2019 OTA RESEARCH & EDUCATION DONORS (as of August 5, 2019)

> Diamond Award (\$250,000+) Smith & Nephew

Platinum Award (\$150,000 - \$249,999)DePuy SynthesZimmer Biomet

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

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> **Copper Award** (\$25,000 - \$49,999) **The Aircast Foundation, Inc. Bioventus**

> > **Sponsor Award** (\$5,000 - \$24,999)

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Sincere Appreciation to 2019 Donors to the OTA Annual Meeting Pre-Meeting Events:

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Acumed Stryker

5

OTA Legacy Society

OTA acknowledges and thanks the many generous donors who give not only of their time, but of their financial resources to ensure the OTA mission thrives.

ICON Award (\$50,000 or greater)

Kathryn E. Cramer, MD⁺ Dr. Todd W. and Mrs. Jennifer Mailly Dr. Thomas (Toney) A. and Mrs. Gina Russell Roy Sanders, MD

LEGEND Award (\$25,000 - \$49,999)

Kyle J. Jeray, MD Ross K. Leighton, MD Douglas W. Lundy, MD, MBA William M. Ricci, MD Marc F. Swiontkowski, MD David C. Teague, MD Bruce H. Ziran, MD, FACS

†=Deceased

OTA Legacy Society, continued

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

Marc A. Aiken, MD Jeffrey O. Anglen, MD Paul T. Appleton, MD Michael T. Archdeacon, MD, MSE **Atlantic Provinces Orthopedic Society** James C. Binski, MD Christopher T. Born, MD Michael J. Bosse, MD Timothy J. Bray, MD Bruce R. Buhr, MD Dr. and Mrs. Joseph Cass Michael W. Chapman, MD Peter A. Cole, MD Curt P. Comstock, MD William R. Creevy, MD Brett D. Crist, MD, FAAOS, FACS, FAOA Gregory J. Della Rocca, MD, PhD Kenneth A. Egol, MD Florida Orthopaedic Institute, Tampa, Florida Stuart M. Gold, MD John T. Gorczyca, MD James A. Goulet, MD Ramon B. Gustilo, MD David J. Hak, MD, MBA, FACS David L. Helfet, MD Alan L. Jones, MD Clifford B. Jones, MD, FACS Gerald J. Lang, MD

Frank W. Maletz, MD, FACS J. Lawrence Marsh, MD Simon C. Mears, MD, PhD Theodore Miclau, III, MD Steven J. Morgan, MD James V. Nepola, MD William T. Obremskey, MD, MPH, MMHC Steven A. Olson, MD Glenn E. Oren, MD OrthoArizona, Phoenix, Arizona Brendan Patterson, MD Andrew N. Pollak, MD Michael J. Prayson, MD Robert A. Probe, MD Mark Cameron Reilly, MD Andrew H. Schmidt, MD John Schwappach, MD Brian R. Sears, MD Michael S. Sirkin, MD Jeffrey M. Smith, MD David C. Templeman, MD Paul Tornetta, III, MD Dr. Peter & Mrs. Frances Trafton **USCF/SFGH Orthopaedic Trauma** Institute Heather Vallier, MD J. Tracy Watson, MD John Charles Weinlein, MD Edward C. Yang, MD



OTA celebrates the launch of the Roy Sanders OTA Traveling Fellowship!



This immersive leadership experience for early to mid-career orthopaedic trauma surgeons includes travel to 8 - 10 North American trauma centers where the fellows will engage with highly established leaders in the orthopaedic trauma community and OTA.

The first class of traveling fellows will be announced November of 2019.

The OTA extends sincere gratitude to Roy Sanders, MD, for his ongoing leadership and his generous endowment of the Roy Sanders OTA Traveling Fellowship. The program will enrich the lives of the selected fellows and help build the next generation of OTA leaders.

Complete details regarding the program are available on the OTA website: https://ota.org/fellowship/traveling-fellowship

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

2019 Sponsors + Award (\$100,000+) Roy Sanders

2019 Sponsors Award (\$5,000 - \$25,000) David C. Teague

2019 Members Award (\$1,000 - \$4,999)

John D. Adams, Marc A. Aiken, Michael T. Archdeacon, Michael Billhymer, Yelena Bogdan, Joseph Borrelli, Chad P. Coles, Curt P. Comstock, Richard Coughlin, Brian P. Cunningham, James N. DeBritz, Niloofar Dehghan, Gregory J. Della Rocca, Mark Dyball, Eric W. Fulkerson, Kevin P. Haddix, Steven P. Haman, Daniel Scott Horwitz, Justin R. Kauk, Stephen A. Kottmeier, Jacqueline J. Krumrey, Ross K. Leighton, Eric Lindvall, Jeffrey Low, Douglas W. Lundy, Michael McKee, Brian H. Mullis, Robert F. Ostrum, Robert O'Toole, Michael Prayson,
Abid A. Qureshi, Mark W. Richardson, William M. Ricci, Edward K. Rodriguez, Heather A. Vallier, John C. Weinlein, Sharese M. White, Philip R. Wolinsky, Jennifer H. Wood, Richard S. Yoon,

2019 Friends Award (\$250 - \$999)

Peter Althausen, Jeffrey O. Anglen, Paul T. Appleton, Paul M. Balthrop, Brett Allen Barrick, Emily Benson, James C. Binski, James A. Blair, Matthew R. Bong, Michael J. Bosse, Brandon T. Bruce, Kathleen Caswell, Daniel S. Chan, Michael W. Chapman, Brett D. Crist, Woodie Cross, Danielle Nichole Ries De Chaaffin, George S. Dyer, Kenneth A. Egol, Michael S. Eilerman, Darin Friess, Michael J. Gardner, Jacqueline Geissler, Richard Evan Gellman, Gerald Q. Greenfield, Sean M. Griffin, Steven Gross, Luke Harmer, Giselle M. Hernandez, Thomas F. Higgins, Joseph Hoegler, Joseph Hsu, Kyros Reinhard Ipaktchi, Madhav A. Karunakar, James Kellam, Lawrence B. Kempton, Dirk W. Kiner, Brian J. Kistler, Michael Krosin, William Lack, Gerald J. Lang, Thomas M. Large, Mark A. Leberte, Thuan V. Ly, J. Lawrence Marsh, Armen K. Martirosian, Paul E. Matuszewski, James F. Mautner, Eric Meinberg, Matthew Ramesh Gopinath Menon, Theodore Miclau III, Hassan R. Mir, Matthew A. Mormino, Brent L. Norris, Steve A. Olson, Patrick M. Osborn, Steven R. Papp, Brendan M. Patterson, Matthew D. Putnam, William M. Reisman, Howard Richter, Jeremy W. Russell, H. Claude Sagi, Drew T. Sanders, Bruce J. Sangeorzan, Thomas M. Schaller, Susan A. Scherl, Andrew H. Schmidt, John R. Schwappach, John A. Scolaro, Daniel Segina, Andrew Sems, Anjan Shah, Daniel V. Sheerin, Justin C. Siebler, Jordan L. Smith, John W. Staeheli, Daniel L. Stahl, Michael D. Stover, Eric Swart, Marc F. Swiontkowski, Daniel L. Tayag, Brian M. Tonne, Jose Bernardo Toro, Peter G. Trafton, Andrew Trenholm, Rob E. Van Demark, Gregory A. Vrabec, Emily Wagstrom, J. Tracy Watson, David Brian Weiss, Russell D. Weisz, Paul S. Whiting, John J. Wixted

2019 Associates Award (up to \$249)

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Bronze Award (\$50,000 - \$74,999) Foundation for Orthopedic Trauma Globus Medical

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Sponsor Award (\$5,000 - \$24,999) Acumed Arthrex PFS Med Inc

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

The Geneva Foundation

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Todd W. Mailly William M. Ricci

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2018 Associates Award (up to \$249)

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CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS



COTA acknowledges the generous 2018 financial support for the 2018-2019 Fellowship Year from the following Industry Partners:

Smith and Nephew	\$300,000
DePuy Synthes	\$200,000
Stryker	\$150,000
Medtronic	\$75,000
Zimmer Biomet	\$25,000

2018-19 COTA Board of Directors:

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

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

website: www.cotagrants.org

Thank you to Drs. Swiontkowski and Vallier for your years of service.

COTA welcomes Andrew Evans, MD and Mai Nguyen, MD to the 2019-20 Board.



2019 BASIC SCIENCE FOCUS FORUM

September 25-26, 2019

Room 605/607

Basic Science Committee

Edward J. Harvey, MD, Chair Michael T. Archdeacon, MD Andrew R. Evans, MD, FACS Justin Haller, MD Christopher Lee, MD Aaron Nauth, MD Emil H. Schemitsch, MD

Learning Objectives

Upon successful completion of this course, participants will be able to:

- Outline internal fixation principles to guide treatment
- Explore new concepts in polytrauma with attention to haemorrhage and wound care
- Discover the basic science and clinical applications of induced membrane surgery
- Understand the major techniques in delivering antibiotics in surgery
- Comprehend the basic science and clinical applications of bone grafting
- Understand what new regulatory rules will mean to you for research and innovation.

The Orthopaedic Trauma Association 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.





2019 BASIC SCIENCE FOCUS FORUM

WEDNESDAY, September 25, 2019

(Room 605/607)

- 6:00 AM Speaker Ready Room (E Concourse)
- 6:15 AM **Registration** (*Mile High Ballroom Pre-function Area*)
- 6:45 AM Continental Breakfast (Room 605/607)
- 7:30 AM Introduction Edward J. Harvey, MD, Program Chair

7:35 – 8:35 AM	SYMPOSIUM I BIOMECHANICAL MODELS KEY CONSIDERATIONS IN STUDY DESIGN
	Moderators: Emil H. Schemitsch, MD Peter Augat, PhD
7:35 AM	What are the Most Important Characteristics of a Good Biomechanical Study? Peter Augat, PhD
7:44 AM	FE versus Composite Bone versus Cadaver Bone: How Do I Choose? <i>Michael Hast, PhD</i>
7:53 AM	How Do I Select an Experimental Test and FE Analysis Protocol? <i>Mark Heyland, PhD</i>
8:02 AM	Use of Biomechanics Research for Implant Design: What are the Pros and Cons? <i>Michael Bottlang, PhD</i>
8:11 AM	How I Use the Results of Biomechanical Research in Clinical Practice! Emil H. Schemitsch, MD
8:20 AM	Discussion

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

Basic Science Focus Forum – WEDNESDAY, SEPTEMBER 25, 2019

8:35 – 9:10 AM	PAPER SESSION I BIOMECHANICS - HOT TOPICS
	Moderators: Emil H. Schemitsch, MD Peter Augat, PhD
8:35 AM (p. 59) PAPER 1	Comparison of Three Methods for Maintaining Inter-Fragmentary Compression After Fracture Reduction and Fixation in an Osteoporotic Sawbones Model Brendan G. Swain ; Brigham K. Au, MD; Matthew Landrum, MD; Craig M. Birch, MD
8:41 AM (p. 60) PAPER 2	Supplemental Fixation of Supracondylar Distal Femur Fractures: A Biomechanical Comparison of Dual-Plate and Plate-Nail Fixation Techniques David Wright, MD; Donald Desanto, MD; Michelle H. McGarry, MD; Thay Q. Lee, PhD; John A. Scolaro, MD
8:47 AM (p. 61) PAPER 3	Dramatically Improved Strength of Proximal Humeral Fixation with a Tuberosity-Specific Fixation Plate Robert Walker, MD; Paulo Castaneda, BS; Jill Anne Goodwin, MD; Michael D. McKee, MD, FRCSC
8:53 AM (p. 62) PAPER 4	Biomechanical Evaluation of Locked Plating Fixation for Unstable Femoral Neck Fractures Emily Bliven, BS; Simon Hackl, MD; Sabrina Sandriesser; Peter Augat, PhD
8:59 AM	Discussion
9:10 AM	Refreshment Break
9:25 – 10:25 AM	SYMPOSIUM II: THE POLYTRAUMA PATIENT: CURRENT CONCEPTS AND EVOLVING CARE
	Moderators: Christopher Lee, MD Justin Haller, MD
9:25 AM	Overview Christopher Lee, MD
9:30 AM	Hemorrhage Control Todd E. Rasmussen, MD
9:40 AM	Timing of Surgery Hans-Christoph Pape, MD
9:50 AM	Spectrum of Coagulopathy in Trauma: Acute Trauma-induced Coagulopathy versus Venous Thromboembolism

Joshua L. 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, SEPTEMBER 25, 2019

- 10:00 AMNegative Pressure Wound Therapy in Polytrauma Patients
James P. Stannard, MD
- 10:10 AM Discussion

10:25 –	PAPER SESSION II:
11:15 AM	GENERAL TRAUMA TOPICS

Moderators:	Christopher Lee, MD
	Justin Haller, MD

10:25 AM Intra-Articular Relaxin-2 as a Treatment for Arthrofibrosis (p. 63) Edward Rodriguez, MD; Stephen Okajima; Philip Hanna, MD; PAPER 5 Aron Lechtig, MD; William Blessing; Maria Belen Cubria; Angie N. Sabogal, MD; Juan V. Camacho, MD; Mark Grinstaff, PhD; Ara Nazarian 10:31 AM Vaporized versus Combusted Nicotine: A Biomechanical Comparison of (p. 64) Achilles Tendon Healing in a Rat Model PAPER 6 Matthew R. Garner, MD; Patrick M. Kennedy, DPT, MD; Kaitlin L. Saloky, BS; Aditya Yadavalli, BS; Erin M. Barlow, BA; Michael C. Aynardi, MD; Jesse E. Bible, MD, MHS; Gregory S. Lewis, PhD; Aman Dhawan, MD 10:37 AM Discussion 10:47 AM Early Immunotypes Identify Trauma-Tolerant and Trauma-Sensitive (p. 65) Patients with Orthopaedic Injuries Todd O. McKinley, MD; Greg E. Gaski, MD; Yoram Vodovotz, PhD; PAPER 7 Timothy R. Billiar, MD 10:53 AM Intramedullary Nailing Alters Pulmonary Neutrophil Deposition and (p. 66) Cell Surface Receptor Expression in Experimental Orthopedic Trauma in Rats PAPER 8 Michel Teuben; Martijn Hofman; Johannes Greven; Zhi Oiao; Alba Shehu; Kai O. Jensen, MD; Frank Hildebrand, MD; Roman Pfeifer, MD; Hans-Christoph Pape, MD 10:59 AM Local versus Systemic Inflammation in a Standardized Porcine Trauma Model: Is There a Discernible Effect of the Magnitude of Injuries? (p. 67) PAPER 9 Sascha Halvachizadeh, MD; Michel Teuben; Yannik Kalbas; Frank Hildebrand, MD; Paolo Cinelli, PhD; Roman Pfeifer, MD; Hans-Christoph Pape, MD 11:06 AM Discussion Walk to Room 401-404 INDUSTRY LUNCH (No CME credits offered) 11:25 AM-12:25 PM Zimmer Biomet Principles of Proximal Humeral Fracture Fixation: A Case-Based and (Room 401-404) Comparative Review of Current Technologies in Plating and Nailing Faculty: Frank Liporace, MD and Prof. Michael Wich

Box lunch provided by OTA.

12:35 – 1:35 PM	SYMPOSIUM III: THE INDUCED MEMBRANE (MASQUELET) TECHNIQUE FOR BONE DEFECTS: BASIC SCIENCE, CLINICAL EVIDENCE AND TECHNICAL ISSUES
	Moderator: Aaron Nauth, MD
12:35 PM	Overview
12:40 PM	Basic Science Evidence for the Induced Membrane Technique J. Tracy Watson, MD
12:50 PM	The Induced Membrane Technique: Clinical Evidence <i>Janet Conway, MD</i>
1:00 PM	Indications and Contraindications for the Induced Membrane Technique <i>Paul Tornetta III, MD</i>
1:10 PM	The Induced Membrane Technique: Technical Tips <i>Brent Norris, MD</i>
1:20 PM	Discussion

1:35 -PAPER SESSION III:2:10 PMMASQUELET OR SEGMENTAL BONE DEFECT

	Moderator: Aaron Nauth, MD
1:35 PM (p. 68) PAPER 10	Is the Bioactivity of Induced Membranes Time-Dependent? <i>Jan Gessmann, MD</i> ; Thomas Rosteius, MD; Kavitha Sivalingam; Dominik Seybold; Elvira Peter; Thomas A. Schildhauer, MD; Manfred Koeller
1:41 PM (p. 69) PAPER 11	Evaluation of Local Gene Expression in Response to the Presence of Antibiotics in a Polymethylmethracylate Spacer Max Davis , MD; Mark Hake, MD; Andrea Alford
1:47 PM (p. 70) PAPER 12	Thermal Stability of "End of the Line" Antibiotics When Used in Polymethylmethacrylate Bone Cement <i>Ashley Levack, MD</i> ; Kathleen Turajane, BS; Xu Yang, MD; Andy Miller, MD; Mathias P.G. Bostrom, MD; David Wellman, MD
1:53 PM (p. 71) PAPER 13	Effectiveness of Bioactive Ceramic Based 3D Printing Scaffold Coating with BMP-2 in Induced Membrane Technique for Critical Sized Bone Defect of Rabbit Jae-Woo Cho; Beom-Soo Kim, MD; Do-Hyun Yeo, MD; Wontae Cho; Eic Ju Lim; Seungyeob Sakong; Dong-Wan Kang; Imju Jeong, PhD; Iong-Keon Oh, MD, PhD

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Basic Science Focus Forum – WEDNESDAY, SEPTEMBER 25, 2019

1:59 PM	Discussion	
2:10 PM	Break	
2:25 – 3:05 PM	PAPER SESSION IV: INFECTION OR ABC DELIVERY	
	Moderators: Edward J. Harvey, MD Catherine G. Ambrose, PhD	
2:25 PM	Overview Edward J. Harvey, MD	
2:30 PM (p. 72) PAPER 14	The Potential of Metagenomic DNA Sequencing for Pathogen Identification in Orthopaedic Non-union <i>Gerard Chang, MD</i> ; Timothy Tan, MD; Karan Goswami, MD; John T. Strony, BS; Keenan Sobol, BS; Brianna Fram, MD; Javad Parvizi, MD, FRCS; James C. Krieg, MD	
2:36 PM (p. 73) PAPER 15	Antibiotic Elution from a Magnesium Phosphate Resorbable Cement Brandon L. Roller; James L. Cook, DVM, PhD; Aaron M. Stoker, MS, PhD	
2:42 PM (p. 74) PAPER 16	The Effects of Sterilization Techniques on Bioactivity of PMMA Antibiotic Beads Containing Vancomycin and Tobramycin James Chung-Jade Shaw, MD; Andrea Baker; Yesul Tina Kim, BS; Madison Milhoan; Joshua L. Gary, MD; Andrew R. Burgess, MD; Heidi B. Kaplan, PhD; Catherine G. Ambrose, PhD	
2:48 PM (p. 75) PAPER 17	A Novel Diagnostic Blood Test for Acute Septic Arthritis: A Prospective Validation Study Blake J. Schultz, MD ; Tim E. Sweeney; Melissa Remmel, MSc; Uros Midic, PhD; Malcolm DeBaun, MD; Michael J. Gardner, MD	
2:54 PM	Discussion	
3:05 PM	Walk to Room 401-404	

Basic Science Focus Forum – WEDNESDAY, SEPTEMBER 25, 2019

3:15– 4:20 PM	JOINT SESSION IV: LOCAL DELIVERY OF ANTIBIOTICS FOR BONE INFECTIONS: CURRENT INSIGHTS (Room 401-404)
	Moderators: Peter V. Giannoudis, MD, FACS, FRCS Edward J. Harvey, MD
3:15 PM	Overview Peter V. Giannoudis, MD, FACS, FRCS
3:20 PM	Cement Bids and Cement Spacers: An Update <i>David J. Hak, MD</i>
3:30 PM	Matrices Edward J. Harvey, MD
3:40 PM	Bone Substitute Options and Effectiveness <i>Peter V. Giannoudis, MD, FACS, FRCS</i>
3:50 PM	Coated Nails Brett D. Crist, MD
4:00 PM	The Role of Bioglass Nikolaos Kanakaris, MD, PhD
4:10 PM	Discussion
4:20 PM	BSFF Concludes for the Day
	Peter Giannoudis, MD and the International Committee invite you to stay for the conclusion of the International Trauma Care Forum.
	 Key Note Lecturer from the Guest Nation, Christian Allende, MD Best of the Best Paper Session
	Please see page 24 for full International Trauma Care Forum agenda.
	After the International Trauma Care Forum adjourns for the day, you are invited to attend the International Reception.
5:25 PM- 6:25 PM	International Trauma Care Forum Reception (Four Seasons Ballroom Pre-function Area) Join your colleagues for refreshments and view the

international posters display. With special thanks and support from KCI, an Acelity company.

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2019 BASIC SCIENCE FOCUS FORUM

THURSDAY, September 26, 2019 (Room 605/607)

- 6:00 AM Speaker Ready Room $(\bar{E} Concourse)$
- **Continental Breakfast** 6:45 AM (Room 605/607)
- Introduction 7:30 AM Edward J. Harvey, MD, Program Chair

7:35 – 8:30 AM	SYMPOSIUM V: BONE HEALING SYMPOSIUM: ADVANCES IN BIOLOGY AND TECHNOLOGY	
	Moderators: Andrew Evans, MD John Wixted, MD	
7:35 AM	NSAIDs and Bone Healing – What is the Answer? Joseph Borrelli Jr, MD, MBA	
7:45 AM	Metabolic Optimization – A Missed Opportunity in Bone Health? Vitamin D and Calcium Use <i>Brian Mullis, MD</i>	
7:55 AM	Strategies to Optimize Fracture Healing When Competing with Infection <i>Brett Crist, MD</i>	
8:05 AM	Advances in MSc Harvest for Bone Healing – Can We Make It Work Now? <i>Mark Lee, MD</i>	
8:15 AM	Discussion	

Basic Science Focus Forum – THURSDAY, SEPTEMBER 26, 2019

8:30 – 10:05 AM	PAPER SESSION V: BONE HEALING	
	Moderators: Andrew Evans, MD TBD	
8:30 AM (p. 76) PAPER 18	Δ Enhancing Bone Healing with Boron Salt <i>Susan Mengxiao Ge, MD</i> ; Lina Hadidi, MD; Marianne Comeau-Gauthier, MD; Ore-Oluwa Olasubulumi; Jose Luis Ramirez Garcia Luna; Géraldine Merle; Edward J. Harvey, MD, MSc, FRCSC	
8:36 AM (p. 77) PAPER 19	BMP2 Accelerates Healing and Prevents Infection in Two Porcine Critical Sized Defect Models Todd O. McKinley, MD; Melissa Kacena, PhD; Paul J. Childress, PhD; Jeffrey Anglen, MD, FACS; Tien Gabriel Chu, PhD; Austin Wininger; Karl D. Shively, MD; Roman Natoli, MD	
8:42 AM (p. 78) PAPER 20	Osteogenic and Chondrogenic Differentiation Defects in Geriatric Human Skeletal Stem Cells from Acute Fractures Lawrence H. Goodnough, MD; Thomas H. Ambrosi, MSc, PhD; Malachia Hoover; Michael Bellino, MD; Julius A. Bishop, MD; Michael J. Gardner, MD; Michael T. Longaker, MD; Charles K.F. Chan, PhD	
8:48 AM (p. 79) PAPER 21	Biocompatible Ex Vivo-induced Designer Fracture Hematoma for the Healing of Segmental Bone Defects Vaida Glatt; Anna Woloszyk; Kevin Tetsworth, MD	
8:54 AM (p. 80) PAPER 22	Δ Unleashing β-Catenin with a New Anti-Alzheimer Drug for Bone Tissue Regeneration Marianne Comeau-Gauthier, MD ; Magdalena Tarchala, MD; Jose Luis Ramirez Garcia Luna, MD; Edward J. Harvey, MD, MSc, FRCSC; Géraldine Merle, PhD	
9:00 AM	Discussion	
9:10 AM	Break	
9:25 AM (p. 81) PAPER 23	A Stem-cell Based Evidence for NSAID Safety During Fracture Healing Thomas Han Ambrosi, MSc, PhD; <i>Lawrence H. Goodnough, MD</i> ; Michael J. Gardner, MD; Julius A. Bishop, MD; Michael Bellino, MD; Michael T. Longaker, MD; Charles K.F. Chan, PhD	
9:31 AM (p. 82) PAPER 24	Bioassay of Circulating Collagen X Degradation Product Correlates with Mouse and Human Fracture Healing Progression Zachary Working, MD; Sarah Almubarak, MD; Ryan Coghlan; Jiun Chiun Chang, PhD; Aman Chopra, BA; Elizabeth R. Morris, BA; Ronen Schweitzer, PhD; William Horton, MD; Theodore Miclau, MD; Chelsea S. Bahney, PhD	

 Δ OTA Grant

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Basic Science Focus Forum – THURSDAY, SEPTEMBER 26, 2019

BASIC SCIENCE

9:37 AM (p. 83) PAPER 25	Optimization of Autogenous Bone Grafting in the Induced Membrane Technique in a Small Animal Segmental Bone Defect Model <i>Hening Sun, BS</i> ; <i>Charles Godbout, PhD; Emil H. Schemitsch, MD;</i> <i>Aaron Nauth, MD</i>	
9:43 AM (p. 84) PAPER 26	Developing a Novel Porcine Meta-Critical Sized Bone Defect Model for Clinical Translation Roman Natoli, MD ; Melissa Kacena, PhD; Jeffrey Anglen, MD, FACS; Tien Gabriel Chu, PhD; James Patrick Fischer; Karl D. Shively, MD; Todd O. McKinley, MD	
9:49 AM (p. 85) PAPER 27	Reamed Irrigation-Aspiration (RIA) is Associated with Enhanced Fracture Hematoma Cell Viability and Decreased Neutrophil Maturation in Porcine Intramedullary Nailing Michel Teuben; Sascha Halvachizadeh, MD; Yannik Kalbas; Zhi Qiao; Nikola Cesarovic, DVM, PhD; Frank Hildebrand, MD; Paolo Cinelli, PhD; Hans-Christoph Pape, MD; Roman Pfeifer, MD	
9:55 AM	Discussion	
10:05 – 11:05 AM	SYMPOSIUM VI: REGULATION OF ORTHOPAEDIC DEVICES: FUTURE IMPLICATIONS FOR RESEARCH AND INNOVATION	
	Moderator: Saam Morshed, MD	
10:05 AM	Overview	
10:10 AM	Regulatory Changes for the Industry - Europe and North America <i>Robert Poggie, PhD</i>	
10:20 AM	What Research does Industry Value? Roy Sanders, MD	
10:30 AM	Data Assets and the Promise of Orthopaedic Trauma Registries <i>Mitchell Harris, MD</i>	
10:40 AM	Crowdsourcing, Contract Research, and Future Strategies for Testing and Approval of New Devices <i>Vincent Devlin, MD</i>	
10:50 AM	Discussion	
11:05 AM	Adjourn to INDUSTRY LUNCH SYMPOSIA (On-site Registration Available) Boxed lunch provided by OTA.	



2019 INTERNATIONAL TRAUMA CARE FORUM

September 25-26, 2019

(Room 601/603)

International Committee

Peter V. Giannoudis, MD, FACS, FRCS Chair Ney Amaral, MD Fernando de la Huerta, MD Theodore Toan Le, MD Hans-Christoph Pape, MD, FACS Anjan R. Shah, MD Robert D. Zura, MD

Learning Objectives

Upon successful completion of this course, participants will be able to:

- Revisit surgical techniques of pelvic and acetabulum reconstruction
- Understand internal fixation principles to guide treatment for tibial plateau and fragility fractures
- Comprehend the parameters affecting salvage versus amputation for severe lower limb injuries
- Outline all the latest upper and lower extremity fracture fixation techniques
- Explore all the latest advances in treating bone infections

The Orthopaedic Trauma Association designates this live activity for a maximum of **11.5** *AMA PRA Category* **1** *Credits*[™]. Physicians should claim only the credit commensurate with the extent of their participation in the activity.





2019 INTERNATIONAL TRAUMA CARE FORUM

WEDNESDAY, September 25, 2019

(Room 601/603)

6:00 AM	Speaker Ready Room (E Concourse)
6:15 AM	Registration (Mile High Ballroom Pre-function Area)
6:45 AM	Continental Breakfast (Room 601/603)
7:30 AM	Welcome Peter V. Giannoudis, MD, FACS, FRCS, Program Chair
7:35 – 8:15 AM	SYMPOSIUM I SURGICAL TECHNIQUES: HOW I DO IT PELVIC INSTABILITY REVISITED
	Moderators: Ross K. Leighton, MD Christian Allende, MD
7:35 AM	Introduction Ross K. Leighton, MD
7:37 AM	When I Do Pubis Symphysis and How? <i>Paul Tornetta III, MD</i>
7:47 AM	Sacroiliac Joint Open: My Preferred Method of Reconstruction <i>Peter V. Giannoudis, MD, FACS, FRCS</i>
7:57 AM	Sacroiliac Joint MIS: What Implant and Why? Mark Reilly, MD
8:07 AM	Discussion

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

8:15 – 8:47 AM	PAPER SESSION 1: ACETABULUM - FEMORAL HEAD INJURIES		
	Moderators: Hans-Christoph Pape, MD Erik Kubiak, MD		
8:15 AM (p. 86) PAPER 28	Morphometric Analysis and Safety of Percutaneous Fixation of Anterior Column of Acetabulum in an Indian Population: A Preliminary Report <i>Vivek Trikha, MD</i>		
8:21 AM (p. 87) PAPER 29	Internal Fixation of Acetabular Fractures in an Older Population Using the Lateral-Rectus Approach: Short-Term Outcomes of a Retrospective Study Shicai Fan, MD; Jiahui Chen; Han Liu; Canbin Wang		
8:27 AM (p. 88) PAPER 30	Safety of Surgical Hip Dislocation in Femoral Head Fracture-dislocation <i>Jeong Heo</i> ; Chang-Wug Oh, MD; Joon-Woo Kim, MD, PhD; Kyeong Hyeon Park, MD; Il Seo, MD		
8:33 AM (p. 89) PAPER 31	Clinical Results of Osteochondral Autograft from Ipsilateral Femoral Head for Femoral Head Defect after Posterior Hip Fracture Dislocation – Short Term Preliminary Study Yougun Won, MD; Gisoo Lee; Chan Kang, MD, PhD		
8:39 AM	Discussion		
8:47 AM	Morning Break		
9:00 – 10:02 AM	IOTA/SYMPO TIBIAL PLATEAU FRACTURES: PERSPECTIVES ON A COMPLEX P	SIUM II: GLOBAL ROBLEM	
	Moderators: Peter V. Giannoudis, MD, FACS, FRCS Achille Contini, MD Rafeal Amadei, MD	INTERNATIONAL ORTHOPAEDIC TRAUMA ASSOCIATION	
9:00 AM	Overview Peter V. Giannoudis, MD, FACS, FRCS		
9:02 AM	Complex Plateau Fractures: Initial Management and Timing of Definitive Treatment <i>Kees Jan Ponsen, MD, PhD</i>		
9:12 AM	Post-Fixation Stability: What is the Optimal Construct for Early Mobility: <i>Kodi Kojima, MD</i>		
9:22 AM	The Posteromedial Fragment: When and How to Fix Sushrut Babhulkar, MD		

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9:32 AM	Posterior Plateau Fractures: Approach and Fixation
	Francisco Chana Rodríguez, MD

9:42 AM **Compartment Syndrome and Plateau Fracture:** Treatment Approach and Recommendations Bertil Bouillon, MD

9:52 AM Discussion

SYMPOSIUM III: GUEST NATION: ARGENTINA 1



10:02 – 10:44 AM	AMPUTATION VS. SALVAGE OF SEVERE LOWER LIMB INJURIES		
	Moderators: Heather Vallier, MD Bibiana Dello Russo, MD		
10:02 AM	Overview Bibiana Dello Russo, MD		
10:04 AM	Haggled Extremity Scoring Systems: Still Valid? Marcelo Rio, MD		
10:14 AM	How Do I Proceed with Salvage? Guido Carabelli, MD		
10:24 AM	What Do I Consider as the Gray Zone Making It Difficult to Decide <i>David Teague, MD</i>		
10:34 AM	Discussion		
10:44 – 11:14 AM	SYMPOSIUM IV: ROTATOR CUFF LESIONS		
	Moderators: Michael D. McKee, MD Kodi Kojima, MD		
10:44 AM	Early Reconstruction: Why and How? Lonnie Douglas, MD		
10:54 AM	Late Reconstruction: My Preferred Method - Outcomes Chad Myeroff, MD		
11:04 AM	Discussion		
11:14 AM	Walk to Room 401-404		

11:25 AM– 12:25 PM (Room 401-404)	INDUSTRY LUNCH Zimmer Biomet Principles of Proximal Hur Comparative Review of Cu Faculty: <i>Frank Liporace, MD</i> Box lunch provided by OTA	(No CME credits offered) neral Fracture Fixation: A Case-Based and rrent Technologies in Plating and Nailing and Prof. Michael Wich
12:25 PM	Break / Return to Room 601	/603
12:35 – 1:09 PM	PAPER SESSION II: PELVIC INJURIES	
	Moderators: R. Malcolm St Fernando de la	nith, MD 1 Huerta, MD
12:35 PM (p. 90) PAPER 32	The Intra- and Interrater Reliability of the Fragility Fractures of the Pelvis Classification and Their Therapeutic Relevance: A Multicenter Assessment Philipp Pieroh, MD; Andreas Höch; Florian Gras, MD; Sven Märdian; Alexander Pflug; Silvan Wittenberg; Christoph Ihle; Notker Blankenburg; Kevin Dallacker-Losensky, MD; Tanja Lieselotte Schröder; Steven C. Herath, MD; Daniel Wagner, MD; Hans-George Palm, MD, MBA; Christoph Josten Prof; Fabian Stuby, MD	
12:41 PM (p. 91) PAPER 33	Accuracy of Percutaneous Sacro-Iliac Screw Fixation for Pelvic Ring Injuries using Standardized Image Intensifier Protocol with Lateral Shots as the Corner Stone for Screw Placement: Prospective Cohort Study with Post-Op Computed Tomography as the Reference Standard Job N. Doornberg, MS; Jan Erik Madsen, MD, PhD; Mark Rickman, MD	
12:47 PM (p. 92) PAPER 34	Use of Ultrasonography for Evaluation of Stability of Lateral Compression Type 1 (LC-1) Pelvic Fractures to Assist Determination of Treatment Strategy <i>Bin-Fei Zhang</i> ; <i>Pengfei Wang</i> , <i>MD</i> ; <i>Yan Zhuang</i>	
12:53 PM (p. 93) PAPER 35	Quality of Life After Pelvic Ring Fractures: Long-Term Outcomes: A Multicentre Study <i>Erik Hermans MD</i> ; Lars Brouwers; Thijs Van Gent; Jan Biert; Mariska Adriana De Jongh, PhD; Koen Lansink, MD, PhD; Michael Edwards, MSc, PhD	
12:59 PM	Discussion	
1:09 – 1:25 PM		SPECIAL INTEREST LECTURE:
1:09 PM	IM Nail Rescue with Plate Santiago Svarzchtein, MD	Fixation

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1:25 – 2:13 PM	PAPER SESSION II: LOWER LIMB INJURIES	
	Moderator: Victor A. de Ridder, MD	
1:25 PM (p. 94) PAPER 36	Comprehensive Evaluation and Treatment Strategy of Tibia Plateau Fracture with Knee Dislocation Zhe Song, MD; Yangjun Zhu, MD; Kun Zhang, MD; Weilou Feng, MD	

INTL FORUM

1:31 PM (p. 95) PAPER 37	Poor Sporting Abilities After a Tibial Plateau Fracture Involving the Posterior Column - How Can We Do Better? Liselore Quintens, MD; Juriaan Van Den Berg, MD; Maike Reul; Esther MM Van Lieshout, PhD; Siebe De Boer, MD; Michael Verhofstad; Harm Hoekstra	
1:37 PM (p. 96) PAPER 38	The Application of a New Type Ultradistal Locking Tools for Intramedullary Nailing in the Treatment of Tibial Fractures Hongliang Liu, MD; Cheng Ren, MD	
1:43 PM	Discussion	
1:49 PM (p. 97) PAPER 39	Secondary Intramedullary Nailing Following External Fixation for Tibial Shaft Fracture: What are the Factors that Affect Infection? Joon-Woo Kim, MD; Chang-Wug Oh, MD; Il Seo, MD; Kyeong Hyeon Park, MD; Jeong Heo, MD	
1:55 PM (p. 98) PAPER 40	Periprosthetic Atypical Femoral Fractures Exist and are Associated with Duration of Bisphosphonate Therapy <i>Samuel Mackenzie, MBChB; Richard Ng, MD; Gordon Thomas Snowden;</i> <i>Matilda Powell-Bowns, MRCSEd; Andrew D. Duckworth, FRCS, MBCHB,</i> <i>MSc, PhD; Chloe Scott, FRCS</i>	
2:01 PM (p. 99) PAPER 41	Functional Outcome of Open Distal Femoral Fractures Managed with Lateral Locking Plates Raghav Arora, MBBS, MS; Deepak Jain, MS; Harpal S. Selhi, MD; Rajnish Garg, MD, MBBS, MS	

2:07 PM Discussion

2:13 – 3:03 PM	SYMPOSIUM V: FEMORAL NECK NON-UNION	
	Moderators: Cyril Mauffrey, MD Florian T. Gebhard, MD, PhD	
2:13 PM	Pre-operative Investigations: What I Need to Know? Steven A. Olson, MD	
2:23 PM	Intertrochanteric Valgus Osteotomy: When and How? <i>William M. Ricci, MD</i>	
2:33 PM	Subtrochanteric Valgus Osteotomy: Indications-My Preferred Method of Treatment? Henry Broekhuyse, MD	
2:43 PM	Femoral Neck Non Union Associated with Femoral Head AVN <i>Peter Giannoudis, MD, FACS, FRCS</i>	
2:53 PM	Discussion	
	Walk to Room 401-404	
3:03 PM	Break (Refreshments) (401-404)	

(Room 401-404)	JOINT SESSION IV:
3:15-	LOCAL DELIVERY OF ANTIBIOTICS FOR
4:20 PM	BONE INFECTIONS: CURRENT INSIGHTS

	Moderators:	Peter V. Giannoudis, MD, FACS, FRCS Edward J. Harvey, MD
3:15 PM	Overview Peter V. Giann	oudis, MD, FACS, FRCS
3:20 PM	Cement Bids and Cement Spacers: An Update <i>David J. Hak, MD</i>	
3:30 PM	Matrices Edward J. Harvey, MD	
3:40 PM	Bone Substitute Options and Effectiveness <i>Peter V. Giannoudis, MD, FACS, FRCS</i>	
3:50 PM	Coated Nails Brett D. Crist, MD	
4:00 PM	The Role of Bioglass Nikolaos Kanakaris, MD, PhD	
4:10 PM	Discussion	

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INTL FORUM

4:20 – 4:35 PM	KEY NOTE LECTURE		
4:20 PM	Non-Union Decision Making Christian Allende, MD		
4:35 – 5:17 PM	PAPER SESSION IV: BEST OF THE BEST - PAPER SESSION		
	Moderators: Michael D. McKee, MD Thomas A. (Toney) Russell, MD César Pesciallo, MD		
4:35 PM	Overview Michael D. McKee, MD		
4:37 PM (p. 100) PAPER 42	Predictors of Hip Fracture Mortality in Ghana: A Single-Center Prospective Study Paa Kwesi Baidoo, MD; James Beguah Odei, PhD; Velarie Yaa Ankrah Ansu, MS; Michael Segbefia; Henry Holdbrook-Smith, MD		
4:43 PM (p. 101) PAPER 43	Treatment for Coexisting Fractures of the Proximal Humerus and Humeral Shaft: ORIF or MIPPO? <i>Zhe Song; Weilou Feng, MD</i>		
4:49 PM (p. 102) PAPER 44	Excellent Outcome After Double Locked Plating in Su Type II or III Periprosthetic Distal Femoral Fractures Kyeong Hyeon Park, MD; Chang-Wug Oh, MD; Ki Chul Park; Jeong Heo; Joon-Woo Kim, MD, PhD		
4:55 PM (p. 103) PAPER 45	Coned Hemipelvis and Total Hip Replacement in Osteoporotic Acetabular Fractures of the Elderly Samuel Edward McMahon ; Owen J. Diamond, MD; Laurence A. Cusick, FRCS (Ortho), MBCHB		
5:01 PM (p. 104) PAPER 46	Prospective Evaluation of Functional Outcome Along with Histological Features of Induced Membrane in Patients with Infective Nonunion Managed with Masquelet Technique Vivek Trikha, MD; Anupam Gupta; Arulselvi Subramanian, MD		
5:07 PM	Discussion		
5:17 PM	Adjourn for the Day		
5:25 PM- 6:25 PM	International Trauma Care(Four Seasons Ballroom Pre-function Area)Forum Reception		
Join your colleagues for networking, viewing of the international pos display and special awards program.			
	With special thanks and support from KCI, an Acelity company.		



2019 INTERNATIONAL

	TRAUMA CARE FORUM		
THURSDAY, September 26, 2019 (Room 601/603)			
6:00 AM	Speaker Ready Room (E Concourse)		
6:45 AM	Continental Breakfast (Room 601/603)		
7:30 AM	Introduction Peter V. Giannoudis, MD, FACS, FRCS, Program Chair		
7:32 – 8:20 AM	PAPER SESSION V: PELVIS AND HIP FRACTURES		
	Moderators: Brent Norris, MD Takashi Matsushita, MD, DMSc		
7:32 AM (p. 105) PAPER 47	Application of Measurement of Femoral Eccentricity on Orthopaedic- Position Radiographic Film of Hip Joint in Total Hip Arthroplasty <i>Junzui Li, MD</i>		
7:38 AM (p. 106) PAPER 48	Arthroplasty Can Improve Long-Term Survival of Female Patients Sustained Femoral Neck Fracture Age Over Ninety: The Ten Years Results of Compare to Conservative Treatment <i>Liu Yang, DC</i>		
7:44 AM (p. 107) PAPER 49	Hemiprothesis After Hip Fracture in Geriatric Patients with Dementia Increases Mortality and Lacks Functional Recovery Konrad Schütze, MD; Peter H. Richter, MD; Alexander Eickhoff; Florian T. Gebhard, MD, PhD; Christian Matthias Ehrnthaller		
7:50 AM	Discussion		
7:56 AM (p. 108) PAPER 50	Venous Thromboembolism Following Delayed Surgery of a Hip Fracture <i>Ji Wan Kim, MD</i> ; <i>Eic Ju Lim; Ki Chul Park</i>		

8:02 AM (p. 109) PAPER 51	Changes in Patellar Fracture Characteristics: A Multicenter Retrospective Analysis of 1596 Patellar Fracture Cases Between 2003 and 2017 Seong-Eun Byun, MD, PhD; Jaeang Sim, MD; Yong Bum Joo; Ji Wan Kim; Won Chul Choi, MD; Young Gon Na, MD; Oog Jin Shon		
8:08 AM (p. 110) PAPER 52	Surgical Treatment with Locking Plate for Nonunion in Femur and Tibia Tomoaki Fukui, MD; Takahiro Niikura, MD, PhD; Keisuke Oe, MD, PhD; Ryosuke Kuroda, MD		
8:14 AM	Discussion		
8:20 – 9:32 AM		IOTA FI AD	SYMPOSIUM VII: IOTA SYMPOSIUM RAGILITY FRACTURE CARE: VANCES IN MANAGEMENT
	Moderators:	Theodore Miclau III, MD Yoram Weil, MD Jose Quintero, MD	INTERNATIONAL ORTHOPAEDIC TRAUMA ASSOCIATION
8:20 AM	Overview Peter V. Giann	oudis, MD, FACS, FRCS	
8:22 AM	Systems Approaches to Fragility Fracture Care: How Can They Help? <i>Timothy Chesser, MB, BS, FRCS</i>		
8:32 AM	Measuring Success: Outcomes Beyond Mortality? Zsolt Balogh, MD		
8:42 AM	Fragility Fractures in a Japanese Population: Does the Treatment Differ? <i>Takashi Miyamoto, MD</i>		
8:52 AM	Managing Bone Loss in Elderly Patients: What Are the Options? <i>Yun Tian, MD</i>		
9:02 AM	Surgical Management of Insufficiency Fractures: When and How? <i>Guy Putzeys, MD</i>		
9:12 AM	Complications Post Osteoporotic Fracture Fixation: Tips and Tricks <i>Fernando de le Huerta, MD</i>		
9:22 AM	Discussion		
9:32 AM	Morning Brea	k	

INT'L FORUM

9:45 –	PAPER SESSION VI:		
10:19 AM	UPPER LIMB INJURIES		
	Moderators: Sushrut Babhulkar, MD Jong-Keon Oh, MD		
9:45 AM (p. 111) PAPER 53	Clinical Application of 'Expanded Paratricipital Approach' for Fixation of Complex Articular Fractures in Distal Humerus: Revisited with Cadaveric Study and Case Series Jae-Woo Cho; Do-Hyun Yeo, MD; Beom-Soo Kim, MD; Eic Ju Lim; Seungyeob Sakong; Dong-Wan Kang; Jinkak Kim, MD; Jong-Keon Oh, MD, PhD		
9:51 AM (p. 112) PAPER 54	Optimal Plate Position in Minimally Invasive Plate Osteosynthesis for Mid-shaft Clavicle Fractures: Simulation Using 3D-Printed Models of Actual Clinical Cases Ji Wan Kim, MD; Ki Chul Park		
9:57 AM	Olecranon Osteotomy Fixation Following Complex Distal Humerus		
(p. 113)	ORIF: Plate or Tension Band?		
PAPER 55	<i>Zhe Song; Yangjun Zhu, MD; Kun Zhang, MD; Weilou Feng, MD</i>		
10:03 AM (p. 114) PAPER 56	The Clinical Benefit of Fibular Allograft Augmentation in Locked Plating of Proximal Humerus Fractures: A Retrospective Study Yeming Wang, MD ; Jianhua Yang; Junyang Liu; Xu Tian; Jingming Dong; Jie Sun, MD, MS		
10:09 AM	Discussion		
10:19 –	PAPER SESSION VII:		
11:00 AM	GENERAL TRAUMA		
	Moderators: Robert Zura, MD Wu Xinbao, MD		
10:19 AM	Clinical Application of 3D Printing Technology in Orthopaedic		
(p. 115)	Trauma Surgery		
PAPER 57	Rahat Jarayabhand, MD; Chittawee Jiamton, MD		
10:25 AM	Empowering Pre-hospital Care Providers to Better Manage Open		
(p. 116)	Fractures		
PAPER 58	Aswinkumar Vasireddy, MBBS; Kelly Jones; Erica F. Ley, MSc		
10:31 AM	B-Ultrasound Surface Positioning Upper Arm Nerve Combined with		
(p. 117)	MIOPP Technique for Upper Humeral Shaft Fracture		

PAPER 59 Wei Fan, PhD

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

INTL FORUM

10:37 AM (p. 118) PAPER 60	Syndesmotic Fixation in Unstable Ankle Fractures: Does Early Postoperative Weight Bearing Affect Radiographic Outcomes? Khalid Al-Hourani, MD; Michael Thomas Stoddart, MBBS; Timothy Chesser, MB, BS, FRCS
10:43 AM (p. 119) PAPER 61	Whether Bisphosphonate Delays Bone Healing After Hip Fracture Fixation in Elderly Patients Ong-Art Phruetthiphat, MD; Yanin Plumarom
10:49 AM	Discussion
11:00 AM	Adjourn to INDUSTRY LUNCH SYMPOSIA (<i>On-site Registration Available</i>) Boxed lunch provided by OTA.



2019 ANNUAL MEETING

September 26-28, 2019

(Four Seasons)

Program Committee

Michael J. Gardner, MD, Program Chair Stephen A. Kottmeier, MD, Program Co-Chair Andrew M. Choo, MD Brett D. Crist, MD Gregory J. Della Rocca, MD, PhD David J. Hak, MD Gilbert R. Ortega, MD David W. Sanders, MD Gerard P. Slobogean, MD

Learning Objectives

After attending the OTA Annual Meeting, participants will be able to:

- Discuss and highlight recently presented prospective clinical trials in orthopaedic trauma
- Summarize evidence-based recommendations for the treatment of common fractures
- Knowledge transfer to initiate practice change to include treatment strategies based on evidence-based medicine
- Identify consensus opinions on many current issues and controversies regarding the treatment of infected fractures.

The Orthopaedic Trauma Association (OTA) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. OTA designates this live activity for a maximum of **21** *AMA PRA Category 1 Credits*TM. Physicians should claim only the credits commensurate with the extent of their participation in the activity.



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



2019 ANNUAL MEETING

Thursday, September 26, 2019

(Four Seasons)

6:00 AM	Speaker Ready Room (E Concourse)
6:15 AM	Registration
11:15 AM	INDUSTRY LUNCH SYMPOSIA (<i>On-site Registration Available</i>) Boxed lunch provided by OTA.
1:00 – 1:20 PM	Welcome and Donor Awards David C. Teague, MD, President Michael J. Gardner, MD, Program Chair

Four Seasons			SYMPOSIUM I:
1:20 – 2:50 PM			WHAT'S NEW IN FRACTURE RELATED INFECTIONS
	Moderator:	William Obremskey, MD	
	What's New in Infection Prevention		

William T. Obremskey, MD

What's New in Infection with Soft Tissue and Bone Defects *Stephen L. Kates, MD*

What is New with Infection and Implant Retention and Antibiotics *Kenneth A. Egol, MD*

What's New in Definition, Implant Development and Phage Therapy Willem-Jan Metsemakers, MD

2:50 – 3:20 PM Refreshment Break Visit Scientific Posters (*E Concourse*) & Technical Exhibits (*Mile High*)

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

See the meeting app for complete listing of authors' disclosure information.

36
Four Seasons 3:20 –	SCIENTIFIC PAPER SESSION I: HIGHLIGHT PAPERS
4:45 PM	Moderators - Michael J. Gardner, MD & Stephen A. Kottmeier, MD
3:20 PM (p. 123) PAPER 62	Hip Fracture Evaluation with Alternatives of Total Hip Arthroplasty versus Hemi-Arthroplasty (X): A Multinational Randomized Controlled Trial of X Patients HEALTH Investigators
3:31 PM (p. 124) PAPER 63	Operative versus Non-operative Treatment of Acute Unstable Chest Wall Injuries – A Multi Centred Randomized Controlled Trial Niloofar Dehghan, FRCSC, MD, MSc ; Aaron Nauth, MD; Emil H. Schemitsch, MD; Milena Vicente RN; Richard Jenkinson MD; Hans J. Kreder, MD; Michael D. McKee, MD, FRCSC; Canadian Orthopaedic Trauma Society (COTS); Unstable Chest Wall RCT Study Investigators
3:37 PM (p. 125) PAPER 64	Autologous Iliac Bone Graft versus Biphasic Hydroxyapatite/Calcium Sulfate Cement for Treatment of Bone Defects in Tibial Plateau Fractures: A Multicenter, Prospective, Randomized Clinical Trial Alex Hofmann, MD; Stanislav Gorbulev; Paul Alfred Grützner; Arndt Peter Schulz, MD, PhD; Rupert Schupfner, OT; Michael Raschke, MD; Martijn Van Griensven; Pol Maria Rommens, MD
3:43 PM	Discussion
3:48 PM (p. 126) PAPER 65	Deltopectoral versus Deltoid Split Approach for Proximal HUmerus Fracture Fixation with Locking Plate: A Prospective <u>RA</u> ndomized Study (HURA Study) Dominique Rouleau, MD; George Yves Laflamme, MD; Frederic Balg, MD; Benoit Benoit, MD; Michel Malo, MD; Francois Vezina, MD; Stephane Leduc, MD
3:54 PM (p. 127) PAPER 66	Δ Locked Plating versus Nailing for Proximal Tibia Fractures: A Multicenter RCT Paul Tornetta III, MD ; Kenneth A. Egol MD; Clifford B. Jones, MD, FACS; Robert F. Ostrum, MD; Catherine A. Humphrey, MD; Robert Paul Dunbar, MD; William M. Ricci, MD; Laura Phieffer, MD; David C. Teague MD; Henry Claude Sagi, MD; Andrew N. Pollak, MD; Andrew H. Schmidt, MD; Stephen A. Sems, MD; Hans-Christoph Pape, MD; Saam Morshed, MD; Edward Perez, MD
4:00 PM	Discussion
4:05 PM (p. 128) PAPER 67	Early Motion and Directed Exercise (EMADE) versus Usual-care, Post Ankle Fracture Fixation: A Pragmatic Randomised Controlled Trial <i>Paul A. Matthews, MA, MSc; Jessica Nightingale, BS; Tim Coughlin;</i> <i>Brigitte Scammell, MD; Benjamin Ollivere, FRCS (Ortho), MD, MBBS</i>

 Δ OTA Grant

THURSDAY, SEPTEMBER 26, 2019

SCHEDULE

4:11 PM (p. 129) PAPER 68	Intravenous Ibuprofen Reduces Opioid Consumption in Acute Pain Management for Orthopaedic Trauma Patients Russell Weisz, MD; Alexander Fokin, MD, PhD; Amy Flynt, PhD; Ines Macias-Perez, PhD; Leo Pavliv, RPH; Maggie Crawford; Ivan Puente
4:17 PM (p. 130) PAPER 69	A Prospective Clinical Trial Comparing Operative versus Nonoperative Fixation of Minimally Displaced Lateral Compression Pelvic Fractures Gerard Slobogean, MD; Greg E. Gaski, MD; Jason W. Nascone, MD; Marcus F. Sciadini, MD; Roman Natoli, MD; Theodore T. Manson, MD; Christopher T. LeBrun, MD; Todd O. McKinley, MD; Walter W. Virkus, MD; Anthony T. Sorkin, MD; Krista M. Brown, MS; Andrea Lynn Howe, BS; Joshua Rudnicki, BS; Blessing Enobun; Nathan N. O'Hara; Jeff Gill, PhD; Robert V. O'Toole, MD
4:23 PM	Discussion
4:28 PM (p. 131) PAPER 70	Does Negative Pressure Wound Therapy Reduce the Odds of Infection and Lower Health-Related Quality of Life in Open Fracture Patients? <i>Yousif Atwan, MD</i> ; <i>Emil H. Schemitsch, MD; Sheila Sprague, PhD; Sofia Bzovsky;</i> <i>Kyle J. Jeray, MD; Brad Petrisor, MD; Mohit Bhandari, MD, FRCSC, PhD;</i> <i>FLOW Investigators</i>
4:34 PM (p. 132) PAPER 71	Impact of Fascia Iliaca Block on Pain Outcomes and Opioid Consumption for Hip Fracture Patients – A Prospective, Randomized Study Spencer Schulte, MD; Mai P. Nguyen, MD; Michael Reich, MD; Adam Adler, MD; Richard Van Tienderen, DO; Isaac Fernandez, MD
4:40 PM	Discussion
4:45 – 5:15 PM	PRESIDENT'S MESSAGE (Four Seasons)"OTA Community"David C. Teague, MD OTA President
5:15 – 6:15 PM	Business Meeting (Members Only)
5:15– 6:15 PM 6:20 – 8:20 PM	Happy Hour – Exhibitor Reception (Mile High) (Sponsored by OsteoCentric Technologies) WELCOME RECEPTION Join your colleagues for cocktails
	and hors d'oeuvres at the Ellie Caulkins Opera House: 1385 Curtis Street, Denver, CO

See the meeting app for complete listing of authors' disclosure information.

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2019 ANNUAL MEETING

Friday, September 27, 2019 (Four Seasons)

6:00 AM	Speaker Ready Room
	(E Concourse)

6:15 AM Registration

6:30 -

7:30 AM

Concurrent Breakout Sessions – Seating available first come, first-served. 6:30 - 7:30 AM

Continental Breakfast 6:30 AM (Outside Breakout Session Rooms)

CONCURRENT **BREAKOUT SESSIONS**

Managing Complex Humeral Fractures: From Proximal to Distal Moderator: Andrew Choo, MD Faculty: Timothy S. Achor, MD; Eben A. Carroll, MD; Michael J. Gardner, MD	(601/603)
Current Strategies and Techniques for Operative Fixation of Complex Ankle Fractures and Fractures of the Tibial Plafond Moderator: Frank Liporace, MD	(201/203)
Faculty: Richard Yoon, MD; Mark Gage, MD; Marcus Sciadini, MD; Michael Maceroli,	, MD
Challenging Issues in Bicondylar Tibia Plateau Fractures Moderator: William T. Obremskey, MD Faculty: Clay A. Spitler, MD; Matthew L. Graves, MD; Chad Matthew Corrigan, MD	(205/207)
The Soft Tissue Envelope: No Chance for ReturnsModerator:Lisa Cannada, MDFaculty:Michael T. Archdeacon, MD; Kenneth A. Egol, MD; James R. Ficke, MD	(605/607)
Pelvic and Acetabulum Fractures Moderator: Paul Tornetta III, MD Faculty: Henry Claude Sagi, MD; Cory Alan Collinge, MD; Hassan Riaz Mir, MD; Michael S. Kain, MD; Stephen A. Kottmeier, MD	(Four Seasons)

SCHEDULE

Four Seasons 7:30 – 9:00 AM	SYMPOSIUM II: A MULTIDISCIPLINARY APPROACH TO HEMODYNAMICALLY UNSTABLE PELVIS RING INJURIES
	Moderator: Cyril Mauffrey, MD
	Acute Pelvis Stabilization David Hak, MD
	Pelvic Angiography and Embolization <i>Sam McMurry, MD</i>
	Aortic Balloon Occlusion (REBOA) and Pelvic Packing: Indications, How It's Done, Complications, and How to Initiate in your Hospital <i>Ernest Moore, MD</i>
	Definitive Management and Outcomes Joshua Parry, MD
9:00 – 9:30 AM	Breakfast/Break Visit Scientific Posters (<i>E Concourse</i>) & Technical Exhibits (<i>Mile High</i>)
9:30 – 11:10 AM	Concurrent Sessions (General Session and Breakout Sessions run concurrently.) Scientific Paper Session II: Tibia and Knee/Tibial Plateau (9:30 – 11:10 AM) Concurrent Breakout Sessions (10:00 –11:00 AM)
Four Seasons 9:30 – 11:10 AM	SCIENTIFIC PAPER SESSION II: TIBIA and KNEE / TIBIAL PLATEAU Moderators - Stephen A. Kottmeier, MD & Yelena Bogdan, MD
9:30 AM (p. 133) PAPER 72	Management of Traumatic Bone Defects in Tibial Plateau Fractures with Antibiotic- Impregnated Biodegradable Calcium Sulfate Beads: A Prospective Clinical Trial Ross K. Leighton, MD; Michael E. Forsythe, MD; George Yves Laflamme, MD; Andrew Furey, MD; Prism Schneider, MD, PhD, FRCSC

SCHEDULE

9:36 AM (p. 134) PAPER 73	 Bicondylar Plateau Fractures: What Predicts Infection Paul Tornetta III, MD; Nathan P. Olszewski, MD; Givenchy W. Manzano, MD; Eleanor Wilson; Joshua Namm, MD; Anna Noel Miller, MD; Daniela Barreto Rocha, MD; Daniel S. Horwitz, MD; Amanda Pawlak, MD; Stephen Kottmeier, MD; Joshua Shapiro, MD; Lincoln Praston, MD; Brian Mullis, MD; Konstantin Gruenwald, BA; Andres F. Rodriguez-Buitrago, MD; Joshua L. Gary, MD; Adam J. Miller, MD; Laura Phieffer, MD; Elizabeth Sheridan, MPH; Katherine Li, MD; Madhav A. Karunakar, MD; Darin M. Friess, MD; David Jenkins, BA; Ross K. Leighton, MD; Rashed S. Alqudhaya, MD; Juan Sebastian Vargas-Hernandez, MD; Brandon J. Yuan, MD; Benjamin Ollivere, FRCS (Ortho), MD, MBBS; Yulanda Myint, FRCS (Ortho), MSc; Patrik Suwak, DO; Sagar Amit Shah, MD; Donald P. Willier, BS; Andrew J. Marcantonio, DO
9:42 AM (p. 135) PAPER 74	Better Fracture Reduction in Patients Undergoing Early Definitive Fixation for Tibial Plateau Fractures with Acute Compartment Syndrome Ilexa Rae Flagstad, BS ; Tony Pedri, MD; Sarah Catherine Peck, BS; Jerald Westberg, BA; Harsh Rajesh Parikh; Andrew H. Schmidt, MD; Brian Cunningham, MD
9:48 AM	Discussion
9:53 AM (p. 136) PAPER 75	Evaluating the Efficacy of Topical Vancomycin Powder in the Treatment of Open Lower-Extremity Fractures <i>Justin Vaida, MD</i> ; <i>Daniel A. Bravin, MD; Michelle Bramer, MD</i>
9:59 AM (p. 137) PAPER 76	Does Topical Vancomycin Powder Use in Fracture Surgery Change Bacteriology and Antibiotic Susceptibilities? An Analysis of the VANCO Trial Robert V. O'Toole, MD; Manjari Joshi; Anthony R. Carlini, MS; Joshua L. Gary, MD; William T. Obremskey, MD, MPH; Clinton K. Murray, MD; Greg E. Gaski, MD; J. Spence Reid, MD; Yasmin Degani, MPH; Tara J. Taylor, MPH; Susan Catherine Jane Collins, MSc; Yanjie Huang; Daniel Oscar Scharfstein; Renan C. Castillo MD; METRC Vanco Investigators
10:05 AM (p. 138) PAPER 77	Infection Rates in Open Tibia Fractures with the Use of Intraoperative Topical Vancomycin/Tobramycin Powder Mark Alan Prevost, MD; William Cutchen; Patrick Graham Young, BS; Patrick Stahel Barousse, MD; Jeffrey Brewer, MD
10:11 AM	Discussion
10:16 AM (p. 139) PAPER 78	Improved Healing of Severe Open Long Bone Fractures Treated with Antibiotic-Formulated Bone Graft During the First Surgical Intervention Post-Injury Doron Norman, MD; Moshe Salai, MD; Noam Emanuel, PhD

SCHEDULE

10:22 AM (p. 140) PAPER 79	Post-Operative Cortical Continuity as a Predictor for Nonunion in Open Tibia Fractures Amy Ford, MD; Madeline Lyons, MD; Elizabeth Harkin, MD; Hobie D. Summers, MD; Garin Hecht, MD; William Dean Lack, MD; Joseph Bowman Cohen, MD
10:28 AM (p. 141) PAPER 80	The Influence of Sagittal Proximal Tibial Anatomy in Tibial Intramedullary Nailing David Cinats, MD; Trevor Stone, MD; Darius Viskontas, MD
10:34 AM	Discussion
10:39 AM (p. 142) PAPER 81	Evaluation of the Orthopaedic Trauma Association Open Fracture Classification (OTA-OFC) as a Predictive Tool in Open Tibial Shaft Fractures <i>Matthew Robert Garner, MD</i> ; Stephen James Warner, MD, PhD; Jacob Anthony Heiner, BS; Yesul Tina Kim, BS; Julie Agel, ATC
10:45 AM (p. 143) PAPER 82	Orthoplastic Reconstruction of Grade IIIB Open Tibial Fractures Using Devitalized Cortical Segments: The Bristol Experience 2014-2018 Khalid Al-Hourani, MD; Michael Thomas Stoddart, MBBS; Umraz Khan; Andrew Riddick, MBBS, FRCS (Ortho); Michael Kelly, MBBS, MD, FRCS (Ortho)
10:51 AM (p. 144) PAPER 83	Perfusion Pressure Lacks Diagnostic Specificity for the Diagnosis of Acute Compartment Syndrome Andrew H. Schmidt, MD; Junrui Di; Vadim Zipunnikov; Katherine Frey, MPH, PhD, RN; Daniel Oscar Scharfstein; Robert V. O'Toole, MD; Michael J. Bosse, MD; William T. Obremskey, MD, MPH; Daniel J. Stinner, MD; COL (ret) Roman A. Hayda, MD; Madhav A. Karunakar, MD; David J. Hak, MD; Eben A. Carroll, MD; Susan Catherine Jane Collins, MSc; Ellen MacKenzie, PhD
10:57 AM (p. 145) PAPER 84	Posterolateral Plating Is a Safe Alternative for the Treatment of Distal Tibia Fractures Michael Schloss, BA; Zachary Hannan, BS; Jared Atchison, BS; Syed Muhammad Raza Zaidi, BA; Alexandra Bryn Mulliken; Nathan N. O'Hara; Jason Warren Nascone, MD; Robert V. O'Toole, MD; Theodore Thomas Manson, MD
11:03 AM	Discussion

CONCURRENT BREAKOUT SESSIONS

Moderator: Clay A. Spitler, MD Faculty: Matthew L. Graves, MD; Brett D. Crist, MD; J. Tracy Watson, MD Compartment Syndrome: The Issues and Solutions You Need to Know About in 2019! Moderator: Emil H. Schemitsch, MD Faculty: David Sanders, MD; Michael J. Gardner, MD; Michael T. Archdeacon, MD; William T. Obremskey, MD; Abdel-Rahman Lawendy, MD; Michael D. McKee, MD From Sling to Reverse: All Things Proximal Humerus ---When, How and Getting it Right Moderator: Richard S. Yoon, MD Faculty: Gregory J. Della Rocca, MD, PhD; Joshua Langford, MD; Mark Gage, MD; David Donohue, MD

Long Bone Nonunion Treatments: A Case-based Discussion Moderator: Stephen James Warner, MD Faculty: Timothy S. Achor, MD; Mark A. Lee, MD; Mark R. Brinker, MD

Maximizing Outcomes in Tibial Pilon Fractures

(605/607)

GUEST NATION PRESENTATION

11:10 – 11:40 AM

10:00 -

11:00 AM

Specific Non-Unions Jorge D. Barla, MD Fernando M. Bidolegui, MD César Pesciallo, MD

Argentina

It is a great honor to welcome the members of the Argentina Trauma Society.

The Guest Nation program was initiated in 2011 in recognition of the importance and benefits of sharing knowledge and experience with international colleagues.

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



(601/603)

(201/203)

(205/207)

11:40 AM -12:10 PM

JOHN BORDER, MD MEMORIAL LECTURER

(General Session Room - Four Seasons)

Milton L. Routt, MD Professor, Orthopedic Surgery McGovern Medical School, University of Texas Health Science Center, Houston, TX

"What Matters"

12:10 -Lunch 1:10 PM Visit Scientific Posters (E Concourse) & Technical Exhibits (Mile High)

12:10 -



New Member Luncheon (Room 403/404)

Women in Orthopaedic Trauma 12:10 -1:10 PM Kathy Cramer, MD Memorial Luncheon (Room 501/502)

> Chair: Carmen A. Quatman, MD, PhD Co-Chair: Emily Wagstrom, MD



With special thanks and support from PFS Med Inc.

12:25 -1:05 PM

LUNCHTIME GUIDED POSTER AND VIDEO TOURS

(PT1) Upper Extremity Guide: Andrew Choo, MD	(Mile High)
(PT2) General Interest Guide: Conor P. Kleweno, MD	(Mile High)
(VT) Video Tours (Mi Guide: Mark Hake MD	

SCHEDULE

1:10 – 2:36 PM **Concurrent Sessions** (General Session and Breakout Sessions run concurrently.) Scientific Paper Session III: Pelvis, Acetabulum & Polytrauma (1:10 – 2:36 PM) Concurrent Breakout Sessions (1:30 – 2:30 PM)

Four Seasons 1:10 – 2:36 PM	SCIENTIFIC PAPER SESSION III: PELVIS AND ACETABULUM AND POLYTRAUMA Moderators - David J. Hak, MD & Joshua A. Parry, MD
1:10 PM (p. 146) PAPER 85	Simultaneous Fracture Fixation and Total Hip Arthroplasty for Osteoporotic Acetabular Fractures in the Elderly Daud Chou, FRCS (Ortho); Ross Coomber, FRCS (Ortho); Thomas Baigent, MBChB; Joseph Martin Queally, MD; Peter Hull, FRCS (Ortho), MBCHB; Andrew Douglas Carrothers, FRCS (Ortho), MD; Ronan O'Leary, MD
1:16 PM (p. 147) PAPER 86	Evaluation of Efficacy of Three-Dimensional Printing Patient-Specific Plates in Treating Acetabular Fractures Involving Disruption of the Quadrilateral Plate Shicai Fan, MD; Canbin Wang; Yuhui Chen; Han Liu
1:22 PM (p. 148) PAPER 87	Retrograde Trans-pubic Screw Osteosynthesis: Retrospective Analysis of 158 Fractures Daniel Wagner, MD ; Marcus Erich Graafen; Alex Hofmann, MD; Pol Maria Rommens, MD
1:28 PM	Discussion
1:33 PM (p. 149) PAPER 88	Outcomes of Single-Stage Versus 2-Stage Bilateral Intramedullary Nail Fixation in Patients with Bilateral Femur Fractures Ilexa Rae Flagstad, BS; Lauren MacCormick Tatman, MD; Melissa White, BA; Austin Heare, MD; Harsh Rajesh Parikh; Jerald Westberg, BA; Tegan Schmidt, BA, BS; Natasha Simske, BS; Alexander Siy, BS; Reuben C. Lufrano, MD; Andres F. Rodriguez-Buitrago, MD; Joseph T. Labrum IV, MD; Nichole Shaw, MD; Jason Nadeau, MS; Erik A. Lund, MD; Patrick Taylor Davis, BS; Daniel Connelly, BS; Jared Atchison, BS; Cyril Mauffrey, MD, MRCS; David J. Hak, MD; Jesse Hahn, MD; Paul S. Whiting, MD; Hassan Riaz Mir, MD, MBA, FACS; Andrew H. Schmidt, MD; Emily Wagstrom, MD; William T. Obremskey, MD, MPH; Robert V. O'Toole, MD; Heather A. Vallier, MD; Brian Cunningham, MD

SCHEDULE

1:39 PM (p. 150) PAPER 89	Factors Influencing Management of Bilateral Femur Fractures: A Multicenter Retrospective Cohort of Early vs Delayed Definitive Fixation Ilexa Rae Flagstad, BS; Lauren MacCormick, MD; Melissa White, BA; Austin Heare, MD; Harsh Rajesh Parikh; Jerald Westberg, BA; Tegan Schmidt, BA, BS; Natasha Simske, BS; Alexander Siy, BS; Reuben C. Lufrano, MD; Nichole Shaw, MD; Jason Nadeau, MS; Patrick Taylor Davis, BS; Daniel Connelly, BS; Jared Atchison, BS; Andres F. Rodriguez-Buitrago, MD; Joseph T. Labrum, IV MD; Erik A. Lund, MD; Cyril Mauffrey, MD, MRCS; David J. Hak, MD; Paul S. Whiting, MD; Hassan Riaz Mir, MD, MBA, FACS; Andrew H. Schmidt, MD; Emily Wagstrom, MD; William T. Obremskey MD, MPH; Robert V. O'Toole, MD; Heather A. Vallier, MD; Brian Cunningham, MD
1:45 PM (p. 151) PAPER 90	An Analysis of Bilateral Femoral Shaft Fracture Outcomes Using a Retrospective Cohort from the NTDB Christopher Thomas Cosgrove, MD; Philip R. Wolinsky, MD; Marschall B. Berkes, MD; Christopher McAndrew, MD; Anna Noel Miller, MD
1:51 PM	Discussion
1:56 PM (p. 152) PAPER 91	Does Intramedullary Nail Fixation of the Tibia Pose the Same Risk of Pulmonary Complications as It Does in the Femur? A Propensity Score-Weighted Analysis of 1541 Fractures Benjamin Matthew Wheatley, MD; Max Coale, BA; Nathan N. O'Hara; Robert V. O'Toole, MD
2:02 PM (p. 153) PAPER 92	The Effect of Time to Irrigation on the Rate of Reoperation in Open-Fractures: A Propensity Score-based Analysis of the Fluid Lavage of Open Wounds (FLOW) Study Herman Johal, MD; Daniel Axelrod, MD; Sheila Sprague, PhD; Brad Petrisor, MD; Sofia Bzovsky; Mohit Bhandari, MD, FRCSC, PhD
2:08 PM (p. 154) PAPER 93	Predicting Mortality After Trauma Using Electronic Medical Record Data: A Retrospective Analysis at a Level-I Trauma Center Ryan W. Fairchild, MD ; Hayden N. Box, MD; John David Watkins, MS; Arun Nethi; Dustin B. Rinehart, MD; Michael Cripps, MD; Manjula Julka, MBA, MD; Adam Jennings Starr, MD
2:14 PM	Discussion
2:19 PM (p. 155) PAPER 94	Posterior Sternoclavicular Dislocation: Do We Need "Cardiothoracic Backup"? Insights from a National Sample Dana Angell Leonard, BA ; Nicole Alexandria Segovia, BS; Japsimran Kaur, BS; Julius A. Bishop, MD; John Vorhies, MD
2:25 PM (p. 156) PAPER 95	The Rate of Mediastinal and Vascular Injury Following Acute Posterior Sternoclavicular Dislocation: A Multicenter Study <i>Matthew Newland Fournier, MD</i> ; Mark R. Sinclair, MD; Evan Zheng, BA; David Andrew Spiegel, MD; Anna Johnson, MD; Apurva Shah, MD, MBA; Anthony Ian Riccio, MD; Marilyn Elliott; Donald S. Bae, MD; Jeffrey R. Sawyer, MD
2:31 PM	Discussion

CONCURRENT 1:30 -**BREAKOUT SESSIONS** 2:30 PM **The Femur Nonunion:** (601/603)Tips and Techniques on Successful Union from Proximal to Distal Moderator: Harmeeth Singh Uppal, MD Faculty: David Barei, MD; Frank A. Liporace, MD; John Alan Scolaro, MD **Controversies in Foot Fractures – The Great Debates** (201/203)Moderator: Benjamin Ollivere, FRCS (Ortho), MD, MBBS Faculty: Paul Tornetta III, MD; Richard E. Buckley, MD; Roy W. Sanders, MD; Joshua Langford, MD; Heather A. Vallier, MD Addressing the Challenges of Practice: (205/207)**Creating Efficiency Despite Overwhelm** Moderator: Jeffrey Mark Smith, MD Faculty: Michael Brodkin, PA-C; Bruce Ziran MD, FACS; Steven J. Morgan, MD; Timothy James Bray, MD; Peter L. Althausen, MD; Todd Allen Swenning, MD; Ryan Edward Will, MD; Katy Yegorova, BA; Daniel John Coll, PA-C Tips and Tricks in Dealing with Obesity in Orthopaedic Trauma (605/607)Moderator: Brett D. Crist, MD Faculty: Kyle Schweser, MD; Gregory J. Della Rocca, MD, PhD; Matthew L. Graves, MD

2:36 – 3:06 PM Refreshment Break Visit Scientific Posters (*E Concourse*) & Technical Exhibits (*Mile High*)

Four Seasons 3:06 – 4:15 PM	SCIENTIFIC PAPER SESSION IV: HIP / FEMUR Moderators - Brett D. Crist, MD & Kyle Schweser, MD
3:06 PM (p. 157) PAPER 96	Cerclage Wire Adjunct in Traumatic Femoral Fracture: A Comparison of Union, Complication and Reoperation <i>Lance Glen Jacobson, MD</i> ; Kathy J. Flint; Ryan Beeker; Shreya Sanjay Veera, BS; Michael K. Savaglio, MS; Timothy G. Weber, MD
3:12 PM (p. 158) PAPER 97	Subtrochanteric Fractures: Does Open Reduction Increase the Risk of Infection and Fracture Healing Complications? Michalis Panteli, MD; James Vun; Ippokrates Pountos, MD; Robert Michael West, MSc; Peter Giannoudis, BS, FACS, FRCS, MBBS, MD

SCHEDULE

3:18 PM (p. 159) PAPER 98	SIGN Intramedullary Nailing Improves Early Postoperative Quality of Life and Function as Compared to Skeletal Traction for Management of Femoral Shaft Fractures in Malawi Linda Chokotho; Hao-Hua Wu, MD; Syed H. Ali; Patrick Albright, BS, MS; David Shearer MD; Brian Lau, MD
3:24 PM	Discussion
3:29 PM (p. 160) PAPER 99	Improving the Diagnosis of Ipsilateral Femoral Neck and Shaft Fractures: A New Imaging Protocol Nathan Brian Rogers, MD; Braden Edward Hartline, MD; Manickam Kumaravel, MD, FRCS; Timothy S. Achor, MD; Joshua Layne Gary, MD; Andrew Moon Choo, MD; Milton L. Routt, MD; John Wesley Munz, MD; Stephen James Warner, MD, PhD
3:35 PM (p. 161) PAPER 100	The Effect of Intramedullary Nail Entry Point on Postoperative Femoral Shaft Fracture Alignment <i>Michael Wesley Honeycutt, MD</i> ; <i>Kyle Cox, MD</i> ; <i>William Tanner Cox, BS</i> ; <i>Gregg Delgado, DO</i> ; <i>Jeffrey Brewer, MD</i>
3:41 PM (p. 162) PAPER 101	Radiostereometric Analysis of Inducible Micromotion After Locked Lateral Plating of Distal Femur Fractures Vincent Galea, BA; Mina A. Botros, BS; Michael McTague, MPH; Michael John Weaver, MD; Mark S. Vrahas, MD; Henrik Malchau, MD; Charles R. Bragdon PhD; Marilyn Heng, FRCSC, MD
3:47 PM	Discussion
3:52 PM (p. 163) PAPER 102	Optimal Configuration of Internal Fixation Implants During Operative Management of Hip Fractures Michael Blankstein, MD, FRCSC ; Patrick Christopher Schottel, MD; Sheila Sprague, PhD; Sofia Bzovsky; Mohit Bhandari, MD, FRCSC, PhD; Marc F. Swiontkowski, MD; Emil H. Schemitsch, MD; FAITH Investigators
3:58 PM (p. 164) PAPER 103	A Pilot Feasibility, 2x2 Factorial Randomized Control Trial Comparing the Sliding Hip Screw versus Cancellous Screws AND Vitamin D3 versus Placebo for the Treatment of Young Femoral Neck Fractures FAITH-2 Trial Investigators
4:04 PM (p. 165) PAPER 104	Intramedullary versus Extra Medullary Fixation for Basicervical Femoral Fractures: Which is Better? Wu Chean Lee, MBCHB; Ping Yen Yeo; Ernest Kwek, MBBS, FRCS (Ortho)
4:10 PM	Discussion

SCHEDULE

4:15 – 5:15 PM	DEBATES
	Join past presidents of the OTA for two debates. The audience will vote* live on who won each debate and the loser of the debate will donate \$500 to the OTA Research and Education Fund.
	1st DEBATE ORIF Calcaneus – Extensile Approach Roy W. Sanders, MD
	ORIF Calcaneus – Sinus Tarsi Paul Tornetta III, MD
	2nd DEBATE Critical Bone Defect Management: Masquelet <i>William M. Ricci, MD</i>
	Critical Bone Defect Management: Bone Transport J. Tracy Watson, MD
	*Voting is conducted through the app. Download the OTA Annual Meeting app to participate.

5:20 – 6:05 PM	SUDS N'SCIENCE GUIDED POSTER AND VIDEO TOURS	
(PT3) International Guide: Peter Giann	10udis, MD	(Mile High)
(PT4) Foot and Ank Guide: Paul Tornel	l e tta III, MD	(Mile High)
(VT) Video Tours Guide: Anna Noel	Miller, MD	(Mile High)

5:30 – 6:30 PM



MILITARY RECEPTION (*License Plate Lobby*) All Active Duty Military, Retired Military, and Landstuhl Distinguished Visit Scholar participants are welcome to addend.



2019 ANNUAL MEETING

Saturday, September 28, 2019 (Four Seasons)

6:00 AM	Speaker Ready Room (E Concourse)
6:15 AM	Registration
6:30 – 7:30 AM	Concurrent Breakout Sessions – Seating available first come, first-served.

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

CONCURRENT **BREAKOUT SESSIONS**

Challenges in Non-union Treatment - A Case-Based Symposium Moderator: <i>Paul S. Whiting, MD</i> Faculty: <i>J. Spence Reid, MD; Gerald J. Lang, MD; Christopher Doro, MD</i>	(601/603)
The Traumatized Midfoot: Tips and Techniques for Successful Reconstruction Moderator: Harmeeth Singh Uppal, MD Faculty: John Wesley Munz, MD; Stephen K. Benirschke, MD; Gregory J. Della Rocca, MD, PhD	(201/203)
Plateaus and Pilons: The Posterior Perspective (ver. 2)Moderator:Stephen A. Kottmeier, MDFaculty:Paul Tornetta III, MD; J. Tracy Watson, MD	(205/207)
Firearm Trauma: A Necessary Discussion Moderator: Todd Allen Swenning, MD Faculty: James R. Ficke, MD; Alan L. Jones, MD; Bruce Ziran, MD; Ann Marie Warren, PhD	(605/607)
Controversies in Treatment of Pelvic Ring Injuries Moderator: Geoffrey Marecek, MD Faculty: John Alan Scolaro, MD; Milton L. Routt, MD; Joshua Layne Gary, MD; Hassan Riaz Mir, MD	(Four Seasons)

See the meeting app for complete listing of authors' disclosure information.

6:30 -

7:30 AM

SCHEDULE

Four Seasons 7:30 – 9:00 AM	SYMPOSIUM III: CONSIDERATIONS FOR LIMB SALVAGE V AMPUTATION FOLLOWING SEVERE LEG AND FOOT TRAUMA
	Moderator: Michael Bosse, MD
	Limb Salvage v Amputation Following Severe Leg and Foot Trauma Michael Bosse, MD
	Early Amputation - Absolute and Relative Indications Joshua Layne Gary, MD
	Optimizing Outcomes for the Limb Salvage Patient Joseph R. Hsu, MD
	Shared Decision Making - Providing Current Data and Patient Education Related to Treatment Selection Benjamin Kyle Potter, MD
	Current EBM Related to Amputation or Reconstruction Outcomes <i>Saam Morshed, MD</i>
9:00 – 9:30 AM	Breakfast/Break Visit Scientific Posters (<i>E Concourse</i>) & Technical Exhibits (<i>Mile High</i>)
9:30 – 10:32 AM	Concurrent Sessions (<i>General Session and Breakout Sessions run concurrently.</i>) Scientific Paper Session V: General Interest (9:30 – 10:32 AM) Concurrent Breakout Sessions (9:30 – 10:30 AM)
Four Seasons	SCIENTIFIC PAPER SESSION V:
9:30 -	GENERAL INTEREST
10:32 AM	Moderators - Andrew M. Choo, MD & David W. Sanders, MD
9:30 AM (p. 166) PAPER 105	The Efficacy of Antibiotic Strategies Employed at the Time of Definitive Wound Closure/Coverage for Severe Lower-Extremity Injuries <i>Clinton Kenneth Murray, MD; Heather C. Yun, MD; Manjari Joshi;</i> <i>Anthony R. Carlini, MS; Renan C. Castillo, MD; Michael J. Bosse, MD;</i> <i>METRC Bioburden Investigators</i>
9:36 AM (p. 167) PAPER 106	Single Dose IV Antibiotic for Low Energy Extremity Gunshot Wounds: A Prospective Quality Improvement Care Pathway Jonathan Carr Savakus, BS; Mai P. Nguyen, MD; Natasha Simske, BS; Joseph F. Golob, MD; Amy Ann McDonald; John J. Como MD, MPH;

Heather A. Vallier, MD

9:42 AM (p. 168) PAPER 107	Readmissions are Not What They Seem: Incidence and Classification of 30-Day Readmissions Following Orthopedic Trauma Surgery Erin Arlene Kelly, MD; Leah Gonzalez, BS; Lorraine Hutzler, MHA; Sanjit R. Konda, MD; Philipp Leucht, MD; Kenneth A. Egol, MD
9:48 AM (p. 169) PAPER 108	Do Patient Reported Outcomes Improve Following Elective Implant Removal? <i>Laurence Kempton MD</i> ; Walter W. Virkus, MD; Krista M. Brown, MS; Todd O. McKinley, MD; Greg E. Gaski, MD
9:54 AM	Discussion
10:01 AM (p. 170) PAPER 109	An Analysis of Medicare Reimbursement Rates in Orthopaedic Trauma: 2000-2018 Jack Haglin, BS; Ariana Lott, MD; David Neil Kugelman, MD; Sanjit R. Konda, MD; Kenneth A. Egol, MD
10:07 AM (p. 171) PAPER 110	Utilization of Multimodal, Narcotic Free, Pain Control Regimen Is Adequate for Patients with Femur and Tibial Shaft Fractures <i>Kyle Jay Klahs, DO</i> ; Isaac Fernandez, MD; Michael Reich, MD; Mai P. Nguyen, MD
10:13 AM (p. 172) PAPER 111	Enhancing Trauma Patient Experience Through Education and Engagement: Development of a Mobile Application <i>Benjamin Randolph Childs, BS</i> ; Anna Marie Swetz; Brendan Andres, BA; Mary Alice Breslin, BA; Sarah Hendrickson, MEd; Timothy A. Moore, MD; Vanessa P. Ho, MD, MPH; Heather A. Vallier, MD
10:19 AM (p. 173) PAPER 112	Can We Believe the Positive Results of RCTs? <i>Paul Tornetta III, MD; Justin J. Koh, MD; Jean Kang, MD</i>
10:25 AM	Discussion

9:30 – 10:30 AM

SCHEDULE

CONCURRENT BREAKOUT SESSIONS

Management of Critical Bone Defects Moderator: Geoffrey Marecek, MD Faculty: Milton Little, MD; Stephen Kottmeier, MD; Mitchell Bernstein, MD; Jaimo Ahn, MD	(601/603)
From Fixation to Revision in Periprosthetic and Interprosthetic Hip & Knee Fractures: When, How and Getting it Right Moderator: Frank Liporace, MD Faculty: Richard Yoon, MD; George Haidukewych, MD; Derek Donegan, MD; Michael Maceroli, MD	(201/203)

Snakes in the G Moderator: <i>Lis</i> Faculty: <i>Hassar</i>	G rass: Common Occupational Hazards sa Cannada, MD 1 Mir, MD; Jeffrey Smith, MD; Eric Meinberg, MD	(605/607)
Four Seasons 10:32 –	SCIENTIFIC PAPER SESSION VI: GERIATRIC	
11:41 AM	Moderators - Gerard P. Slobogean, MD & Ida Leah Gitajn, MD	
10:32 AM (p. 174) PAPER 113	Δ A Multicenter Randomized Trial Evaluating Liposomal Bupivac for Decrease of Narcotic Use in Hip Fractures <i>Paul Edward Matuszewski, MD</i> ; Arun Aneja, MD; Amna Diwan, MD Mark T. Kraus, MD; Eric Scott Moghadamian, MD; Judith Siegel, MD; Raymond D. Wright, MD; Eric F. Swart, MD	aine);
10:38 AM (p. 175) PAPER 114	Preoperative Nerve Blocks for Hip Fracture Patients: A Pilot Randomized Trial <i>Matthew Ramesh Menon, MD</i> ; Lauren Alison Beaupre, PhD; Khalid Al-Maazmi, MD; Ban Tsui, MD	
10:44 AM (p. 176) PAPER 115	Intravenous Iron May Improve Outcomes in Elderly Patients with Operative Hip Fractures Jamie Engel, MD; Joseph N. Gabra, PhD; Patrick Kane, MD; William Jason Kurtz, MD	
10:50 AM	Discussion	
10:55 AM (p. 177) PAPER 116	Pull the Foley: Improved Quality for Geriatric Trauma Patients Wi Indwelling Catheters <i>Sanjit R. Konda, MD</i> ; Joseph Robert Johnson, BS; Erin Arlene Kelly, BA Kenneth A. Egol, MD	i thout , MS;
11:01 AM (p. 178) PAPER 117	Should Urinary Catheter be Retained Preoperatively in Osteosynt of Pertrochanteric Fractures? A Prospective Randomized Clinical Direk Tantigate, MD; Thippatai Chaichompoo, MD; Yuwarat Monteera Theerawoot Tharmviboonsri, MD; Kongkhet Riansuwan, MD	hesis Irial arat, MD;
11:07 AM (p. 179) PAPER 118	Thrombelastography Identifies Hypercoagulability in Hip Fractur Patients Despite Thromboprophylaxis Daniel You, MD; Robert Korley, MD; Richard E. Buckley, MD; Paul James Duffy, MD; Ryan Martin, MD; Tanja Harrison, MPH; Andrea Prism Schneider, MD, PhD, FRCSC	е 1 Soo;
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.

(205/207)

The Treatment of Peri-prosthetic Fractures in 2019: Can We Reach a Consensus? Moderator: Emil Schemitsch, MD

Faculty: Aaron Nauth, MD; Adam Sassoon, MD; Andrew Schmidt, MD; Michael McKee, MD; Nirmal Tejwani, MD

11:13 AM	Discussion
11:18 AM (p. 180) PAPER 119	Can We Predict Failure of Percutaneous Fixation of Femoral Neck Fractures? <i>Christina Kane, MD; Jacob Jo, BA; Judith Siegel, MD;</i> <i>Paul Edward Matuszewski, MD; Eric F. Swart, MD</i>
11:24 AM (p. 181) PAPER 120	Should All Garden I and II Femoral Neck Fractures in the Elderly Be Fixed? Effect of Posterior Tilt on Rates of Subsequent Arthroplasty Kanu M. Okike, MD; Ugo Udogwu, BA; Marckenley Isaac; Sheila Sprague, PhD; Marc F. Swiontkowski, MD; Mohit Bhandari, MD, FRCSC, PhD; Gerard Slobogean, MD, MPH, FRCSC; FAITH Investigators
11:30 AM (p. 182) PAPER 121	Early Weight Bearing after Distal Femur Fractures in the Elderly: A Prospective, Cohort Pilot Study Lisa K. Cannada, MD; Jennifer L. Bruggers, MD; Kyle J. Jeray, MD; Robert D. Zura, MD; Stephanie Lewis Tanner, MS; Sarah Dawson, BSN, RN; Heidi Israel, PhD, RN
11:36 AM	Discussion
11:41 AM– 12:41 PM	Lunch Visit Scientific Posters (<i>E Concourse</i>) & Technical Exhibits (<i>Mile High</i>) Exhibit Hall closes at 1:45 PM

11:55 AM -LUNCHTIME GUIDED12:35 PMPOSTER AND VIDEO TOURS

(PT5) Hip/Femur Guide: Julius A. Bishop, MD	(Mile High)
(PT6) Knee/Tibia Guide: <i>Stephen A. Kottmeier, MD</i>	(Mile High)
(VT) Video Tours Guide: Kyle J. Jeray, MD	(Mile High)

SCHEDULE

Four Seasons 12:41 – 2:11 PM	SYMPOSIUM IV: TRADITIONAL THINKING CHALLENGED: IS THE EVIDENCE FROM RECENT FRACTURE TRIALS STRONG ENOUGH TO CHANGE PRACTICE?
	Moderator: Emil H. Schemitsch, MD
	Should Surgery for Proximal Humerus Fractures Really be Avoided? <i>Emil H. Schemitsch, MD</i>
	Are we Fixing the Right Number of Clavicle Fractures? <i>Michael D. McKee, MD</i>
	Should Antibiotic Powder Be Used in All, None or Just Some Open Fractures? <i>Gerard P. Slobogean, MD</i>
	Is It Really Safe to Treat Pilon Fractures Early? David W. Sanders, MD
	Is There Really No Advantage to VACS in Open Fracture Management? Michael J. Gardner, MD
	Are any Local Adjuncts Used to Stimulate Fracture Repair Ready for Prime Time? J. Tracy Watson, MD
	Why Does Practice not Always Follow the Evidence? <i>Edward J. Harvey, MD</i>
2:11 – 3:20 PM	Concurrent Sessions (<i>General Session and Breakout Sessions run concurrently.</i>) Scientific Paper Session VII: Foot and Ankle (2:11 – 3:20 PM) Concurrent Breakout Sessions (2:15 – 3:15 PM)
Four Seasons	SCIENTIFIC PAPER SESSION VII:
2:11 -	FOOT and ANKLE
3:20 PM	Moderators - Stephen A. Kottmeier, MD & Jodi A. Siegel, MD
2:11 PM (p. 183)	Δ Tightrope versus Screw Fixation of the Tibio-Fibular Syndesmosis: A Long-Term CT Evaluation of Maintenance of Reduction

(p. 183)A Long-Term CT Evaluation of Maintenance of ReductionPAPER 122Prism Schneider, MD, PhD; Jacalyn Thoren, MD; Duncan Cushnie, MD;
Christopher Del Balso, FRCSC, MBBS; Tanja Harrison, MPH; Christina Tieszer;
David Sanders, MD

 $\Delta\,\text{OTA Grant}$

2:17 PM (p. 184) PAPER 123	Better Outcome for Suture Button Compared to Single Syndesmotic Screw for Syndesmosis Injury: 5-Year Results of a Randomized Controlled Trial Benedikte W. Raeder, MD; Wender Figved, MD, PhD; Jan Erik Madsen, MD, PhD; Frede Frihagen, MD; Silje Berild Jacobsen, MD; Mette Renate Andersen, MD
2:23 PM (p. 185) PAPER 124	Immediate Improvement in Physical Function after Symptomatic Syndesmotic Screw Removal Jessica M. Kohring, MD; Catherine A. Humphrey, MD; Kyle T. Judd, MD; Gillian Soles, MD; John T. Gorczyca, MD; John P. Ketz, MD
2:29 PM	Discussion
2:34 PM (p. 186) PAPER 125	Tourniquet Use During Ankle Fracture Fixation Does Not Affect Rates of Wound Healing and Infectious Complications <i>Trenton William Rivera, BA</i> ; Alex Benedick, MD; Heather A. Vallier, MD
2:40 PM (p. 187) PAPER 126	Closed Reduction Percutaneous Fixation versus Open Reduction Internal Fixation of Intra-articular Calcaneal Fractures Nicholas Bolz, MD; Aws Hammad, MD; Robert E. Meehan, MD
2:46 PM (p. 188) PAPER 127	Δ The Impact of Skin Suture Pattern on Incision Perfusion Using Intraoperative Laser Angiography: A Randomized-Clinical Trial of Ankle Fracture Patients Peter Shorten, MD; Robert David Nesbit; Craig Scott Bartlett, MD; Patrick Christopher Schottel, MD
2:52 PM	Discussion
2:57 PM (p. 189) PAPER 128	What Is Too Swollen? Correlation of Soft-Tissue Swelling and Timing to Surgery with Acute Wound Complications for Operatively Treated Lower-Extremity Fractures <i>Matthew D. Riedel, MD</i> ; Amber Parker, BSN; Jorge Briceno, MD; Steven Staffa; Christopher Miller, MD; Jim Wu, MD; David Zurakowski, PhD; John Y. Kwon, MD
3:03 PM (p. 190) PAPER 129	Mid Term 5-Year Follow Up of a Novel Algorithm for Non-Operative Weber B Ankle Fractures <i>Edward Rooney, MD</i> ; Fred Finney, MD; Paul Talusan, MD; James R. Holmes, MD; David Matthew Walton, MD
3:09 PM (p. 191) PAPER 130	Is Routine Radiography in the Follow-up of Trauma Patients with Ankle Fractures (Cost) Effective? Pieter Van Gerven, MD; Pieta Krijnen, PhD; W.P. Zuidema, MD; Mostafa El Mounni; Sidney Rubinstein, PhD; Maurits Van Tulder, PhD; Inger Schipper, FACS, MD, PhD; M. Frank Termaat, MD, PhD
3:15 PM	Discussion

SCHEDULE

2:15 -CONCURRENT3:15 PMBREAKOUT SESSIONS	
Lower Extremity Osteotomies- Learning How to Make Them Work Moderator: Brett D. Crist, MD Faculty: Mark A. Lee, MD; Mitchell Bernstein, MD; Mauricio Kfuri, MD	(601/603)
Peri-Operative Medical Disasters: How to Manage Common Clinical SceneriosModerator:Kyle T. Judd, MDFaculty:Gillian Soles, MD; John T. Gorczyca, MD; Daniel Ari Mendelson, MD; Catherine A. Humphrey, MD; Michael C. Willey, MD	(201/203)
Techniques for Management of Challenging Distal Femur Fractures Moderator: John A. Scolaro, MD Faculty: Cory Alan Collinge, MD; Michael J Gardner, MD; Hobie D. Summers, MD	(205/207)
Fragility Fractures and Bone Health: Current State of the ArtModerator:Stephen L. Kates, MDFaculty:Kyle James Jeray, MD; Joseph M. Lane, MD	(605/607)

Four Seasons	SCIENTIFIC PAPER SESSION VIII: UPPER EXTREMITY								
3:20 – 4:29 PM	Moderators - Michael J. Gardner, MD & Gilbert R. Ortega, MD								
3:20 PM (p. 192) PAPER 131	Two-Year Functional Outcomes After Adolescent Clavicle Trauma: A Multicenter Comparison of Operative versus Non-operative Treatment <i>Benton E. Heyworth MD</i> ; Elizabeth Savika Liotta, MBBS; Brittany Dragonetti, BA; David Neil Williams, PhD; Andrew Tennant Pennock, MD; G. Ying Li, MD; Henry Bone Ellis, MD; Jeffrey J. Nepple, MD; Samuel Clifton Willimon, MD; David D. Spence, MD; Nirav Kiritkumar Pandya, MD; Mininder S. Kocher, MD, MPH; Eric William Edmonds, MD; Philip L. Wilson, MD; Michael T. Busch, MD; Coleen S. Sabatini, MD, MPH; Donald S. Bae, MD								
3:26 PM (p. 193) PAPER 132	General Health Outcomes Following Distal Clavicle Fractures: Results from a Previous Randomized Controlled Trial Christine Schemitsch, BS; Michael D. McKee, MD, FRCSC; Niloofar Dehghan, FRCSC, MD; Emil H. Schemitsch, MD; Aaron Nauth, MD; Milena Vicente, RN; Jeremy Hall, MD, FRCS (ORTHO); Canadian Orthopaedic Trauma Society (COTS)								
3:32 PM (p. 194) PAPER 133	Predictors of Patient-reported Function Following Operative and Non-operative Treatment of Acute Distal Clavicle Fractures <i>Lauren Nowak, MSc</i> ; Michael D. McKee MD, FRCSC; Aaron Nauth, MD; Jeremy Hall, MD, FRCS (ORTHO); Emil H. Schemitsch, MD								

3:38 PM	Discussion
3:43 PM (p. 195) PAPER 134	Predicting Humeral Shaft Fracture Nonunion: The Radiographic Union Score for HUmeral fractures (RUSHU) William M. Oliver, MBBS; Thomas J. Smith, BS; Jamie A. Nicholson, MBCHB, MRCSED; Samuel G. Molyneux, FRCS (Ortho), MSc; Timothy O. White, MD, FRCS; Nicholas D. Clement, PhD; Andrew David Duckworth, FRCS, MBCHB, MSc, PhD
3:49 PM (p. 196) PAPER 135	Radial Head Replacement for Acute Fractures: A Study of Long-Term Outcomes Thomas Carter, MBChB; Caroline D. Cristofaro, BS; Neil Ranjan Wickramasinghe, MBBS; Margaret M. McQueen, MD; Timothy O. White, MD, FRCS; Andrew David Duckworth, FRCS, MBCHB, MSc, PhD
3:55 PM (p. 197) PAPER 136	A Simple Decompression versus Anterior Transposition of the Ulnar Nerve: 2 Year Follow-Up of a Randomized Trial Emil H. Schemitsch, MD; Gurrattan Chandhoke; Christine Schemitsch; Niloofar Dehghan, FRCSC, MD, MSc; Milena Vicente, RN; Aaron Nauth, MD; Jeremy Hall, MD, FRCS (ORTHO), MEd; Michael D. McKee MD, FRCSC; Canadian Orthopaedic Trauma Society (COTS)
4:01 PM	Discussion
4:06 PM (p. 198) PAPER 137	Is There a Correlation Between Functional Results and Radiographic Findings in Patients with Distal Radius Fractures AO Type A3 Treated with a Volar Locking Plate or a External Fixator? <i>Trine Ludvigsen, MD</i> ; <i>Kjell Matre, MD</i> ; <i>Yngvar Krukhaug, MD</i> ; <i>Rakel Sif Gudmundsdottir, MD</i> ; <i>Nils Vetti; Per Martin Kristoffersen; Monika Toppe;</i> <i>Eva Dybvik, MSc, PhD; Jonas Fevang, MD</i>
4:12 PM (p. 199) PAPER 138	Scaphoid Waist Internal Fixation for Fractures Trial (SWIFFT): A Randomised Controlled Trial, Economic Evaluation and Nested Qualitative Study of Cast Immobilization versus Surgical Fixation for the Treatment of Adult Patients with a Bi-cortical Fracture of the Scaphoid Waist Matthew L. Costa, FRCS; Joe Dias, MD; Stephen Brealey, PhD; Caroline Fairhurst; Sebastian Hinde; Liz Cook, MSc; Amar Rangan, FRCS; SWIFFT Study Team Tim Chesser, FRCS – presenting abstract only.
4:18 PM (p. 200) PAPER 139	Immediate Weight Bearing of Plated Both – Bone Forearm Fractures in the Poly-Trauma Patient is Safe Lucas Scott Marchand, MD; Steven Andrew Horton, MD; Alexandra Bryn Mulliken; Ritu Goel; L. Nicole Krum, DPT; George Ochenjele, MD; Nathan N. O'Hara; Robert V. O'Toole, MD; W. Andrew Eglseder, MD; Raymond A. Pensy, MD
4:24 PM	Discussion
4:30 PM	Closing Remarks and Adjourn
	See you next year in Nashville, Tennessee, October 1-3, 2020

 Δ OTA Grant

SCHEDULE

Wed., 9/25/19 Basic Science: Biomechanics-Hot Topics, PAPER #1

Comparison of Three Methods for Maintaining Interfragmentary Compression After Fracture Reduction and Fixation in an Osteoporotic Sawbones Model *Brendan G. Swain*; *Brigham K. Au, MD; Matthew Landrum, MD; Craig Munro Birch, MD UT Southwestern, Dallas, TX, United States*

Purpose: The purpose of this study is to compare 3 different methods of maintaining interfragmentary compression in distal femur fractures after reduction and compression of the fracture with a reduction clamp in an osteoporotic Sawbones model. Our hypothesis is lag screws will not have a significant difference in maintenance of compression compared to positional or locking screws in osteoporotic bone.

Methods: A distal femur plate was used to place pilot holes for the lag screws, positional screws, and locking screws to ensure consistent placement between specimens and uniform, safe placement of the pressure transducer. The intra-articular fracture was then created using a jig and bandsaw to place a vertical split fracture exiting laterally 8 cm proximal to the joint. The fracture was reduced with a pressure transducer in place and clamps were placed with approximately 20 pounds of force. Two 3.5-mm cortical lag screws (group 1), two 3.5-mm cortical positional screws (group 2), and four 5.4-mm distal locking screws through a distal femur locking plate (group 3) were placed across the fracture using standard technique and with a torque-limiting screw driver (lag and positional screws at 1.3 N·m, locking screws at 4 N·m). After releasing the clamp, the interfragmentary compression force was measured. After 2 minutes a steady state was reached and the force recorded again. Statistical analysis was performed using Kruskall-Wallis analysis of variance for comparison of the initial force after clamp removal between the 3 groups. Wilcoxon sgned rank tests were used for comparing baseline force to steady state force within each group.

Results: There were no differences between the 3 groups with respect to initial force applied with the clamps (P= 0.577). Within each group, there were no significant differences between the residual (immediately after clamp removal) and steady state interfragmentary force measurements (2 minutes after removal of clamp) (P >0.232). Locking screws through the plate (group 3, n = 5) only maintained 30.5% of the initial compression force applied by the clamps (P = 0.004), whereas the steady state compression force of the positional screws (group 2, n = 5) and lag screws (group 1, n = 5) increased by 53.7% (P = 0.0586) and 64.2% (P = 0.08), respectively. The steady state forces in the lag screws group and positional screws group were significantly greater than the steady state force of the locking screws through the plate (group 3) (P <0.05 for both comparisons).

Conclusion: In an osteoporotic Sawbones model, when reducing intra-articular distal femur fractures and applying interfragmentary compression with reduction clamps, lag screws and positional screws stoutly maintain, if not increase, the compression force across the fracture, while locking screws with a plate alone result in a loss of compression force. This study supports the use of positional or lag screws outside of the plate before locking screws for fracture fixation in patients with osteoporosis.

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Wed., 9/25/19 Basic Science: Biomechanics-Hot Topics, PAPER #2

Supplemental Fixation of Supracondylar Distal Femur Fractures: A Biomechanical Comparison of Dual- Plate and Plate-Nail Fixation Techniques David Wright, MD; Donald Desanto, MD; Michelle H. McGarry, MD; Thay Q. Lee, PhD; John A. Scolaro, MD VA Long Beach Medical Center, Long Beach, CA, United States

Purpose: Fixation of complex distal femur fractures remains a challenge. Supplemental fixation techniques have been proposed to address fractures in the setting of bone loss or poor-quality bone. The purpose of this biomechanical study was to investigate the effectiveness of dual-plate and plate-nail combinations for supplemental fixation of supracondylar distal femur fractures. We hypothesized that dual-plate constructs would be more stable in torsion, while plate-nail constructs would be more stable in axial compression.

Methods: 24 synthetic osteoporotic femurs were used to compare 4 constructs in an extraarticular supracondylar distal femur fracture gap model (OTA/AO type 33-A3). Constructs were as follows: (1) lateral distal femoral locking plate (LDFLP), (2) retrograde femoral nail (RFN), (3) dual-plate construct with LDFLP + medial 3.5-mm LC-DCP [limited contact dynamic compression plate], and (4) plate-nail construct with LDFLP + RFN. Specimens were cyclically loaded along the mechanical axis of the femur in both torsion and axial compression using an Instron testing machine. Fracture displacement was measured using video tracking software. Following synthetic model testing, dual-plate and plate-nail constructs were directly compared using 7 matched pairs of cadaveric femurs (range: 64-72 years). The primary outcome was construct stiffness in both torsion and axial compression in cadaveric specimens. Stiffness was calculated using the average slope of the force-displacement curve. Analysis was performed using a Kruskal-Wallis one-way analysis of variance with post-hoc Dunn test for synthetic femurs and a paired-samples t-test for cadaveric femurs.

Results: In cadaveric specimens, the dual-plate construct was nearly twice as stiff as the plate-nail construct across all torsional loads (8.41 ± 0.58 Nm/deg vs 4.24 ± 0.41 Nm/deg, P <0.001), and over 2.5 times stiffer across all axial loads (3762.1 ± 337.1 N/mm vs 1448.9 \pm 190.1 N/mm, P <0.001). There were no construct failures. These cadaveric results were consistent with trends observed in the synthetic osteoporotic femurs, although not all differences were statistically significant in the synthetic models.

Conclusion: This study demonstrates that dual-plate constructs are significantly stiffer than plate-nail constructs in both torsion and axial compression in an extra-articular supracondylar distal femur fracture model. In the clinical setting, consideration must be given to the effect of increasing stiffness on fracture healing, as well as the biological impact of placing a second femoral intramedullary or medial surface implant. This study provides an important biomechanical profile of supplemental fixation techniques that have been proposed to improve fixation in complex distal femur fractures.

Dramatically Improved Strength of Proximal Humeral Fixation with a Tuberosity-Specific Fixation Plate

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Purpose: Current proximal humeral locking plates are unable to secure the greater and lesser tuberosities securely and have a high incidence of fixation failure, nonunion, and rotator cuff dysfunction. This study evaluates a proximal humeral plate specifically designed to capture the greater and lesser tuberosities, which may improve tuberosity fixation. The purpose of this biomechanical study was to determine if the new plate design reduces greater tuberosity displacement and increases the load to failure compared to a standard proximal humeral locking plate.

Methods: Six matched cadaveric humerus specimens were acquired and randomized to receive either standard humeral locking plate (Group 1) or tuberosity-specific plate fixation (Group 2, Figure). Specimens were skeletonized with the exception of the rotator cuff insertion on the greater tuberosity. A reproducible 3-part osteotomy was performed for each cadaver. Plate fixation was performed and augmented with standard suture augmentation through the rotator cuff. The construct was loaded at 45° to the greater tuberosity fragment thereby putting the most stress at this fracture fragment. In each trial, fracture displacement, load to failure, number of cycles endured, stiffness, and mechanism of failure were calculated. Calipers and photographs of pins on either side of the osteotomies were used to measure the displacement of each site (surgical neck, greater tuberosity base, and greater tuberosity proximal aspect).

Results: Mean load to failure in Group 1 was 200.8 \pm 163.9 N and Group 2 was 520.3 \pm 203.6 N, respectively (P = 0.049, Fig. 3). Most specimens failed by avulsion of the greater tuberosity segment.

Conclusion: Group 2 (mean 520 N) had a higher load to failure than Group 1 (mean 200 N). The tuberosity- specific plate design dramatically increased the strength of fixation of the greater tuberosity and humeral head. This may decrease the high rate of tuberosity-related complications seen clinically, and translate into improved functional outcomes.



Wed., 9/25/19 Basic Science: Biomechanics-Hot Topics, PAPER #4

Biomechanical Evaluation of Locked Plating Fixation for Unstable Femoral Neck Fractures *Emily Bliven, BS*; Simon Hackl, MD; Sabrina Sandriesser; Peter Augat, PhD Institute of Biomechanics, Trauma Center Murnau, Murnau, Germany

Purpose: Fractures of the femoral neck are commonly treated with multiple cannulated screws, compression hip screws, or proximal femoral locking plates. However, high complication rates are still observed, especially in vertically oriented and more unstable fracture cases. The purpose of this study was to evaluate if treating an unstable femoral neck fracture with a locking plate with spring-loaded telescoping screw system would improve construct stability compared to conventional fixation methods when loaded in a physiological fatigue scenario.

Methods: 30 fresh-frozen femur cadavers were evenly distributed into 3 groups based on bone mineral density (BMD) in the femoral neck. A 31B2 Pauwels type III osteotomy with an additional posterior wedge was cut into each specimen to simulate an unstable multifragmentary fracture. Specimens were implanted by fellowship- trained surgeons with either: 3 cannulated screws in an inverted triangle configuration (CS), a sliding hip screw and anti-rotation screw (CHS+1), or a locking plate with spring-loaded telescoping screw system. Only 2 out of 3 possible screws were utilized in the spring-loaded telescoping screw system. Constructs were mounted in a material testing machine and dynamic fatigue testing was conducted with physiological loads representative of walking with increasing weight bearing. Constructs were loaded until specimen failure or 15- mm actuator displacement was observed. Movement of the femoral head with respect to the shaft was recorded using a high-resolution optical motion tracking system. Statistical evaluation was performed using multivariate analysis of variance with Bonferroni correction and femoral head BMD as a covariate.

Results: Construct stiffness was 582 \pm 344 N/mm and 509 \pm 158 N/mm for the CS and CHS+1 groups, respectively, and 740 \pm 371 N/mm in the spring-loaded telescoping screw group. CHS+1 and spring-loaded telescoping screw specimens failed at twice the average number of cycles as the CS group. Plastic rotation of the femoral head indicative of varus tilt was found to be $1.4 \pm 1.4^{\circ}$ in the CS group, $0.5 \pm 0.6^{\circ}$ in the CHS+1 group, and $0.2 \pm 1.0^{\circ}$ in the spring-loaded telescoping screw group during early stages of loading. Average femoral shortening at 6500 cycles was 2.2 ± 2.5 mm in the CS group, 1.5 ± 1.4 mm in the CHS+1 group, and 0.3 ± 0.5 mm in the spring-loaded telescoping screw group. The observed deformation values demonstrated statistical significance between spring-loaded telescoping screw and CS groups (P<0.05). A moderate correlation was found between femoral head BMD and construct stiffness (r = 0.65, N = 30, P < 0.001).

Conclusion: Use of the spring-loaded telescoping screw system resulted in higher construct stiffness and lower plastic deformation of the femoral head with respect to the shaft during early stages of cyclic loading. This study's findings suggest that the spring-loaded telescoping screw system improves the biomechanical stability of unstable femoral neck fractures when compared to the CS method, and could be a suitable alternative to the use of a hip screw system. Confirmation of these results in a clinical setting is necessary.

See the meeting app for complete listing of authors' disclosure information.

Intra-Articular Relaxin-2 as a Treatment for Arthrofibrosis

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Purpose: We propose the local intra-articular delivery of the naturally-occurring, antifibrotic hormone relaxin-2 as a novel treatment for arthrofibrosis. Relaxin-2 is endogenously upregulated during pregnancy to increase tissue laxity by promoting matrix metalloproteinase production, suppressing collagen and tissue inhibitors of metalloproteinases expression, and blocking transforming growth factor (TGF)- β 1 signaling. Our proposal stems from clinical observation among arthrofibrosis-afflicted female patients who experienced lasting motion restoration and reduced joint pain during and after pregnancy. Given that articular structures are primarily responsible for long-term range of motion (ROM) loss in arthrofibrosis, we hypothesize that relaxin-2 will reduce fibrosis in a rat shoulder arthrofibrosis model.

Methods: 20 female Sprague-Dawley rats underwent surgical suture immobilization of the shoulder to induce fibrosis over the course of 56 days. After suture removal, recombinant human relaxin-2 was administered in 4 different treatment groups: (1) single intra-articular dose (sIA), (2) multiple intra-articular doses (mIA), (3) multiple intravenous doses (mIV), and (4) untreated operated surgical controls. Relaxin-2 was administered at a dose of $1.5 \,\mu\text{g}$ /kg in the sIA and mIA groups and at a dose of $0.5 \,\text{mg}/\text{kg}$ in the mIV group; mIA and mIV treatments were given every 2 days for 10 days. All kinetic measurements were recorded under anesthesia with a digitally controlled torque system, and normalized to each rat's baseline measurements.

Results: The total ROM of the untreated operated control group remained constricted by -24° , or -15% (P < 0.01) for the duration of the experiment when compared to unoperated baselines. Similarly, the mIV treatment group displayed a significant restriction of -31° , or -19% (P < 0.01). For the sIA group there was a temporary improvement in the total ROM measurement directly following the treatment (P = 0.025). However, the animals in the sIA group returned to a restrained total ROM by day 14 and remained restricted by -22° , or -14% (P<0.01) for the duration of the experiment. The results from the mIA treatment group were significantly improved compared to the untreated control group (P < 0.01) and not significantly different from the healthy baseline measurements (P = 0.94).

Conclusion: In a validated rat shoulder contracture model, treatment with multiple intraarticular (mIA) injections of human relaxin-2 significantly improves total ROM, returning it to baseline levels collected prior to limb immobilization. A return to normal ROM is not observed with the sIA and mIV treatment groups. This suggests that a more sustained, lower level dosage is a more effective treatment. Arthrofibrosis is not restricted to the shoulder and is a widespread condition, occurring after trauma, surgical procedures, prolonged immobilization, and other etiologies. Local delivery of relaxin-2 offers a promising new treatment.

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Vaporized Versus Combusted Nicotine: A Biomechanical Comparison of Achilles Tendon Healing in a Rat Model

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Purpose: The negative effects of smoking have been well documented following orthopaedic injury. Although nicotine has been shown to be detrimental to musculoskeletal tissue healing, nicotine in the form of "vaping" is being increasingly used as a perceived healthier alternative to actual smoking and may theoretically obviate many of the harmful volatiles and chemicals contained within combusted tobacco that are additionally harmful to musculoskeletal healing. Our objective was to evaluate the biomechanical and histological effects on Achilles tendon repair between rats that inhaled combusted tobacco, versus those with isolated nicotine exposure via vaping, versus a control group.

Methods: 54 Sprague-Dawley rats were randomly placed in a control, vaping, or cigarette cohort. Each group contained 18 rats and exposure occurred 6 days per week. The smoking cohort was exposed to 2 unfiltered University of Kentucky research cigarettes in a previously validated smoking chamber. The vaping group was exposed to e-cigarette vapor with equivalent nicotine exposure over 10 minutes at a flow rate of 2.4 L/min. The control group was placed in the smoking chamber with room air flow. All rats received their respective daily exposures for 4 weeks prior to surgery when surgical transection and repair of the Achilles tendon was performed. Following surgery, the rats continued 2 additional weeks of smoking, vaping, or control exposure. After sacrifice, Achilles tendons were harvested and tested with controlled tension to failure (n = 15 per group). Histological samples were sent for analysis (n = 2-3 per group). One rat expired prior to sacrifice.

Results: Tensile testing evaluated maximum force to rupture and tissue stiffness. The control group demonstrated highest mean tensile strength of 41.0 N (standard deviation [SD] 10.4 N), with the cigarette cohort having the second highest mean tensile strength at 37.3 N (SD 11.1 N), and finally the vaping group had the lowest at 32.8 N (SD 8.4 N). One-way analysis of variance with heterogeneity of variance was used for evaluation. There was a significant difference detected in load to failure when comparing controls to e-cigarettes (P = 0.026). No statistically significant difference was seen between controls versus cigarettes (P = 0.35). Histological analysis demonstrated no difference among groups.

Conclusion: Our investigation demonstrates that, in a rat model, isolated nicotine exposure via "vaping" significantly impedes biomechanical healing properties of Achilles tendon surgical repair. Although smoking resulted in a lower maximum force to failure as compared to control in these samples, this difference was not significant. While e-cigarettes are often utilized as a perceived "safer" alternative to smoking combusted tobacco, this study suggests that use of e-cigarettes may be more detrimental to tendon healing than combusted tobacco in a rat Achilles model.

Early Immunotypes Identify Trauma-Tolerant and Trauma-Sensitive Patients with Orthopaedic Injuries

Todd O. McKinley, MD; *Greg E. Gaski, MD*; *Yoram Vodovotz, PhD*; *Timothy R. Billiar, MD Indiana University School of Medicine, Indianapolis, IN, United States*

Purpose: Multiply injured patients (MIPs) frequently sustain skeletal trauma. These patients are at risk to develop acute (infections, organ failure) and long-term (nonunion, osteomyelitis) complications. There are anecdotal trauma-tolerant (TT) MIPs who are severely injured but recover without complications in contrast to trauma-sensitive (TS) MIPs who are less injured but develop complications and poor long-term outcomes.

Recent work has demonstrated that early immunologic response to injury may identify patients who are TT or TS. The objective of this study was to compare the early immunologic response between 2 subsets of MIPs with orthopaedic injuries who were phenotypically TT or TS.

Methods: 100 MIPs (admitted to ICU; SS >18), 18-55 years old, were included. Initial hemorrhage was measured by temporal integration of elevated serial shock index values (HR/SBP > 0.9) over the first 6 hours after injury (6-hour shock volume [6hr SHVL]). Organ dysfunction was quantified by averaging Marshall Organ Dysfunction scores from day 2-5 after injury (aMOD). Regression analysis showed close correspondence between aMOD and 6hr SHVL. We identified a subcohort of 13 patients with similar demographics, orthopaedic injuries, and ISS who either had high 6hr SHVL (>60 units) and low aMOD (< 4) (6 patients TT), or who had low 6hr SHVL (< 20 units) and high aMOD (>4) (7 patients TS). We compared serial serum cytokines measured at 0, 8, 24, and 48 hours after injury between TT and TS patients.

Results: ISS (TT = 32.7; TS = 36.6; P = 0.53) and age (TT = 35.7 years; TS = 35.9 years; P = 0.98) were equal between groups. TT patients had high-magnitude initial hemorrhage (6hr SHVL TT = 88.1 units; TS = 8.9 units; P < 0.0001) and low organ dysfunction (aMOD TT = 2.4; aMOD TS = 5.2; P = 0.0016) compared to TS patients. TS patients had more days in ICU (16.0 vs 5.3 days; P = 0.012) and more ventilator days (14.1 vs 2.5 days; P = 0.022). There were no cytokine differences between TT and TS patients at 0 hours. By 8 hours after injury, levels of protective, reparative cytokines interleukin (IL)-9, 21, 22, 23, 33, and IL-17E/IL-25 were reduced and MIG and sIL2RA increased (P < 0.05) in TT patients compared to TS patients. At 24 hours, significant reductions in IL-9, 21, 22, and 33 remained along with reductions in HMGB1 and increases in IL-10 in TT patients. No differences were measured at 48 hours.

Conclusion: There were distinct immunotypes identified that discriminated TT and TS patients in cohorts of MIPs who were otherwise similar in age and injury severity. Differences were primarily in tissue-protective cytokines. Information that could risk-stratify response to injury was evident by 8 hours after injury. Such information could be useful to inform initial and staged orthopaedic intervention decisions.

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Intramedullary Nailing Alters Pulmonary Neutrophil Deposition and Cell Surface Receptor Expression in Experimental Orthopaedic Trauma in Rats

Michel Teuben; Martijn Hofman; Johannes Greven; Zhi Qiao; Alba Shehu; Kai O. Jensen, MD; Frank Hildebrand, MD; Roman Pfeifer, MD; Hans-Christoph Pape, MD University Hospital Aachen, Aachen, Germany

Purpose: Polymorphonuclear neutrophils (PMNs) are the most highly abundant immune cells in circulation. Excessive PMN deposition and activation in vital organs is associated with inflammatory complications such as acute respiratory distress syndrome (ARDS). Intramedullary nailing (IMN) for long bone fractures has been identified as a risk factor for the development of inflammatory complications. However, the impact of IMN on pulmonary neutrophil deposition and activation is unclear. We hypothesized that IMN is associated with temporary increased pulmonary neutrophil presence and activation.

Methods: A rat model including IMN and a femur fracture was utilized. Groups were terminated after 3, 7, and 14 days. Lung parenchymal and broncho-alveolar lavage fluid (BALF) PMNs were collected and analyzed by flow cytometry. Cell counts as well as membrane expression levels of CD11b, CD62L, and CD11a were compared between groups.

Results: Pulmonary neutrophil numbers were increased 3 days after insult. Additionally, cell surface expression levels of CD11b (P < 0.01) and CD62L (P < 0.01) on parenchymal neutrophils were found to be increased after 3 days of observation as well. A gradual restoration of neutrophil activation and numbers was observed thereafter. Activation status of the bronchoalveolar neutrophil pool differed significantly from their parenchymal counterparts.

Conclusion: We demonstrated that our standardized rat model is feasible to study long-term innate immune responses in the tissue compartment to trauma. This study further shows that IMN is associated with temporary increased pulmonary neutrophil deposition. Moreover, concurrent increased integrin and selectin receptor expression on lung neutrophils was found. This phenomenon suggests that integrin and selectin receptor dynamics modulate PMN pulmonary tissue homing. Upcoming studies should focus on the modulation of integrin and/or selectin signaling on neutrophils and the potential to interfere in lung neutrophil homing processes.

Local versus Systemic Inflammation in a Standardized Porcine Trauma Model: Is There a Discernible Effect of the Magnitude of Injuries?

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Purpose: Severe injury leads to inflammatory changes known to be associated with systemic complications (organ failure/ARDS [acute respiratory distress syndrome]). The aim of this study was to analyze the acute response after local extremity versus multiple injuries associated with severe hemorrhage in a large animal model.

Methods: We used a standardized pig model: hemorrhagic shock (pressure controlled, 1 hour, 25 mm Hg), liver laceration, femoral shaft fracture, blunt thoracic trauma (group Polytrauma [PT]). Control animals were submitted to isolated trauma (femur fracture only, group MT). Fracture stabilization was by nailing. Observation period was 6 hours. Time points were baseline (BL), trauma (TR), completion of resuscitation, and 2, 4, and 6 hours after nailing. The systemic inflammation was measured with enzyme-linked immunosorbent assay (ELISA) (interleukin [IL]-6, IL-10). Soft-tissue analyses were performed with polymerase chain reaction (PCR) (IL-6, IL-10) of muscle and fatty tissue harvested from the fracture site at baseline and at termination.

Results: Group PT (n = 27) showed a significant increase in systemic IL-10 1 hour after resuscitation until the end of observational period (P <0.02). Further, our data show significant differences in systemic IL-6 values when comparing group PT to group MT (n = 25) (P <0.008). The local circulation was decreased at the fracture site in group PT compared to group MT (P <0.03). The local increase in IL-6 and IL-10 of fatty tissue is comparable in group MT and group PT. The local microcirculation in the extremities differ in groups MT and PT (P <0.05)

Conclusion: In the acute phase of inflammation after severe injury, the significant changes observed in systemic inflammation do not translate into the local tissue reaction. Our data

reveal that the local vascularity is lower in polytraumatized animals, which might explain the lack of this response. Further studies are needed to reveal whether this is associated with a delayed reperfusion damage.

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	111.0	Baselin	ŧ.	Trauma	Resuscitation		Tra 2h		Tra 4h		Termination		
		Me	an 5D	Mean	SD.	Mean	SD	Mean	5D	Mean	SD.	Mean	50
group PT	11.10	24	5 23.2	320.2	386.4	475,2	416.9	210.8	152.1	281.8	199.7	274.6	336.6
group MT		.27.	.0 41.2	299.7	342.4	206,6	292.9	112,6	48.6	104,1	87.0	139.2	345.0
1.00		ins.	5	ns		ns.		11		28			
group PT	IL 6			71.7		216.5	281.9	472.4	446,4	745.0	488.8	660.8	462,6
group MT				10.5		22.1	47.4	79.9	174.9	197.0	230.5	282.0	315.3
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Is the Bioactivity of Induced Membranes Time-Dependent?

Jan Gessmann, MD; Thomas Rosteius, MD; Kavitha Sivalingam; Dominik Seybold; Elvira Peter; Thomas A. Schildhauer, MD; Manfred Koeller BG University Hospital Bergmannsheil, Bochum, Germany

Purpose: The Masquelet technique is a 2-stage surgical procedure for the reconstruction of segmental bone defects. Bone grafting is recommended at 4-6 weeks after cement-spacer implantation assuming the highest bioactivity of the cement spacer induced membranes at this point in time. In clinical practice, this narrow time interval is often not met due to ongoing soft-tissue healing (eg, after free flap surgery). Furthermore, successful treatment has also been reported if bone grafting was performed after several months or even years. Therefore, the aim of this study was the structural and cellular characterization of cement spacer induced membranes and the analysis of membrane bioactivity over time.

Methods: Membranes from 65 patients (35-82 years) were analyzed. Based on the time point of membrane biopsy, 4 groups were formed: group 1, 8-28 days; group 2, 29-49 days; group 3, 50-63 days; and group 4, 78-113 days. The bioactivity of the membranes was histologically and immunohistologically studied by analysis of protein profiles of membrane lysates using protein microarrays. In addition, after co-culture of membranes with mesenchymal stem cells (MSCs) outgrowth and osteogenic differentiation of MSCs were measured. Osteogenic differentiation was assessed by calcification (alizarin red), alkaline phosphatase (ALP), C-terminal propeptide of procollagen I (CICP), osteoprotegerin (OPG), osteopontin (OPN), osteocalcin (OC), and bone-specific ALP (BAP).

Results: Microarray analyses revealed increased protein expression of angiogenesis factors, inflammatory mediators, and osteoinductive growth factors in Masquelet membrane lysates. The angiogenesis factors showed highest expression in the early time group (8-28 days). The expression of osteoinductive growth factors was comparable with slight variations at all time points. Histologically, increased vascularization occurred especially in the younger membranes (8-28 days). Immunohistochemical analyzes confirmed increased angiogenesis by the expression of angiogenin, CD31, CD34, CD90, CD105, and EMMPRIN. In the group of 29-49 days predominantly fibrotic tissue with parallel collagen fiber orientation was detected. In addition, the osteogenic markers (matrix metalloproteinase [MMP]-9, AP, OP, and OC) and osteoclasts could be detected by TRAP (tartrate-resistant acid phosphatase) staining. MSCs (CD105/CD73) were found at all time points.

Conclusion: The induced membranes showed specific time-dependent, but not significantly different, stages of development with increased angiogenesis and vascularization in the early phases and increased fibrosis in later phases. Comparable osteoinductive bioactivity and MSCs were observed at all time points. Thus, the previously postulated narrow time frame of 4-6 weeks until bone grafting can be questioned. However, further clinical trials are necessary to verify these in vitro results.

Evaluation of Local Gene Expression in Response to the Presence of Antibiotics in a Polymethylmethacrylate Spacer

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Purpose: The Masquelet technique is a 2-stage surgical procedure utilized in the treatment of segmental bone defects. The biology of the induced membrane is critical to the success of this technique. The use of antibiotics within the PMMA (polymethylmethacrylate) spacer is controversial as their effect on the induced membrane are unknown. This study examined the effect of antibiotics in the PMMA cement on gene expression of the induced membrane in a rat model of the Masquelet technique.

Methods: The femora of 18 Sprague-Dawley rats were exposed. Following the placement of a PEEK (polyetheretherketone) plate, a 5-mm defect was created. The right femur of each rat received a PMMA spacer containing vancomycin and tobramycin and left side received one without antibiotics. After 4 weeks, the rats were euthanized and tissue from the membrane and femur in contact with the PMMA spacer were collected.

Samples were morselized and RNA was isolated for quantitative real time polymerase chain reaction (qRT- PCR). Comparison of gene expression was made between membrane and bone tissue formed with and without the presence of antibiotics.

Results: Six rats were not included due to loss of fixation prior to the 4-week point. The expression of the tested genes was not significantly different in the membrane and bone between the samples with and without antibiotics (Fig. 1).

Conclusion: In this rat model, the presence of antibiotics in the PMMA spacer had no significant effect the expression of 6 genes within the induced membrane and surrounding bone. The tested genes were selected as markers of the biologic processes that we believe are modulated in the induced membrane technique and are critical to the efficacy of the Masquelet technique. While further study on the effects of antibiotics in the clinical setting is needed, these data suggest that antibiotics can be used without altering the biologic potential of the membrane.



Average Gene Expression (Normalized to Beta-Actin)

Thermal Stability of "End of the Line" Antibiotics When Used in Polymethylmethacrylate Bone Cement

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Purpose: "End of the line" antibiotics such as amikacin, meropenem, and minocycline are used systemically to treat multidrug-resistant gram-negative infections; however, their use in polymethylmethacrylate (PMMA) is not routine and has not been well documented. One barrier to inclusion of alternative antibiotics in PMMA is the high polymerization temperatures of this material. The purpose of this study is to quantify the thermal stability of selected antibiotics using clinically relevant PMMA bead and tibial spacer models.

Methods: Polymerization temperatures of Simplex PMMA were measured in a 1-cm custom bead mold and 8 × 5 × 3 cm tibial spacer (Stage One) model at 30-second intervals. Maximum temperatures for each time point were used to generate thermal profiles that were programmed into a thermocycler (C1000 Touch, Bio-Rad). Stock solutions of antibiotics were made (USP reference standards of Tobramycin, amikacin, meropenem trihydrate, and minocycline hydrochloride). Tobramycin validated the methodology given its known thermal stability. Each antibiotic solution was subjected to one of the 2 thermal profiles followed by immediate incubation at 37°C to mimic clinical implantation. Samples were removed from incubation at 8 time points across 28 days for testing of microbiologic activity. The minimum inhibitory concentration (MIC) of each antibiotic was evaluated against Escherichia coli (American Type Culture Collection 25922, Microbiologics Inc.) using a microbroth dilution assay in quadruplicate. MICs of temperature-exposed antibiotics were compared to those of stock solutions of antibiotics that had not undergone heating or incubation.

Results: The thermal conditions of the 1-cm bead and tibial spacer models did not alter the MICs for any antibiotics. Tobramycin and amikacin also showed minimal change in MIC over time when subjected to prolonged incubation at body temperature. The MIC of meropenem increased four-fold after 7 days of incubation and rose exponentially over the next 21 days. The antimicrobial activity of minocycline declined at 24 hours and by 7 days was higher than the testable range for the assay used.

Conclusion: Having appropriate options available for local therapy in the face of infection is of paramount importance. Amikacin retained antimicrobial activity over time when subjected to the thermal conditions of PMMA in the tested 1-cm bead and tibial spacer models. Amikacin (and perhaps meropenem) may be acceptable alternative antibiotics for local delivery in PMMA for the treatment of severe infections, especially gram-negative infections, that are resistant to currently used antibiotics. Further studies on the elution characteristics of these antibiotics from various PMMA models are also warranted.

Effectiveness of Bioactive Ceramic-Based 3D Printing Scaffold Coating with BMP-2 in Induced Membrane Technique for Critical Sized Bone Defect of Rabbit

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Purpose: Although autogenous bone graft has been an optimal filling material in induced membrane technique, limited availability and complications of harvest site have led to the need for alternatives for optimal graft material. Our study is aimed to investigate the effect of 3-dimensional (3D) printing bioceramic scaffold coating with bone morphogenetic protein (BMP)-2 in critical sized metadiaphyseal bone defects in rabbit.

Methods: A 10-mm segmental bone defect was made at metadiaphyseal area of distal femur of 14 New Zealand White rabbits (average age, 4.5 months; weight, 3.0-3.5 kg). The defect was filled with polymethylmethacrylate (PMMA) cement and stabilized with 2.0-mm LCP T-plate. A week after first operation, CT scan was performed to design and print out defect specific bioceramic scaffold. After 4 weeks for maturation of membrane, the animals were randomized into Group 1 (3D printing bioceramic scaffold alone) and Group 2 (3D printing bioceramic scaffold coating with BMP-2) for implantation. Radiographs were performed every 4 weeks.

Euthanasia was performed at 8 weeks after grafting for visual, radiological, conventional CT, micro CT, biomechanical, and histological studies.

Results: Radiographic assessment showed that union rate of defect was significantly higher in Group 2 (7/7, 100%) than Group 1 (2/7, 29%). The average volume of newly formed callus measured in conventional CT was 472.55 mm3 in Group 1 and 1010.8 mm3 in Group 2. Total bone volume and tissue mineral density within scaffold, which were measured in micro CT, were greater in Group 2 than in Group 1. The average static and dynamic stiffness were significantly higher in Group 2. Histological examination revealed newly formed bone in both groups. Meanwhile, active new bone formation was found in Group 2.



Maturation of induced membrane for 4 weeks



Implantation of 3D printing bioceramic scaffold coating with BMP



Complete bony regeneration after 8 weeks

Conclusion: Bone regeneration in critical sized bone defect could be obtained with 3D printing bioceramic scaffold coating with BMP-2 in a small animal model. A 3D printing bioceramic scaffold coating with BMP-2 could be an alternative graft material in induced membrane technique for critical sized bone defect.

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

Wed., 9/25/19 Basic Science: Infection or ABC Delivery, PAPER #14

The Potential of Metagenomic DNA Sequencing for Pathogen Identification in Orthopaedic Nonunion

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Purpose: Fracture nonunion remains a devastating complication that confers significant morbidity. While it is known that nonunions may occur for several reasons, broadly classified as septic or aseptic, the true extent to which the presence of microbes preclude fracture healing remains unknown. With the increasing availability of metagenomic sequencing techniques, such as next-generation sequencing (NGS), rapid and high throughput detection of all microbial DNA present within a clinical sample is now possible. It has therefore been proposed that a significant percentage of nonunions actually harbor microbes that escape detection by conventional culture methods. To date, no study has examined the metagenomic profile of fracture nonunions or explore the clinical relevance of this signal. Our aim was to investigate the role of NGS in the diagnosis of nonunion compared to culture, as well as its association with treatment outcomes in terms of fracture union.

Methods: In this prospective study, samples were collected from 20 consecutive patients undergoing open surgical intervention for long bone nonunion (7 femurs, 9 tibias, 4 humeri). Nonunion was defined as a failure to progress towards union within an anticipated time frame as defined by the attending surgeon. We excluded patients with pathological fractures or those on preceding antibiotic therapy. Three tissue samples (superficial membrane; proximal and distal fracture) and 3 intraoperative swabs (fracture site; hardware) were obtained at the time of the surgical procedure and sent for NGS. Tissue specimens from concordant sites were sent to the institutional laboratory for culture. Patients were followed for a minimum of 6 months (range, 6-11) for radiological evidence of union. Concordance and bivariate statistics were used to compare NGS, culture, and union rates. Principal coordinates analysis of NGS species diversity was also conducted.

Results: Among the total cohort, 14 nonunions were culture-negative (14/20; 70.0%) and 6 were culture-positive (6/6; 100.0%). Among the positive culture cases, complete concordance between NGS and culture results was noticed in 6 cases (100% dominant species similarity). Among the 14 cases of culture-negative nonunion, NGS identified a microbe in 6 cases (42.9%). NGS detected multiple organisms in most positive samples (mean 2.9 microbes) but 1 organism was typically dominant. Of note, positive NGS signal in culture-negative cases was inversely associated with fracture union at interim follow-up (50% vs 75%); however, this trend did not reach statistical significance (P = 0.12).

Conclusion: NGS may be a useful adjunct in identification of the causative organism in culture-negative nonunion. Our findings suggest that some cases of nonunion may have additional organisms that escape detection when culture is used. Further multicenter work is required to determine the clinical implications of organisms detected on metagenomic sequencing.
Wed., 9/25/19 Basic Science: Infection or ABC Delivery, PAPER #15

Antibiotic Elution from a Magnesium Phosphate Resorbable Cement

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Purpose: Successful treatment of bone infection may involve debridement and use of antibiotic-loaded cement. Polymethylmethacrylate (PMMA) has several disadvantages when used for this purpose, including need for second-surgery removal. Calcium sulfate bioresorbable cements are an alternative to PMMA, but resorption is commonly associated with wound drainage. To address these issues, the novel magnesium phosphate resorbable bone void filler cement OsteoCrete has been used increasingly. This study was designed to test the hypothesis that OsteoCrete mixed with an antibiotic would inhibit bacterial growth without decreasing osteoblast viability.

Methods: Antibiotic beads were created by mixing 5 cm3 of OsteoCrete (OC) for 2 minutes, adding 1 g of vancomycin, mixing another 30 seconds, and spreading the putty mixture over a bead mat. Control OC beads did not contain vancomycin (vanc). Beads were incubated for 30 minutes, then removed from the mat. Zone of Inhibition Test: OC-vanc and cntrol beads (n = 6 each) were placed on Staphylococcus aureus and Pseudomonas aeruginosa agar plates. Plates were incubated for 24 hours at 37°C, then zone of inhibition was measured. Osteoblast Cell Culture: Osteoblasts were seeded onto OC-vanc and control beads, cultured with or without 10 mL of Ss aureus or P. aeruginosa, and incubated at 37°C for 9 days. Resazurin Metabolic Assay: After 9 days, the resazurin assay was performed to determine metabolic activity in each well. If beads were cytotoxic, level of fluorescence would be lower than controls. Bacterial growth would increase fluorescence compared to controls. Statistical analyses: Paired t-tests and 1-way analysis of variance with Tukey HSD (honestly significant difference) post hoc test were performed.

Results: Zone of Inhibition: Control beads did not elicit any zones of inhibition for either bacteria. There were significant zones of inhibition for OC-vanc beads (S. aureus 3.51 cm2, P. aeruginosa 0.53 cm2, P <0.001). Resazurin Metabolic Assay: Fluorescent levels were as follows: control = 51,834; OC-vanc = 54,463; OC-vanc + S. aureus = 58,252; Control + S. aureus = 72,937; OC-vanc + P. aeruginosa = 55,544; control + P. aeruginosa = 1,706,360. The significantly (P <0.001) increased level of fluorescence in the control + P.aeruginosa compared to controls was indicative of marked bacterial growth.

Conclusion: The data from this study indicate that OsteoCrete elutes sufficient antibiotic to inhibit bacterial growth while avoiding cytotoxicity to osteoblasts. As such, antibiotic-loaded OsteoCrete can be considered as a viable option for clinical use in bone infections.

Wed., 9/25/19 Basic Science: Infection or ABC Delivery, PAPER #16

The Effects of Sterilization Techniques on Bioactivity of PMMA Antibiotic Beads **Containing Vancomycin and Tobramycin**

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Purpose: Local delivery of antibiotics to prevent and treat musculoskeletal infection has become common practice. Traditionally, polymethylmethacrylate (PMMA) cement is loaded with antibiotics in an operating room (OR), which can be time-consuming and cumbersome. Prefabricating antibiotic beads and storing them may decrease OR times and allow for use in other settings, but requires post-fabrication sterilization. We sought to determine whether the method to ensure sterilization of prefabricated beads or the subsequent shelf storage has any effect on their bioactivity.

PAPER ABSTRACTS

Methods: All antibiotic beads were made by mixing a Simplex P bone cement 40-g package containing 1 g of tobramycin with an additional 1 g of vancomycin powder and using the largest bead cavities in a bead mold (Stimulan). Sterile beads were made inside a Class II Biosafety Cabinet, replicating an OR, to be used as controls. Nonsterile beads were made in a similar fashion, but without a sterile environment, and were randomly allocated to be sterilized via autoclave, ethylene oxide gas, or ultraviolet light. Six beads from each of the 4 groups-(1) made sterile, (2) autoclaved, (3) ethylene oxide, and (4) UV (ultraviolet) lightwere placed into sterile Eppendorf tubes containing 1 mL phosphate-buffered saline (PBS) in an incubator at 37°C. Additional beads from each group were kept in airtight sterile tubes without light and a shelf life study tested each of the 4 groups after being stored for 1 week, 1 month, and 3 months. This entire process was repeated a second time with a separate package of cement providing a sample size of 12 beads for each sterilization method and time point studied. The beads were placed into PBS solution to elute for 24 hours and then removed from solution and placed into a separate sterile solution at 37°C for 7 more days. A Kirby Bauer assay was then performed by placing disks containing eluted antibiotics from each of the 4 groups onto Mueller-Hinton agar plates inoculated with Staphylococcus aureus ATCC 49230. After 16-18 hours of incubation at 37°C, the plates were removed and diameters of zones of inhibition (ZOI) were measured digitally using the ImageJ computer software program.

Results: There were no statistically significant differences at any time point (0 days, 1 week, 1 month, 3 months) for the average ZOI in the first 24 hours and subsequent week of elution in each of the 4 groups.

Conclusion: Antibiotic-containing PMMA beads can be prefabricated in either a sterile field, or fabricated in a nonsterile fashion and then sterilized by autoclave, ethylene oxide, or UV light. Storage for up to 3 months does not reduce the efficacy of the beads in eluting antibiotics.

Wed., 9/25/19 Basic Science: Infection or ABC Delivery, PAPER #17

A Novel Diagnostic Blood Test for Acute Septic Arthritis: A Prospective Validation Study Blake J. Schultz, MD; Tim E. Sweeney; Melissa Remmel, MSc; Uros Midic, PhD; Malcolm DeBaun, MD; Michael J. Gardner, MD Stanford University, Palo Alto, CA, United States

Purpose: Septic arthritis is an orthopaedic emergency requiring immediate surgical intervention. Current diagnostic standard of care is an invasive joint aspiration. Aspirations provide information about the inflammatory cells in the sample within a few hours, but there is often ambiguity about whether the source is infectious (eg, bacterial) or noninfectious (eg, gout). Cultures can take days to result, so decisions about surgery are often made with incomplete data. Additionally, aspirations carry risk and require technical skill and potentially advanced imaging. Novel diagnostics are thus needed. The 'Sepsis MetaScore' (SMS) is an 11- messenger RNA (mRNA) host immune blood signature that can distinguish between infectious and noninfectious acute inflammation. It has been validated in multiple cohorts across heterogeneous clinical settings from outpatient acute infections to patients in ICU suspected of sepsis. Here we studied whether the SMS may hold diagnostic validity in determining if acute arthritis was due to an infectious cause.

Methods: We conducted a blinded, prospective, noninterventional clinical study of the SMS. All patients undergoing workup for a septic primary joint at a Level-I trauma center were enrolled. Patients proceeded through the normal standard-of-care pathway, including joint aspiration and inflammatory labs (white blood cells [WBC], erythrocyte sedimentation rate [ESR], and C-reactive protein [CRP]). At the time of the lab draw, venous blood was also drawn into PAXgene RNA-stabilizing tubes and mRNAs were measured using NanoString nCounter. SMS was calculated blinded to clinical results.

Results: A total of 19 samples were included, of which 11 were infected based on aspiration or intraoperative cultures. The SMS had an area under the receiver operating characteristic curve (AUROC) of 0.86 for separating infectious from noninfectious conditions. For comparison, the AUROCs for ESR = 0.56, CRP = 0.59, and WBC = 0.58. At 100% sensitivity for infection, the specificity of the SMS was 50%, meaning half of non-septic patients could have been ruled out for further intervention.

Conclusion: In this study, the SMS showed a high level of diagnostic accuracy in predicting septic joints compared to other diagnostic biomarkers. This quick blood test could be an important tool for early, accurate identification of acute septic joints and need for emergent surgery, improving clinical care and health-care spending.

Δ Enhancing Bone Healing With Boron Salt

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Purpose: Fracture nonunion can be as high as 20% in certain clinical scenarios and has a high associated socioeconomic burden. It has been shown that bioceramics can positively affect bone healing through localized changes in the ionic environment. Boron has been shown to regulate the Wnt/ β -catenin pathway, critical for bone healing, via GSK3 β . Here we aim to demonstrate that the local delivery of boric acid can accelerate bone healing, as well as to elucidate how boric acid, via the regulation of the Wnt/ β -catenin pathway, impacts the osteogenic response of bone-derived osteoclasts and osteoblasts during each phase of bone repair.

Methods: Bone repair was quantified using bilateral 1 mm x 2 mm femoral cortical window defects created using a burr in 20 healthy and skeletally mature C57 mice. This allowed for control and experimental groups to be in the same animal. On the experimental side, boric acid (dose 8 mg/kg) was injected every 48 hours to the defect site whereas on the control side, saline was used. Mice were divided into 2 groups and were then euthanized and their femora harvested at either the early inflammatory phase at 7 days (n = 10) or the regeneration phase at 28 days(n = 10) postsurgery. MicroCT was then used to quantify the amount of bone regeneration and neovascularization at the site of the defect. Histological analysis with staining for alkaline phosphatase (ALP) and tartrate-resistant acid phosphatase (TRAP) was used to quantify osteoblast and osteoclast activity respectively.

Results: Preliminary microCT interpretation revealed that the experimental group exhibited more bone formation, more trabeculae, less total porosity (%), as well as a more robust periosteal reaction. Histological staining showed that ALP activity was higher in boron-treated femurs when compared to controls at day 7. At day 28, the ALP-positive osteoblast activity was more important in the control group whereas TRAP-positive osteoclast activity was higher in the boron group. This early onset in osteoblast activity during the inflammatory phase and the later transition to osteoclast dominance in the regeneration phase in the boron-treated femure suggests that boron, through the upregulation of activated β -catenin, positively upregulates osteoblast expression.

Conclusion: Localized injections of boric acid in mice bone defects accelerated and improved physiological bone healing at different stages. It is suspected that boron enhances bone healing through inactivation of GSK3 β and the subsequent increase in activated β -catenin. Currently, further data quantification as well as immunohistochemistry staining for GSK3 β and nonphosphorylated (active) β -catenin is being performed to confirm this proposed mechanism. The addition of this inexpensive and widely available ion could potentially become a noninvasive, cost-effective treatment modality to augment fracture healing and decrease nonunion rates in high-risk patients.

BMP2 Accelerates Healing and Prevents Infection in 2 Porcine Critical Sized Defect Models

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Purpose: Severely injured limbs with segmental bone defects (SBDs) frequently develop nonunions and infections. Adjunctive therapies to facilitate bone healing and prevent infection have been repeatedly explored to treat SBDs. Bone morphogenetic protein 2 (BMP2) has been shown to facilitate healing in SBDs and has also been shown to have direct effects on T-cells. Several clinical studies have suggested that BMP2 can mitigate infection. Here we report the effects of BMP2 on promoting bone healing and preventing infection in 2 novel porcine critical sized defect (CSD) models.

Methods: 16 Yucatan Minipigs (YMPs) were subjected to 25-mm SBDs resected from the midtibial diaphysis. The SBDs were stabilized with a statically locked custom porcine intramedullary nail (IMN). Eight pigs were treated with a saline-impregnated collagen sponge placed in the defect and 8 pigs received an identical sponge impregnated with BMP2. Eight additional YMPs were subjected to a 40-mm SBD from the midtibial diaphysis. The SBDs were stabilized with an 8-hole 3.5 compression plate on the lateral surface and an 8-hole one-third tubular plate applied to the anteromedial tibial surface (ORIF [open reduction and internal fixation]). Four pigs had saline-impregnated collagen sponges and 4 pigs had BMP2-impregnated sponges. The IMN pigs were sacrificed at 6 months postsurgery and the ORIF pigs were sacrificed 3 months after surgery. Three trauma- trained orthopaedic surgeons measured mRUST [modified Radiographic Union Scale in Tibial fractures] scores on serial radiographs made at monthly intervals.

Results: All 8 IMN YMPs treated with BMP2 healed (mRUST at 6 months: 15.1 ± 1.0) in contrast to only 1 of 8 YMPs treated with saline (mRUST 6 months: 9.2 ± 2.4 ; P <0.00001). Three of 4 BMP2-treated YMPs with ORIF healed (mRUST 3 months: 14.3 ± 1.0) in contrast to 0 of 4 ORIF YMPs treated with saline (mRUST 3 months: 8.3 ± 1.2). One BMP2-treated ORIF YMP had catastrophic hardware failure 1 week after surgery and was sacrificed. Mean mRUST score at 2 months in the BMP2-treated pigs was 12.3 ± 1.9 in the IMN group and 13.2 ± 1.3 in the ORIF group, demonstrating rapid healing effects of BMP2 in both models. Seven of 8 YMPs treated with saline and IMN developed surgical site infections that occurred from 28 days to 173 days after surgery. In contrast, only 1 of 8 BMP2-treated YMPs with IMN had an infection 120 days after surgery. Likewise, 3 of 4 of the saline-treated ORIF YMPs had wound infections in contrast to 0 of 3 BMP2-treated YMPs after ORIF.

Conclusion: BMP2 was effective in promoting rapid SBD healing. In addition, infections were minimized in the BMP2 groups. The infections in saline-treated animals were delayed and potentially resulted from nonunion and limb instability. This new porcine CSD model may be an effective model to study SBD interventions.

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

Osteogenic and Chondrogenic Differentiation Defects in Geriatric Human Skeletal Stem Cells from Acute Fractures

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Purpose: Geriatric fragility fractures are increasingly prevalent, with significant rates of implant complications, reoperation, and mortality. Evidence suggests aging is associated with impaired stem cell function in human tissues undergoing regeneration. In human fractures, the effect of aging on human skeletal stem cells (hSSCs) in fractures is unknown. We hypothesized that hSSCs prospectively purified from geriatric fragility fractures demonstrate intrinsic functional defects, which can be traced to underlying hSSC signaling defects.

Methods: We isolated hSSCs (Podoplanin+, CD146- CD73+ CD164+) by fluorescenceactivated cell sorting (FACS) from human fractures. Purified SSCs from geriatric fractures were analyzed subsequently for clonogenicity by colony-forming unit formation (CFU-F) (n = 151 <65 years; n = 55 >65 years). After osteogenic and chondrogenic differentiation, cell staining for Alizarin red and Alcian blue was quantified by spectrophotometry. SSC frequency, CFU-F, and Alizarin red / Alcian blue staining were compared to patient age by linear regression for continuous variables or χ 2 for categorical variables.

Results: There was no association between patient age and SSC frequency at the fracture site. There was also no association on CFU-F% or CFU size. However, there was a significant decrease in osteogenic and chondrogenic differentiation associated with increased patient age (P < 0.05).

Conclusion: SSCs from geriatric fractures retain their proliferative ability but demonstrate differentiation defects potentially contributing to adverse healing outcomes. Our results

could open avenues for patient-specific therapeutic strategies to improve healing in geriatric fragility fractures.



 A) hSSC from geriatric patients demonstrate significantly diminished alizarin red staining (A) and alcian blue staining (B) after osteogenic differentiation (A) or micromass culture (B) compared to young patients.
OD, optical density at specified wavelength.

Biocompatible Ex Vivo-Induced Designer Fracture Hematoma for the Healing of Segmental Bone Defects

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Purpose: The fracture hematoma is a natural fibrin scaffold and is crucial for the initiation of bone healing, serving as a reservoir for growth factors and a space for (stem) cell infiltration. However, it is not clear if hematomas in normal fractures, which heal, differ structurally from the ones in large bone defects, which do not heal. Therefore, the aim of this study was to determine the structural properties of hematomas in normal and large bone defects, and to assess if the structure of a normal fracture hematoma can be mimicked ex vivo using a coagulating factor (CF) to enhance the repair of large bone defects.

Methods: Defects of 1 and 5 mm were created in the rat femurs. In vivo fracture hematomas and whole blood were collected on day 3. CF was added at various concentrations to citrated blood to form ex vivo hematomas. Scanning electron microscopy (SEM) was used to determine structural properties. Alamar Blue assay was used to assess the effect of the CF on the cell viability of rat bone marrow mesenchymal stem cells (MSCs).

Results: SEM images of in vivo hematomas revealed that fibrin fibers in 5-mm defects (320 \pm 64 nm) were 50% thicker compared to 1-mm defects (209 \pm 20 nm) 3 days after surgery (Fig. 1). Increasing concentrations of CF led to thinner fibrin fibers in ex vivo hematomas, which ranged from 173 \pm 9 nm at the lowest concentration to 93 \pm 3 nm at the highest. Cell proliferation rate decreased with an increasing concentration of CF, showing a 6.9 \pm 0.9-fold growth at the lowest concentration, a 3.3 \pm 0.3-fold at the highest, and a 7.6 \pm 1.1-fold increase without the CF.

Conclusion: This study is the first to quantify in vivo structural differences of hematomas between normal fractures and large bone defects. Likewise, using CF we were able to modulate the structure of fibrin fibers in ex vivo-induced hematomas. The cell viability assays confirmed biocompatibility of the CF at lower concentrations. Taken together, this study showed

that mimicking the structure of normal fracture hematomas could be the first step towards developing new treatment strategies that improve the healing of large segmental bone defects.



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Δ Unleashing &-Catenin With a New Anti-Alzheimer Drug for Bone Tissue Regeneration

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Purpose: The Wnt/ β -catenin signaling pathway is critical for bone regeneration. Being involved in several developmental processes, Wnt/ β -catenin signaling must be safely targeted. Recent work has shown that Tideglusib, a selective and irreversible small molecule non-ATP [adenosine triphosphate]-competitive glycogen synthase kinase 3- β (GSK-3 β) inhibitor currently in trial for Alzheimer's patients, can promote tooth growth and repair cavities. Despite some differences, bone and tooth formation exhibit some similarities; thus we hypothesize that this new drug can in theF same manner accelerate bone healing.

Methods: Biodegradable FDA [Food and Drug Administration]-approved collagen sponges filled with or without GSK-3 β inhibitor (Tideglusib) were implanted in 1 x 2-mm unicortical femoral defects (n= 35 mature Wild-type male mice). Bone defect repair on control and experimental (GSK-3 β inhibitor) groups was assessed after 1 week (n = 22), 2 weeks (n = 24), and 4 weeks (n = 24) with microCT and histological analysis for alkaline phosphatase (ALP, osteoblast activity), tartrate-resistant acid phosphatase (TRAP, osteoclasts), and immunohistochemistry to confirm the activation of the Wnt/ β -catenin pathway.

Results: Our results showed that Tideglusib significantly enhanced cortical bone bridging (20.6 ± 2.3) when compared with the control (12.7 ± 1.9; P = 0.001). Activity of GSK-3 β was effectively downregulated at day 7 and 14 (P = 0.04) resulting in a higher accumulation of active β -catenin at day 14 in the experimental group compared to the control (P = 0.03). Furthermore, the onset of ALP activity appears earlier in the experimental group (P = 0.02). At 4 weeks, we observed a significant drop in ALP in the experimental group (0.47 ± 0.05) compared to the control (1.01 ± 0.19; P = 0.02) and a decrease in osteoclasts (experimental = 1.32 ± 0.36; control = 2.23 ± 0.67; P = 0.04).

Conclusion: Local downregulation of GSK-3 β by Tideglusib during bone defect repair resulted in significant increase in amount of new bone formation. The early upregulation of osteoblast activity is 1 explanation of bone healing augmentation. This is likely the effect of upregulation of β -catenin following pharmaceutical inhibition of GSK-3 β . Indeed, it has been previously demonstrated that β -catenin activation positively regulates osteoblasts, once committed to the osteoblast lineage. As a GSK-3 β inhibitor, Tideglusib demonstrates a different mechanism of action compared to other GSK-3 β antagonists. Here, the treatment was applied immediately after the injury and did not interfere with precursor cells recruitment and commitment. This safe and FDA-approved drug could be used in prevention of nonunion in patients presenting with high risk for fracture-healing complications.

Basic Science: Bone Healing, PAPER #23 Wed., 9/25/19

△ Stem Cell-Based Evidence for NSAID Safety During Fracture Healing

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Purpose: Whether nonsteroidal anti-inflammatory drugs (NSAIDs) hinder human fracture healing by direct action on osteoblast differentiation remains unknown. While animal studies suggest NSAIDs are deleterious to osteoblast differentiation in vitro and in vivo, human clinical trials have yet to demonstrate an effect of NSAIDs on fracture healing. We have prospectively purified bona fide skeletal stem cells (SSCs) from human fracture sites and hypothesized that that human SSCs (hSSCs) would not be functionally impaired by NSAID administration.

Methods: We prospectively isolated hSSCs (Podoplanin+, CD146–, CD73+, CD164+) and human osteoprogenitors (hOPs [mesenchymal stem cells]; Podoplanin-, CD146+) by fluorescence-activated cell sorting (FACS) from human fractures. Purified SSCs were cultured in the presence or absence of 3 common NSAIDs and analyzed subsequently for colonyforming units (CFU-F). After osteogenic and chondrogenic differentiation, cell avidity for Alizarin Red and Alcian Blue was quantified by spectrophotometry. Experiments were performed in triplicate on n = 4 healthy adults (age. 44-85 years).

Results: Physiologic and supraphysiologic concentrations, as well as initial pulsed and continuous NSAID administration, failed to inihibit hSSC (and hOP) differentiation into osteoblasts and chondrocytes. NSAID administration failed to affect clonogenicity of human SSCs. We demonstrate that hSSCs prospectively isolated from human fracture sites maintain functionality independent of NSAID application.

Conclusion: Our results add evidence to emerging clinical data suggesting NSAID administration for postoperative analgesia is safe for fracture healing.

PAPER ABSTRACTS

 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.

Bioassay of Circulating Collagen X Degradation Product Correlates with Mouse and Human Fracture Healing Progression

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Purpose: No tool exists to quantitatively measure fracture healing. The purpose of this study is to validate a bioassay for collagen X (CXM, intact trimeric noncollagenous-1 domain) as a marker of endochondral ossification to quantitatively assess fracture biology in a robust murine model and preliminary human testing.

Methods: Closed midshaft tibia fractures were created using a classic drop-weight device. Serum was collected from mice at euthanasia at 5, 7, 10, 14, 21, 28, and 42 days postinjury and compared to uninjured controls. Fractured tibias were harvested for gene/histology analysis. Separately, 32 healthy and 16 injured (long bones) humans consented for fingerprick blood draw for CXM analysis.

Results: Murine data supports peak and resolution of CXM after fracture: Serum collected from mice after euthanasia shows a CXM peak (14 days). CXM values change over time in both male (F <0.001) and female (F<0.001) mice. Male CXM at day 14 is significantly higher than at all other time points (Tukey's honestly significant difference (HSD), P <0.01, P <0.05 at day 7). Similarly, female CXM at day 14 was significantly increased compared to days 0, 5, and 21 postfracture (P <0.01). No significant difference in baseline CXM was found between uninjured adult males and females. Human CXM corresponds to fracture progression: Healthy adult baseline CXM established at 71.8-629.6 ng/mL, median of 253.3 ng/mL, without clear age/sex-related trends (age 20-63 years). Long bone fracture healing (n = 16)

shows a CXM peak between 10 and 20 days postfracture. Elderly patients (>60 years) demonstrate elongated CXM peak corresponding with clinical and preclinical evidence for delayed healing.

Conclusion: This proof of concept study via murine model and limited human subjects suggests collagen X may be a reasonable first quantifiable biomarker of fracture healing. Human trials have begun.



Fig. 1A-B Serum collected from mice following euthanasia between 5 and 42 days post-fracture shows a peak in CXM at 14 days post-fracture. CXM values change over time in both male ($F_{1/M} = 0.001$) and female ($F_{2/M} = 0.001$) mice. Tukey's HSD indicates that male CXM at day 14 is statistically higher than at all other time points (p < 0.01, p < 0.05 at Day 7). Similarly in female mice, CXM at day 14 is statistically higher than at 21 post-fracture (p < 0.01).



Fig. 2 Human CXM corresponds to fracture progression. (A-B) Healthy adults show a range of 71.84-6286 mg/ml and a madian value of 253.3 mg/ml (grey line), and no clear age- or sex-related trends associated with CXM levels in a cohort ranging from 20-63 pears old. (Q) Long bone fracture healing from an initial cohort of 16 patients shows a similar peak in CXM levels between 10-20 days post fracture (black dotted trend lines). In patients over 60 years old, we see a shifted CXM peak that corresponds with clinical and preclinical evidence for delayed healing in effective patients (red dotted trend lines).

Optimization of Autogenous Bone Grafting in the Induced Membrane Technique in a Small Animal Segmental Bone Defect Model

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Purpose: The induced membrane technique (IMT), also known as the Masquelet technique, is a 2-stage surgical approach used to manage nonunions and segmental bone defects. Since its inception, multiple variations of this technique have been described in clinical research but the optimal approach has not yet been determined. While several animal models have been developed to study this technique, bone grafting protocols and bone healing have rarely been reported and are highly variable. This study was aimed at optimizing bone grafting in a rat model of the IMT in order to achieve consistent healing outcomes.

Methods: A model of the IMT in Fischer 344 rats was established by creating a 5-mm defect in the femur. The defect was then filled with a polymethylmethacrylate spacer and stabilized with a plate and screws. Four weeks later, the spacer was removed with preservation of the membrane. Bone grafting was harvested from an isogenic donor rat and placed into the defect, followed by closure of the membrane and incision site. Experiments were conducted in 2 separate groups. In group 1, bone graft was harvested from the proximal femur, distal femur, proximal tibia, and pelvis, resulting in a variable amount of cortical and cancellous bone. The time from donor sacrifice to grafting was up to 240 minutes. One donor Fischer 344 rat provided bone graft for 5-6 isogenic graft recipients. In group 2, bone graft was harvested from vertebral bodies instead of the pelvis (in addition to the femur and tibia) and a high-speed burr was used to reduce the contribution of cortical bone to the graft. In addition, the time from donor sacrifice to grafting was strictly limited to under 120 minutes in all animals. To achieve this, 1 donor rat was used for 3-4 isogenic graft recipients. The volume of graft used and all other aspects of the intervention were standardized in both groups. Healing rates between groups were compared on the basis of serial radiographs.

Results: There were 17 animals in group 1, and 16 animals in group 2. In all animals, removal of the cement spacer was feasible at 4 weeks, fixation remained stable, and there was an identifiable membrane that could be used to contain the graft. Radiographic assessment at 8 weeks post bone grafting demonstrated a union rate of 23% in group 1 versus 87% in group 2.

Conclusion: We were able to develop a consistent and effective model of the IMT in Fischer 344 rats. We found several key steps to optimize the bone grafting technique in our model including: the use of vertebral bodies and cancellous portions of the femur and tibia, use of a high-speed burr to minimize the contribution of cortical bone to the graft, and limiting donor sacrifice to grafting time below 120 minutes. These modifications resulted in a significant increase in the healing rates in our model. This optimized model may serve as a guide for further preclinical investigation of the IMT.

Developing a Novel Porcine Meta-Critical-Sized Bone Defect Model for Clinical Translation

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Purpose: Segmental bone defects (SBDs) from high-energy trauma can result in infection and nonunion. Surgeons are continuously looking for effective methods to treat SBDs. Robust preclinical models that can test emerging surgical strategies and adjunctive therapies are an important research tool. Most critical-sized defect (CSD) models have been in small animals. Several ovine and canine preclinical models have been reported. In contrast, porcine CSD models are largely undeveloped. Porcine models offer the advantage of marked immunologic fidelity to the human injury response. Here we describe our progress developing a porcine CSD model.

Methods: Eight adult Yucatan Minipigs (YMPs) were subjected to a 25-mm SBD in the midtibial diaphysis via resection through an anterior approach and treated with a custom made intramedullary nail (IMN). Four YMPs were subjected to a 25-mm SBD and treated with a 7-hole 3.5-mm compression plate on the lateral tibial surface and an adjunctive 7 hole 1/3 tubular plate on the anteromedial tibial surface (small ORIF [open reduction and internal fixation]). An additional 4 YMPs were subjected to a 40-mm SBD and treated with an 8-hole 3.5-mm compression plate and an 8-hole 1/3 tubular plate placed in an identical manner as the smaller defect (large ORIF). IMN pigs were sacrificed at 6 months after surgery. Small ORIF and large ORIF groups were sacrificed 3 months after surgery. Serial radiographs were taken monthly until sacrifice. Three orthopaedic trauma surgeons recorded modified radiographic union scale in tibial fractures (mRUST) scores on all specimens. Mean mRUST for each group at each time point was calculated. Union was confirmed at sacrifice by direct observation.

Results: Mean mRUST scores for the IMN, small ORIF, and large ORIF groups at 1 month were 6.2 ± 1.5 , 7.1 ± 1.1 , and 5.3 ± 1.1 (P >0.2). At 4 months, only 1 of 8 IMNs healed with a mean mRUST of 8.5 ± 1.4 . Three of 4 small ORIFs had healed with a mean mRUST of 11.6 ± 1.8 (P <0.0001 compared to IMN). The fourth pig was progressing to union (mRUST 9.5) at the time of sacrifice. All 4 of the large ORIFs were sacrificed at 3 months due to flail nonunions of the affected leg. Fracture healing was slow but progressive in the small ORIF group. Monthly interval mRUST scores were 1 month = 7.1 ± 1.1 ; 2 months = 9.5 ± 0.9 , 3 months = 10.8 ± 1.3 , 4 months = 11.7 ± 1.8 (1 mo vs 2 mo P <0.00001; 2 mo vs 3 mo P = 0.0002; 3 mo vs 4 mo P = 0.0571).

Conclusion: We have developed a "meta-CSD" model in which healing was arrested with IMN fixation but successful with rigid internal fixation in the smaller defect. This model offers a variety of options to test therapies that can promote healing using IMN fixation, or to investigate concomitant conditions that may arrest healing (ie, muscle injury, hemorrhagic shock, diabetes) using rigid internal fixation with the smaller defect.

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Reaming Irrigation and Aspiration (RIA) Is Associated with Enhanced Fracture Hematoma Cell Viability and Decreased Neutrophil Maturation in Porcine Intramedullary Nailing

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Purpose: The quality of early fracture hematoma dictates the healing process in long bone fractures. The impact of different reaming protocols for intramedullary nailing (IMN) on cellular characteristics of early fracture hematoma is unclear. We hypothesized that the application of reaming irrigation and aspiration (RIA) techniques optimizes cellular content of fracture hematoma.

Methods: Twenty-four pigs underwent standardized femur fracturing. Thereafter they were exposed to different protocols of IMN. Group A was underwent IMN without reaming, group B was treated with conventional reaming + IMN, and group 3 was composed of animals treated with RIA and subsequent nailing. Animals were observed for 6 hours and thereafter fracture hematoma was collected. Immune cells were isolated and studied by flow cytometry. Cell viability was tested by Annexin-V. Neutrophil activation was determined by Mac-1/CD11b- cell surface expression levels, whereas FcyRIII/CD16-receptor expression was utilized to investigate neutrophil maturation.

Results: All animals survived the observation period and proportions of leukocyte subtypes did not differ between groups. However, the percentage of viable fracture hematoma immune cells (Annexin-V-negative cells) was significantly higher in animals treated with RIA compared with conventional reaming (respectively mean 86.7% vs 96.5%, P = 0.04). Furthermore, neutrophil CD16-expression was significantly lower (-35%, P = 0.04) in those animals treated with RIA compared with the conventional reaming condition. Additionally, we observed a trend toward decreased neutrophil CD11b-expression in the RIA group compared with group A (+54%) and group B (+61%).

Conclusion: The current study reveals that utilization of RIA techniques for treatment of long bone fractures is associated with increased immune cell viability and less neutrophil senescence in early fracture hematoma. These findings suggest an important role of reaming techniques on local cellular immune homeostasis during the early phase of fracture healing. In order to improve cellular content of early fracture hematoma, future investigations should focus on optimization of RIA protocols.

Morphometric Analysis and Safety of Percutaneous Fixation of Anterior Column of Acetabulum in an Indian Population: A Preliminary Report Vivek Trikha, MD

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Purpose: There has been an emerging trend in percutaneous fixation of minimally or nondisplaced fractures of anterior column of acetabulum. Considerable morphometric variations have been described in literature for its complex structure which can influence the safety of percutaneous screw fixation. This study presents a preliminary data of morphometric variations and safety of percutaneous fixation of fractures of anterior column of acetabulum in an Indian population.

Methods: CT-based data obtained in form of DICOM (Digital Imaging and Communications in Medicine) files from 102 uninjured pelves was retrospectively analyzed in iPlan (BrainLab AG). Dimensions of narrowest zones around acetabulum and superior pubic ramus were measured. A method for calculation of axis anterior column of acetabulum was derived by joining these narrowest zones. Screw trajectories were directed along this axis and their lengths were measured from the lateral cortex to the point of first cortical perforation on superior pubic ramus. Screw length, distance of exit point from pubic symphysis, and the length of anterior column up to pubic tubercle were measured and compared among male and female groups.

Results: The morphology of osseous corridor of anterior column of acetabulum varied along its length with 2 constriction zones, first in acetabular region and second in superior pubic ramus region. Significant morphometric variations occur among male and female cases, with males having a wider osseous corridor in general. Only 54% cases (67.6% males and 22.5% females) allowed safe applicability of 6.5-mm diameter screw trajectories (with additional 4 mm of safety corridor). For female cases, the screw lengths were smaller and the screw exit point on superior ramus was more lateral compared to male cases.

Conclusion: Considerable intrapopulation and interpopulation morphometric variations of anterior column have been observed. The vertical height of the acetabular constriction zone is the chief parameter in deciding the safe applicability of anterior column screw. Standard screws of 6.5 mm and 7.3 mm diameters may not be safe for all the patients for percutaneous fixation. There is need of an individualized preoperative CT-based approach while planning for percutaneous fixation of the anterior column fractures.

Internal Fixation of Acetabular Fractures in an Older Population Using the Lateral-Rectus Approach: Short-Term Outcomes of a Retrospective Study

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Purpose: This study is designed to examine the clinical efficacy and surgical techniques of the lateral-rectus approach for treatment of acetabular factures in elderly patients.

Methods: After appropriate exclusion, 65 elderly patients with an acetabular fracture that was treated through the lateral-rectus approach from January 2011 to October 2016 were selected retrospectively. By analyzing the medical records retrospectively, the patients' characteristics, fracture type, mechanism of injury, comorbid conditions, American Society of Anesthesiologists (ASA) class, operative time, intraoperative blood loss, and postoperative complications were assessed. Clinical examination radiographs were taken, aligned with the Matta evaluation system. Functional outcomes were evaluated using surveys including Short Form (SF)-36, Harris hip score, and modified Merle D'Aubigne-Postel score.

Results: All 65 patients had undergone the single lateral-rectus approach successfully. Surgery duration was 101.23 min on average (range, 45-210) and intraoperative bleeding was 798.46 mL on average (range, 250-1800). According to the Matta radiological evaluation, the quality of reduction evaluated 1 week after surgery was rated as "anatomical" in 41 cases (63.1%), "imperfect" in 12 (18.5%), and "poor" in 12 (18.5%). The modified Merle D'Aubigne-Postel score performed 18 months after surgery was categorized as excellent in 40 cases (61.5%), good in 10 (15.4%), and fair in 15 (23.1%). The mean Harris hip score was similarto present research, being 87.18. The mean SF-36 score was 69.12 which was considered as normal for the group age 60 years and older. Several complications were found, including screw loosening in 10 cases, fat liquefaction of incision in 2 cases, deep vein thrombosis in 2 cases, and temporary weakness of hip adductors in 5 cases. None of the patients had heterotopic ossification.

Conclusion: The lateral-rectus approach is a valuable alternative to the ilioinguinal and modified Stoppa approach, for the treatment of acetabular fractures in elderly patients.

Safety of Surgical Hip Dislocation in Femoral Head Fracture-Dislocation Jeong Heo; Chang-Wug Oh, MD; Joon-Woo Kim, MD, PhD; Kyeong Hyeon Park, MD; Il Seo, MD Kyungpook National University Hospital, Jung-gu, Daegu, Korea, Republic of

Purpose: Although surgical hip dislocation(SHD) has been used for open reduction of femoral head fracture- dislocation (FHFD), viability of femoral head after SHD has not yet been studied. We evaluated the viability of femoral head with a radio-scintigraphy or MRI and the functional outcome, in patients who underwent SHD in FHFD.

Methods: 35 patients with FHFD had underwent SHD in our institution (from 2009 to 2017). We evaluated one of single-photon emission CT (SPECT), bone scan, or MRI to find any clues of avascular necrosis (AVN), at postoperative 30 weeks. Exclusion of AVN was defined as no evidence of AVN on plain radiograph at postoperative ≥ 1 year with normal radio-scintigraphy or MRI, or no evidence of AVN on plain radiograph at postoperative ≥ 2 years without radio-scintigraphy or MRI. Excluding 3 cases, 32 out of 35 cases were included (mean follow-up 145.6 weeks; mean age, 36.9 years). There were 9 cases of head fracture alone, 2 cases with femoral neck fracture, 20 cases with acetabular fracture, and 1 case with both acetabular fracture and femoral neck fracture. In Pipkin's classification, there were 4 type I, 5 type II, 2 type III, and 21 type IV. Radiological outcome (using Matta's grading) and Harris hip score (HSS) were evaluated at the latest follow-up.

Results: Two of 32 cases showed AVN (1 Pipkin type III, 1 type IV), which had displaced femoral neck fracture. The incidence of AVN did not depend on the type of Pipkin classification (P = 0.748). Incidence of AVN was significantly increased with femoral neck fracture (P = 0.006). According to Matta's grading, 8 (25%) were excellent, 18 (56.25%) were good, 5 (15.625%) were fair, and 1 (3.125%) was poor. The mean HSS was 81.53 and significantly lower in AVN group (P = 0.004).

Conclusion: SHD in FHFD is a safe and effective procedure to achieve satisfactory radiological and functional outcomes unless accompanying femoral neck fracture.

Clinical Results of Osteochondral Autograft From Ipsilateral Femoral Head for Femoral Head Defect After Posterior Hip Fracture Dislocation: Short-Term Preliminary Study

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Purpose: The purpose of this study was to evaluate clinical, radiological and functional outcomes of patients who had osteochondral autograft harvested from the ipsilateral femoral head for a femoral head defect after posterior hip fracture dislocation.

Methods: This study was approved by our IRB. A retrospective chart review of a prospectively performed operation was performed at 2 university hospitals between March 1, 2014, and June 30, 2018. All fractures were classified by the AO/OTA classification. We included the patients who had minimum 6 months of follow-up. 10 displaced head fractures were addressed through posterior surgical dislocation and 2 patients had no posterior dislocation and were operated using Smith-Petersen approach. An osteochondral graft was harvested from inferior non-weight-bearing articular surface and grafted to osteochondral defect. All patients were full weight- bearing by 3 months.

Results: We had 86 femoral head fracture dislocations. Five patients were excluded due to loss of follow-up. 12 of 81 with type I/II Pipkin fracture-dislocation with the articular defect and reduced within 12 hours of injury were identified for review. The patients were followed for a mean of 13.2 months. There was no osteonecrosis. Decreased joint space was identified in 2 patients. All fractures achieved union. The mean Harris hip score of last follow-up was 89.1 (range, 56-98). One patient who was operated using the Smith-Petersen approach had femoral nerve palsy.

Conclusion: The clinical and radiological results after treatment of femoral head fracture dislocation with articular defect by osteochondral autograft harvested from its own non-weight-bearing articular surface show good outcomes.

The Intra- and Interrater Reliability of the Fragility Fractures of the Pelvis Classification and Their Therapeutic Relevance: A Multicenter Assessment *Philipp Pieroh, MD; Andreas Höch; Florian Gras, MD; Sven Märdian; Alexander Pflug;*

Silvan Wittenberg; Christoph Ihle; Notker Blankenburg; Kevin Dallacker-Losensky, MD; Tanja Lieselotte Schröder; Steven C. Herath, MD; Daniel Wagner, MD; Hans-George Palm, MD, MBA; Christoph Josten Prof; Fabian Stuby, MD University Leipzig, Leipzig, Germany

Purpose: In the elderly, the fracture morphology and remaining stability of the pelvic ring differ. The fragility fractures of the pelvis (FFP) classification system was introduced to address these differences. However, data on the reliability and impact on treatment decision are still rare and were therefore determined in the present study.

Methods: 60 CT scans with FFP from 6 hospitals were classified (complete, only main group) 3 times by 6 experienced, 6 inexperienced surgeons, and 1 surgeon trained by the originator of the FFP classification ("gold standard"). Furthermore, the therapeutic decision (surgical/nonsurgical treatment) was determined. Intra-/interrater reliabilities were determined. The "gold standard", submitting hospital, and the majority vote were used as references to assess the percentage of agreement for each FFP main group was determined.

Results: For the FFP classification the intrarater reliability was moderate (complete: 0.46; main group: 0.60) and the interrater reliability was substantial for the main group (0.61) and moderate for the complete (0.53) classification. Percentage of agreement revealed values of 70% to 80%, depending on the reference used. The lowest agreement was found for FFP II and III. The intrarater (0.54) and interrater (0.42) reliability of the therapy decision were moderate. For FFP II, the lowest agreement of 66% was observed with respect to the therapy recommendation of the "gold standard". The observer's therapy decisions were in agreement with those of the submitting hospital in >75% for FFP I only. For the remaining main groups lower agreements were observed, with the lowest value for FFP III (60%).

Conclusion: The FFP classification system, based on image morphological data only, seems to be a suitable indicator for the treatment decisions of FFP. However, the therapy of FFP II and III should be thoroughly evaluated. In addition, other clinical parameters seem to influence the therapy decision, independent of the classification, and may be responsible for the low agreement of the therapy decision of the submitting hospital with those of the observers.

Accuracy of Percutaneous Sacroiliac Screw Fixation for Pelvic Ring Injuries Using Standardized Image Intensifier Protocol with Lateral Shots as the Cornerstone for Screw Placement: A Prospective Cohort Study with Postoperative CT as the Reference Standard

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Purpose: The purpose of this prospective cohort study of patients treated with percutaneous sacroiliac (SI) screws for traumatic pelvic ring instability was to evaluate the accuracy of SI screw placement using a standardized image intensifier (II) protocol-using lateral II shots as the cornerstone for screw placement. Pre- and postoperative CT served as the reference standard to determine accuracy of SI screw positioning to calculate diagnostic performance characteristics, as well as for mapping of bony corridors and screw trajectories.

Methods: 52 screws were placed in 24 patients undergoing percutaneous SI screw fixation for pelvic ring instability and were prospectively enrolled from a Level-I trauma center in Australia, between September 2017 and May 2018. There were 14 type LC (lateral compression) ring injuries, 6 APC (anteroposterior compression), 2 VS (vertical shear) type, and 2 atypical injuries. 35 S1 screws were placed, with bilateral S1 screws in 7 patients, and 17 S2 screws. A uniform protocoled intraoperative fluoroscopy regimen was followed, using the lateral II shot as the cornerstone for screw entry and positioning, as follows: (1) obtain a perfect lateral II shot of the pelvis and sacrum, using specific landmarks and protocoled technique; (2) determine wire entry point and direction based on anatomical landmarks, and advance the wire 8 cm into the sacrum; and (3) subsequent alternating inlet and outlet views to verify positioning in extraforaminal bony corridors prior to definitive screw placement. Postoperative CT imaging was obtained in all cases to serve as the reference standard. For each individual case, the theoretical safe corridors as well actual screw trajectories were mapped on CT and superimposed to evaluate accuracy of our protocol using a standard II. Diagnostic accuracy was calculated according standard formulas.

Results: There were no foraminal protrusions in this series. Our protocol led to an accuracy of 94.3% for S1 screw placement and 94.1% for S2 screw placement, defined as the actual screw trajectory being within the cortical margin of the safe corridor when images were superimposed. Two S1-screws (5.7%) were found to be on the cortical border of the safe zone corridor, and 1 S2 screw (5.9%) was borderline; however, without protrusion of the S1 and S2 neuroforamina. No patients developed new neurological symptoms after surgery.

Conclusion: A uniform standardized protocol using lateral II shots as the corne stone of screw placement to guide percutaneous SI screw fixation for pelvic ring instability, and subsequent alternating inlet and outlet views, is accurate and safe in terms of screw placement within cortical margins of safe zone corridors. The technique allowed full wire placement in all cases prior to changing the II from lateral to inlet/outlet views, and thus facilitates simplicity as well as reproducibility. Therefore, we conclude that standard intraoperative II techniques according to a stepwise protocol is safe and effective for percutaneous SI screw 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.

Use of Ultrasonography for Evaluation of Stability of Lateral Compression Type 1 (LC-1) Pelvic Fractures to Assist Determination of Treatment Strategy

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Purpose: Lateral compression type 1 (LC-1) pelvic fractures represent a wide spectrum of heterogeneous injuries. These include both stable and unstable patterns; however, determining whether an LC-1 fracture is stable or unstable is a challenge, and the method used to evaluate fracture stability is complicated.

Methods: We prospectively collected and analyzed data from 22 patients with LC-1 pelvic fractures, who underwent ultrasonography and a pelvic compression and separation test, in order to evaluate the role of ultrasonography in determining fracture stability and assist decision-making for treatment strategy.

Results: 22 patients (15 men and 7 women) were included in the study. Following an ultrasound examination, 10 patients were classified into the stable group and 12 into the unstable group. In total, 13 patients received conservative treatment and 9 underwent surgery. At follow-up, there were no differences in fracture healing times or fracture-related complications between the 2 groups. The Majeed score was comparable between the 2 groups and most patients recovered well. There was a moderate degree of consistency in kappa values (K = 0.571, P = 0.01) between the classification of stability and the final treatment received. In addition, the sensitivity of ultrasonography was 66.67% and the specificity was 76.92%.

Conclusion: In conclusion, ultrasonography is a useful tool for diagnosing the stability of LC-1 pelvic fractures and assists the determination of treatment strategy. Left-right mobility ≥ 0.3 cm may be used as the criterion for determining instability.

Quality of Life After Pelvic Ring Fractures: Long-Term Outcomes. A Multicenter Study *Erik Hermans, MD*; Lars Brouwers; Thijs Van Gent; Jan Biert; Mariska Adriana De Jongh, PhD; Koen Lansink, MD, PhD; Michael Edwards, MSc, PhD Radboudumc Nijmegen, Nijmegen, Netherlands

Purpose: This study was conducted to determine long-term (5-10 years) health-related quality of life (HRQOL) and ceiling effects in patients with a pelvic ring fracture.

Methods: We identified all patients with pelvic ring fractures after high-energy trauma admitted at 2 Level-I trauma centers in the Netherlands from 2006 to 2011. Patients were asked to complete the Majeed Pelvic Score (MPS), EuroQol-5 Dimensions (EQ-5D), and Short Musculoskeletal Function Assessment (SMFA) questionnaires. HRQOL analysis used a multiple linear regression model.

Results: In total, 136 patients returned the questionnaires. The median follow-up period was 8.7 years. The mean MPS and EQ-5D VAS (visual analog scale) scores were 85.1 and 74, respectively. The mean EQ-5D index scores were 0.87, 0.81, and 0.82 in Tile B, A, and C patients, respectively. The mean SMFA index was 24. A ceiling effect was observed for one-third of the patients. After multiple linear regression analysis, no differences were identified among the various fracture types for each questionnaire, with the exception of 2 subscales of the MPS.

Conclusion: Patients who suffer pelvic ring fractures generally have good HRQOL outcomes after 5-10 years. No significant differences were found among different fracture types. Long-term follow-up of patients with Tile C fractures is warranted.

Comprehensive Evaluation and Treatment Strategy of Tibia Plateau Fracture with Knee Dislocation

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Purpose: Tibia plateau fracture with knee dislocation is a potentially devastating injury that occurs more frequently than is reported and recognized. It is also a complex, high-energy injury that has frequent-associated complications. To achieve the best functional outcome possible with a minimum of complications, it is important to develop a treatment algorithm or protocol. Our article involves a high index of the discussion for the comprehensive evaluation, surgical treatment, and clinical efficacy of tibia plateau fracture with knee dislocation.

Methods: 41 cases of tibia plateau fractures with knee dislocation were treated in our department between June 2012 and June 2016. There were 26 males and 15 females with an average age of 43.6 years (range, 19-65). According to Schatzker classification, there were 9 type-IV cases; 17 type V cases; and 15 type VI cases. According to the Hohl-Moore classification, there were 11 type-I, 9 type II, and 21 type V cases. Comprehensive preoperative imaging examinations (radiographsand CT scan), and careful and accurate assessment for the state of blood vessels, nerves, fracture, and ligament were taken for all patients. Lateral and medial combined approach is adopted for the rigid internal fixation of fracture and ligament repair after the anatomical reduction of fractures and dislocations. All the patients were followed with the time of fracture healing, Rasmussen radiographic scores, and Hospital for Special Surgery (HSS) knee functional scores.

Results: 41 cases were followed for an average of 14.8 months (12-24 months). All fractures healed in a mean time of 11.6 weeks (10-14 weeks). Rasmussen radiographic scores at 12 months after surgery were excellent in 29 cases, good in 7 cases, fair in 3 cases, and poor in 2 cases. HSS knee functional scores at last follow-up were excellent in 27 cases, good in 8 cases, fair in 3 cases, and poor in 3 cases; the excellent/good rate was 85.4%.

Conclusion: Tibia plateau fractures with knee dislocation should be attached with importance to the comprehensive evaluation of the fractures, ligaments around the knee joint, blood vessels, nerves and local soft tissues, preventing the osteofascial compartment syndrome, the misdiagnosis and misdiagnosis of the injuries of blood vessels and nerves, performing the anatomical reduction and rigid internal fixation of fractures after definitive diagnosis and recovery of soft tissues, and giving the consideration to the recovery and reconstruction of the dislocation of knee joint at the same time, to ensure the early functional exercise of knee joint and obtain the satisfied clinical efficacy.

Poor Sporting Abilities After a Tibial Plateau Fracture Involving the Posterior Column: How Can We Do Better?

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Purpose: Tibial plateau fractures with involvement of the posterior column are an important prognostic factor toward poor functional outcome. While clinical and radiological outcomes of tibial plateau fractures are elaborately studied, there has been very little appreciation for the impact of these injuries on the patients' physical lifestyles, in particular their ability to participate in sports. We aimed to assess the sporting abilities postoperatively with special emphasis on type of sports and sport specific movements, as well as the time needed to resume sports, restricting factors in sports engagement, and patient satisfaction. We aimed to provide prognostic information on return to sports.

Methods: Demographic, clinical, and radiological variables were collected from 82 consecutive multicentric patients between 2014 and 2016. Prospectively, Knee injury and Osteoarthritis Outcome Score (KOOS) and sporting abilities before and after surgery were determined using questionnaires at a mean follow-up of 33 months postoperatively.

Results: The response rate was 62% (51 patients). Involvement in sports significantly decreased, with only 68.4% of patients resuming sports after their injury (P <0.001). The mean time needed to partially or fully resume was 6-9 and 9-12 months, respectively. The ability to resume at the preinjury level of effort and performance were only 22% and 12%, respectively. Restricting factors were pain (66%), fear of reinjury (37%), limited range of motion (26%), and instability (21%). The majority (59%) of patients were unsatisfied with their physical abilities. Significantly worse outcomes were observed in patients playing high-impact sports, experiencing knee pain during physical activity, and suffering from extension/valgus or flexion/varus trauma.

Patients playing high-impact sports proved by far the most important high-risk group, being 6.8 times more likely to not return to sports, having a longer rehabilitation period, being 11.7 times less likely to play at the preinjury level of effort, being 11.4 times more likely to suffer from pain-related knee problems during physical activity, and being 17.2 times more likely to be unsatisfied with their physical abilities.

Conclusion: Tibial plateau fractures with involvement of the posterior column significantly hamper patients' sporting abilities, leaving the majority of patients unsatisfied. Preoperative counseling about the prognosis and setting realistic expectations, optimizing rehabilitation and pain management postoperatively, and advising low- impact sports might improve the engagement in physical activities and the emotional impact on the patients.

The Application of a New Type of Ultradistal Locking Tools for Intramedullary Nailing in the Treatment of Tibial Fractures

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Purpose: Despite the advances made over the years in nail design and instrumentation, distal locking remains a demanding step of the procedure, resulting in potential vast theater time consumption and increased radiation exposure for both the patient and the surgeon. The aim of this study was to evaluate the clinical significance of a new type of ultradistal locking tools for tibial intramedullary nailing, a retrospective analysis.

Methods: We have designed a new type of ultradistal locking tools for intramedullary nailing in the treatment of tibial fractures. The locking tools are made up of the 7.0-mm drill bit, the sleeve, the 7.0-mm reamer, and the conical rod. 286 cases from January 2014 to June 2018 were divided into group A and group B. The patients in group A used traditional locking tools, and the patients in group B used the new type ultradistal locking tools. Time consumption of operation, the number of intraoperative fluoroscopy treatments, and one-time locking ratio in 2 groups were observed.

Results: The average time consumption of operation in group A is 72.5 ± 3.7 minutes, the time in group B is 56.8 ± 2.4 minutes; the comparison between the 2 groups is statistically significant (P = 0.017). The average number of intraoperative fluoroscopy treatments in group A is 23 ± 4.4 , the number in group B is 10 ± 4.3 ; the comparison between the 2 groups is statistically significant (P = 0.020). The average one-time locking ratio in group A was 85.54% and 96.36% in group B; the comparison between the 2 groups has statistical significance (P = 0.013).

Conclusion: The operation of the new type of ultradistal locking tools is easy, and has no additional cost. The application of the new type of ultradistal locking is a more practical method.

96

Secondary Intramedullary Nailing Following External Fixation for Tibial Shaft Fracture: What are the Factors that Affect Infection?

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Purpose: External fixation (EF) is a safe option for stabilization of tibial fractures in the polytraumatized patient as well as in fractures with severe soft-tissue damage. Intramedullary nailing (IMN) is the standard of treatment for the tibial shaft fractures. Sometimes, temporary EF is used before definitive nailing in case with compromised soft tissue or multiple injuries. Secondary IMN following EF of tibial shaft fracture is controversial, notably due to the infection risk, which is not precisely known. The purpose of the present study was to evaluate the incidence of infection and to identify its influencing factors after secondary IMN of tibial shaft fractures.

Methods: A prospective analysis was performed on 29 patients who were available to follow up for longer than 12 months from among those who underwent secondary IMN after EF for tibial shaft fractures. The patients included 26 men and 3 women, with a mean age of 51.4 years. The causes of injury were traffic accidents (n = 24), direct hit (n = 4), and a fall from height (n = 1). According to the AO/OTA classification, 11 were type A, 5 were type B, and 13 were type C fractures, including 17 open fractures (I: 3, II: 6, IIIA: 7, IIIB: 1 [Gustilo-Anderson criteria]). Acute compartment syndrome was accompanied in 5 cases. 20 patients had fractures other than tibia that required stabilization. 17 patients had non-orthopaedic injuries at head, chest, or abdomen.

Fracture was stabilized with EF initially, and internal conversion with IMN was done at an average of 19.8 days after patients' general condition and/or open wound improved. At the time of internal conversion, the EF pin site grades were 0 in 8 cases, 1 in 14 cases, 2 in 5 cases, and 3 in 2 cases, as described by Dahl. Additional procedures for soft-tissue coverage were required in 6 cases (skin grafting: 5, free flap: 1). Results were assessed according to the achievement and time to osseous union and complications, especially infections, at the final follow-up. Statistical analysis was performed to identify factors influencing results.

Results: Primary union was achieved by 27 of the 29 study subjects (93.1%) at an average of 18.8 weeks. Of 2 cases of nonunion, 1 had segmental bone loss at the index injury and healed after early autogenous bone graft. The other case of aseptic nonunion was healed after autogenous bone graft at 7 months post-initial surgery. There were 2 cases of deep infection (6.9%). Although the presence of open fracture and the duration of EF were not related to the occurrence of infection, pin site of grade 3 at the time of internal conversion had a strong relation to the development of infection versus pin site grade <3 (P = 0.013, Pearson's χ 2 test).

Conclusion: Our findings demonstrate secondary IMN for thbial shaft fracture showed a low infection rate, considered to be a reliable procedure. However, caution should be taken to manage the EF pin site. Definitive surgery should be performed early, before onset of EF pin site infection.

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Periprosthetic Atypical Femoral Fractures Exist and are Associated with Duration of Bisphosphonate Therapy

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Purpose: At present periprosthetic fractures are excluded from the definition of atypical femoral fractures (AFFs). This study challenges this exclusion by reporting a series of periprosthetic fractures that meet the criteria for AFFs and would otherwise be classified as periprosthetic atypical femoral fractures (PAFFs). The study aims to identify predictors of PAFFs among patients on bisphosphonate therapy and to quantify the complications encountered in their treatment.

Methods: Patients presenting to a university teaching hospital with periprosthetic femoral fractures from 2007- 2018 were retrospectively reviewed. Patients with features of AFFs (cases: n = 22; median age 83 years ;range, 44-94; 19 female) and those on bisphosphonate therapy with typical fractures (controls: n = 17; median age 83 years; range, 60-86; 13 female) were identified by 2 observers. Univariate and multivariate analysis was performed to identify predictors of PAFF from: age, gender, BMI [body mass index], type and duration of bisphosphonate therapy and its indication, social deprivation, bone mineral density (T-score), serum calcium, albumin, alkaline phosphatase, and time from primary implant.

Results: Interobserver agreement for classification of PAFF was excellent ($\kappa 0.944$, P < 0.001). Univariate analysis demonstrated that compared to controls, patients with PAFFs had higher BMIs ($28.3 \pm 7.3 \text{ vs } 21.5 \pm 3.1$, P = 0.001), longer durations of bisphosphonate therapy (median 5.3 years [range, 1-13.9] versus 2.4 years [0.1-15.4], P = 0.04), were less likely to be on alendronate (74% vs 94%, P = 0.1) and were more likely to have secondary osteoporosis as an indication for bisphosphonate therapy (18% vs 0%, P = 0.089). Multivariate analysis conformed duration of bisphosphonate therapy only as an independent predictor of PAFF (R2 = 0.703, P = 0.05). Following initial fracture management (PAFFs: 19/22 fixation, 3/22 revision arthroplasty; typical fractures: 12 fixation, 3 revision arthroplasty, 2 nonoperative), complication rates were higher in PAFFs (13/22, 59%) than in the control group (5/17 [29%], P = 0.065). Relative risk of any complication for PAFF compared to controls was 1.73 (0.96-3.11, 95% CI [confidence interval]); for reoperation, 1.39 (0.97 to 1.99); for mechanical failure of fixation, 1.2 (0.89 to 1.65); and for nonunion, 1.15 (0.1-1.45).

Conclusion: Atypical femoral fractures do occur in association with prostheses. Longer duration of bisphosphonate therapy is an independent predictor of PAFF in patients sustaining periprosthetic femoral fractures while on bisphosphonate therapy. Complication rates are higher following PAFFs, particularly mechanical failure and nonunion requiring reoperation. Larger numbers are needed to identify other important features in both the etiology and management of this fracture type.

Functional Outcome of Open Distal Femoral Fractures Managed with Lateral Locking Plates

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Purpose: Distal femoral fractures are difficult injuries to treat with complex intra-articular fracture patterns. In open distal femur fractures, the associated soft-tissue injury and traumatic bone loss further create an unfavorable environment for bone healing. This prospective study evaluated the functional outcome of open distal femoral fractures managed with anatomic lateral locking plates and assessed the incidence of nonunion, implant failure, and need for secondary procedures.

Methods: 34 patients (28 M: 6 F) with open distal femur fractures with a mean age of 40.8 years (range, 20-65 years) were included in the study. Patients with Gustilo-Anderson Grade IIIC fractures and patients managed with nonlocking modalities were excluded. 70.6% (n = 24) of the fractures were Type IIIA and 55.9% (n = 19) were AO/OTA Type C3 fractures. In 76.5% (n = 26) patients, definitive fixation using anatomic lateral locking plate was done while in 23.5% (n = 8) patients with gross contamination, multiple injuries, or with delay in surgery, knee-spanning external fixation was done. In this group, definitive fixation with lateral locking plates along with bone grafting was done after the stabilization of general condition of the patient and healing of soft tissues within an average period of 5.5 weeks (range, 4-e8 weeks). Nonunion was defined as failure of union of 3 or more cortices at 6 months or no radiological progress in union for the preceding 3 months in presence of bone defect involving 2 or more cortices. Patients were followed for a mean period of 9.4 months (range, 6-19 months). Functional outcome was evaluated using Sanders Score.

Results: In the primary plating group, 69.2% (n = 18) fractures united at an average time of 27 weeks (range, 21-40 weeks). The remaining 8 patients underwent bone grafting at an average time of 22.3 weeks (range, 17-32 weeks). In the external fixator group, all 8 patients underwent lateral locked plating with bone grafting and united at an average time of 39.6 weeks (range, 31-50 weeks). At final follow-up, the mean Sanders Score was 30.1 (range, 19-40) with 73.5% of patients (n = 25) having good to excellent functional outcomes. One patient was excluded from evaluation of this score as he had severe neurological deficit due to head injury. The mean flexion was 91° (range, 30°-130°) with 87.9% (n = 29) of the patients having some restriction of flexion movement. 42.2% (n = 14) patients were able to get back to their jobs without any difficulty. There were 2 cases of infection and 2 cases of implant failure, 1 of which required revision fixation.

Conclusion: Open distal femoral fractures are complex difficult-to-treat injuries that need individualized management for each patient. Lateral locked plating either as primary fixation or after temporary external fixator offers excellent stability to allow fracture union. A proactive approach to identify and manage potential healing difficulties is advisable to promote bone healing.

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Predictors of Hip Fracture Mortality in Ghana: A Single-Center Prospective Study *Paa Kwesi Baidoo, MD*; James Beguah Odei, PhD; Velarie Yaa Ankrah Ansu, MS; Michael Segbefia; Henry Holdbrook-Smith, MD Korle Bu Teaching Hospital, Accra, Ghana

Purpose: Hip fractures constitute about 20% of the trauma workload. The associated mortality at 1 month and 1 year are about 10% and 20%-25%, respectively. And of those who survive, most never regain the preinjury quality of life. Few studies in Africa have examined the parameters associated with increased mortality over a long period, from the time of injury. This study therefore aimed at finding risk factors that may increase mortality in patients with proximal femur fractures over a 4-year period.

Methods: Incidence of mortality was assessed among 76 participants with proximal femur fractures from January to December 2014 and followed for 4 years. Outcome of interest was mortality at 1 month, 6 months, I year, and 4 years. Hazard ratios (HRs) were calculated using Cox proportional hazards regression, adjusting for mortality risk factors.

Results: Among the 76 participants (mean age, 75.8 years [standard deviation (SD) 12.02], 36 males [47.4%]), there were 21 death cases. The mean (SD) for days from time of injury to surgery was 16.4 (16.2). Hip fracture type was composed of 38 (50%) intertrochanteric, 35 (46.05%) transcervical, and 3 (3.95%) basicervical.

Mortality at 1 month, 6 months, 1 year, and 4 years was 6.6%, 13.2%, 19.7%, and 27.6%, respectively. A yearly increase in age was associated with a 1.053-fold increase in the risk of death (P = 0.026). Comparing females to males, there was no significant difference in mortality (HR = 0.56, P = 0.324). Participants with normal platelets levels versus those with abnormal platelets were at higher risk of dying (HR = 33.97, P = 0.002). Also, participants with an American Society of Anesthesiologists (ASA) score of III or IV were 3.575 times more likely to experience death than those with an ASA score of I or II (P = 0.011). Additionally, a higher risk of death was associated with patients with chronic obstructive pulmonary disease (COPD) (HR = 6.32, P = 0.038) and osteoporosis (HR = 14.55, P = 0.001).

Conclusion: Age, ASA score, COPD, and osteoporosis were the main predictors of mortality in the study population. These could serve as a guide when managing patients with proximal femur fractures in order to improve the outcome.

Treatment for Coexisting Fractures of the Proximal Humerus and Humeral Shaft: ORIF or MIPPO?

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Purpose: The incidence of injuries to the proximal humerus is 3%-5%. There are rare occasions when a humeral shaft fracture is associated with injury to the proximal humerus. In the few case reports that have been published describing this injury, the proximal humerus fracture is invariably associated with a shoulder dislocation. This association of proximal humerus fracture (with or without dislocation) and ipsilateral humeral shaft fracture should be recognized and probably should be included in future classification systems. This injury requires an early referral to an orthopaedic surgeon for definitive management. The surgical selections of open reduction and interval fixation (ORIF) or minimally invasive percutaneous plate osteosynthesis (MIPPO) were allowed for more accurate reduction and better function of the upper extremity for the coexisting fractures of the proximal humerus and humeral shaft. However, there is still a controversy for the surgical techniques of the appropriate treatment of this special type of complex fractures. The purpose of this study is to investigate the therapeutic efficacy between ORIF and MIPPO using the long PHILOS locking compression plate on the coexisting fractures of the proximal humeral shaft.

Methods: This was an IRB-approved and retrospective study conducted at a single academic Level-I institution. Study participation required nonpathological, coexisting proximal humerus and humeral shaft fractures requiring ORIF or MIPPO techniques. Of 59 patients who met these criteria from January 2011 to June 2016, 36 patients were matched to ORIF and 23 patients were matched to MIPPO. All cases were fixed with the long PHILOS locking compression plate. The 2 groups were matched for age, gender, injury mechanism and reduction technique. Aspects of the treatment courses and surgical treatments of each group were tallied, interpreted, and analyzed for statistical significance. P value was set at <0.05.

Results: There was no significance between the 2 groups with respect to length of surgery, hospital admission time, total treatment time, radial nerve palsy, fracture healing time, or range of motion. However, there was significant difference with respect to intraoperative blood loss and transfusion, referral to pain management, and functional recovery time. Technically, the MIPPO group had better surgical treatment and clinical effects than the ORIF group.

Conclusion: This study demonstrates the clinical efficacy of MIPPO techniques for coexisting fractures of the proximal humerus and humeral shaft is significantly difference from ORIF in some respects. However, there are still some disadvantages of MIPPO technique, such as major technological hurdles, high requirements for surgeon, long learning curve, and high radiation exposure. In conclusion, both ORIF and MIPPO can be used for the surgical treatment of coexisting fractures of the proximal humerus and humeral shaft. Nevertheless, the MIPPO technique is a better option obviously if you have rich surgical experiences.

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Excellent Outcome After Double Locked Plating in Su Type II or III Periprosthetic Distal Femoral Fractures

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Purpose: Periprosthetic distal femur fractures (PPDFFs) are a challenging injury of the elderly population, frequently associated with poor bone quality and limited bone quantity. Although minimally invasive osteosynthesis has been used with retrograde nail, or lateral locked plating, nonunion or malunion is not uncommon in Su type II or III fractures. We prospectively performed medial and lateral locked plating in these fractures and evaluated outcomes and complications.

Methods: 24 patients with PPDFFs, treated by 2 surgeons, were identified using an institutional trauma registry. 17 patients with at least 12 months of radiographic and clinical follow-up were included, excluding 7 patients with insufficient follow-up. There were 12 (71%) Su type II and 5 (29%) type III fractures. All patients underwent medial locked plating with open reduction and lateral locked plating with minimally invasive plate osteosynthesis (MIPO). We evaluated the radiographic and clinical outcomes for all patients.

Results: 16 of 17 patients achieved union at an average of 19 weeks postoperatively (94%). Postoperative limb alignment was satisfactory (within 5° compared to contralateral side) in all cases, with 89° of lateral distal femoral angle (LDFA) and 86.6° of posterior distal femoral angle (PDFA) on average. All patients recovered the knee range of motion and the daily life, as they did before the injury. There was 1 (6%) case of nonunion with wound dehiscence due to preexistent vascular problem.

Conclusion: Double locked plating may not disturb the healing of fracture or soft tissue, and helps to achieve a satisfactory radiographic and functional outcomes in Su type II or III periprosthetic distal femoral fractures.



Coned Hemipelvis and Total Hip Replacement in Osteoporotic Acetabular Fractures of the Elderly

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Purpose: Acetabular fractures in the elderly are a complex problem associated with high levels of morbidity and mortality. One treatment option is to fix and then perform an acute total hip arthroplasty to allow early mobilization and reduce the risks of immobility. This is a prolonged procedure, often requiring dual approaches, and commonly followed by a period of limited weight bearing. The coned hemipelvis, traditionally used in tumor surgery, can be used in these patients via a single posterior approach, reducing operative time and allowing immediate full weight bearing. It is hypothesized that these advantages may reduce 1-year mortality and provide a safe surgical option for patients with acetabular fractures that were deemed too frail for standard fix and replace techniques. This paper represents the first published series of this technique and the results of the first 18 cases at a minimum 1-year follow-up.

Methods: 17 patients (18 cases), who had a coned hemipelvic reconstruction and total hip replacement with dual mobility acetabular component for a complex osteoporotic acetabular fracture, were prospectively followed for the radiographic and clinical outcomes. All patients had a minimum 1-year follow-up (mean 26 months; range, 14-48).

Results: The mean patient age was 79 years (range, 65-87), and mean ASA [American Society of Anesthesiologists] score 3.3 (3-5). There were (OTA/Letournel classification) 11 anterior column posterior hemitransverse, 4 associated both column, and 3 transverse with posterior wall fractures. Mean operative time was 93 minutes (67-114). There were 8 minor postoperative complications. 16 of 17 patients were full weight bearing day 1 postoperatively. Median length of acute hospital stay was 11 days (5-27). Preoperative mobility status was maintained in 9 patients, and 14 patients returned to their premorbid living status. Mortality was 6% at 1 year. There have been no thromboembolic events, deep infections, or cases of prosthesis migration. There has been 1 late dislocation in an immobile patient, which was treated conservatively. The mean Oxford Hip Score is 39.8 (24-44), mean EQ-5D-5L [EuroQol-5 Dimensions 5 Levels] index score 0.59 (-0.24 to 0.84) and the mean EQ-5D-5L overall health score 72.7 (30-92).

Conclusion: This technique provides a paradigm shift in the management of these challenging patients by emphasizing immediate full weight bearing and a reduced surgical insult giving a low complication rate, good rate of return to premorbid status, and reduced 1-year mortality rate, when compared to existing treatment modalities. The coned hemipelvis and total hip replacement is safe and effective, and may represent the new treatment of choice in the elderly, medically frail patient who sustains a complex acetabular fracture.

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Prospective Evaluation of Functional Outcome Along with Histological Features of Induced Membrane in Patients with Infective Nonunion Managed with the Masquelet Technique

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Purpose: The reconstruction of critical sized bone defects that occur after removal of dead and sequestrated bone in infective nonunions is a major challenge for the orthopaedic community. The induced-membrane technique as proposed by Masquelet is a promising approach for this complex problem. This study aims to analyze the overall clinical, functional, and radiological outcome of patients with infective posttraumatic nonunion treated by the Masquelet technique along with studying the morphology and osteogenic properties of the membrane thus formed.

Methods: A prospective study was conducted from January 2016 to December 2018 in 19 patients with posttraumatic infected nonunion of lower limb bones. In stage I, radical debridement of bone was done along with antibiotic cement spacer insertion. Stage II was performed after a minimum of 6-8 weeks based on the biochemical and clinical features suggestive of cessation of infection. In this stage, the cement spacer was removed and bone grafts taken from iliac crest; autogenous fibula mixed with bone substitutes was used to fill the bone defect as reamer-irrigator-aspirator (RIA) is not available in our region. Size of defect, timing to stage II surgery, and time to bone union along with any complications were analyzed in this study. Histological properties of the induced-membrane sample taken during stage II were also studied using light microscopy.

Results: 19 patients underwent Masquelet's staged procedure with 14 tibial and 5 femoral defects. After stage I, the mean defect created was 7.1 ± 2.3 cm (mean \pm standard deviation [SD]) with range 4-11 cm. Average time to stage II was 11.56 ± 4.64 weeks (mean \pm SD). At the end of the study period, 15 patients had united clinically as well as radiologically and the mean time to union was 11.5 months. Three patients had recurrence after stage II of the Masquelet technique. These patients were then managed with the Ilizarov technique of corticotomy and bone transport. Histological examination of the membrane revealed a 2-layered architecture with inner cellular layer and outer fibrous layer. Average membrane thickness was 4.78 ± 2.19 mm (mean \pm SD) and the mean microvessel density/hpf (40x) was 9.68 ± 4.99 (mean \pm SD). 68.7% of the membranes depicted presence of acute/chronic inflammatory infiltrates with foreign body giant cells and 25% of the samples showed new bone formation. The thickness as well as the microvessel density of the membrane was maximum between 8 and 12 weeks.

Conclusion: The Masquelet technique is an effective way of managing large bone defects especially due to infective nonunions. Our study provides evidence regarding successful clinical outcomes of this technique. Moreover, the study also characterizes the induced membrane as osteogenic with features similar to periosteum in histology with peak biological properties between 8 and 12 weeks. However, the issue of reactivation of infection despite normal biochemical and clinical markers still remains a major issue in this technique. Procurement of adequate amount of good quality bone grafts also remains a concern where RIA is not available.

Application of Measurement of Femoral Eccentricity on Orthopaedic-Position Radiographic Film of Hip Joint in Total Hip Arthroplasty Junzui Li, MD

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Purpose: Our objective was to investigate the accuracy and reliability of hip orthopaedic film in measuring femoral eccentricity before total hip arthroplasty.

Methods: 412 patients who underwent hip CT, hip radiograph, and pelvic radiograph examination in the Third Affiliated Hospital of Guangxi Medical University were selected. The femoral offset (FO) was measured on 3 kinds of slices .According to the value of femoral eccentricity measured by CT, the reliability of femoral eccentricity measured by hip joint and pelvic radiograph were compared.

Results: The FO was 39.2 mm (95% confidence interval [CI]: 37.3-40.5) on the pelvic radiograph, the FO was 44.3 mm (95% CI: 42.2-45.8) on the radiograph of the hip joint, and the FO measured on CT was 44.5 mm (95% CI: 43.1-45.3). Compared with the value measured on CT, the FO on the pelvic orthopaedic film decreased by 5.3 mm (95% CI: 4.4-6.8), and the FO on the hip orthopaedic film was similar to that on CT.

Conclusion: The femoral eccentricity measured on hip joint orthogonal radiograph is more accurate than that measured on pelvic orthogonal radiograph. Accordingly, the method of measuring femoral eccentricity onhip joint orthogonal radiograph is of academic value and worth popularizing.



PAPER ABSTRACTS

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Arthroplasty Can Improve Long-Term Survival of Female Patients Sustained Femoral Neck Fracture Age Over 90: The 10-Year Results Compared to Conservative Treatment *Liu Yang, DC*

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Purpose: China's population of age over 90 years accounts for nearly 15% of the same age group of the total world population. There is a lack of data reflecting the short and long-term outcome of nonagenarian patients suffering femoral neck fracture in a China context. The main purpose of the current retrospective study was to evaluate and compare the short and long-term mortality between operative and nonoperative treatment of femoral neck fracture patients over 90 years of age during the same 10-year period. The second goal is to analyze the influence of gender difference on the mortality of these patients.

Methods: From January 2007 to December 2016, all consecutive nonagenarian and centenarian patients with femoral neck fracture admitted to our hospital were included for evaluation. The end point of follow-up was defined as the date of death or emigration, or 30 August 2018, whichever came first, and survival was determined at this time. The primary outcome was defined as 30-day mortality, 1-year, 2-year, 3-year, 4-year, and 5-year mortality after injury. Survival status analysis was performed by the Kaplan-Meier method for all- cause mortality. Using the log-rank (Mantel-Cox) test, the stratified analyses by gender, arthroplasty group and vonservative group, educational level, and marital status were performed to compare the difference of survival distributions.

Results: Finally, 104 patients, 54 women (51.9%) and 50 men (48.1%), were included in the study. The arthroplasty group and the conservative treatment group included 37 and 67 patients, respectively. The median age of the arthroplasty group and conservative was 93years (range, 90-100) and 92 years (range, 90-103), respectively. The survival time of arthroplasty group is significantly higher than the conservative group (24.50 months vs 40 months, P = 0.012). The cumulative mortality after injury of 30 days, 1 year, 2 years, 3 years, 4 years, and 5 years for conservative group and arthroplasty group was 14.9% versus 8.1%, 26.9% versus 10.8%, 34.3% versus 18.9%, 46.3% versus 29.7%, 52.2% versus 35.1%, and 58.2 versus 40.5%, respectively. The gender difference of survival distributions between the conservative group and arthroplasty group is significant for women (P <0.05), but not for men (P = 0.6222).

Conclusion: The arthroplasty procedure can improve the short and long-term survival of femoral neck fracture patients age above 90 years, especially for women. Arthroplasty treatment in the extreme elderly should not be discounted on the grounds of age alone. It can be anticipated that almost two-thirds of the patients will survive more than 5 years after surgery.

Hemiprothesis After Hip Fracture in Geriatric Patients with Dementia Increases Mortality and Lacks Functional Recovery

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Purpose: Operative timing, perioperative management, and postoperative rehabilitation are rising challenges in orthopaedic geriatric trauma. The aim of this study was to determine the outcome of patients with dementia or severe commodities treated with hemiprosthesis after hip fracture.

Methods: A retrospective chart review of 326 patients (mean age 81 ± 9 years; 230 women and 96 men) with hip fractures treated between 2009 and 2014 with a hemiprosthesis was performed. Primary outcome measures were surgical and nonsurgical complication rates, best achievable mobilization, and mortality.

Results: Patients with dementia had 20-fold increased risk to be bedridden after surgery and 9-fold increased risk of dying. Furthermore, they needed significantly more revision surgeries because of surgical complications. Patients classified American Society of Anesthesiologists (ASA) IV and V had significantly lower postoperative mobilization levels with only 10% able to walk with crutches and 53% bedridden. They also had significantly more nonsurgical complications while dementia had no effect on nonsurgical complication rate.

Conclusion: Patients classified ASA IV and V or suffering dementia showed poor outcome after hip fracture treated with hemiprosthesis. Multidisciplinary approaches including surgeons, geriatricians, and psychiatrists are needed to improve the outcome of these patients. Minimally invasive alternatives to arthroplasty treatment should be considered for a selected group of patients.



Venous Thromboembolism Following Delayed Surgery of a Hip Fracture

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Purpose: The goal of this study was to evaluate the incidence of venous thromboembolism (VTE) in patients with hip fractures whose surgery was delayed, and the effect of prophylaxis intervention regards to its success in preventing thromboembolic complications.

Methods: The medical records of patients who presented with a fracture were retrospectively obtained. Inclusion criteria were the following: (1) surgically treated patients with hip fracture, (2) surgical delay >24 hours from injury to surgery, (3) aged 50 years or older, and (4) low-energy injury. Exclusion criteria were (1) pathologic fracture and (2) multiple trauma patients. Delayed surgery was defined as surgery 24 hours after injury. All patients had DVT prophylaxis postoperatively. Our conventional protocol of prophylaxis for VTE was anti-embolism stocking without screening (group 1, n = 59). From September 2017, our intensive protocol for VTE was performed with indirect deep venous thrombosis (DVT) CT and pulmonary embolism (PE) CT (group 2, n = 60). When DVT was detected on screening, inferior vena cava (IVC) filter was applied before the operation. Our prophylaxis protocol consisted of mechanical prophylaxis immediately after admission and chemical prophylaxis from admission to postoperative 7 days. Overall postoperative symptomatic VTE incidence was evaluated. The relationship were analyzed between VTE and each age, sex, fracture classification, body mass index (BMI), time from injury to admission, time from admission to surgery, transfer from other hospital, preoperative infection, medical comorbidity using Charlson comorbidity index (CCI), history of DVT or varicose vein, preoperative anticoagulation agent, preoperative ambulation state using Koval score, operation method (osteosynthesis vs arthroplasty), operation time, ICU stay, and hospital stay. We compared the incidence of postoperative VTE between the 2 groups.

Results: 111 patients (38 males and 81 females) with a mean age of 78.2 years were enrolled. The percentage of patients transferred from other hospitals was 68.1%. There were 63 cases of femur neck fractures, 49 cases of intertrochanteric fractures, and 7 cases of subtrochanteric fractures. The average time from injury to admission was 90.2 hours (range, 0.5-2160 hours), and the average time from admission to the operation was 75.3 hours (range, 16-934 hours). The average time from injury to operation was 165.5 hours (range, 25-2250 hours). A total of 8 patients developed VTE (6.7%), of whom 2 had DVT, 3 had PE, and 3 patients had both DVT and PE. Four patients (6.7%) were screened on preoperative evaluation in group 2. The other 4 patients developed VTE postoperatively, and they were group 1. In group 1, postoperative VTE occurrence of 6.8% (4/59) was higher than that 0% (0/64) in group 2 (P = 0.040).

Conclusion: The patients with delayed hip fracture surgery showed a high prevalence of preoperative VTE, but our management protocol showed effective successful prevention of symptomatic VTE including PE.
Thurs., 9/26/19 Intl Forum: Pelvis and Hip Fractures, PAPER #51

Changes in Patellar Fracture Characteristics: A Multicenter Retrospective Analysis of 1596 Patellar Fracture Cases Between 2003 and 2017

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Purpose: This study aimed to investigate the characteristics of patellar fracture and the changes in these characteristics over time in Korea.

Methods: A total of 1596 patients with patellar fracture who visited 5 university hospitals from 2003 to 2017 were included for the analysis. The demographic characteristics of the patients, including age, gender, and body mass index, and fracture characteristics, including fracture classification, injury mechanism, fixation method, and postoperative complication rate, were analyzed through a review of the medical records.

Results: There were 988 (61.9%) male patients and 608 (38.1%) female patients. The mean age was 51.3 years (range, 3-97) for the study group, 47.6 (range, 8-94) years for male patients, and 57.3 (range, 3-97) years for female patients. An increasing trend in the proportion of patients aged >60 years and female patients was observed during the study period (P = 0.002 and P <0.001, respectively). According to the AO/OTA classification, type C1 was the most common type, with 427 (26.8%) cases, followed by type C3, with 418 (26.2%) cases. In male patients, type C3 was the most common, with 291 (29.5%) cases, whereas in female patients, type C1 was the most common type, with 202 (33.2%) cases (P<0.001). The incidence of highenergy injuries was higher in male patients than in female patients (P < 0.001). The fixation method showed a significant difference among periods. The percentage of tension-band wiring decreased from 65.5% in 2003-2005 to 35.3% in 2015-2017 (P <0.001). The combined method showed an increasing tendency from 14.9% in 2003-2005 to 40.3% in 2015-2017 (P <0.001). Among 1596 patients, operative treatment was performed in 1095 cases(68.6%). Nonunion including fixation failure was the most common complication, accounting for 35.1% of all complications. Patients aged >60 years with patellar fracture showed a higher percentage of low-energy injuries and higher postoperative complication rates than younger patients (P < 0.001 and P = 0.002, respectively).

Conclusion: Patellar fractures in the female and elderly populations are increasing. Patellar fractures in elderly patients showed a higher postoperative complication rate and percentage of low-energy injury than those in younger patients. Therefore, patellar fractures in the elderly population should be considered fragility fractures, and further studies are warranted to suggest a specific treatment plan for fragility patellar 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.

Thurs., 9/26/19 Intl Forum: Pelvis and Hip Fractures, PAPER #52

Surgical Treatment with Locking Plate for Nonunion in Femur and Tibia *Tomoaki Fukui, MD*; *Takahiro Niikura, MD, PhD; Keisuke Oe, MD, PhD; Ryosuke Kuroda, MD Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan*

Purpose: Factors leading fractures to nonunion include instability of fracture sites, decreased biological activity, and inappropriate reduction. In a case such that the causative factor of nonunion is judged as insufficient stability, a surgical treatment to enhance stability will be selected. Although the method of fixation varies depending on the cases, after the locking plate appeared, stability by plate fixation dramatically improved and it started to be used for surgery of nonunion. However, there are relatively few reports about nonunion treatments with locking plates. The purpose of this study is to investigate the outcome of the cases that were surgically treated using the locking plate for nonunion in femur and tibia.

Methods: 54 patients were diagnosed as nonunion of femurs or tibias and undertook surgical treatments for nonunion of femur or tibia using locking plates in our institution from 2007 to 2017 and were able to be followed longer than 1 year postoperatively. The treatment course of these cases was investigated mainly by radiographic evaluation.

Results: The mean age at the time of the nonunion surgery was 51.0 years, and there were 38 males and 15 females. Among 28 femoral nonunions, 8 and 24 cases achieved radiographic bony union at 6 months and 1 year after the surgery, respectively. There was only 1 case of correction loss, which was recognized 14 months postoperatively. Three cases including the case of correction loss required reoperations; however, they eventually resulted in bony fusion. Of 25 tibial nonunion, 12 and 21 cases got bone fusion at 6 months and 1 year after surgeries, respectively. Bone fusion was finally obtained in all cases except for 1 case, which showed correction loss 14 months after surgery. However, there was no case requiring reoperation. There were 19 cases in the femur and 23 cases in the tibia using only the locking plate as the internal fixation material. In other cases, it was used in combination with intramedullary nails and so on.

Conclusion: In the cases of surgical treatment using locking plates for femoral and tibial nonunion, good results were generally obtained. Compared to the femur, there was a tendency that more cases were treated with only locking plates in the tibia.

Clinical Application of "Expanded Paratricipital Approach" for Fixation of Complex Articular Fractures in Distal Humerus: Revisited with Cadaveric Study and Case Series

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Purpose: Although extensor mechanism-sparing paratricipital approach (expanded paratricipital approach) has been introduced and clinically used for managing complex articular fracture of the distal humerus, there had been no clinical guideline in which type of fracture is indicated best for this approach. Aims of this study are to verify the superiority of articular assessment of extensor mechanism-sparing paratricipital approach compared with conventional approach and to find out certain reference line of articular assessment for suggesting clinical guidance of this approach.

Methods: We designed 2 studies which included cadaveric study and retrospective comparison study of clinical cases. Cadaveric study was designed to compare expanded and conventional paratricipital approach using 40 matched paired elbows from 20 fresh-frozen cadavers. Accessible articular length and distances of osteotomy marking from capitellotrochlear sulcus and medial epicondyle were calculated based on osteotomy markings of articular surface from lateral and medial side, respectively. 36 OTA/AO 13C fracture cases treated by expanded paratricipital approach at a single Level-I trauma center from 2015 to 2017 were divided into2 groups based on the location of main fracture line, which was measured by preoperative CT scan. Demographics, Intraoperative details (operation time and quality of reduction), clinical outcome (union rate, postoperative complications, and presence of unscheduled surgery), and functional outcome (Mayo Elbow Performance Score and DASH [Disabilities of the Arm, Shoulder and Hand score) were retrospectively analyzed and compared between the 2 groups.

Results: Cadaveric study shows that expanded paratricipital approach can allow more articular exposure than conventional approach (69.4% vs 52.7% of transepicondylar width). Location of lateral osteotomy marking was significantly medially located in expanded paratricipital approach (6.9 mm vs 1.7 mm medial to capitellotrochlear sulcus). Based on the result of cadaveric study, a fracture line that lies 7 mm medial to capitellotrochlear sulcus was selected as a reference line for ideal indication of approach. Comparison between Group 1 (15 cases, main fracture line lies lateral to reference line) and Group 2 (21 cases, main fracture line lies medial to reference line) shows significant difference in operation time (138 min vs 165 min), quality of reduction (malreduction rate 20% vs 33%), and complication rate. Union rate and functional outcome were not significantly different between the 2 groups.

Conclusion: Expanded paratricipital approach makes wider exposure in articular surface of distal humerus than that of conventional approach. However, this study can support that expanded paratricipital approach can be more successfully applied to a fracture that has main articular fracture line that does not exceed 7 mm medial to capitellotrochlear sulcus.

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Optimal Plate Position in Minimally Invasive Plate Osteosynthesis for Midshaft Clavicle Fractures: Simulation Using 3D-Printed Models of Actual Clinical Cases

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Purpose: This study evaluated the optimal anatomical locking plate position using 3-dimensional (3D)-printed models of the clavicle.

Methods: 3D models of the fractured clavicle were reproduced from 17 patients who underwent minimally invasive plate osteosynthesis (MIPO) procedures. The fracture location-the percentage of the distal fragment length compared to the entire clavicle-ranged from 30% to 44%. We evaluated 4 commercially available plate systems for position and fitting with the bone. After reducing the fracture on each 3D model, we determined the best plate-fitting system.

Results: All the 8-hole anatomical plates fitted well when the plate was positioned in the middle of the clavicle for fracture locations between 40% and 60% (Fig. 1). All 3 cases with a fracture location \geq 40% were treated with the 8-hole anatomical plate, and the simulation study showed that these cases had an acceptable fit with the 8-hole anatomical plate and the lateral clavicle plate. Among 11 cases with a fracture location between 30% and 40%, only 4 cases had an acceptable fit onto the shole anatomical plate and the lateral plate, but the other 8 cases had an acceptable fit onto the clavicle with a reversed position of the anatomical plate or the lateral clavicle plate. In actual clinical practice, the 8-hole anatomical plate in 2 cases. The 8-hole anatomical plate was found to be unsuitable when the fracture location was

<30%, in which case the lateral fragment was not enough for 3 screws to be fixed. In this case, only the lateral clavicle plate had an acceptable fit. The length of the lateral fragment when the fracture location was 30% equaled about 4.5 cm, which was the minimum length required to fix 3 bicortical screws.

Conclusion: Fitting the anatomical plate in MIPO for clavicle fractures depends on the fracture location. This can help surgeons determine the optimal plate for clavicle MIPO.



Olecranon Osteotomy Fixation Following Complex Distal Humerus ORIF: Plate or Tension Band?

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Purpose: Distal humeral fractures in adults are complex and technically demanding injuries to manage. Operative intervention is indicated in most cases and is often complicated by difficult exposure, osteoporotic bone, and comminution in the metaphyseal and / or articular region. There is controversy regarding a number of issues pertaining to the management of distal humeral fractures, including the correct operative approach, fixation strategies, the role of total elbow arthroplasty, management of the ulnar nerve, and indications for prophylaxis against heterotopic ossification. A transolecranon approach allows for improved visualization and more accurate reduction for the complex fractures of distal humerus. However, there is still a controversy for the internal fixation of olecranon osteotomy following the open reduction and internal fixation (ORIF) of complex distal humerus fractures. The purpose of this study is to discussthese 2 methods of olecranon repair following olecranon osteotomy in the ORIF of distal humerus fractures.

Methods: This was a retrospective study of distal humerus fractures treated through an olecranon osteotomy approach. All cases with the olecranon osteotomy were fixed with either plate fixation or tension band. According to the comprehensive imaging examinations (radiographs and CT scan), careful analysis and accurate assessment for complex fractures of distal humerus were performed for all patients, and treatment strategy was decided meanwhile. Measured outcomes included the range of motion, healing time of olecranon osteotomy, and development of complications. Mayo Elbow Performance Index (MEPI) scores were obtained for all patients.

Results: 119 cases of complex fractures of distal humerus from June 2012 to June 2017 were identified and included a total of 81 eligible patients with OTA type 13-C2 or 13-C3 fractures. There were 43 males and 38 females with the average age of 42.6 years (range, 21-63). According to AO/OTA classification, there were 36 type 13-C2 cases, and 45 type 13-C3. 39 patients had fixation of the olecranon osteotomy with tension band, and 42 were fixed with plate fixation. All of the 81 cases were followed for an average time of 28.6 months (range, 24-40 months). Groups did not differ with respect to any preoperative characteristic. Clinically there were no significant differences in healing time of olecranon osteotomy, range of motion at any time point, complications related to the osteotomy, or patient MEPI scores.

Conclusion: Plate fixation and tension band of olecranon osteotomy following ORIF of complex distal humerus with a transolecranon approach had similar outcomes. Therefore, the acquainted surgical intervention and the cost difference of each modality should be considered by orthopaedic surgeons when repairing the olecranon.

The Clinical Benefit of Fibular Allograft Augmentation in Locked Plating of Proximal Humerus Fractures: A Retrospective Study

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Purpose: The purpose of this study was to evaluate the clinical benefit of fibular allograft augmentation for locked plating of unstable proximal humerus fractures.

Methods: We retrospectively assessed the functional outcome and complications in 23 patients with proximal humeral fractures with a disrupted medial column, treated with a locking plate and an endosteal fibular strut graft. The average patient age was 57.43 years. Postoperative assessments included radiographic imaging, range of motion, pain according to the visual analog scale (VAS), Constant-Murley score, and complications.

Results: No patients were lost to follow-up and no major complications were recorded. There was no osteonecrosis or screw penetration of the articular surface. All fractures healed clinically and radiographically. After an average follow-up of 28.17 months, the mean Constant score was 89.83 points. The median VAS pain level was 0.91 point. According to the Paavolainen method, 19 patients had good results with a neck-shaft angle of $130 \pm 10^{\circ}$, and 4 patients showed fair results with a neck-shaft angle of 100° to 120° . There was no significant difference in the initial postoperative ($126.73^{\circ}\pm 5.81^{\circ}$) and final ($124.62^{\circ}\pm 5.09^{\circ}$) neck-shaft angles. The average height loss of humerus head is 0.12 ± 0.09 cm.

Conclusion: For unstable proximal humerus fractures with medial comminution, locking plate fixation with fibular graft augmentation was a reliable technique to restore the integrity of the medial column and provided satisfactory clinical and radiological outcomes.

Clinical Application of 3D Printing Technology in Orthopaedic Trauma Surgery *Rahat Jarayabhand, MD*; *Chittawee Jiamton, MD Bhumibol Adulyadej Hospital, Bangkok, Thailand*

Purpose: Our objective was to evaluate and summarize the uses and clinical applications of 3-dimensional (3D) printing technology in orthopaedic trauma surgery.

Methods: Data from all consecutive trauma cases operated with the use of 3D printing technology were collected and evaluated. The workflow starts from obtaining CT data from the patient and sending them to the team of engineers. The surgeon discusses the plan of treatment with the team and after discussion 3D images are created according to the specific needs of each case, such as 3D model of fracture, mirror image from the nonfractured side, simulation of fracture reduction, osteotomy and drilling guides, and patient-specific implants. After the planning is approved from the team, all the necessary models, guides or implants are printed. Surgery is done according to plan and the clinical applications of 3D printing and results of treatment are recorded. Postoperative anatomic parameters in each particular case were compared to the uninjured side.

Results: A total of 19 cases were treated with use of 3D printing technology. Six acetabulum fractures (5 both- column and 1 transverse with posterior wall) models were printed and used for preoperative contouring of plate and planning of screws. One model of pelvis malunion was printed for preoperative planning. Four cases of malunion distal end radius fracture were treated with cutting and drilling guides and fixation with commercially available locking plates. Two malunions of forearm (1 Monteggia fracture and 1 radial shaft) were treated with cutting and drilling guides and patient-specific plates. Four cases of clavicle fractures were treated with patient- specific plates with drilling guides for plate placement and 2 of the cases were malunions corrected with cutting guide. One case of nonunion proximal tibia was treated with customized cutting guide for allograft. One case of malreduction of pronation external rotation ankle fracture was corrected with drilling guide for plate placement and syndesmotic screw insertion, and fixation with a patient-specific plate. In total, fracture models were printed for all cases, 12 cases used cutting and drilling guides, and 7 cases were fixed with patient-specific implants. Comparable anatomic parameters to the uninjured side were achieved in all cases.

Conclusion: From our study the clinical application of 3D printing technology in orthopaedic trauma surgery can be summarized as follows: (1) preoperative planning, using models and simulation of fracture reduction; (2) malunion correction, with cutting and drilling guides; (3) intraoperative navigation for implant positioning and fracture reduction, using cutting and drilling guides; and (4) patient-specific 3D-printed implant. This innovative technology is very promising and can be applied for orthopaedic trauma surgery especially in areas with complex anatomy, nonunions, and malunions for the achievement of anatomical reduction in these difficult cases.

Empowering Pre-hospital Care Providers to Better Manage Open Fractures *Aswinkumar Vasireddy, MBBS; Kelly Jones; Erica F. Ley, MSc Essex & Herts Air Ambulance Trust, Earls Colne, United Kingdom*

Purpose: The early administration of antibiotics has been shown to significantly reduce the incidence of early infections in open fractures. As a result, national clinical governing bodies recommend early intravenous (IV) antibiotic administration, ideally within 1 hour from the time of injury. This target is difficult to achieve unless antibiotics are administered by prehospital care providers. Physician-led prehospital air ambulance care teams exist throughout the country. By engaging with this group, there is an opportunity to improve the early management of open fractures. A previous study undertaken in 2016 showed low prehospital antibiotic administration rates of 51%. The aim of this study is to demonstrate how an ongoing educational and governance program, combined with engagement from orthopaedic staff, can lead to improvements in care.

Methods: Following the results of the 2016 study, regular educational updates were undertaken with prehospital care providers via the weekly case review meetings and monthly governance meetings. All new staff in the service also had to complete a formal assessment that tested their knowledge of clinical protocols. A repeat retrospective review of records from January 2017 to December 2018 was completed to determine if there was an improvement in performance. The primary intervention being reviewed was prehospital IV antibiotic administration. Other interventions that were reviewed included documentation of clinical examination findings, use of splints, and appropriate triage of patients to a major trauma center or orthoplastics center. This study received ethical approval from the prehospital care provider's IRB.

Results: 126 patient suffered open fractures and were treated by the Air Ambulance Service between 2017 and 2018. Results showed an improved antibiotic administration rate of 68%. In patients with isolated open fractures, the rate of IV antibiotic administration was considerably higher at 79%. In those with multi-system injury, the rate was slightly lower at 51%. There were also associated improvements in the accuracy of clinical documentation, use of splints, and appropriate triage of patients to major rrauma centers.

Conclusion: By engaging with prehospital care services, early interventions in the management of open fractures can be safely completed in the field prior to hospital arrival. Such engagement helps provide a more integrated approach to patient care and helps a trauma network work more effectively. This study highlights the continued importance of ongoing education, regular case discussion, and audits in order to improve and maintain an effective and efficient service.

B-Ultrasound Surface Positioning Upper Arm Nerve Combined with MIPPO Technique for Upper Humeral Shaft Fracture *Wei Fan, PhD*

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Purpose: This was a comparison of the effects of B-ultrasound surface positioning upper arm nerve combined with MIPPO (minimally invasive percutaneous plate osteosynthesis) technique and simple MIPPO technique in the treatment of upper humeral shaft fracture.

Methods: We retrospectively analyzed 105 patients with upper humeral shaft fracture. There were 52 cases of B-ultrasound surface positioning upper arm nerve combined with MIPPO technique group, and 53 cases of simple MIPPO technique. The operation time, intraoperative blood loss, fracture healing time, and complication rate were recorded and compared between the 2 groups. At the last follow-up, the Neer shoulder function score (MEPS [Mayo Elbow Performance Score]) was used to assess joint function. There was no significant difference in preoperative general data (age, gender, fracture classification) between the 2 groups (P >0.05), which were comparable.

Results: 105 patients were followed for 10 to 18 months (mean 12 months). B-ultrasound surface positioning upper arm nerve combined with MIPPO technique group surgery time ($62.8 \pm 8.6 \text{ min}$), intraoperative blood loss ($107.4 \pm 5.6 \text{ mL}$), and complication rate (7.8%) were compared with simple MIPPO technique group surgery. There was significant difference in time ($96.8 \pm 7.5 \text{ min}$), intraoperative blood loss ($215.4 \pm 7.2 \text{ mL}$), and complication rate (22.2%) (P <0.05). Efficacy was evaluated according to MEPS score: B-ultrasound surface positioning upper arm nerve combined with MIPPO technique group: excellent in 47 cases, good in 2 cases, fair in 1 case, poor in 2 cases; excellent and good rate was 94.2\%. Simple MIPPO technique group: excellent in 41 cases, good in 2 cases, fair in 4 cases, poor in 6 cases; the excellent and good rate was 77.4%. The excellent rate of B-ultrasound upper arm nerve combined MIPPO technique group was significantly higher than that of MIPPO-only group (P < 0.05).

Conclusion:Forupperhumeral fractures, the B-ultrasound surface positioning upper arm nerve combined with MIPPO technique group is significantly better than the simple MIPPO technique group in operation time, surgical bleeding volume, and complication rate. The patient can obtain good clinical results and is worthy of promotion.



Syndesmotic Fixation in Unstable Ankle Fractures: Does Early Postoperative Weight Bearing Affect Radiographic Outcomes?

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Purpose: Syndesmotic ankle injuries are unstable, leading to tibiofibular diastasis. The decision to weight-bear patients following stabilization of ankle fractures with syndesmotic instability remains controversial and varies both within and between centers. We aimed to analyze whether early full weight bearing following syndesmotic fixation affected early and late radiographic PP suggestive of diastasis.

Methods: This was a retrospective comparative cohort study of 86 patients, over a 2-year period in a Level- I trauma center. The primary outcome measure was early diastasis. The secondary outcomes were late diastasis, wound complications, and reoperation. Analysis of variance was used for the predictor variable of weight- bearing status. We assumed a priori that P values <0.05 were significant.

Results: Median age was 36 years (interquartile range [IQR] 30), with 54 males and 32 females. Median follow- up was 12 weeks (IQR 6). There was no significant difference when comparing weight-bearing status and change in radiographic measurements intraoperatively compared to 6 and 12-week follow-up radiographs (tibiofibular clear space P = 0.799, tibiofibular overlap P = 0.733, and medial clear space P = 0.261). There was no association with weight-bearing status and late diastasis or secondary outcomes.

Conclusion: After surgical stabilization of an unstable syndesmotic injury, full weight bearing did not lead to syndesmotic diastasis in the early postoperative period. Full weight bearing is recommended following ankle fixation, which includes syndesmotic fixation.

Whether Bisphosphonate Delays Bone Healing After Hip Fracture Fixation in Elderly Patients

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Purpose: Hip fracture has been recognized as the most serious complication of osteoporosis because of its consequence including disability, poor quality of life, increased risk of mortality, and health-care costs. Therefore, bisphosphonates are widely used for osteoporotic patients and their efficacy is reduction of the risk of fragility fracture in clinical trials. Previous animal studies demonstrated that delaying a single dose of zoledronic acid (1 or 2 weeks after fracture) displayed significantly increasing bone strength and fracture repair while a yearly intravenous zoledronic acid in clinical study (The HORIZON-RFT) significantly reduced any new clinical fracture for a secondary prevention of hip fracture. However, current studies lack data demonstrating whether bisphosphonate delays bone healing after hip fracture repair in clinical practice. Therefore, the purpose of our study is to define whether bisphosphonates after proximal femoral nail antirotation (PFNA) fixation for elderly intertrochanteric fracture interrupt the fracture repair.

Methods: After IRB approval, 174 elderly patients with intertrochanteric fractures from low energy trauma underwent PFNA fixation. Demographic data, comorbidity, time to union, functional outcome, and complications were collected. Patients were classified into 2 groups: patients taking bisphosphonates after fracture repair and those who did not receive bisphosphonates. All patients received supplemental vitamin D and calcium. The primary outcome was measured by time to clinical union and radiographic union (weeks) between groups. The secondary outcome measured the functional outcome (Harris Hip Score, HHS) and complications including mortality rate between groups.

Results: There was comparable functional class and comorbidities between those with bisphosphonate and those without bisphosphonate intake. The former group had significantly lower mortality rate than the latter group (6.7% vs 23.5%, P = 0.004) while there was no difference in time to clinical union (6.9 weeks vs 6.7 weeks, P = 0.505), radiographic union (12.4 weeks vs 12.1 weeks, P = 0.223), and functional outcome (HHS) between both groups.

Conclusion: Bisphosphonate is useful for osteoporotic hip fracture, including significantly decreased mortality rate without inhibiting bone healing after fracture fixation in clinical practice.

PAPER ABSTRACTS

FINAL PROGRAM



OTA 35TH ANNUAL MEETING COLORADO CONVENTION CENTER • DENVER, COLORADO

THURSDAY - SATURDAY, SEPTEMBER 26 - 28, 2019

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ORTHOPAEDIC — TRAUMA — ASSOCIATION PAPER ABSTRACTS

Hip Fracture Evaluation with Alternatives of Total Hip Arthroplasty versus Hemi-Arthroplasty (X): A Multinational Randomized Controlled Trial of X Patients *HEALTH Investigators*

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Purpose: Displaced femoral neck fractures can have devastating impacts on quality of life and patient function. Evidence for optimal surgical approach is far from definitive. X aimed to evaluate unplanned secondary procedures following total hip arthroplasty (THA) versus hemi-arthroplasty (HA) within two years of initial surgery for displaced femoral neck fractures. Secondary objectives evaluated differences in patient function, health-related quality of life, mortality, and hip-related complications.

Methods: X is a large randomized controlled trial that included X patients across 81 centers in X countries. Patients aged 50 years or older with displaced femoral neck fractures received either THA or HA. Participants were followed for 24 months post-fracture and a Central Adjudication Committee adjudicated fracture eligibility, technical placement of prosthesis, additional surgical procedures, hip-related complications, and mortality. The primary analyses were a Cox proportional hazards model with time to the primary study endpoint as the outcome and THA versus HA as the independent variable. Using multi-level linear models with three levels (centre, patient, and time), with patient and centre entered as random effects, the effect of THA versus HA on quality of life (Short Form-12 (SF-12) and EQ-5D), function (Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)), and mobility (Timed Up and Go Test (TUG)) were estimated separately. The last participant follow-up is scheduled for May 2019 and the trial results will be released at the OTA annual meeting.

Results: Patients were a mean X years old, X% female, and X% Caucasian. We identified that X secondary procedures occurred in X patients over the two-year follow-up period (X%, 95% CI: XX-XX). THA conferred the following risk of a secondary procedure within two years relative to HA (RR:XX, 95% CI: YY-YY, p=X). In comparison to HA, THA impacted secondary outcomes as follows: health-related quality of life, as measured by the SF-12 and EQ-5D (Adjusted Mean Difference (AMD) XX, 95% CI: YY-YY, p=X; AMD XX, 95% CI: YY-YY, p=X, respectively); functional outcomes and mobility, as measured by the WOMAC and TUG (AMD XX, 95% CI: YY-YY, p =X; AMD XX, 95% CI: YY-YY, p=X, respectively). The two-year mortality rate was XX (RR:XX, 95% CI: YY-YY, p=X) in the THA group and XX (RR:XX, 95% CI: YY-YY, p=X) in the HA group.

Conclusion: This study represents a major international effort to identify the most effective arthroplasty option for displaced femoral neck fractures. These results will impact clinical practice and enhance the quality of life for 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.

Operative versus Nonoperative Treatment of Acute Unstable Chest Wall Injuries: A Multicenter Randomized Controlled Trial

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Purpose: Unstable chest wall injuries have high rates of mortality and morbidity. These injuries can lead to respiratory dysfunction, and are associated with high rates of pneumonia, sepsis, prolonged ICU stays, and increased health-care costs. Numerous studies have demonstrated improved outcomes with surgical fixation compared to non-operative treatment. However, an adequately powered multicenter randomized controlled study using modern fixation techniques has been lacking.

Methods: We present a multicenter, prospective, randomized controlled trial comparing surgical fixation of acute, unstable chest wall injuries with the current standard of nonoperative management. Patients aged 16-85 years with a flail chest (3 or more consecutive, segmental, displaced rib fractures), or severe deformity of the chest wall, were recruited from multiple trauma centers across North America. Exclusion criteria included: severe pulmonary contusion, severe head trauma, randomization >72 hours from injury, inability to perform surgical fixation within 96 hours from injury (in those randomized to surgery), fractures of the floating ribs, or fractures adjacent to the spine not amenable to surgical fixation. Patients were seen in follow-up for 1 year. The primary outcome was days free from mechanical ventilation in the first 28 days following injury. Secondary outcomes were days in ICU, rates of pneumonia, sepsis, need for tracheostomy, mortality, general health outcomes, pulmonary function testing, and other complications of treatment. A sample size of 206 was required to detect a difference of 2 ventilator-free days between the 2 groups, using a 2-tailed alpha error of 0.05 and a power of 0.80.

Results: A total of 207 patients were recruited from 15 sites across Canada and USA, from 2011-2018. 99 patients were randomized to nonoperative treatment, and 108 were randomized to surgical fixation. Overall, the mean age was 53 years, and 75% of patients were male. The commonest mechanisms of injury were: motor vehicle collisions (34%), falls (20%), motorcycle collisions (14%), and pedestrian injuries (11%). The mean ISS at admission was 26, and patients had a mean of 10 rib fractures. 89% of patients had pneumothorax, 76% had hemothorax, and 54% had pulmonary contusion. There were no differences between the 2 groups in terms of demographics. The final results will be available and presented at the OTA meeting in Denver.

Conclusion: This is the largest randomized controlled trial to date, comparing surgical fixation to nonoperative treatment of unstable chest wall and flail chest injuries. The results of this study will shed light on the best treatment options for patients with such injuries, help understand outcomes, and guide treatment. The final results will be available and presented at the OTA meeting in Denver.

See the meeting app for complete listing of authors' disclosure information.

Autologous Iliac Bone Graft versus Biphasic Hydroxyapatite/Calcium Sulfate Cement for Treatment of Bone Defects in Tibial Plateau Fractures: A Multicenter, Prospective, Randomized Clinical Trial

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Purpose: Bone graft substitutes are widely used for augmentation of traumatic bone defects in tibial plateau fractures, but their clinical outcome in comparison to autologous bone grafting remains under debate. This study investigates the differences in quality of life, pain and radiographic subsidence in the treatment of tibial plateau fracture-associated bone defects using either autologous iliac bone graft (AIBG) or a bioresorbable hydroxyapatite/calcium sulfate cement (BONE VOID FILLER [CBVF]).

Methods: 137 patients with acute traumatic depression fractures of the proximal tibia (AO types 41-B2 and AO 41-B3) were enrolled in a prospective, controlled, randomized, multicenter trial including 20 centers. Patients were randomized to receive either AIBG or CBVF to reconstruct the subchondral bone defect after open reduction and internal fixation. Primary outcome measure was the Short Form-12 version 2 (SF-12v2) Physical Component Summary (PCS) score at week 26. The co-primary end point was the pain level 26 weeks after surgery measured by a visual analog scale (VAS). The SF-12v2 Mental Component Summary (MCS) score after 26 weeks and subsidence of the tibia plateau on radiographs at 26 weeks served as key secondary end points.

Results: Age, gender, fixation method (locking vs non-locking plates), and fracture patterns were comparable in the 2 groups. CBVF was noninferior to AIBG regarding the SF-12v2 PCS and MCS, as well as in the pain score (VAS) at 26 weeks. There was a significant reduction of blood loss and a trend towards a shorter duration of surgery (not significant) in the CBVF group. Rate of articular subsidence during the 3 to 6-month follow-up period was equal in both groups.

Conclusion: Equal patient-reported outcomes and radiological results can be achieved in tibial plateau fractures if hydroxyapatite/calcium sulfate cement or AIBG are used. The indication for autologous bone grafting in tibial plateau fractures therefore needs careful consideration.

Deltopectoral versus Deltoid Split Approach for Proximal <u>HU</u>merus Fracture Fixation with Locking Plate: A Prospective <u>RA</u>ndomized Study (HURA Study)

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Purpose: There are 2 options when choosing the surgical approach for locking plate fixation to treat proximal humerus fractures (PHFs). The deltoid split (DS) approach, developed according to minimally invasive surgery principles, and the classic deltopectoral (DP) approach, believed to increase the risk of avascular necrosis and making access to the greater tuberosity more difficult. The purpose of the present study (NCT-00612391) was to compare outcomes for both methods in terms of function, quality of life, and complications in a prospective randomized multicenter study using CONSORT (Consolidated Standards of Reporting Trials) guidelines.

Methods: From 2007 to 2016, all patients, from 2 university trauma centers, meeting the inclusion criteria (PHF Neer II/III, isolated injury, skeletal maturity, speaking French or English, available for follow-up (FU), ability to fill questionnaires) were invited to participate. Exclusion criteria were: preexisting pathology to the limb, patient-refusing or too ill to undergo surgery, patient needing another type of treatment (nail, arthroplasty), axillary nerve impairment, open fracture. After consent, patients were randomized to 1 of the 2 treatments using the dark envelope method. Preinjury status was documented by questionnaires (Short Form-12 [SF12], Q-DASH [an abbreviated version of the Disabilities of the Arm, Shoulder and Hand Questionnaire], Constant score). Range of motion was assessed. Patients were followed at 2 and 6 weeks, and 3, 6, 12, 18, and 24 months. Power calculation was done with primary outcome: Q-DASH.

Results: A total of 83 patients were randomized; 44 to the DS and 39 to the DP approach with a mean age of 62 years (\pm 14) and 77% were females. Groups were equivalent in terms of age, gender, body mass index (BMI), severity of fracture and preinjury scores, Neer II (53%) and Neer III (47%). Minimum FU was 12 months, mean was 26 months. All clinical outcome measures were in favor of the deltopectoral approach. Primary outcome measure, Q-DASH, was better statistically and clinically in the DP group (12 vs 26, P = 0.003). Patients with DP had less pain and better quality of life scores than with DS (VAS [visual analog scale] 1/10 vs 2/10, P = 0.019 and SF12 mental 56 vs 51, P = 0.049, respectively). Constant-Murley score was higher in the DP group (73 vs 60, P = 0.014). However, active external rotation was better with the DS approach (45° vs 35°). There were more complications in DS patients, with 4 screw cut-outs versus 0, 4 avascular necrosis versus 1, and 5 reoperations versus 2. Calcar screws were used for a majority of DP fixations (57%) versus a minority of DS (27%) (P = 0.012).

Conclusion: The primary hypothesis on the superiority of the deltoid split incision was rebutted. The added difficulty involved with the use of calcar screws and intramuscular dissection for the DS approach could be partly responsible for this difference. The DP approach should be used during Neer II and III PHF fixation.

126

See the meeting app for complete listing of authors' disclosure information.

△ Locked Plating versus Nailing for Proximal Tibia Fractures: A Multicenter RCT *Paul Tornetta. MD*; Kenneth A. Egol, MD; Clifford B. Jones, MD, FACS; Robert F. Ostrum, MD; Catherine A. Humphrey, MD; Robert Paul Dunbar, MD; William M. Ricci, MD; Laura Phieffer, MD; David C. Teague, MD; Henry Claude Sagi, MD; Andrew N. Pollak, MD; Andrew H. Schmidt, MD; Stephen A. Sems, MD; Hans-Christoph Pape, MD; Saam Morshed, MD; Edward Perez, MD Boston University Medical Center, Boston, MA, United States

Purpose: Both intramedullary (IM) nails and locked plates are utilized for their treatment of extra-articular proximal tibia fractures. The purpose of this study was to evaluate the radiographic, functional, and patient-based outcomes of locked plates (P) versus IM nails (N) for proximal tibia fractures.

Methods: All adult patients with A1-3 or C1 proximal tibia fractures were offered entry into an OTA-funded randomized controlled trial (RCT). Randomization was with permutated blocks for open and closed fractures using a HIPAA (Health Insurance Portability and Accountability Act)-compliant web-based system. Patients requiring articular reduction were excluded. Demographics, fracture characteristics, surgical variables, radiographs, walking ability, Short Musculoskeletal Function Assessment (SMFA), bother index, and EQ-5D (EuroQol 5 Dimensions) were assessed based on available patients at each time point (3, 6, and 12 months). Comparisons were made with Graphpad software.

Results: 108 patients were randomized and 99 patients (76 M; 23 F) aged 20 to 87 years (average, 46) treated with nails (52) or locked plates (47) were followed. There were no differences in demographics or injury pattern. Average ISS was 11.2 (11.8 N; 10.7 P), 36% were open, 18% had simple intra-articular extension, and 52% smoked. Compartment syndrome was more common in the nail group (4:1). Surgical time did not differ between the groups (180 [P] vs 155 [N] min, P = 0.7). 40% of nails were done in relative extension and 42% had blocking screws. Malalignment >5° occurred in 3 patients in each group. Walking ability, stair climbing, pain, and use of supports were graded using categorical values. There were no differences at any time point between the groups. 50% of both groups were full weightbearing at 3 months. At 1 year, the average patient could walk >10 blocks, walk stairs using a railing, and needed no supports. 7% of both nails and plates lacked at least 5° of extension. There was no difference in the SMFA, bother index, EQ-5D, or EQ Index at 3, 6, or 12 months (P = 0.55-0.98). At 1 year the average scores were: SMFA 28.4, bother 26.6, EQ-5D 0.70, and EQ health 70. There were 3 deep infections in the nail group (2 closed; 1 open) and 1 deep (open) and 2 superficial infections (1 closed; 1 open) in the plate group. Nonunions occurred in 4 nails and 5 plates. 20 and 17 adverse events occurred in the nail and plate groups, respectively.

Conclusion: With the number studied, we found no difference in the radiographic, functional, or patient-based outcomes of nails compared with locked plates for proximal tibia fractures. Patients have substantial disability at 1 year regardless of treatment. Complications were common, but rates did not differ between groups.

 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.

Early Motion and Directed Exercise (EMADE) versus Usual Care, Post Ankle Fracture Fixation: A Pragmatic Randomized Controlled Trial

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Purpose: Ankle fractures are one of the most common injuries treated surgically. However, over 20% have functional restrictions or ongoing pain 6 months following injury. Usual care postsurgery is around 6 weeks of cast immobilization. This is known to be associated with disuse atrophy and joint stiffness, and an alternative strategy is a removable splint and early directed physiotherapy-based rehabilitation. Our objectives were to (1) develop an early motion and directed exercise (EMADE) physiotherapy intervention and (2) determine the outcomes of EMADE versus immobilization at 12 weeks following operative fixation.

Methods: Patients were recruited following surgery into a pragmatic randomized control trial (RCT) testing usual care against the EMADE program. We recruited 157 with surgically fixed Weber B ankle fractures. The EMADE physiotherapy intervention (between weeks 2 and 4 postsurgery) combined non-weight-bearing progressive home exercises with manual therapy, advice, and education. The usual care group received plaster cast immobilization. The primary outcome was the Olerud-Molander ankle score (OMAS) questionnaire at 12 weeks postsurgery (minimal clinically important difference [MCID]: 10 OMAS points). Secondary measures included the EQ-5D-5L (EuroQol 5 Dimensions 5 Levels. The protocol was registered and published. Follow-up was to 12 months and a range of secondary outcomes and patient experience data were collected in addition to the primary outcome score.

Results: 130 participants returned their 12-week postsurgery data, achieving 80% power to detect a change at the MCID level. At the primary outcome of 12 weeks, group mean OMAS scores were 62.0 and 48.8 (standard deviation [SD] 21, 22.5) favoring EMADE (P <0.001). There were no intervention-related or unexpected adverse events, including instability or wound breakdown.

Conclusion: This RCT yielded both clinical and statistical outcomes in favor of the EMADE physiotherapy intervention over the usual care of 6 weeks immobilization, in surgically fixed Weber B ankle fracture patients.





AM19: Program Committee Highlight Papers, PAPER #68 Thurs., 9/26/19

Intravenous Ibuprofen Reduces Opioid Consumption in Acute Pain Management for **Orthopaedic Trauma Patients**

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Purpose: This study was undertaken to evaluate the efficacy of intravenous ibuprofen (Caldolor) administration in the management of acute pain in orthopaedic trauma patients and to minimize opioid use.

Methods: This randomized, double-blind, parallel design, placebo-controlled trial was conducted at a Level-I trauma center. A total of 99 orthopqedic trauma patients with fractures of the ribs, face, extremities, and/or pelvis were randomized to receive either 800 mg intravenous (IV) ibuprofen (53 patients) or placebo (44 patients). The treatment was administered every 6 hours for a total of 8 doses within 48 hours of admission and the same PRN (pro re nata, or as-needed) medications along with 20 mg IV or oral Pepcid twice a day. Analyzed variables included: pain intensity measured by Numerical Rating Scale, opioid consumption adjusted to morphine equivalent dose, and time to first narcotic administration. The primary outcomes were reduction in opioid consumption, time to first narcotic medication, and decrease in pain intensity. Treatment assignment remained blind to all authors, until all results were obtained and statistical analysis had been completed.

Results: Two groups had comparable baseline characteristics: age, gender composite, mechanism of injury, type of injury, ISS, and initial pain intensity. IV ibuprofen statistically significantly reduced opioid consumption compared with placebo during the initial 48hour time period (P = 0.017). Pain intensity calculated as pain intensity differences was not significantly different between groups over the entire period but was significantly different at 8 hours. Time to first narcotic medication was significantly longer in the Caldolor group (hazard ratio: 1.640; 95% confidence interval: 1.009, 2.665; P = 0.046).

Conclusion: IV ibuprofen provided adequate analgesia, prolonged time to first narcotic administration, and reduced the amount of prescription opioids required for pain treatment in orthopgedic trauma patients, which makes Caldolor a recommended candidate for managing acute pain in the diverse trauma 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.

A Prospective Clinical Trial Comparing Operative versus Nonoperative Fixation of Minimally Displaced Lateral Compression Pelvic Fractures

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Purpose: The purpose of this trial was to compare the early pain and functional outcomes of operative fixation versus nonoperative management for lateral compression (LC) pelvic fractures.

Methods: Patients ages 18 to 80 years with an LC pelvic ring injury consisting of a complete posterior fracture and <1 cm of displacement were approached for randomization at 2 centers. For patients refusing randomization, a separate observational cohort was recruited after patients selected their treatment (to minimize surgeon selection bias). 50 patients were treated nonoperatively and 44 with surgical fixation, with 67% of participants being randomized. 72% of the included fractures were displaced <5 mm and 67% were LC-1 patterns. Standard principles of reduction and fixation methods were applied to the surgical group, with most patients receiving a closed or percutaneous reduction (87%). The mean age was 44 years (standard deviation [SD] 18). The primary outcome was patient-reported pain using the 10-point Brief Pain Inventory (BPI). Functional outcome was measured using the 100-point Majeed pelvis score. Outcomes were analyzed using longitudinal regression models to compare the average treatment effect from 96 hours postinjury to 2, 6, and 12 weeks postinjury. A Bayesian analysis with noninformative priors was used to determine the probability of the average treatment effect exceeding the minimum clinically important difference (MCID) for the pain outcome. Analyzes of the 63 randomized patients and the entire patient cohort obtained similar results; therefore, the data from all 94 patients are presented for simplicity.

Results: The unadjusted average treatment effect of surgery sustained over the 12 weeks was a 0.9-point reduction in BPI score (SD 0.2) and a 7.7-point improvement in Majeed score (standard error [SE] 2.8). Point estimates showed differences between treatment groups at each follow-up for the pain and functional outcomes. Based on a 1.0-point MCID estimate for the BPI, there is a 32% probability the average 3-month treatment benefit from surgical fixation exceeds the clinically important threshold for pain improvement.

Conclusion: These results suggest surgical fixation provides a small average improvement in pain and functional outcome for up to 3 months. However, the probability of achieving a clinically important benefit must be balanced with the costs and risks of surgery for each individual patient.

Does Negative Pressure Wound Therapy Reduce the Odds of Infection and Lower Health-Related Quality of Life in Open Fracture Patients?

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Purpose: Negative pressure wound therapy (NPWT) is commonly used to manage severe open fracture wounds. The recently completed randomized controlled trial (RCT) evaluated the effect of NPWT versus standard wound management on 12-month disability and rate of deep infection among patients with severe open fractures of the lower limb and reported no differences. Using data from the trial of open fracture patients, we aimed to evaluate the impact of NPWT on the odds of having deep infections and health-related quality of life (HRQL).

Methods: Our analyses included participants from the open fracture trial who had Gustilo II and III lower extremity fractures. To adjust for the influence of injury characteristics on type of dressing received, a propensity score was developed from the data set. A one-to-one matching algorithm was then used to pair patients with a similar propensity for NPWT. Mixed effects logistic regression was used to evaluate the association between type of wound dressing and development of a deep infection requiring operative management (dependent variable) in the matched cohort. Gustilo type, irrigation solution, fracture location, mechanism of injury, and degree of contamination were included as adjustment variables. To determine any differences in HRQL between the NPWT and standard wound dressing groups, we conducted 2 multilevel models with 3 levels (center, patient, and time) and included Short Form-12 (SF-12) Physical Component Summary (PCS) and SF-12 Mental Component Summary (MCS) as dependent variables. Gustilo type, irrigation solution, fracture location, mechanism of injury, degree of contamination, and preinjury SF-12 scores were included as adjustment variables. All tests were 2-tailed with alpha = 0.05.

Results: After applying propensity score-matching to adjust for the influence of injury characteristics on type of dressing used, there were 270 matched pairs of patients available for comparison. The odds of developing a deep infection requiring operative management within 12 months of initial surgery was 4.22 times higher in patients who received NPWT compared to those who did not receive NPWT (odds ratio [OR] 4.22, 95% confidence interval [CI] 2.26-7.87; P <0.0001). 1329 participants were included in our HRQL analysis and those treated with NPWT had significantly lower SF-12 PCS at all follow-up visits (6 weeks, 3 months, 6 months, 12 months) postfracture (P = 0.01). Participants treated with NPWT had significantly lower SF-12 MCS at 6 weeks postfracture (P = 0.03).

Conclusion: Our analysis found that patients treated with NPWT had higher odds of developing a deep infection requiring operative management and that being treated with NPWT was associated with lower physical quality of life in the 12 months postfracture. While there may have been other potential adjustment variables not controlled for in this analysis, our results suggest that the use of this treatment should be re-evaluated.

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

Impact of Fascia Iliaca Block on Pain Outcomes and Opioid Consumption for Hip Fracture Patients: A Prospective, Randomized Study

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Purpose: Hip fractures are a common injury among the elderly. Injury to this population leaves them vulnerable to substantial morbidity and mortality. The cornerstone of perioperative pain management for hip fractures is typically opioid medications. Retrospective studies for hip fractures and extrapolation from high-level arthroplasty studies suggest that regional nerve blockade is an option for decreasing opioid use among those with hip fractures. Our objective was to perform a prospective, randomized study to validate the efficacy of a fascia iliaca block (FIB) on pain, opioid use, and function after operative treatment of hip fractures.

Methods: A single-center, prospective, randomized controlled study of patients between 18-99 years old treated operatively in 2018 through January 2019 for femoral neck, intertrochanteric, or subtrochanteric hip fractures was performed at a Level-I trauma center. Patients were randomized to either receive the block or not to receive the block based on medical record number (MRN). Polytrauma patients, pathologic fractures, revision procedures, and patients with dementia were excluded. Primary outcomes were the morphine equivalent dose (MED) of opiate consumption, visual analog scale (VAS) scores, postsurgical 72-hour ambulatory distance, block-associated complications, and the length of stay (LOS). Secondary outcomes were postoperative complications and the discharge disposition.

Results: 85 patients (n = 48, block) with a mean age of 77 years were included. Demographics, fracture type, and disposition at discharge were similar. While there was no difference in VAS scores, the study group demonstrated decreased opiate use (MED 62.3 vs 107.5, P = 0.07). The block group trended toward greater postoperative day 3 walking distance (30' vs 9', P = 0.07) and 72-hour cumulative walking distance (70' vs 27', P = 0.08). Patients with a block trended toward a decreased LOS (5 days vs 6 days, P = 0.16).

Conclusion: Preliminary data from our Level-I study suggest adjuvant FIBs to multimodal postoperative pain regimens for patients with hip fractures may decrease the amount of narcotic consumption in the postoperative period and allow for increased postoperative mobilization.

Management of Traumatic Bone Defects in Tibial Plateau Fractures with Antibiotic-Impregnated Biodegradable Calcium Sulfate Beads: A Prospective Clinical Trial Ross K. Leighton, MD; Michael E. Forsythe, MD; George Yves Laflamme, MD; Andrew Furey, MD; Prism Schneider, MD, PhD, FRCSC Nova Scotia Health Authority, Halifax, NS, Canada

Purpose: There has been widespread interest in utilizing local antibiotics in fractures involving significant soft- tissue trauma where postoperative infections are a major concern. STIMULAN Rapid Cure (Biocomposites) is a resorbable calcium sulfate that can be mixed with a variety of antibiotics and formed into beads to create a nonstructural void filler. The primary goals of this study were to assess resorption of the device (STIMULAN Rapid Cure with antibiotics) and identify device-related adverse events in tibial plateau fractures.

Methods: This was a multicenter, prospective study of 30 patients with a tibial plateau fracture (AO-OTA type 41B and 41C), recruited from 5 trauma centers. The articular surface was reduced, the fracture was fixed with plates and screws, and the subchondral void was filled with the device. We assessed the local wound reaction to the device by recording redness, swelling, and serous drainage. We also measured the resorption rate of the calcium sulfate on serial radiographs. Follow-up was done at 6 weeks, 12 weeks, 6 months, and 1 year. Secondary outcomes were time to union and postoperative depression of the subchondral surface. Descriptive statistics were used for analysis.

Results: 13 male and 17 female patients were included. Patients had a mean age of 53 years (range, 29 to 78) and a mean body mass index of 29 (standard deviation [SD] = 8.7). Postoperative swelling and redness were within normal limits. Two patients reported serous drainage: 1 resolved without treatment, the other required oral antibiotics for superficial infection of a stitch abscess. There were no other infections at the operative site and no local or systemic allergic reactions. There was 1 report of intra-articular heterotopic ossification requiring debridement. Three patients experienced hardware irritation: 1 was revised to a smaller plate and 2 required implant removal. One patient was revised to a total knee replacement after loss of fixation. None of these were deemed related to the study device. 76.7% of fractures were healed by 3 months with 100% healed at 1 year with no significant subchondral collapse. Resorption of the material averaged 70% by 12 weeks and 87% had no visible calcium sulfate beads on radiographs at 6 months.

Conclusion: This device appears to perform well when mixed with antibiotics for fractures with a high risk of infection. An additional advantage is being able to choose from a range of antibiotics. Surgical site drainage was very low, and 100% union rate was achieved. There were no remaining beads visible at 1 year. This should be a safe surgical augment for local release of a chosen antibiotic into the subchondral void of a tibial plateau fracture.

Bicondylar Plateau Fractures: What Predicts Infection

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Purpose: The purpose of this study was to identify the patient, injury, and treatment factors associated with infection of bicondylar plateau fractures.

Methods: We reviewed consecutive patients with bicondylar plateau fractures at 16 centers. Demographics (treating hospital, age, gender, mechanism of injury, ISS, BMI, smoking, diabetes, medications, ETOH, IVDA, OTA type, compartment syndrome (CS)) and treatment variables (temp ex fix, plate location, incisions, time to surgery, and operative time) were tabulated. Superficial or deep infection within 120 days was the primary outcome.

Results: There were 1094 patients, (647M; 447F) aged 18-89 (avg 46) with OTA 41C1-3 fxs. Avg BMI = 29, ISS = 10. There were 105 open (64 type 3), 138 CS, 103 diabetes (DM), 128 ETOH, and 318 smokers. Median F/U = 357 days. There were 78 (7%) infections. Time to surgery (11vs 8 days p=0.002) and surgical time (224 vs. 171 mins p=0.0001) were greater in infected patients. Univariate analysis showed smoking, DM, IVDA, ETOH, BMI, open fx, 41C3 (vs C1,2), temporary ex fix, deep fasciotomy site used for definitive fixation, and dual plating (vs unilateral) were associated with infection. Multivariate analysis showed DM (OR 2.8; p=0.003), grade 3 open (OR 2.7; p=0.015), and dual plating (OR 2.2;p=0.008) were associated with, and temporary ex fix (OR 1.7;p=0.08) and ETOH (OR 1.8; p=0.07) trended towards, infection. Compartment release was not associated with infection (p=0.8); fixation through the deep fasciotomy wound was associated with infection (p=0.04) while use of the same skin incision but different deep incision trended towards association (p=0.1). There was statistical site variation with 1 center statistically below (p=0.016) and 2 trending above (p=0.07) predicted infection rates when accounting for DM, grade 3 injury, and ETOH.

Conclusion: Infection after ORIF of bicondylar plateau fractures was 7% and associated with DM and grade 3 open fracture. Alcohol use trended toward association. Several factors that reflect worse soft tissue injury were associated with infection: time from injury to surgery, use of temporary ex fix, operative time, and dual plating. The only surgeon-controlled factor in the multivariate analysis was the use of dual plates while OTA fracture type was not. Fixation through the same fascial incisions as a compartment release was associated with infection. Finally, center expertise may play a role as one center had a statistically lower and two trended towards higher adjusted infection rates.

Better Fracture Reduction in Patients Undergoing Early Definitive Fixation for Tibial Plateau Fractures with Acute Compartment Syndrome

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Purpose: The purpose of our study was to evaluate the timing of definitive fixation of tibial plateau fractures (TPFs) after compartment release. Our primary outcome was infection. Our secondary outcome was articular reduction and alignment.

Methods: A multicenter retrospective review of TPFs requiring operative repair that were complicated by acute compartment syndrome was performed. Patient demographics, injury characteristics, and treatment course were identified. Patients met inclusion criteria if treated with open reduction and internal fixation (ORIF) and fasciotomy, had >8-week follow-up, and were skeletally mature. Radiographs were blinded and graded on articular reduction and alignment by an attending orthopaedic surgeon. Patients were categorized into 2 groups: those receiving definitive fixation before or during fasciotomy closure (early fixation group) and those receiving definitive fixation after fasciotomy closure (delayed fixation group).

Results: A total of 79 patients met inclusion criteria. Thirty-eight were treated with early definitive fixation and 41 with delayed fixation. Gender, age, BMI, diabetic status, and smoking status were comparable between the groups (p=0.48, 0.46, 0.19, 0.87, 0.23, respectively). Additionally, open fracture and AO/OTA classification was not significantly different between the groups (p=0.07, 0.59, respectively). Patients undergoing early definitive fixation had a mean time to fixation of 4.0 days +/- 2.5 [3.2, 4.9] vs 17.5 +/- 12.6 [13.5, 21.4] (p<0.01). Deep infection was not significantly different between groups; 5 (13.2%) in the early fixation group and 5 (12.5%) in delayed fixation (p=0.90). In the early fixation group, 25 (39.7%) fasciotomy sites were closed with split thickness skin grafts (STSG) vs 7 (9.3%) in the delayed fixation group (p<0.001). Alignment was not significantly different between groups, early fixation resulted in a higher probability for attaining anatomic reduction, 27 (71.0%) vs 11 (27.5%) in delayed fixation (p<0.01).

Conclusion: Our study suggests early definitive fixation leads to improved articular reduction without an increased risk of infection. Acute compartment syndrome is a frequent complication in patients with tibial plateau fractures, and to date there is limited information to guide timing of definitive fixation. While this study is underpowered to appropriately evaluate risk in this setting, this study highlights the need for a further investigative study.

Evaluating the Efficacy of Topical Vancomycin Powder in the Treatment of Open Lower-Extremity Fractures

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Purpose: Despite standardized use of intravenous (IV) antibiotics, infection in open lower-extremity fractures remains high. Several examples in orthopaedic spine literature demonstrate both safety and efficacy in preventing postoperative infections when vancomycin powder is topically administered in the surgical wound. Therefore, vancomycin powder may provide a valuable adjunctive resource to improve patient care in the management of traumatic open fractures.

Methods: A retrospective review of 410 open lower-extremity fractures (subtrochanteric and distal) in adults from 2010-2015 at our institution were reviewed for development of deep infection (including species and sensitivity if present) and the development of unanticipated wound complications requiring intervention. 47 patients from 2016-2017 presenting with an open lower-extremity fracture were treated with vancomycin powder applied directly to the wound before closure in addition to the standard of care consistent with evidence-based literature (IV antibiotics with external fixator, intramedullary nail, etc). Wounds not primarily closed in the initial procedure received vancomycin powder then and at definitive closure. All patients were monitored per the treating surgeon's standard follow-up protocol and had follow-up of at least 3 months.

Results: 36 of 410 patients (8.78%) in the historical control group developed a deep infection compared to 4 of 47 patients (8.51%) in the vancomycin powder group (P = 0.966). The bacterial species cultured from the infected patients trended away from gram-positive organisms (55.56% of control infections vs 25% of intervention infections), although not achieving statistical significance (P = 0.246). There was a statistically significant increase in the incidence of unanticipated wound complications requiring intervention with the use of topical vancomycin powder (5.12% vs 12.77%) (P = 0.035, OR [odds ratio] 2.71).

Conclusion: The use of topical vancomycin powder does not appear to reduce the infection rate in open lower- extremity fractures, although the bacterial species cultured does appear to trend away from gram-positive organisms. Further, the use of vancomycin powder led to a statistically significant increase in unanticipated wound complications requiring intervention. Overall, the use of topical vancomycin powder does not appear to improve the management of open lower-extremity fractures.

PAPER ABSTRACTS

Fri., 9/27/19 AM19: Tibia and Knee/Tibial Plateau, PAPER #76

Does Topical Vancomycin Powder Use in Fracture Surgery Change Bacteriology and Antibiotic Susceptibilities? An Analysis of the VANCO Trial

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Purpose: Recently the VANCO trial demonstrated that topical vancomycin powder used in tibial plateau and pilon fracture surgery appeared to decrease surgical site infection, particularly in terms of gram-positive infections. However, it is unknown if the bacteriology differs between patients who have infections with or without vancomycin powder, particularly in regard to the emergence of different organisms or increased rate of antibiotic resistant pathogens. Our hypothesis was that there would be no differences in the species or susceptibilities in the patients who did and did not receive vancomycin powder.

Methods: This study was a preplanned secondary aim of the VANCO trial (980 patients enrolled in a phase III, prospective, randomized clinical trial, comparing topical vancomycin powder to controls in high-energy tibial plateau and pilon fractures). For this study we analyzed only patients with deep surgical site infections (n = 29 in the treatment arm and n = 45 in the control arm) as determined by a blinded adjudication committee. Pathogens and susceptibilities were determined from routine clinical sterile culture in the operating room. The primary outcome measures were pathogen type and bacterial susceptibilities.

Results: There were differences in the pathogens observed in the 2 treatment arms. As would be expected based on vancomycin's activity against gram-positive bacteria, there was a lower proportion of gram-positive bacteria in the treatment group (55% vs 76%, Fisher's exact test: P < 0.01). Rates of methicillin-resistant Staphylococcus aureus (MRSA) infections were comparable in both groups (14% vs 9%) but rates of methicillin-susceptible S. aureus (MSSA) infections (17% vs 42%) and coagulase-negative Staph (CoNS) infections (10% vs 18%) were observed to be higher in the control group. Gram-negative rod infections were similar in both groups (52% vs 42%). There was no important difference in susceptibilities between groups including the rates of vancomycin- resistant enterococcus or MRSA (17% vs 11%).

Conclusion: Vancomycin powder decreases the likelihood of gram-positive infections. We were unable to assess the effect of vancomycin powder on MRSA infections because rates were low in both groups but there were fewer MSSA and CoNS infections in the vancomycin group. There was no concerning evolution of gram- negative rod infections or increased resistance patterns observed. Clinicians should be reassured that the use of topical vancomycin powder does not appear to produce infections with pathogens that will be more difficult to treat than would have occurred without its use.

Infection Rates in Open Tibia Fractures with the Use of Intraoperative Topical Vancomycin/Tobramycin Powder

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Purpose: Postoperative infections have the potential to be a devastating consequence following open fractures. Time to intravenous antibiotics, timing and quality of initial debridement, and the severity of the soft-tissue injury have been shown to significantly impact infection rates. Administration of local antibiotics, with topically applied vancomycin and tobramycin powder, has been effective in spine and pelvic/acetabulum surgery with reduced rates of surgical site infection (SSI). However, there is a paucity of data related to topically applied antibiotics and open fractures. This study retrospectively compares postoperative infection rates in open tibia fractures in patients receiving topically applied vancomycin and tobramycin powder intraoperatively and those not receiving topically applied antibiotics.

Methods: During a 33-month period 90 patients with open tibia fractures were treated at a Level-I trauma center. 66 patients were treated with topically applied antibiotics at the open fracture site during initial debridements, while 24 patients did not receive localized antibiotic therapy. Fractures were classified according to the area of the tibia fracture (plateau, shaft, pilon) and the type of open fracture according to the Gustilo- Anderson classification. The outcome measure reviewed was deep infection requiring a formal irrigation and debridement in the operative theater.

Results: The overall rate of infection in open tibia fractures was found to be 18.9%. A majority of the infections occurred in Gustilo-Anderson type III open fractures yielding an infection rate of 22.5%. In type III fractures, those not receiving topical antibiotics (n = 14) had an infection rate of 42.9% compared to the treatment group's (n = 57) infection rate of 17.5% (odds ratio = 3.53, confidence interval: 1.0-12.4; P < 0.05).

Conclusion: Topical administration of vancomycin and tobramycin powder into the wounds of Gustilo- Anderson type III open tibia fractures results in a statistical decrease in postoperative infection rates.

	Infection ra	ites (%)		
	Type I (n=9)	Type II (n=10)	Type III (n=71)	Total (n=90)
Overall infection number (%)	0 (0.0%)	1 (10.0%)	16 (22.5%)	17 (18.9%)
	Topical antibi	otics used		
Total number	2	7	57	66
Number of infections	0 (0.0%)	1 (14.3%)	10 (17.5%)	11 (16.7%)
N	o Topical antil	biotics used		
Total number	7	3	14	24
Number of infections	0 (0.0%)	0 (0.0%)	6 (42.9%)	6 (25.0%)
Gus	tilo-Anderson	Classification		

Improved Healing of Severe Open Long Bone Fractures Treated with Antibiotic-Formulated Bone Graft During the First Surgical Intervention Post-Injury

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Purpose: Severe open fractures are associated with bacterial contamination that may lead to a high rate of bone infections and delayed unions. We hereby present the results of a randomized controlled study in a total of 47 patients with Gustilo III (A, B) and 4 patients with Gustilo I tibia fractures, treated with a doxycycline-eluting synthetic bone graft capable of constantly releasing the antibiotic over an extended period of 4 weeks (PLEX- DBG).

Methods: The trial included 24 patients treated with PLEX-DBG in addition to standard of care (the PLEX- DBG group) and 27 treated with standard of care (the SOC group). PLEX-DBG was inserted into the bone void during the first surgical procedure post-injury, with a 52-week follow-up period.

Results: Three cases of serious bacterial-related adverse events were recorded in the SOC group only, including 1 case of deep bone infection and 2 cases of nonunion that required additional surgery. Based on a blinded radiographic healing assessment, the percentage of patients presenting callus at 3 of 4 cortices during 24 weeks post-procedure was significantly higher in the PLEX-DBG group as compared to patients in the SOC group (88.2% vs 57.1%, respectively; P <0.04). Time from surgery to bone healing, assessed by the presence of a callus in 2 out of 4 cortices during 36 and 52 weeks post-procedure, was significantly shorter in the PLEX-DBG group versus SOC (94.3 \pm 11.2 vs 175.6 \pm 26.2 days, P <0.006 and 94.3 \pm 11.2 vs 185.9 \pm 26.5 days, P <0.003, respectively). Time to callus formation at 3 of 4 cortices during 52 weeks post-procedure was 30% lower in the PLEX-DBG group as compared to the SOC group (123.1 \pm 15.8 vs 182.5 \pm 23.7 days, respectively; P <0.067). Moreover, painfree weight bearing was demonstrated in 41% of the patients in the PLEX-DBG group 12 weeks post-surgery, versus none of the patients (0%) receiving SOC alone (P <0.003). The ratio between patients reporting pain-free weight bearing in PLEX-DBG versus SOC groups increased even further at 16 to 20 weeks post-surgery.

Conclusion: The implantation of PLEX-DBG in patients with severe open long bone fractures already during the first surgical intervention post-injury resulted in less bacterial-related complications, earlier bone union, and reduced pain on weight bearing. These benefits may increase the rate of return to active duty for PLEX-DBG- treated patients.

Post-Operative Cortical Continuity as a Predictor for Nonunion in Open Tibia Fractures

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Purpose: Open tibia fractures maintain an all-comer nonunion rate of 2%-48%. Patient-specific factors such as smoking and NSAID (nonsteroidal anti-inflammatory drug) use, as well as fracture pattern characteristics, such as transverse pattern and postoperative fracture gap, have been reported widely in the literature with varying effects on nonunion rate. We analyzed all open extra-articular tibia fractures at our institution over a decade to determine which factors predict nonunion in our patient population.

Methods: 107 patients with 115 AO/OTA Type 41A2-3, 42A-C, 43A open tibial shaft fractures treated surgically at a Level-I academic trauma center from 2007-2017 were retrospectively reviewed. 27 patient, injury, and surgeon-related prognostic factors were analyzed for predictors of nonunion. Nonunion was defined as failure of progression of fracture healing for 6 months or at least 2 consecutive months with lack of cortical continuity on 2 of 4 cortices on anteroposterior and lateral radiographs. Hazard ratio estimates were performed to identify statistically significant associations.

Results: The nonunion rate was 22.6% with 26 instances of nonunion. The median followup was 13.9 months. Postoperative cortical fracture gap (P = 0.04) and deep infection (P < 0.01) were significant predictors of nonunion. Postoperative cortical continuity of 0%-25% resulted in a hazard ratio for tibial nonunion of 5.20. Deep infection resulted in a hazard ratio of 6.95. The overall deep infection rate was 11% with 13 occurrences; 10/13 deep infections were in the setting of Gustilo-Anderson type 3 fractures. The patients (5/6) who had an infection but achieved bony union had cortical continuity >75%. No other characteristics of the injury, including mechanism of injury, fracture pattern, fasciotomies, and the need for soft-tissue coverage were predictive of nonunion. No patient-specific factors predicted fracture union, including diabetes, smoking, steroid, and NSAID use.

Conclusion: This study found that postoperative cortical continuity and deep infection were significant predictors of nonunion in open extra-articular tibia fractures treated with operative fixation. Our data indicated that the presence of a fracture gap or only 1 cortex in continuity is a strong radiographic predictor of nonunion, and cortical continuity may be protective against nonunion in the setting of infection. When reporting on the risk of nonunion, fractures should be subcategorized by fracture gap given that fractures with limited or no cortical contact following fixation predictably go on to nonunion and warrant a staged approach.

The Influence of Sagittal Proximal Tibial Anatomy in Tibial Intramedullary Nailing *David Cinats, MD*; *Trevor Stone, MD*; *Darius Viskontas, MD Royal Columbian Hospital, New Westminster, BC, Canada*

Purpose: Tibial intramedullary nailing (IMN) is an effective treatment for tibial fractures but is associated with a significant postoperative complication rate. The ideal surgical approach for nail insertion remains controversial. Previous studies have compared the influence of suprapatellar (SP) and infrapatellar (IP) approaches on tibial IMN, but no study has evaluated the effect of proximal tibial anatomy on tibial IMN.

Methods: This was a randomized controlled trial randomizing patients to the IP or SP approach at a Level-I trauma center by 6 surgeons experienced in the procedure. Novel measurements were developed to quantify proximal tibial anatomy including proximal tibial angle (PTA) (Fig 1A) and start point centrality (SPC) (Fig. 1B, SPO = x/y). Guidewire and nail position were evaluated on intraoperative and postoperative films. Patients were stratified into 4 groups based on nail insertion method and PTA (high PTA + SP, high PTA + IP, low PTA + SP, low PTA + IP). Pearson's correlation coefficient and unpaired 2-tail Student t-test was performed using SPSS.

Results: 46 tibias in 45 patients were randomized (22 IP, 24 SP). Correlation coefficient for PTA and SPC was 0.79. Insertion method did not influence wire start point, nail position, or fracture alignment. SP nailing had significantly shorter surgical times compared to IP nailing (45.5 vs 55.6 min, P = 0.03). Patients with low PTA + IP nailing had significantly longer operative times (60.4 min) when compared to the other 3 groups (45.3 min). When stratified by PTA, patients with high PTA >22° (Fig. 1A) had more central start points, more vertical guidewire position, more central nail position, and less eccentric reaming compared to patients with low PTA <22° (Fig. 1B).

Conclusion: Tibial anatomy influences nail insertion and nail position. Patients with low PTA who underwent IP nailing had significantly longer operative times, which can be considered an indicator of difficulty of the operation and suggests that patients with this anatomy should be considered for SP nailing. This is the first study examining the influence of anatomy on tibial nail start point.



Evaluation of the Orthopaedic Trauma Association Open Fracture Classification (OTA-OFC) as a Predictive Tool in Open Tibial Shaft Fractures

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Purpose: This study was undertaken to correlate the Orthopaedic Trauma Association Open Fracture Classification (OTA-OFC) with complication rates and to determine if it can be used as a predictive tool in the treatment of open tibial shaft fractures.

Methods: This is a retrospective review from 2 high-volume Level-I trauma centers of open tibial shaft fractures (OTA 42) over a 6-year period. Open fracture characteristics (OTA-OFC) were recorded. Primary outcomes were type of definitive closure, 90-day wound complication rates, need for unplanned return to operating room (OR) within 90 days for wound complication, and nonunion rates.

Results: A total of 538 patients were included for study. 57.4% (n = 309) were closed primarily at index surgery or in a delayed fashion. Local soft-tissue advancement or rotational flap was used in 9.7% (n = 52) while free soft-tissue transfer was used in 22.3% (n = 120). 12 patients (2.2%) had skin grafting while 43 patients (8%) required an amputation. Two patients were treated with wet-to-dry dressings (0.3%). Of those followed for 90 days (n = 454), 41 (9.0%) had a significant wound complication and 38 (93%) of those required an unplanned reoperation. 70% were infections (8 superficial, 21 deep) and 29% (n = 12) were wound dehiscence. All 5 OTA- OFC classification groups significantly correlated with type of definitive closure (r = 0.17-0.78, P < 0.05) with OTA-OFC skin showing the strongest correlation (r = 0.78). OTA-OFC muscle weakly correlated with wound complication (r = 0.10, P = 0.03) and no OTA-OFC classification correlated with need for an unplanned secondary procedure at 90 days. OTA-OFC skin, muscle, and arterial all weakly correlated with nonunion (r = 0.18-0.25, P <0.05). OTA-OFC contamination neared a significant correlation with nonunion (r = 0.125, P = 0.053). Using logistic regression, OTA-OFC muscle was predictive of nonunion in this patient population (odds ratio [OR] = 2.8; 95% confidence interval [CI] 1.6, 4.8). No other OTA-OFC category was predictive of a complication.

Conclusion: Several important findings were identified in our patient population of open tibia fractures. Approximately 10% of open tibial shaft fractures experience a wound complication within 90 days of definitive soft-tissue coverage and the majority of those patients will require a second surgical procedure. The OTA-OFC correlates variably with type of definitive closure, the development of a wound complication, and the occurrence of a nonunion. Importantly, OTA-OFC muscle classification is predictive of the development of nonunion. This information should be used by treating surgeons when counseling patients regarding their risk of complications when diagnosed with an open tibial shaft fracture.

Orthoplastic Reconstruction of Grade IIIB Open Tibial Fractures Using Devitalized Cortical Segments: The Bristol Experience 2014-2018

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Purpose: Type IIIB open tibial fractures are devastating high-energy injuries requiring joint decision-making between orthopaedic and plastic surgeons. At initial debridement, the surgeon will often be faced with large bone fragments with tenuous if any soft-tissue attachments, with convention being that these are discarded to avoid infection. We aimed to determine if orthoplastic reconstruction using mechanically relevant devitalized bone (ORDB) was associated with an increased infection rate in type IIIB open tibial shaft fractures.

Methods: This was a retrospective comparative cohort study of 113 patients, over a 4-year period in a Level- Itrauma center. The primary outcome measure was deep infection rate and the number of operations. The secondary outcomes were nonunion, infection associated flap failure, isolated flap failure, and overall complication rate. A binary logistic regression model was utilized for primary and secondary outcomes. We assumed a priori that P values of less than 0.05 were significant.

Results: Median age was 42.9 years (interquartile range [IQR] 37) with a median follow-up of 1.7 years (IQR 0.9). 44 patients had ORDB as part of their reconstruction, with the remaining 69 not requiring this. Eight patients (8/113, 7.1%) developed a deep infection (ORDB 1/44, non-ORDB 7/69). This was not significant (P = 0.119). The median number of operations was 2. 16 operations (16/223, 7.2%) were reoperations as a result of complications. Two of these operations (2/16, 12.5%) were in patients who underwent ORDB. There was no association between reoperation and ORDB (P = 0.389). There was no significant difference in secondary outcomes between groups.

Conclusion: The data published in this study suggest that mechanically relevant devitalized bone fragments can safely be used in the definitive reconstruction of these injuries when this is undertaken in a single sitting as part of an effective orthoplastic approach.

Perfusion Pressure Lacks Diagnostic Specificity for the Diagnosis of Acute Compartment Syndrome

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Purpose: We evaluate the diagnostic performance of various thresholds of perfusion pressure (PP) using a novel diagnostic reference standard for acute compartment syndrome (ACS).

Methods: 191 patients with high-risk leg injuries were enrolled in a multicenter observational trial designed to validate a clinical decision rule predicting ACS. Each patient had a standardized data set collected prospectively regarding their injury, evolution of symptoms and vital signs (Q4H [every 4 hours]), surgeries, and 6-month outcome. Outcome data included photos and radiographs of the injured limb, SMFA [Short Musculoskeletal Function Assessment] score, and detailed assessment of motor function and sensation. The data also included continuous intramuscular pressure measurement, to which the treating surgeon had been blinded. The diagnostic reference for each patient was the median likelihood of ACS assigned by a panel of 9 experienced orthopaedic trauma surgeons, who independently reviewed each patient's data set and assigned a likelihood of ACS from 0 (no ACS) to 1 (certain ACS). Cases with discordance were reviewed in a meeting of the entire panel, and then patients were rescored. Consensus was not forced. Patients were grouped based on median likelihood ratings into 3 categories: low likelihood (≤ 0.3); uncertain (0.31 to 0.7); and high likelihood (>0.7). Sensitivity analyses were performed using different definitions of likelihood. The diagnostic performance of PP thresholds between 10 and 30 mm Hg were evaluated using the categorization of the panel as the diagnostic standard for each patient. The PP criterion was defined as positive if PP was \leq the specified threshold for at least 2 consecutive hours as proposed in the current literature.

Results: 150 subjects had \geq 2 hours of PP data in at least 1 compartment; 138 were assessed as low likelihood of ACS, 6 as uncertain, and 6 as high likelihood. A PP threshold of 30 mm Hg yielded 65 false positive (FP) cases and 1 false negative (FN) result, with diagnostic sensitivity = 0.83, specificity = 0.53, positive predictive value = 0.07, and negative predictive value = 0.99.Results were similar for other PP thresholds (10, 15, 20, 25 mm Hg) and were insensitive to narrower ranges of low or high likelihood, or when patients were excluded for whom there was less agreement among the panel (those with larger deviations from the median likelihood).

Conclusion: No value of PP had ideal diagnostic performance; each tested threshold had many FP and some FN results. Using PP of \leq 30 mm Hg for >2 hours as a threshold for fasciotomy would have resulted in 47% of the patients with a low likelihood of ACS being treated surgically. These data question published recommendations and suggest the need for further research to develop better diagnostic tests for when to perform fasciotomy.

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Fri., 9/27/19 AM19: Tibia and Knee/Tibial Plateau, PAPER #84

Posterolateral Plating Is a Safe Alternative for the Treatment of Distal Tibia Fractures *Michael Schloss, BA*; Zachary Hannan, BS; Jared Atchison, BS; Syed Muhammad Raza Zaidi, BA; Alexandra Bryn Mulliken; Nathan N. O'Hara, MPH; Jason Warren Nascone, MD; Robert V. O'Toole, MD; Theodore Thomas Manson, MD Shock Trauma Center, Baltimore, MD, United States

Purpose: Distal tibia fractures are typically treated with nails if enough purchase can be obtained, or medial or anterolateral plates for more distal fractures. A less common approach is to plate the tibia posteriorly using an anatomically contoured plate. Although there are theoretical advantages to plating under the robust soft-tissue envelope of the posterior tibia, the outcome and safety of this treatment have not yet been described. We hypothesized that plating the posterior tibia would be associated with an acceptable complication profile.

Methods: 80 consecutive patients with fracture of the distal tibia were treated with an anatomically contoured 3.5-mm T-shaped locking compression plate using a posterolateral approach between January 2008 and April 2018 at a single Level-I trauma center. The mean age of the study group was 47 years (standard deviation [SD]: 15), 63% were male, 49% had open fractures, and 31% were polytrauma patients. 11 fractures were AO/OTA type 42, 24 were AO/OTA type 43A, and 45 were AO/OTA type 43C. 67 patients were treated with an initial spanning external fixator and staged open reduction and internal fixation (ORIF) and the median time in external fixation for these patients was 25 days (interquartile range [IQR]: 15-53). The primary outcome of interest was unplanned reoperation due to hardware failure, nonunion, infection, or hardware prominence.

Results: The overall risk of unplanned reoperation was 17% (13/80). Of the 13 patients who required reoperation, 5 reoperations occurred due to nonunion or malunion (6%), 3 due to infection (4%), 3 due to infected nonunion (4%), and 2 due to hardware prominence (3%). According to the documentation at the follow- up visits, alignment was lost in 2 patients. One patient developed a nonunion in 11° varus and 12° recurvatum, and 1 developed a malunion in 21° varus and 19° recurvatum. Both patients required revision surgery. No plate breakage occurred in any patients during the follow-up period. One patient who required an unplanned reoperation due to infection had a persistent infection before the posterolateral placement of a contoured plate. The median time to reoperation was 221 days (range, 22-436). Only 1 complication, a case of wound dehiscence, was noted due to the posterolateral approach.

Conclusion: Use of a posterolateral approach with a precontoured locking compression T-plate for the treatment of distal tibia fractures led to reasonable outcomes at our institution with an acceptable risk of unplanned reoperation, even with a high proportion of open fractures that were commonly staged with external fixation. Surgeons may consider this as a reasonable treatment option in these difficult patients, particularly in open distal fractures that are difficult to plate from the front due to soft-tissue concerns.

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

Simultaneous Fracture Fixation and Total Hip Arthroplasty for Osteoporotic Acetabular Fractures in the Elderly

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Purpose: Comminuted, displaced acetabular fractures with articular impaction in the elderly osteoporotic population present significant treatment challenges. To allow early postoperative rehabilitation and limit the sequelae of immobility and avoid the risk of posttraumatic degenerative changes, simultaneous fracture fixation and total hip arthroplasty (THA) has been advocated in selected patients. We present a consecutive series of 41 patients treated with simultaneous acetabular fracture fixation and THA and describe their immediate postoperative and most recent clinical and radiographic outcomes.

Methods: 41 consecutive patients between April 2014 and May 2017 underwent simultaneous fracture fixation and THA for acetabular fractures in patients over 60 years. Electronic medical notes were reviewed retrospectively to assess process of care, perioperative physiology, immediate postoperative complications, and mortality. Median follow-up was 30 months (range, 13-57 months). Patient-reported outcomes were assessed at 1 year with Oxford Hip Scores (OHS) and EuroQol-5 Dimensions (EQ-5D) questionnaires. Radiographic assessment was performed at 6 weeks and at 1 year for signs of fracture nonunion and early implant problems.

Results: The median age at surgery was 77 years (range, 57-94), 70% were American Society of Anesthesiologists (ASA) grade III or above. Eight patients (20%) required intraoperative transfusion of packed red blood cells. 21 patients were sitting out in a chair by postoperative day 1, 60% were mobilizing by postoperative day 5, 2 (5.7%) developed an acute kidney injury, 8 (20%) developed new episodes of respiratory signs, 9 (22.5%) experienced transient postoperative cognitive dysfunction, and 2 (5%) were returned to theater within 5 days, 1 with a hip dislocation and 1 with an iliac artery thrombus. There were no postoperative nerve palsies but 1 deep prosthetic joint infection requiring single-stage revision. There were no deaths within 30 days, 3 patients (7%) died within 12 months, and 1 patient died at 23 months. Median OHS at 1 year was 36 (range, 22-47). There were no fracture nonunions and 1 acetabular component had migrated on radiographic follow-up requiring revision.

Conclusion: To our knowledge this study presents the largest consecutive published series of osteoporotic acetabular fractures treated with a fix and replace technique. While simultaneous fixation and THA is conceptually attractive, this medically complex group of patients requires considerable support in the perioperative and immediate postoperative recovery period. Whichever surgical technique is employed it is likely that the perioperative medical support provided plays a significant role in the overall outcome of these patients. Further studies are required to provide clinicians with more information to decide on how best to provide a holistic management strategy for this injury in this frail patient cohort.

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Evaluation of Efficacy of Three-Dimensional Printing Patient-Specific Plates in Treating Acetabular Fractures Involving Disruption of the Quadrilateral Plate

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Purpose: Our objective is to introduce the procedure of design, production, and application of three-dimensional printing patient-specific (3DPPS) Ti-6AI-4V plates in treating complicated acetabular fractures involving disruption of the quadrilateral plate (QLP) and evaluate the efficacy of 3DPPS plates in comparison with the conventional method of intraoperative contouring of reconstruction plates for acetabular fracture fixation.

Methods: From January 2016 to June 2017, 50 patients with acetabular fractures involving disruption of the QLP were included in this study. Patients were divided into 2 groups. Group A contained 15 patients treated with 3DPPS Ti-6Al-4V plates. In Group B (35 patients), the conventional method of shaping reconstruction plates intraoperatively to adapt the fracture region was used. Blood loss, operative time, reduction quality, postoperative residual displacement, and complications were compared between the 2 groups. Reduction quality was measured using criteria described by Matta.

Results: The study showed no significant differences in all preoperative variables (P >0.05). The operative time and blood loss in Group A were decreased compared to Group B; the difference was statistically significant (P<0.05). There was no significant difference in reduction quality between the 2 groups (P >0.05). Reduction quality in Group A was anatomic in 10 (66.7%), satisfactory in 4 (26.7%), and poor in 1 (6.7%). In Group B, quality was anatomic in 18 (51.4%), satisfactory in 13 (37.1%), and poor in 4 (11.4%). Residual displacement in Group A was less than Group B, which was statistically significant (P <0.05). One case in Group A exhibited a loose public screw postoperatively. One case of wound infection, 1 deep

vein thrombosis (DVT) in the ipsilateral lower limbs, 1 traumatic arthritis, and 2 obturator nerve injuries were observed in Group B.

Conclusion: With a 3DPPS Ti-6Al-4V plate, surgeons can simplify the surgical procedure and improve the surgical outcome of complicated acetabular fracture surgery. It is a feasible, accurate, and effective implant for acetabular fracture 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.

Retrograde Transpubic Screw Osteosynthesis: Retrospective Analysis of 158 Fractures *Daniel Wagner, MD*; *Marcus Erich Graafen; Alex Hofmann, MD*; *Pol Maria Rommens, MD University Medical Center Mainz, Department of Orthopedics and Traumatology, Mainz, Germany*

Purpose: Anterior lesions are found in 80% of patients with pelvic ring fractures. Operative stabilization of the anterior ring enhances its stability at about 30%. There is only limited information about clinical outcome and complications using minimally invasive retrograde transpubic screws.

Methods: All consecutive patients treated with a retrograde transpubic screw in a Level-I trauma center from 2003-2017 were included. Patient records and radiographs were studied. Fracture mechanism was classified as high-energy or fragility fracture of the pelvis (FFP). Assessed were: implant loosening, suboptimal positioning, peri-implant infection, hematoma, neurovascular damage, and operative revision. Nonunion was defined as radiographic lack of union after 6 months. Categorical data were compared using χ^2 test; P <0.05 was regarded as statistically significant.

Results: 158 retrograde transpubic screws were implanted in 128 patients; half were in FFPs, half in high- energy trauma. Mean age was 64 ± 21 years, 83 females and 45 males. 63% of the screws ended in the supra- acetabular region. There were 10% early implant-associated complications (suboptimal positioning, peri-implant infection, hematoma); therefore 5% of the screws were revised. There were no neurovascular or urologic complications. After a mean follow-up of 58 weeks, there were signs of loosening in 9%. A nonunion rate of 10% was observed in patients with a minimum follow-up of 6 months; this correlated with a peri-implant infection (P = 0.001), operation >6 months after trauma (P = 0.02), and nonsignificantly with implant loosening (P = 0.076). There was no correlation of nonunion with patient age, the fracture mechanism, or a nonexcellent reduction. In total, 12.5% of the patients were reoperated; in 5.1%, a reosteosynthesis was conducted.

Conclusion: Compared to alternative methods of anterior pelvic ring fixation, retrograde transpubic screws show good clinical results with lower or similar complication rates. Fracture union did not depend on fracture mechanism or age. Hence, this minimal-invasive method is especially attractive in elderly patients with an FFP. Because it is an internal fixation of the superior pubic ramus with relative stability, an anatomic open reduction is not necessary to achieve fracture union.

Outcomes of Single-Stage versus 2-Stage Bilateral Intramedullary Nail Fixation in Patients with Bilateral Femur Fractures

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Purpose: This study aims to evaluate complications in patients with bilateral femur fractures treated with intramedullary nailing (IMN) during either 1 single or 2 separate anesthetic events.

Methods: A multicenter retrospective review of patients with bilateral femur fractures from 1998-2018 was performed at 9 Level-I trauma centers. Patients treated during 1 anesthetic event were classified as the single- stage group and those treated during 2 separate anesthetic events were classified as the 2-stage group. Data collection included patient demographics, injury characteristics, and patient outcomes. Analysis consisted of comparative tests and logistic risk regression.

Results: A total of 227 patients were included, with 170 in single-stage with a mean of 55.0 hours \pm 145.5 (32.7, 77.4) to definitive fixation and 57 in 2-stage with a mean of 165.5 hours \pm 221.0 (106.9, 224.2) to definitive fixation. The 2-stage group had a mean of 74.6 hours \pm 61.8 (66.4, 82.8) between procedures. Age and gender were similar between groups (P = 0.15, 0.21, respectively). Mean ISS was 25.2 and 24.3 in the single- and 2- stage groups, respectively (P = 0.65); head, chest, and abdominal injuries were comparable between groups (P = 0.73), 0.22, 0.67, respectively). Patients in the 2-stage group had a longer hospital length of stay (LOS, 28.8 vs17.0 days; P = 0.01) and ICU LOS (11.9 days vs 7.6 days; P < 0.01). The 2-stage group had higher rates of the following complications: acute respiratory distress syndrome (ARDS) (14.0% vs 6.5%; P = 0.05), rhabdomyolysis (12.3% vs 0%; P < 0.01), inpatient dialysis (8.8% vs 1.2%; P < 0.01), and stroke (8.8% vs 2.4%; P = 0.05). Pulmonary embolism and fat embolism were comparable between the 2 groups (P = 0.38, P = 0.32, respectively). Inhospital mortality was higher in the single-stage group (3.5% vs 1.8%), but not statistically significant (P = 0.68). Early definitive fixation group was at a 72% reduced risk for ARDS when adjusting for age, gender, ISS, GCS (Glasgow Coma Scale), admission lactate, head and chest injury, and institution.

Conclusion: Our study did not demonstrate a difference in pulmonary emboli and fat emboli between the 2 treatment strategies, but that there is increased incidence of ARDS, rhabdomyolysis, stroke, and need for inpatient dialysis in the 2-stage group. This is the largest, multicenter study to date evaluating outcomes between single- and 2- stage IMN fixation for bilateral femur fractures.

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Factors Influencing Management of Bilateral Femur Fractures: A Multicenter Retrospective Cohort of Early versus Delayed Definitive Fixation Ilexa Rae Flagstad, BS; Lauren MacCormick, MD; Melissa White, BA; Austin Heare, MD; Harsh Rajesh Parikh; Jerald Westberg, BA; Tegan Schmidt, BA, BS; Natasha Simske, BS; Alexander Siy, BS; Reuben C. Lufrano, MD; Nichole Shaw, MD; Jason Nadeau, MS; Patrick Taylor Davis, BS; Daniel Connelly, BS; Jared Atchison, BS; Andres F. Rodriguez-Buitrago, MD; Joseph T. Labrum IV, MD; Erik A. Lund, MD; Cyril Mauffrey, MD, MRCS; David J. Hak, MD; Paul S. Whiting, MD; Hassan Riaz Mir, MD, MBA, FACS; Andrew H. Schmidt, MD; Emily Wagstrom, MD; William T. Obremskey, MD, MPH; Robert V. O'Toole, MD; Heather A. Vallier, MD; Brian Cunningham, MD University of Minnesota & HealthPartners, St. Paul, MN, United States

Purpose: This study was conducted to evaluate institutional differences in management of bilateral femur fractures.

Methods: Patients with bilateral femur fractures treated between 1998 and 2018 at 9 Level-I trauma centers were retrospectively reviewed. Patients were grouped into early definitive fixation (DF) or delayed DF, based on whether definitive fixation of both femurs was accomplished before or after 24 hours from injury. Analysis consisted of parametric score selection for reversed logistic regression in predicting utilized treatment strategy.

Results: A total of 313 patients were included; 167 patients were classified as delayed DF and 146 as early DF. Age (P = 0.49) and gender (P = 0.71) were comparable between groups. Patients receiving delayed DF had a higher ISS, lower Glascow coma scale (GCS),

and higher admission lactate (P <0.01); however, treatment strategy differed significantly by institution (P <0.01, Fig. 1). Independent logistic odds models for predicting utilized treatment modality identified institution as most reliable influencer (c-statistics: ISS, 0.63; lactate, 0.64; GCS, 0.63; institution, 0.76). When all variables were evaluated in conjunction, institution remained the strongest contributor (χ 2 statistic: institution, 44.8; ISS, 10.2; lactate, 5.8; GCS, 0.2.

Conclusion: In this study, institution was the strongest predictor of treatment strategy in patients with bilateral femur fractures. This study demonstrates an opportunity to a create standardized care pathway for patients with these injuries.



An Analysis of Bilateral Femoral Shaft Fracture Outcomes Using a Retrospective Cohort From the NTDB

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Purpose: Bilateral femoral shaft fractures are uncommon injuries and have been associated with increased morbidity and mortality relative to unilateral fractures. The current literature includes only small case series, many of which predate modern resuscitation and fixation standards. Our study aim was to document the effect of modernly treated bilateral femur fractures on outcomes using the National Trauma Data Bank (NTDB).

Methods: Patients in the NTDB between the years 2007-2015 who had operatively treated femoral shaft fractures were reviewed. Demographic and injury data were analyzed both collectively, and within subgroups according to age and ISS. Our primary outcome measures were complication rates, hospital length of stay, days in the ICU, days on a ventilator, and mortality rates.

Results: 119,213 patients met the inclusion criteria for this study, of whom 6892 (5.8%) sustained bilateral femoral shaft fractures. Relative to unilateral injuries, bilateral femur fractures demonstrated an increased number of overall complications (0.74 vs 0.50, P <0.0001, confidence interval [CI] 1.234-1.276), longer length of stay (14.3 vs 9.2, P <0.0001, CI 1.0081-1.0083), number of ICU days (5.3 vs 2.4, P <0.0001, CI 1.0166-1.0171), and number of days on a ventilator (3.1 vs 1.3, P <0.0001, CI 1.0127-1.0132). The overall in-hospital mortality rate was 2.4% for bilateral and 1.5% for unilateral fractures (P <0.0001, CI 1.35-1.85). Bilateral femoral shaft fractures were independently associated with longer hospital and ICU stays, and days on a ventilator when matched by similar presenting ISS scores and age (P <0.0001). In all patients, delay in fracture fixation beyond 24 hours was associated with increased mortality (P <0.0001) with each additional day up to the first 3 days. Delay up to the first 6 days was associated with worse outcomes in all other primary measures (P <0.0001 to P = 0.0278).

Conclusion: In addition to overall higher mortality rates, bilateral femoral shaft fractures independently increase the risk for complications, prolonged hospital and ICU stays, and number of days on a ventilator, relative to unilateral injuries, even after matching for age and ISS. Hospital metrics must be adjusted to properly account for the added severity of these injuries and select appropriate scoring systems to reflect the unique physiologic burden of bilateral injuries. Timely definitive fixation is critical in both unilateral and bilateral injuries, as delay is associated with worse primary outcomes and higher mortality rates.

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Does Intramedullary Nail Fixation of the Tibia Pose the Same Risk of Pulmonary Complications as It Does in the Femur? A Propensity Score-Weighted Analysis of 1541 Fractures

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Purpose: A subset of polytrauma patients with femoral shaft fractures are thought to be at risk for poor pulmonary outcomes with initial intramedullary nailing (IMN) and are thus treated initially with "damage control". This concern does not exist for the tibia despite data demonstrating that IMN of the tibia also intravasates marrow that makes its way to the lungs. The aim of this study was to compare the differences in the duration of mechanical ventilation between femur and tibia factures treated with IMN. The secondary aim was to compare differences in the risk of pulmonary complications between the 2 fracture locations.

Methods: This retrospective cohort study was performed at a single Level-I trauma center. Our registry was queried for patients who had undergone IMN of tibial or femoral shaft fractures between January 2008 and September 2014. Those with concomitant tibial and femoral shaft fractures were excluded. Patient demographics and admission data, including ISS, were collected. Ventilator days was the primary outcome. ICU days, tracheostomy, pulmonary embolism (PE), acute respiratory distress syndrome (ARDS), and mortality were secondary outcomes. Propensity score weighting was used to balance baseline covariates for an adjusted analysis. A subgroup analysis included only patients with an ISS >17. A total of 1541 fractures were included (699 tibia and 842 femur). The femur cohort had a lower proportion of male patients, a higher median ISS (14 vs 10; P <0.001), and a greater proportion with a thoracic abbreviated injury scale (AIS) >2 (36% vs 25%; P <0.001) compared to the tibia. There was no difference in age. The subgroup of patients with an ISS >17 included 577 patients (219 tibias and 358 femurs).

Results: In the unadjusted analysis, femur fractures had an increase in ventilator days (1.4 days; P <0.001), ICU days (1.8 days; P <0.001), and tracheostomy (odds ratio [OR]: 1.7; P <0.01). There was no difference in the rate of PE, ARDS, or mortality (OR: 1.2, 1.6, and 1.2; P >0.2). In the propensity score-adjusted estimates, there were no differences in any of the measured outcomes (P >0.40). In polytrauma patients we found no difference in the length of ventilator or ICU days, or the risk of tracheostomy, PE, ARDS, or mortality in the unadjusted (P >0.2) or propensity score-weighted estimates (P >0.3).

Conclusion: The findings are surprising and suggest that IMN fixation of the tibia in polytrauma patients may have a similar increased risk of poor pulmonary outcomes as femoral nailing, after adjustment for important covariates linked to poor pulmonary outcomes. Clinicians should consider that tibial nailing may also have vital consequences on lung function and future clinical study is needed to further verify this hypothesis.

The Effect of Time to Irrigation on the Rate of Reoperation in Open Fractures: A Propensity Score-Based Analysis of the Fluid Lavage of Open Wounds (FLOW) Study Herman Johal, MD; Daniel Axelrod, MD; Sheila Sprague, PhD; Brad Petrisor, MD; Sofia Bzovsky; Mohit Bhandari, MD, FRCSC, PhD Hamilton General Hospital, Hamilton, ON, Canada

Purpose: This study was conducted to determine if a relationship exists between timing of wound irrigation and debridement (I+D) and subsequent reoperation rate for infection or healing complications within 1 year for patients with open extremity fractures requiring surgical treatment.

Methods: This was a secondary analysis of a randomized controlled trial. Propensityadjusted regression allowed for a matched cohort and adjusted analysis within the study population to determine if time to I+D put patients independently at risk for reoperation, while controlling for injury, patient, and treatment-related confounding factors.

Results: For the unadjusted analysis, the proportion of patients requiring reoperation did not differ between early and late I+D groups. Prior to matching, the patients managed with early I+D had a higher proportion requiring reoperation for infection or healing complications (17.0% vs 12.8%; odds ratio [OR] 0.72, 95% confidence interval [CI] 0.54 to 0.94, P = 0.02). Similarly, when analyzed as a continuous variable each hour of delay was associated with a decrease in unplanned reoperation for infection or wound healing complication (OR 0.97, 95% CI 0.95 to 0.99, P = 0.004). However this does not account for selection bias of more severe injuries preferentially being treated earlier. In the propensity-matched cohort (n = 764), reoperation rates did not differ between early and late groups (16.1% vs 16.6%; OR 0.71, 95% CI 0.47 to 1.07, P = 0.10). When analyzing time as a continuous variable, there was still no association between time and unplanned reoperation (OR 0.99; 95% CI 0.97 to 1.02, P = 0.71).

Conclusion: When accounting for patient, injury, and treatment-related factors, delayed I+D for open fractures does not independently increase the risk of unplanned reoperation for infection or wound-related complications.

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Predicting Mortality After Trauma Using Electronic Medical Record Data: A Retrospective Analysis at a Level-I Trauma Center

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Purpose: The timing of fracture fixation in polytraumatized patients has been an evolving concept. Conventional methods to determine patient stability and resuscitation status rely on a subjective interpretation of vital signs and laboratory values, with the intent of guiding clinical decision-making and the decision to use damage control versus early definitive fixation principles. Prior multivariate models have tried to use this physiologic data to predict mortality risk and therefore guide treatment, but due to a number of limitations, they have not proven clinically useful. The purpose of our study was to use electronic medical record (EMR) data and machine learning techniques to develop an automated algorithm that predicts 48-hour mortality in polytraumatized patients during the first 72 hours of their hospitalization.

Methods: The PolyTrauma Early Mortality Model (PTEMM) is a machine learning algorithm that uses EMR data to predict 48-hour mortality during the first 72 hours of hospitalization. The model updates every 12 hours, evolving with the patient's physiologic response to trauma and ongoing resuscitation. The model was developed and trained on 4567 hospitalized polytrauma patient encounters from 2009-2014 and was tested on 484 encounters from 2015-2016. Area under the receiver operating characteristic curve (ROC), sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and positive and negative likelihood ratios (LRs) were used to evaluate model performance.

Results: The PTEMM accurately predicted 52 of the 56 12-hour time intervals within 48 hours of mortality, for a sensitivity of 92.8% (95% confidence interval [CI] 82.7%-98.0%). The specificity was 92.2% (95% CI 90.8%-93.6%), and the PPV was 31.7% (95% CI 27.7%-36.0%). The model predicted survival for 1342 time intervals and was incorrect 4 times, yielding an NPV of 99.7% (95% CI 99.2%-99.9%). The positive LR was 12.0 (95% CI 9.9-14.6), and the negative LR was 0.08 (95% CI 0.03-0.20). The area under the ROC curve was 0.96 (95% CI 0.94-0.97). Model performance was stable over the first 72 hours of hospitalization.

Conclusion: Prior mortality risk models have provided only a vague, static prediction of in-hospital mortality that is impractical to use in the clinical setting. By relying only on EMR data to provide an automated risk that evolves with the patient's physiologic response to trauma, the PTEMM overcomes many of the limitations of prior models. The PTEMM provides the clinician with a more clearly defined description of mortality risk and therefore may prove to be a useful tool to augment clinical decision-making for polytrauma patients early in their hospitalization.

Posterior Sternoclavicular Dislocation: Do We Need "Cardiothoracic Backup"? Insights From a National Sample

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Purpose: Posterior sternoclavicular dislocation (P-SCD) is an uncommon injury without evidence-based guidelines for management. Case reports warn of its association with catastrophic vascular injury but the true incidence is unknown. Many authors advise closed or open reduction with "Cardiothoracic Backup," which is vaguely defined and costly. Here we use the Healthcare Cost and Utilization Project's Nationwide Inpatient Sample (HCUP-NIS) to determine risk factors for vascular injury associated with P-SCD and guide resource utilization.

Methods: We used data from the HCUP-NIS from 2015-2016 and defined a cohort of patients with SCD using ICD-10-CM diagnosis codes. We then further isolated a subset with P-SCD. We describe the incidence of thoracic vascular injury, demographics, and ISS in this cohort.

Results: Of an estimated 550 patients who had a sternoclavicular dislocation, 140 (25%) were identified as having a P-SCD. No vascular injuries occurred in the P-SCD cohort. Among all patients with SCD <2% of patients had a vascular injury, all of whom had an ISS >16, independent of the SCD or the vascular injury itself (Fig. 1). Among patients with an isolated P-SCD injury (55), overall length of stay was 1.8 days and total charges averaged \$29,724.45. There was no mortality among patients with isolated P-SCD.

Conclusion: Here we report no vascular injuries in the largest known series of P-SCD. Among all patients with SCD, vascular injury was rare, occurring only in severely polytraumatized patients. The recommendation for routine involvement of cardiothoracic surgeons in all cases of P-SCD should be re-examined.



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The Rate of Mediastinal and Vascular Injury Following Acute Posterior Sternoclavicular Dislocation: A Multicenter Study

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Purpose: Acute posterior sternoclavicular dislocations (APSCDs) are rare injuries, historically with concern for injury to the great vessels/mediastinal structures from initial trauma or subsequent treatment. Orthopaedic texts, conferences, and journal articles often cite the need for a vascular surgeon to be present/available during the surgical treatment of these injuries. To our knowledge, however, there are no large studies characterizing the rate of injury to vascular and mediastinal structures with APSCD. The purpose of this study was to characterize the rate of vascular injury with APSCD in a large multicenter cohort.

Methods: Following IRB approval, records of skeletally immature patients (\leq 25 years) treated for APSCD were retrospectively identified and collected from each participating center. Patient demographic information, injury mechanism, associated mediastinal injuries, and need for vascular/general surgery intervention were recorded. Mediastinal structures that were injured or compressed by mass effect were specifically characterized by review of preoperative CT imaging. Statistical comparisons were done using Student t tests, with P values <0.05 considered significant.

Results: We identified 127 patients (87% male) with a mean age of 14.7 years (range 5-22 years). APSCD was most commonly the result of a sporting injury (96, 76%), with patients also commonly sustaining injuries resulting from same-level falls (13, 10%) and high-energy motor vehicle trauma (13, 10%). The most common findings on CT imaging were compression of the subclavian or brachiocephalic veins (46, 38%). Associated injuries, including clavicle shaft fractures, pulmonary contusions, humerus fractures, and rib fractures were documented in a minority of patients. 11 patients had successful closed reduction, and 2 were treated with observation. 114 patients underwent open reduction and internal fixation, with 25 failed or unstable closed reductions preceding open treatment. Vascular or general surgery was documented as available for 85 procedures (67%). There were no instances of vascular or mediastinal injury during reduction or fixation requiring intervention.

Conclusion: In this multicenter series of 127 APSCDs, which is the largest in the literature to date, no injuries to the great vessels/mediastinal structures requiring intervention were identified. While this study suggests vascular injuries following APSCD are quite rare, vascular complications are catastrophic when they do occur. Treating providers should consider these data and their own institutional resources to maximize patient safety during the treatment of APSCD.

PAPER ABSTRACTS

Fri., 9/27/19 AM19: Hip/Femur, PAPER #96

Cerclage Wire Adjunct in Traumatic Femoral Fracture: A Comparison of Union, Complication, and Reoperation *Lance Glen Jacobson, MD*; Kathy J. Flint, MS; Ryan Beeker; Shreya Sanjay Veera, BS; Michael K. Savaglio, MS; Timothy G. Weber, MD St. Vincent Hospital, Indianapolis, IN, United States

Purpose: The purpose of this study was to compare the results of fractures of the femur in which the reduction was assisted with the use of cerclage wire(s) to those femoral fractures treated with closed, indirect reduction. The primary outcome was fracture union. Secondary outcomes included complication or reoperation.

Methods: We performed a retrospective observational study which included 236 lower extremity traumatic fractures (31A-33C) in adults at a Level-I trauma center. Study (cerclage) and control groups were age, sex, and fracture-matched for comparison. Fractures were treated with intramedullary nailing or plate fixation based on surgeon judgement. Chart and radiographic reviews were used to determine union and any return to surgery. Patients lacking a minimum of 9 months follow-up were excluded in order to capture the most accurate potential union and reoperation numbers. Quality of reduction was measured by an independent observer using3 parameters: (1) <10°of angulation in orthogonal radiographic views, (2) <5 mm of displacement between the major fracture fragments, and (3) <5 mm of gap between the major fracture fragments. A good reduction was one that met all 3 criteria, an acceptable reduction met 2 criteria, and a bad reduction met 1 or none of the criteria.

Results: Patients operated using cerclage had no significant difference in final union rates (P = 0.749), wound complication (P = 1.000,) or hardware removal for pain (P = 0.6218). Overall reoperation rates were 9.3% (cerclage) and 17.8% (non-cerclage). Nonunion / fixation failure requiring additional surgery was significantly higher in the non-cerclage group (P = 0.0263). In this study patients were 3.14 times more likely to have a nonunion or fixation failure if cerclage was not used. Furthermore, there was a significantly higher proportion of good (n = 92) (P < 0.0001) or good / acceptable (n = 116) (P < 0.0001) quality reductions than bad (n = 2) using cerclage, resulting in a patient being 13.29 times more likely to have a bad quality reduction when cerclage was not used.

Conclusion: Despite long-standing beliefs that cerclage wire may result in prevention of callus formation and inhibition of local blood supply, our study suggests that in the long bone fracture population cerclage may actually assist with union. Finally, cerclage did not result in any additional wound or hardware removal complications and had a lower reoperation rate.

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Subtrochanteric Fractures: Does Open Reduction Increase the Risk of Infection and Fracture Healing Complications?

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Purpose: The aim of our study was to investigate if open reduction of fractures involving the subtrochanteric region resulted in a higher incidence of infection and fracture healing complications.

Methods: Following IRB approval, all consecutive patients presenting with a fracture involving the subtrochanteric region were retrospectively identified (January 2009-December 2016). Exclusion criteria included patients undergoing their primary operations at other institutions and patients lost to follow-up.

Results: 560 patients fulfilled the eligibility criteria and were included in the study. 261 patients had an open reduction of their fracture. The mean age of this group was 70.48 years (SD [standard deviation] 21.00), 139 were female, mean ASA (American Society of Anesthesiologists) was 2.70 (SD 0.90), and 22 patients had an ISS >16. Time to operation was 1.93 days (SD 2.01), duration of operation was 126.67 min (SD 44.43), the grade of senior surgeon in theaters was a consultant in 131 cases and length of hospital stay (LOS) was 21.89 days (SD 18.76). 299 patients on the other hand were managed with a closed reduction, with a mean age of 75.31 years (SD 17.14), while 203 were female, mean ASA was 2.75 (SD 0.79) and 14 patients had an ISS >16. Time to operation was 2.25 days (SD 2.89), duration of operation was 97.38 min (SD 37.54), grade of senior surgeon in theaters was a consultant in 123 cases and LOS was 22.75 days (SD 19.34). 16 patients from the open reduction group and 19 patients from the closed reduction group died before discharge from hospital. When we compared the 2 groups, statistically significant differences were identified in age (P =(0.003), gender (P = 0.001), fracture classification as per AO (P = 0.005), duration of operation (P < 0.001), and grade of senior surgeon (P = 0.035), whereas these groups where otherwise comparable. Regarding the incidence of infection, in the open reduction group there were 17 patients diagnosed with deep and 28 patients with superficial infections, compared to 3 and 4 patients, respectively, in the closed reduction group (P < 0.001). Moreover, there were 29 patients in the open reduction group and 26 patients in the closed reduction group diagnosed with a nonunion (P = 0.320). Further linear regression analysis of the factors contributing to risk of infection identified only open reduction as being statistically significant, having an odds ratio (OR) of 4.60 (confidence interval [CI]: 1.87- 11.30). On the contrary, no factor was identified to be contributing to the risk of fracture healing complications (delayed or nonunion).

Conclusion: This study demonstrates that the single predictive factor of infection following intramedullary nailing of subtrochanteric fractures is need for open reduction (OR 4.60). Open reduction, however, is not associated with an increased risk of delayed/nonunion, but it is associated with increased operating times, which may reflect a more complex fracture pattern.

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OTA Humanitarian Scholar Presentation

SIGN Intramedullary Nailing Improves Early Postoperative Quality of Life and Function as Compared to Skeletal Traction for Management of Femoral Shaft Fractures in Malawi

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Purpose: Femoral shaft fractures cause significant morbidity in low- and middle-income countries (LMICs). Intramedullary (IM) nailing, the gold standard treatment in developed countries, remains underutilized in LMICs such as Malawi given limited expertise and availability of fluoroscopy. Although technology permitting image- unassisted IM nailing is now available in LMICs, skeletal traction remains the standard of care. This prospective study aimed to compare postoperative quality of life, functional outcomes, and radiographic healing between patients treated with SIGN (Surgical Implant Generation Network) IM nailing (IMN) and skeletal traction (ST) in Malawi.

Methods: Adults with femoral shaft fractures (AO/OTA 32A-C) were enrolled from March 2016 to July 2018 at 2 central and 3 district hospitals in Malawi. Patients were managed by image-unassisted IMN (SIGN) or ST, as determined by their treatment team. Baseline demographics, injury, and treatment characteristics were recorded on enrollment. Patients were followed up at 6 weeks and 3, 6, and 12 months postoperatively. Quality of life was assessed via EuroQol-5 Dimensions (EQ-5D), functional status via Short Musculoskeletal Function Assessment (SMFA), and radiographic healing by mRUST (modified radiographic union in tibial fractures) score.

Results: Of 270 enrolled patients (IMN 111, ST 159), there were no differences in baseline characteristics (P>0.05). EQ-5D-assessed quality of life (minimum clinically important difference [MCID] = 0.10) was decreased in patients treated with skeletal traction versus IMN at 6 weeks (0.28 vs 0.49, P <0.001) and 3 months (0.63 vs 0.72, P = 0.016) postoperatively but comparable at 6 months (0.81 vs 0.82, P = 0.70). Functional status as assessed by SMFA Function and Bothersome indices (MCID = 4) was likewise worse in patients treated with traction versus IMN at 6 weeks (Function 52.2 vs 41.6, P <0.001; Bothersome 50.4 vs 39.6, P <0.001) and 3 months (Function 35.5 vs 27.5, P = 0.001; Bothersome 33.1 vs 26.0, P = 0.01). SMFA Function but not Bothersome index was worse in skeletal traction patients at 6 months (Function 21.5 vs 15.2, P = 0.01; Bothersome 19.2 vs 15.0, P = 0.16). There was no difference between cohorts in mRUST score at any time point (P >0.05). There was no difference in the rate of reoperation (IMN: 1.4% vs ST: 1.8%, P = 0.77), nonunion (IMN: 0.4% vs ST: 1.4%, P = 0.21), or leg-length discrepancy (IMN: 36% vs ST: 38%, P = 0.66) between groups at 6 months.

Conclusion: Quality of life and function were significantly improved in the early postoperative period in patients with femoral shaft fracture treated with image-unassisted IMN, as compared to ST. By final follow-up, there was no difference in quality of life or function between groups, and radiographic healing was similar.

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Improving the Diagnosis of Ipsilateral Femoral Neck and Shaft Fractures: A New Imaging Protocol

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Purpose: Despite increased awareness of ipsilateral femoral neck and shaft fractures in patients with high- energy injuries, the misdiagnosis rate remains 6%-22%. The purpose of this study was to determine if the diagnosis of ipsilateral femoral neck fractures in patients with high-energy femoral shaft fractures can be improved with MRI compared to radiographic and CT imaging.

Methods: Beginning in September 2018, the imaging protocol for acute high-energy femoral shaft fractures was altered to include rapid-sequence MRI of the pelvis and the proximal femurs to assist in diagnosing acute ipsilateral femoral neck fractures. All patients with acute high-energy femoral shaft fractures received standard radiographic imaging as well as thin-cut pelvis CT imaging at the time of presentation. These patients were then placed in skeletal traction, and rapid-sequence MRI of the pelvis was obtained. The primary sequences for evaluation of proximal femur fractures were confined to a large field of view coronal T1 and coronal STIR (short-tau inversion recovery). These are limited short sequences, which take less than 10 minutes.

Results: During the 4-month study period, 37 consecutive patients presented with 39 acute, high-energy femoral shaft fractures. The average patient age was 29.1 years (range, 14-82), and 28 patients were male while 9 were female. 10 of 39 (25.6%) femoral shaft fractures were open. Two femoral shaft fractures (5.1%) had ipsilateral femoral neck fractures detected on radiographs. Of the remaining 37 femoral shaft fractures, none had a femoral neck fracture definitively identified on thin-cut CT imaging. 33 of 37 (89%) underwent large field of view pelvis and proximal femur MRI to evaluate the ipsilateral femoral neck. Four patients (12.1%) were diagnosed with a femoral neck fracture, not identified on CT or radiographic imaging. Two of these were complete and 2 were incomplete femoral neck fractures. In all 4 of these patients, the operative plan and rehabilitation protocol was changed based on these findings.

Conclusion: Based on a change in imaging protocol to include MRI for evaluation of ipsilateral femoral neck fractures in acute high-energy femoral shaft fractures, our early results suggest the number of femoral neck fractures may be underrepresented compared to radiographic and CT imaging alone. Importantly, due to the rapid sequences used for the MRI, we were able to obtain this imaging in a high percentage of polytrauma patients without altering their overall care. This new imaging algorithm will continue to improve our diagnosis of ipsilateral femoral neck and shaft fractures and optimize the care of patients with high-energy injuries.

The Effect of Intramedullary Nail Entry Point on Postoperative Femoral Shaft Fracture Alignment

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Purpose: Intramedullary femoral nailing technique has evolved and improved since its development in 1939. However, postoperative malalignment continues to be a known complication. The purpose of this study is to determine if there is a postoperative alignment advantage with femoral nail entry point and to determine if fracture location and fracture pattern secondarily affect alignment.

Methods: A retrospective radiographic review was performed from a university hospital database of 530 patients with 552 femoral shaft fractures (AO/OTA 32A1-32C3) treated with intramedullary nailing from October 2007 to November 2018. Three orthopaedists and 1 radiologist independently measured radiographic femoral alignment using immediate postoperative radiographs. Postoperative malalignment was defined as >5° of angulation in any plane. The differences in alignment were assessed based on femoral nail entry point (trochanteric, piriformis, or retrograde), fracture pattern, and fracture location.

Results: The primary independent risk factors for postoperative malalignment in femoral shaft fractures were proximal fracture location and 32C3 fragmentary segmental fractures. In proximal femoral shaft fractures, the overall malalignment percentage was 28.1% (relative risk: 1.74, P = 0.0015). Use of a piriformis entry nail significantly decreased the rate of postoperative malalignment. In proximal femur fractures treated with piriformis entry nails, only 4% were malaligned, whereas 39% of proximal femur fractures treated with trochanteric entry nails were malaligned (relative risk: 0.14, P = 0.048). Regardless of fracture location, 32A3 fractures had the lowest rate of postoperative malalignment of 5.8% (relative risk: 0.36, P = 0.0044) and 32C3 had the highest rate of 27.5% (relative risk: 1.71, P = 0.0095). In the combined fracture location and stability subgroup, midshaft femur fractures with stable fracture patterns (32A1, 32A2, and 32A3 subtypes) had the lowest rate of postoperative malalignment of 6.8% (P = 0.0071).

Conclusion: Piriformis entry femoral nails may provide an alignment advantage for proximal third femoral shaft fractures as the central and posterior entry point counteracts the characteristic proximal femur deforming forces and there is no proximal lateral bend in the nail. Proximal third and 32C3 segmental type femoral shaft fractures provide an alignment challenge, and increased care should be taken to evaluate intraoperative femoral shaft alignment with these fracture types.

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Radiostereometric Analysis of Inducible Micromotion After Locked Lateral Plating of Distal Femur Fractures

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Purpose: The aim of this study was to evaluate interfragmentary motion throughout the course of healing for distal femoral fractures using radiostereometric analysis (RSA) to determine if RSA is a viable technique for assessing nonun α ion.

Methods: 16 patients with operatively treated distal femur fractures were enrolled into a prospective study. Sample size was determined based on a nonunion rate of 10%, which would allow the detection of a 0.09-mm difference between the groups at (power = 0.9; α <0.05). Six tantalum beads were inserted in the most proximal and distal fracture fragments intraoperatively. Patients were evaluated postoperatively and at 2, 6, 12, 26, and 52 weeks from surgery. Two set of RSA radiographs were taken: (1) non-weighbearing and (2) with up to 30 lb of weight on the extremity in the axial plane. At each visit, a comparison between the radiographic sets was used to measure inducible micromotion. In addition, at each visit, patients completed the Patient-Reported Outcomes Measurement Information System (PROMIS) assessment of pain and function.

Results: 14 cases presented with evidence of progressive fragment bridging and improved symptoms at 26 weeks. For these cases of suspected union, inducible micromotion had decreased between 2 and 12 weeks (<0.001) and then remained constant over time (P >0.492). Patient-reported pain and functional improvements paralleled the decreasing inducible micromotion through the course of the study (Fig. 1). Two cases (12.5%) proceeded to nonunion. In contrast with the cases of union, RSA for the cases of nonunion revealed no decrease in inducible micromotion by the 12-week visit (P >0.191). At 12 weeks, nonunion cases demonstrated greater inducible micromotion in the proximodistal plane compared to the cases of union (mean difference: 0.17 mm (±0.05); P <0.001).

Conclusion: Fracture healing may be evaluated with RSA, which reveals differences in micromotion patterns between the cases of union and nonunion within 12 weeks of surgery.



Optimal Configuration of Internal Fixation Implants During Operative Management of Hip Fractures

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Purpose: Numerous technical factors have been thought to be associated with improved outcomes after femoral neck fracture fixation. Using data from a multicenter trial of femoral neck fracture patients aged ≥50 years who underwent internal fixation with cancellous screws (CS) or a sliding hip screw (SHS), we evaluated which technical factors were associated with: (1) revision surgery within 24 months to promote fracture healing, relieve pain, treat infection, or improve function; (2) functional health, as defined by the Short Form-12 (SF-12) Physical Component Summary (PCS); and (3) hip function, as defined by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Methods: We performed a multivariable Cox regression using revision surgery as the dependent variable and technical factors as independent variables. We adjusted for fracture displacement as it had been predictive of revision surgery previously. Separate analyses were conducted for CS and SHS groups. We performed multilevel, repeated-measures mixed models with 3 levels (center, patient, and time), with patient and center entered as random effects. For both CS and SHS models, we used SF-12 PCS and WOMAC scores as dependent variables (1 for each model). We included technical factors and time of assessment as independent variables in fixed effects. Preinjury scores and several prognostic variables were adjustment variables. All tests were 2-tailed with $\alpha = 0.05$. For CS models, we included screw (or pin) diameter, use of partially threaded screws with short or long threads, screw formation, screw (or pin) orientation, and use of washers as technical factors. For SHS models, we included screw position, number of holes in sideplate, use of a bicortical sideplate, use of supplemental screws, and final tip-apex distance as technical factors.

Results: Complete data were available for 459 (mean age: 72.8 years; 66% female) and 504 (mean age: 73.0 years; 64% female) patients to perform revision surgery analyses in CS and SHS groups, respectively. For the health-related quality of life (HRQL) analyses, complete data ranged between 288 and 303 patients per group (mean age: 71.1 years; 65% female). In the CS model, a 3-screw (apex at bottom) formation was associated with a significantly lower risk for revision surgery as compared to a 2-screw formation (hazard ratio 0.47, 95% confidence interval 0.24-9.35; P = 0.03). Regardless of treatment group, no other technical factors were found to be predictive of revision surgery and HRQL (P > 0.05).

Conclusion: Other than a 3-screw (apex at bottom) formation, there was no optimal configuration of internal fixation implants associated with reduced revision surgery and improved HRQL outcomes after femoral neck fracture fixation. Patient and injury factors such as age, gender, and fracture displacement play a more significant role in outcomes than technical aspects of fracture fixation.

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A Pilot Feasibility, 2 x 2 Factorial Randomized Controlled Trial Comparing the Sliding Hip Screw versus Cancellous Screws and Vitamin D3 versus Placebo for the Treatment of Young Femoral Neck Fractures

FAITH-2 Trial Investigators

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Purpose: The treatment of young femoral neck fractures remains controversial because the optimal internal fixation implant is unknown and the implications of treatment failures can profoundly impact functional outcome. Additionally, the use of adjuvant vitamin D3 supplementation to improve outcomes after fracture remains unproven. The purpose of this trial was to determine the feasibility of a definitive multicenter randomized controlled trial comparing the sliding hip screw (SHS) and cancellous screws (CS), and vitamin D3 versus placebo for the treatment of femoral neck fractures in young patients.

Methods: Adult femoral neck fracture patients ages 18-60 yearswere enrolled from 15 North American hospitals. A 2 x 2 factorial design was used to randomly allocate patients to SHS or CS and to vitamin D3 4000 IU or placebo daily for 6 months. The primary outcome was trial feasibility, defined by measures of recruitment, medication adherence, and data quality. The secondary outcome was a composite outcome of clinically important complications, including reoperation, nonunion, osteonecrosis, and fracture shortening >1 cm.

Results: We randomized 91 patients over a 4-year period, and 86 participants were included in the analysis. The mean age of participants was 41.1 years (standard deviation 12.4). 71% of fractures were displaced and 44% were vertical Pauwels 3 patterns. The primary feasibility criteria were not achieved due to slow enrollment and low vitamin D adherence, with only 55% of participants taking \geq 75% of their daily supplement. 14 patients in the CS group (33%) and 11 patients in the SHS group (26%) experienced the composite complication outcome; reoperations accounted for 7 (16%) CS events and 9 (21%) SHS events. There were 3 conversions to total hip arthroplasty (THA) in the SHS group and 1 conversion to THA in the CS group. There were 2 cases in the CS group (5%) and 1 case (2%) in the SHS group of isolated femoral neck shortening >1 cm that did not result in femoral head osteonecrosis or a reoperation. A composite complication occurred in 14 patients (35%) in the placebo group and in 11 patients (24%) in the vitamin D group. There were no vitamin D-related adverse events reported.

Conclusion: This pilot study was unable to demonstrate the feasibility of a definitive trial. The adherence with daily vitamin D3 supplementation is low among young femoral neck fracture patients and is unlikely to be an effective method of supplementation. Overall, >25% of young femoral neck fracture patients experience complications of their injury.

Intramedullary versus Extramedullary Fixation for Basicervical Femoral Fractures: Which Is Better?

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Purpose: Basicervical femoral fractures (BCFs) (AO classification: 31B3) are a rare type of hip fracture and the optimal choice of fixation is unknown. Our primary objective was to determine whether an extramedullary fixation with the dynamic hip screw (DHS) or an intramedullary fixation with the proximal femoral nail antirotation (PFNA) would provide a better fixation. Our secondary objective was to compare the outcomes of these 2 fixation methods. We hypothesized that the PFNA would cause a "wedge effect," described as a medial displacement with a resultant varus neck-shaft angle (NSA), and therefore have worse outcomes.

Methods: All BCF fixations with the DHS and the PFNA over 5 years were reviewed. The NSA before and after insertion of the implants were measured from the intraoperative imageintensifier and compared. The images were also reviewed for adequacy of fracture reduction, any intraoperative loss of reduction, and whether there was any qualitative change in the NSA after the insertion of the implants. Outcomes compared were the Modified Barthel Index (MBI) at 1 year postsurgery and complications.

Results: 49 BCFs were identified from 2745 hip fractures in the institution's hip fracture registry. 31 DHS and 18 PFNA fixations were performed. The mean age was similar in both groups (79.1 \pm 9.4 vs 81.3 \pm 8.4, P = 0.420). The distribution of gender (81% vs 61% female, P = 0.135), laterality (52% right vs 72% left, P = 0.157), bone mineral density (T-scores: $-3.3 \pm$ 1.0 vs -3.4 ± 0.9 , P = 0.926), and the NSA before the insertion of implants were also similar $(137.2^{\circ} \pm 5.1^{\circ} \text{ vs } 134.8^{\circ} \pm 5.6^{\circ}, P = 0.191)$. The preoperative MBI was significantly higher in the DHS group (92.8 \pm 11.5 vs 76.6 \pm 31.6, P = 0.019). The NSA after the insertion of the DHS was significantly larger than the PFNA group ($138.7^{\circ} \pm 5.1^{\circ}$ vs $133.6^{\circ} \pm 5.6^{\circ}$, P = 0.003). The mean NSA increased with the DHS but decreased with the PFNA ($1.6^{\circ}\pm 2.3^{\circ}$ vs -1.2° \pm 2.3°, P <0.001). The NSA after fixation was significantly different from the NSA before fixation in both groups (P = 0.001 and P = 0.035). There was no significant difference in the proportion of patients with adequate reduction (80.6% vs 66.7%, P = 0.272), intraoperative loss of reduction (25.8% vs 38.9%, P = 0.338), and qualitative change in the NSA after the insertion of the implant (9.7% vs 0%, P = 0.288). At 1 year postsurgery, the MBI had reduced significantly in both groups (P < 0.001 and P = 0.002) but remained higher in the DHS group $(83.5 \pm 21.4 \text{ vs } 72.5 \pm 25.0, P = 0.025)$. However, the mean change in MBI over the year was similar between both groups (-9.3 ± 21.1 vs -4.1 ± 23.2 , P = 0.670). The DHS group had no complications while there was 1 patient in the PFNA group with a peri- implant infection. The complication rates were similar (P = 0.367).

Conclusion: In BCFs, fixation with the DHS increased the NSA while the PFNA caused a wedge effect. However, the 1-year clinical outcomes were similar.

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The Efficacy of Antibiotic Strategies Employed at the Time of Definitive Wound Closure/Coverage for Severe Lower-Extremity Injuries

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Purpose: There are currently no guidelines to assist with the selection and duration of antibiotics used at the time of definitive wound closure/coverage in severe injuries to the lower extremity. Wound bioburden surveillance and targeted antibiotic therapy is not current practice. This study was designed to evaluate the clinical efficacy of the antibiotic therapy employed at the time of definitive wound closure/coverage in patients with severe lower-extremity injuries.

Methods: 655 patients were prospectively enrolled from 39 centers into a study of the wound bioburden in severe lower-extremity injuries that required either delayed wound closure or flap coverage. At the time of definitive coverage/closure, wound tissue samples were collected and processed at a central microbiology laboratory. We captured the antibiotic types and the dose and duration strategy in the wound coverage/closure perioperative period. An expert infectious disease panel evaluated each patient with a positive wound culture. Based on the bacteria recovered and the antibiotics provided, each patient's therapy was rated as: inefficient, possible effective, or effective for the treatment of the wound bioburden.

Results: Tissue cultures from 195/655 patients (29.8%) were positive at the time of definitive coverage/closure. Recovered organisms included staphylococcus (30.8% overall; CONS [coagulase-negative staphylococci], 27.2%; MSSA [methicillin-sensitive Staphylococcus aureus], 3.1%; MRSA [methicillin-resistant S. aureus], 1.5%), enterobacter (18.5%), and enterococcus (11.8%). The most common antibiotic strategy for this cohort was either Ancef alone (43.1%) or Ancef in combination with gentamycin, tobramycin, or vancomycin (14.4% combined). The expert infectious disease panel rated 111 of 195 cases (56.9%) as having an ineffective antibiotic exposure, 64/195 (32.8%) as having possibly effective exposure, and 20/195 (10.3%) as effective exposures. Of the 20 effective exposures, 3 (15.0%) developed a subsequent deep infection. Of the 64 possibly effective exposures and the 111 ineffective exposures, 14 (21.9%) and 28 (25.2%) developed a subsequent deep infection, respectively.

Conclusion: 57% of the antibiotic therapies administered in this study at the time of wound coverage / closure were likely ineffective against the recovered wound bioburden. The data show a trend toward increasing deep infection rates with less effective antibiotic exposure. Future therapies likely need to target the wound bioburden.

Single-Dose IV Antibiotic for Low-Energy Extremity Gunshot Wounds: A Prospective Quality Improvement Care Pathway

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Purpose: Low-energy gunshot wounds (GSWs) are common, and no established standard of care exists for infection prophylaxis. Recent data have demonstrated efficacy of a single dose of intravenous (IV) antibiotics in the emergency department (ED) for infection prophylaxis. We implemented a care pathway to standardize antibiotics after low-energy isolated extremity GSWs. A single dose of cefazolin is administered (clindamycin for penicillin allergy), and tetanus immunization status is updated. The purpose of this project isto describe our results after implementation.

Methods: All patients presenting with GSW to our trauma center over 35 months were prospectively assessed; 87 with subacute presentation and 478 with GSW to nonextremity regions were excluded. High-energy injuries (n = 7), injuries from BB guns (n = 6), graze wounds (n = 8), and injuries requiring revascularization (n = 39) were excluded. Patients with fracture undergoing fixation (n = 51) received a single dose in the ED plus an additional 24 hours of perioperative antibiotics. No antibiotics were prescribed subsequently. Infection and administration of subsequent antibiotics were recorded.

Results: 1197 patients presented with GSWs; 572 had isolated, low-energy extremity injuries, and 389 (68%) had >4 weeks of follow-up and / or developed infection prior. This included 356 men (92%) with mean age 30 years. Most common sites were the upper leg (43%), lower leg (24%), and upper arm (15%); 140 (36%) had associated fractures, 54% of which had fixation. Overall, 127 patients (33%) did not receive the recommended single dose of antibiotics. 60 received extra IV and/or oral antibiotics. 67 received no antibiotics. Our overall infection rate was 11% (44 of 389), primarily superficial wound infections (27 of 44, 61%), with 6 patients (1.5%) requiring surgical debridement. Patients initially treated with the single-dose pathway had a 9% infection rate. Conversely, 19% of patients receiving no antibiotics developed an infection (P = 0.03). The single-dose pathway reduced infections compared with a group of similar patients treated in our hospital previously for GSWs (15.7%, P = 0.03). No benefit was seen to routine supplemental IV or oral antibiotics in addition to the pathway (12% infection rate, P = 0.63).

Conclusion: A standardized care pathway of single-dose IV antibiotic is simple and inexpensive and appears safe. It is associated with a low risk of infection after GSW to the extremities. Prospective evaluation demonstrated that this protocol reduced infection versus our historical cohort and versus those receiving no antibiotics.

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Readmissions Are Not What They Seem: Incidence and Classification of 30-Day Readmissions Following Orthopaedic Trauma Surgery

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Purpose: A common measure of quality of care in the health-care setting is the 30-day readmission rate. Readmission within 30 days of discharge is often associated with increased hospital spending, reduced revenue, and decreased patient satisfaction. This quality measure fails to consider if a readmission is truly related to the initial admission. The purpose of this study was to evaluate the causes of 30-day readmissions following orthopaedic trauma surgery and to categorize them accordingly.

Methods: A retrospective chart review of all patients, aged 18 to 100 years, who were admitted to a large, academic medical center between January 1, 2011 and October 1, 2018 for operative treatment of a traumatic fracture injury was performed. Patient records were reviewed for readmissions within 30 days of discharge. Readmissions were categorized into 1 of 3 major categories: orthopaedic treatment complications, unrelated medical conditions, and non-complications. Orthopaedic treatment complications included infection or pain and swelling at the surgical or graft site, tendon rupture, DVT (deep venous thrombosis), and implant dislocation.

Unrelated medical conditions included exacerbation of preexisting medical conditions and unrelated new onset medical conditions that developed following discharge. Noncomplications included planned readmissions, interfacility transfers, and falls resulting in new fracture. A χ^2 test of homogeneity was performed to assess any difference in the proportion of readmissions between the hospital-reported readmission rate and the orthopaedic treatment complication readmission rate.

Results: A total of 1955 patients who were initially admitted to the orthopaedic trauma service for a fracture or injury and underwent operative treatment were included in this analysis. 89 patients were readmitted within 30 days of discharge with an overall readmission rate of 4.55%. Within the cohort of 89 patients with 30-day readmissions, 30 (33.7%) were orthopsedic treatment complications, 36 (40.4%) were unrelated medical conditions, and 23 (25.8%) were non-complications. The readmission rate due to orthopsedic treatment complications was 1.53%. A χ 2 test of homogeneity revealed a statistically significant difference in proportions between the hospital-reported readmission rate and the orthopaedic treatment complication readmission rate, P<0.0005.

Conclusion: The blanket use of 30-day readmissions as a measure of hospital quality of care overestimates the number of preventable readmissions and penalizes surgeons and hospitals for caring for patients with less than optimal health. The orthopaedic surgical community should work with payers to better understand the best measures to quantify quality of care for the orthopaedic trauma patient.

Do Patient-Reported Outcomes Improve Following Elective Implant Removal? *Laurence Kempton, MD*; Walter W. Virkus, MD; Krista M. Brown, MS; Todd Owen McKinley, MD; Greg E. Gaski, MD Indiana University School of Medicine, Indianapolis, IN, United States

Purpose: Patients with residual pain following healed fractures may benefit from implant removal. Few studies have quantified changes in patient-reported outcomes (PROs) following elective implant removal. We hypothesized that patients undergoing hardware removal (HWR) primarily to relieve pain would also have significant improvements in PROs pertaining to both pain and function.

Methods: This prospective observational study enrolled 188 patients who elected to undergo removal of implants primarily to reduce pain following successful fracture fixation. Patients were excluded if they had significant pain at other locations unrelated to the HWR site. PROs were obtained preoperatively and 3 months postoperatively utilizing the Patient-Reported Outcomes Measurement Information System (PROMIS) physical function (PF) and pain interference (PI) domains. Demographic data, injury characteristics, and intraoperative and postoperative complications were also recorded. Descriptive analyses were conducted. Linear regression analyses examined whether preinjury PROs predicted 3-month postoperative PROs. Minimal clinically important difference (MCID) in PROMIS scores was \geq 5 points based on 0.5 times the standard deviation (SD) of preoperative scores.

Results: 153 patients were available for 3-month follow-up. The mean improvement in PF was 5.7 (SD 9.9) and mean reduction in PI was 6.7 (SD 11.3). 117 patients (76%) experienced improvement in PF, 4 (3%) had no change, and 32 (21%) reported a decline. Considering MCID, 87 patients (57%) reported clinically significant improvement (>5) in PF and 15 patients (9.8%) had a significant decline (>5) in PF. 114 patients (75%) experienced an improvement in PI, of whom 91 (59%) improved >5. 27 patients (18%) reported a worse PI, of whom 16 (10%) had a decline in PI >5. 12 patients (8%) had no change in PI. Worse preinjury PROMIS PF and PI scores were significant positive predictors for improvement in postoperative PF and PI (R2 = 0.32, P < 0.001 and R2 = 0.23, P < 0.001, respectively). The only postoperative complication and apparent direct cause of worse postoperative PROs was 1 infection treated with surgical debridement.

Conclusion: Although the primary indication for implant removal in this population was pain relief, 57% of patients also had a clinically relevant improvement in patient-reported physical function. Three-fourths of patients reported some degree of pain relief 3 months postoperatively. In addition, patients who start with worse global indices of pain and function are more likely to improve after HWR. This suggests that implant-related pain directly contributes to global dysfunction.

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An Analysis of Medicare Reimbursement Rates in Orthopaedic Trauma: 2000-2018 Jack Haglin, BS; Ariana Lott, MD; David Neil Kugelman, MD; Sanjit R. Konda, MD; Kenneth A. Egol, MD NYU Langone Medical Center, New York City, NY, United States

Purpose: There is a paucity of data regarding financial trends for procedural reimbursement in orthopaedic trauma. A comprehensive understanding of such trends is important as continued progress is made to advance agreeable reimbursement models. The purpose of this study was to evaluate monetary trends in Medicare reimbursement rates for 20 commonly utilized orthopaedic trauma surgical procedures from 2000 to 2018.

Methods: The Physician Fee Schedule Look-Up Tool from the Centers for Medicare & Medicaid Services was queried for each of the included 20 Current Procedural Terminology (CPT) codes in orthopaedic trauma. The procedure list was compiled by the senior author prior to collection in order to ensure a comprehensive analysis of commonly utilized procedures. All monetary data were adjusted for inflation to 2018 US dollars (USD) utilizing the consumer price index. Both the average annual and the total percentage change in reimbursement were calculated based on these adjusted trends for all included procedures.

Results: After adjusting for inflation, the average reimbursement for all procedures decreased by 23.0% from 2000 to 2018. The greatest mean decrease was observed in the open treatment of trimalleolar ankle fracture with internal fixation (-48.8%). The only procedure with an increased adjusted reimbursement rate throughout the study period was the open treatment

of scapular fracture with internal fixation (+4.0%). Additionally, the adjusted reimbursement rate for all included procedures decreased by an average of 1.5% each year (Table 1).

Conclusion: This is the first study to evaluate trends in procedural Medicare reimbursement for orthopaedic trauma. When adjusted for inflation, Medicare reimbursement for included procedures has steadily decreased from 2000 to 2018. Increased awareness and consideration of these trends will be important for policymakers, hospitals, and surgeons in order to ensure continued access to meaningful surgical orthopaedic trauma care in the United States.

CPT Code	Procedure	Average % Change Year to Year Adjusted	Total % Change 2000- 2018 Adjusted
23515	Open treatment of clavicular fx w/ internal fixation	-0.2%	-3.0%
23615	Open treatment of proximal humeral fx w/ internal fixation	-0.5%	-5.6%
24515	Open treatment of humeral shaft fx w/ plate/screws	-1.3%	-20.4%
24586	Open treatment of periarticular elbow fx elbow (distal humerus and proximal ulna and/or proximal radius)	-1.5%	-23,79%
23585	Open treatment of scapular fx (body, glenoid or acromion) w/ internal fixation	+0.2%	+4.0%
24685	Open treatment of ulnar fx, proximal end (eg. olecranon or coronoid process)	-1.7%6	-26,0%
25515	Open treatment of radial shaft fx w/ internal fixation	-1.5%	-24.5%
25545	Open treatment of ulgar shaft fx w/ internal fixation	-1.9%	-28.4%
27235	Percustaneous fixation of femoral fx, proximal end. neck	-1.5%	-25.1%
27236	Open treatment of femoral fx, proximal end, neck, internal fixation or prosthetic replacement	-1.4%	-21.8%
27244	Treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fx; with plate/screw type implant	-1.3%'n	-19.9%
27248	Open treatment of greater trochanteric fx w/ internal fixation	-1.7%	-29.6%
26506	Open treatment of feunoral shaft fx w/ plate/screws w/ intramedullary implant	-1.2%	-18.5%
27507	Open treatment of femoral shaft fx w/ plate/screws	-1.8%	-30.3%
27536	Open treatment of tibial fx, proximal (plateau); bicondylar w/ internal fixation	-0.9%	-14.3%
27758	Open treatment of tibial shaft fx with plate/screws	-1.6ªa	-25.7%
27759	Treatment of tibial shaft fx by intramedollary implant	-1.6%	-26.6%
27814	Open treatment of bimalleolar ankle fx w/ internal fixation	-1.7%6	-26.5%
27822	Open treatment of trimalleolar ankle fx w/ internal fixation	-3.1%	-48.8%
27828	Open treatment of pilon or tibial platond fx w internal fixation	-2.8%	-40,8%
	Average	-1.5%	-23.0%

Table 1. Adjusted Reimbursement Trends, All values adjusted for inflation

Utilization of Multimodal, Narcotic-Free, Pain Control Regimen Is Adequate for Patients with Femur and Tibial Shaft Fractures

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Purpose: The United States is facing an opioid epidemic. Although this is a global crisis, America is faring far worse than other countries. There is likely an overutilization of opioid analgesics in postoperative orthopaedic trauma patients, which is contributing to this problem. The purpose of this study was to determine if a multimodal pain regimen without a Schedule II narcotic effectively controls postoperative pain for trauma patients with a femur or tibial shaft fracture.

Methods: The trauma registry at our Level-I trauma center was queried for patients with a diagnosis of femur shaft (OTA/AO 32A) or tibial shaft fractures (OTA/AO 42A) between October 2016 and October 2018. Patients between the ages of 18-95 years whose fractures were managed operatively were included in the study. Our standard postoperative pain regimen at discharge includes Tylenol #3, Tramadol, gabapentin, and a nonsteroidal anti-inflammatory medication (NSAID). If pain is not controlled, then a Schedule II narcotic (eg, hydrocodone, oxycodone, or dilaudid) was utilized in placed of Tylenol #3 or Tramadol. Patients without postoperative follow up were excluded from the study. Discharge medications, analgesics, and visual analog scale (VAS) scores during the first 6-week follow-up appointments were recorded.

Results: 119 patients (N = 81 male) with 129 operative fractures and a mean age of 43 years (range, 18-92) were included in the analysis. Fracture patterns included OTA/AO 32 (N = 52), and 42 (N = 77). 64 patients (54.8%) had an isolated injury to the tibia or femur, while 55 (46.2%) were polytrauma patients. 42 femurs (81%) and 68 tibias (88%) were treated with intramedullary nails. There was no unplanned admission or return to the emergency room due to pain control. Overall, only 10.0% (12/119) of patients required any use of Schedule II narcotic medications for pain management either at discharge or at clinic follow-up. Eight patients (6.7%) were discharged with a Schedule II narcotic, 5 of whom were transitioned to narcotic-free regimens at their 2-week clinic visits. Of the patients discharged with the standard multimodal non-narcotic regimen (N = 111), only 3.6% required a Schedule II narcotic within their 6-week follow-up. Median (interquartile range [IQR]) VAS scores demonstrated a downward trend at 3.0 (0.0-6.5), 1.0 (0.0-5.5), and 0.0 (0.0-5.0), respectively. VAS scores at the last follow-up were significantly lower than those reported at the first follow-up appointment, P = 0.009.

Conclusion: Multimodal pain control regimens in the immediate postoperative follow-up period appear to be effective in treating postoperative pain after femoral and tibial shaft fractures, including in the setting of polytrauma. Adhering to a multimodal pain management regimen for postoperative femoral and tibial shaft fracture patients without the use of narcotic medications decreases the amount of opioids in circulation and the morbidity and mortality associated with their use.

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Enhancing Trauma Patient Experience Through Education and Engagement: Development of a Mobile Application

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Purpose: The purpose was to determine the feasibility of using an open-access mobile device application to improve patient education and engagement during recovery after trauma.

Methods: A patient education app was developed to provide basic information regarding injury, treatment, and recovery for orthopaedic and other injuries at a 5th grade reading level. Providers, patients, and families were made aware of the app in an urban, public academic Level-I trauma center. Surveys were obtained regarding experience with the app. Decision to use or not use the app, age, satisfaction, reasons for not using the app, and desired improvements were gathered from the survey. Analytical data regarding downloads were collected from the app retailer.

Results: The app was downloaded 314 times from Google Play and Apple stores. User sessions (individual app uses) were split in a bimodal distribution between those who used the app for greater than 2 minutes (36%) and those who used for less than a few seconds (40%). Pages in the app were viewed 3952 times in 2 years. Patients visited "My Injury", "Recovery Timeline", and "FAQ" most often. The majority (55%) of users rated it as helpful or extremely helpful on a 5-point Likert scale. Surveys revealed that 48% of those offered the app used it, and that 68% of users were patients, 23% spouses, and 9% other family members. There was no gender difference in app participation, both 48%. Participation was less in those age \geq 55 years (12% vs 68%, P <0.001), also reflected in mechanism of injury with 82% of those admitted for motor vehicle collision versus 9.1% of those who fell from standing, using the app, P <0.001. 17% of patients did not have a device to use the app. Most patients without phones had them damaged or lost during their trauma. Suggestions for improvements included more information on nonorthopaedic injuries and Spanish language.

Conclusion: There was strong interest in this simple and free patient education app. Over one-third of user sessions were greater than 2 minutes, and a majority of patients reported high satisfaction. Despite a relatively low-income population, 5 of 6 patients had access to an app-capable device. Nearly half of patients downloaded the app when offered. Those above age 55 years were less likely to use the app. This represents an innovative opportunity for education and engagement of our patients and their families.

Can We Believe the Positive Results of RCTs? *Paul Tornetta III, MD; Justin J. Koh, MD; Jean Kang, MD Boston University Medical Center, Boston, MA, United States*

Purpose: Randomized control trials (RCTs) inform changes in practice. We sought to evaluate a series of RCTs from the orthopaedic trauma (Tr) literature as well as in general surgery (GS) and medicine (M) to determine: (1) the calculated risk of a false positive outcome, and (2) the actual error rate in multiple outcome reporting (alpha error).

Methods: 25 RCTs in 25 journals from June 2018 backwards were chosen. The presence of a specified primary outcome was evaluated. All others considered secondary outcomes. If no primary outcome was specified, all outcomes were considered equal. For studies reporting a difference (a positive finding) we used a published equation to calculate the risk of alpha error (incorrectly concluding a treatment difference) due to multiple reporting via multiple time points or intergroup comparisons without appropriate correction. Each trial was tested for alpha error in each statistically positive outcome. Comparisons of orthopaedic trauma were made with general surgery and medical trials.

Results: 295 studies met criteria (53 Tr, 119 GS, 123 M). Explicit statement of the primary outcome was present in 70%, 69%, and 99% of Tr, GS, and M studies, respectively (P <0.0001). Multiple time points or intergroup comparisons were present in 58% (Tr), 62% (GS), and 81% (M) of studies. Corrections for the multiple evaluations were performed in only 11% (Tr), 9% (GS), and 7% (M) of trials and statements about adjustments were made in 11% (Tr), 10% (GS) and 23% (M). The calculated per paper risk of alpha error was $62\% \pm 25\%$, $66\% \pm 27\%$, and $69\% \pm 25\%$ for Tr, GS, and M trials, respectively. For Tr trials with a primary outcome identified, the calculated risk of alpha error was $21\% \pm 18\%$ for primary outcomes and $55\% \pm 28\%$ for secondary outcomes. The actual rates of alpha error when determined were 30% for primary outcomes, 78% for secondary outcomes, and 89% for any outcome. For all Tr trials, the actual alpha error rate per paper was 88%. The actual alpha error rate was always within the 95% confidence interval of the calculated risk. Of the 1566 total outcomes in the 53 Tr papers, 366 were reported as positive and of these, 164 (45%) remained statistically significant after appropriate adjustments were made.

Conclusion: The majority of RCTs in all fields identify a primary outcome. The vast majority of RCTs in all fields report multiple outcomes, but an average of only 10% make adjustments for them. The theoretical calculated rate of alpha error accurately predicted the actual alpha error rate in orthopaedic trauma trials for primary, secondary, and all outcomes, supporting the value of the calculation to predict random chance resulting in a positive outcome in RCTs. Adjustments for multiple evaluations are not being performed in the majority of RCTs in orthopaedic trauma. Potentially inaccurate positive findings exist in all fields. Finally, 45% of individual outcomes remained positive after adjustments for multiple outcomes although 89% of the papers had at least 1 positive result that was in error.

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Δ A Multicenter Randomized Trial Evaluating Liposomal Bupivacaine for Decrease of Narcotic Use in Hip Fractures

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Purpose: Decreasing opioid use in pain control for hip fractures is paramount to preventing complications associated with opioids such as delirium, urinary retention, and falls. Liposomal bupivacaine is a local anesthetic that can last in tissues for up to 72 hours. Use of liposomal bupivacaine in the treatment of pain after fractures could improve care by decreasing the need for opioids thus decreasing opioid-related complications. The purpose of this trial was to assess the effectiveness of liposomal bupivacaine in the treatment of hip fractures. We hypothesized that use of liposomal bupivacaine would result in decreased opioid usage and decreased pain.

Methods: This study was a phase III, prospective randomized trial, conducted at 2 Level-I trauma centers. Patients aged 55 years and older having sustained a hip fracture treated with either cephalomedullary nail, sliding hip screw, or hemiarthroplasty were included. Patients were block randomized to receive either an injection of normal saline (placebo) or liposomal bupivacaine at the surgical/fracture site according to manufacturer guidelines. Patients were treated with standard postoperative pain protocol. The primary outcome was total morphine equivalents over 24, 48, and 72 hours. Secondary measures included average visual analog pain scale (VAS) and Confusion Assessment Method (CAM) scores. Target enrollment was 50 patients after power analysis.

Results: 55 patients were enrolled and 53 were included in the analysis. Average age was 76 years (standard deviation [SD]: 1.23), 69.8% female. Total morphine milligram equivalents for 24 hours were 49.75 placebo (P) versus 39.6 liposomal bupivacaine (TX) (95% CI [confidence interval] 37.43-62.07, 20.79-8.40; P = 0.35). For 48 hours, they were P: 62.03 versus TX: 49.88 (95% CI 45.04-79.02, 28.31-71.44; P = 0.36). At 72 hours, they were P: 13.43 versus TX: 8.13 (95% CI –2.05 to 28.91, –2.34 to 18.59; P = 0.50). For total, P: 65.39 versus TX: 52.48 (95% CI 45.68-85.10, 30.21-74.75; P = 0.37). 24-hour VAS scores were P: 3.9 versus TX: 2.81 (95% CI 3.03-4.77, 1.90-3.71; P = 0.08). 48-hour VAS scores were P: 3.74 versus TX: 3.44 (95% CI 2.98-4.51, 2.45-4.42; P = 0.61). 72-hour scores were P: 3.32 versus TX: 2.97 (95% CI 2.21-4.42, 2.06-3.88; P = 0.63). There was no difference in CAM scores at all time points (P > 0.05).

Conclusion: This is the first randomized trial to investigate the use of liposomal bupivacaine in geriatric hip fractures. Although we demonstrated decreased narcotic use and VAS pain at all time points, this was not statistically significant. Large variations in pain medication requirement likely account for this finding. Liposomal bupivacaine may decrease narcotic requirement and likely improve pain scores. Future larger trials informed by this trial may demonstrate a significant difference, but likely a small effect size with minimal clinical significance.

Preoperative Nerve Blocks for Hip Fracture Patients: A Pilot Randomized Trial *Matthew Ramesh Menon, MD*; Lauren Alison Beaupre, PhD; Khalid Al-Maazmi, MD; Ban Tsui, MD University of Alberta, Edmonton, AB, Canada

Purpose: Hip fracture is common in older people; >95% are treated with surgery. Pain after hip fracture is substantial, but opioids are associated with significant adverse effects in older patients. Regional anesthesia may reduce opiiod use while providing adequate pain management. Our objective was to determine how preoperative femoral nerve block (FNB) affects pre- and early postoperative outcomes: (1) daily pain levels, (2) opioid use, and (3) mobilization day 1 postoperatively.

Methods: The study design was a randomized allocation of 73 participants (~2:1 FNB:control); this allocation allowed group comparison and potential subanalyses within the FNB group (n = 50) to determine if patients with cognitive impairment could be treated with preoperative FNB. Patients aged \geq 65 years, ambulatory pre-hip fracture, Mini Mental Status Examination (MMSE) score \geq 13, and able to provide direct or proxy consent were included. Those admitted >30 hours after injury or with regular use of opiates prefracture were excluded. The FNB group received FNB preoperatively using a standardized protocol. The control group received usual care.

Demographic and medical data, opioid use (in oral morphine equivalents), and pain at rest and with activity were collected preoperatively. Pain and opioid use were collected postoperatively as was the number of participants mobilized day 1 postoperatively. We compared group outcomes using linear mixed modeling for continuous and χ^2 tests for categorical variables.

Results: Overall, 73 participants were enrolled (25 Control: 48 FNB). The FNB group was slightly older (mean [standard deviation (SD)] 80.1 [8.7] vs 76.2 [9.2]; P = 0.09) and had more males (21 [42%] vs 5 [22%]; P = 0.09) than the control group. The mean MMSE score for both groups was >24 (P = 0.35 for group comparison), suggesting minimal cognitive impairment of participants. Both groups reported similar pain at rest (p=0.17) and activity (p=0.21), with significant reductions in pain over time (p<0.001 for both). Opioid consumption was nonsignificantly higher and more variable in the control group preoperatively (median [25, 75 quartile] 10.6 [0, 398] vs 7.5 [0, 125]; P = 0.26) and postoperatively (13.1 [0, 950] vs 10.0 [0, 260]; P = 0.31). 41 (85%) of FNB participants mobilized on day 1 versus 16 (73%) of control participants (P = 0.21)

Conclusion: Preoperative FNB did not change reported pain between groups with pain reducing over time in both groups. Although not significantly different, opioid consumption was more variable in the control group and more FNB patients successfully mobilized on day 1 postoperatively. Participants with cognitive impairment were not enrolled due to difficulty in obtaining proxy consent. A definitive randomized trial would be feasible and add valuable information about pain management following hip fracture.

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Intravenous Iron May Improve Outcomes in Elderly Patients with Operative Hip Fractures

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Purpose: Hip fractures are a common injury in elderly patients with high morbidity and mortality rates. The incidence of anemia in these patients is substantial; many require allogenic blood transfusions, which are costly and can have detrimental effects on patients. Studies have targeted reducing transfusion rates and improving outcomes using intravenous (IV) iron with mixed results. However, these studies took place before a shift in patient care toward restrictive transfusion protocols and early operative fixation. The presented study examined the effects of IV iron on patients with hip fractures, undergoing surgery within 48 hours, and being treated with a highly restrictive transfusion protocol. We hypothesized that the use of IV iron will reduce transfusion rates, hospital length of stay, and 30-day readmission rate.

Methods: A retrospective chart review (December 2015-December 2017) was performed on patients with fractures of the proximal femur. Patients were included if they were over the age of 60 years, underwent hemiarthroplasty or surgical fixation of their fracture, and had a recorded hemoglobin of less than 11g/dL. An experimental group (n = 119), which received 300 mg of IV iron (iron sucrose) when their hemoglobin fell below 11g/dL, was compared to a control group (n = 120) with respect to transfusion rate, length of stay, and 30- day readmission rate.

Results: There was a trend toward shorter length of stay in patients receiving IV iron (P = 0.063). In addition, there was a trend toward a decrease in 30-day readmission rate (P = 0.051) with a 59% reduction in the odds of 30-day readmission when a patient received IV iron. The study found no significant difference in transfusion rates for patients receiving IV iron (P = 0.118). It should be noted that the experimental group contained more patients with peritrochanteric fractures (P = 0.002) and undergoing intramedullary nailing (P = 0.035) than the control group.

Conclusion: This study presents a compelling argument for further research regarding the use of IV iron in elderly patients undergoing surgery for a hip fracture. Transfusion rates and length of stay are increased in patients with intertrochanteric fractures and patients undergoing intramedullary nailing. Since there were a higher number of these patients in the IV iron group, this may have falsely elevated transfusion rates and length of stay. A large, prospective, randomized controlled trial should be performed to assess the true effects of perioperative IV iron on elderly hip fracture patients.

Pull the Foley: Improved Quality for Geriatric Trauma Patients Without Indwelling Catheters

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Purpose: Urinary tract infections (UTIs) are a common complication in geriatric orthopaedic trauma patients and are often presumed to be related to indwelling Foley catheters. To address this issue, our institution implemented a hospital policy beginning October 1, 2016 that prompts straight catheterization of trauma patients as the new standard of care, in lieu of indwelling Foley catheters. This study sought to compare rates of UTI, length of stay, and cost of inpatient care before and after implementation of this new policy to assess its effectiveness in elderly orthopaedic trauma patients.

Methods: Between September 1, 2014 and October 1, 2017, patients aged 55 years and older presenting with orthopaedic fractures to 1 academic medical center were identified. On admission, patient factors including age, gender, injury severity, fracture category (spine, pelvis, upper extremity, lower extremity, polytrauma), Charlson Comorbidity Index, preinjury ambulatory status, and use of an assistive device were collected. Patients were followed prospectively throughout hospitalization to assess health-care quality measures including development of UTI, length of stay, and total inpatient cost. Chi-square and Mann-Whitney U tests were used to assess differences in hospital quality measures before and after policy implementation. Regression analyses were then run to determine whether this hospital policy predicted a reduction in UTIs, length of stay, and inpatient cost after controlling for all patient factors.

Results: This study included 1509 patients with 1040 (68.9%) being hospitalized prior to and 469 (31.1%) after new policy implementation. The overall UTI rate was 6.2%, which decreased from 7.1% before to 4.1% after policy enactment (P = 0.022). There was also an associated decrease in median hospital length of stay from 4.0 days to 2.0 days following policy implementation (P <0.001). After controlling for all patient factors, patients who were hospitalized following the implementation of the hospital policy had lower odds of UTI (odds ratio [OR]: 0.501, P = 0.019), a predicted reduction in length of stay by 1.7 days (slope coefficient [β]: –1.685, P<0.001), and no difference in predicted inpatient cost (P = 0.302).

Conclusion: Terminating the use of indwelling Foley catheters in the elderly orthopaedic trauma population significantly reduced the odds of developing a UTI during hospitalization and predicted a significant reduction in length of stay. Institutions and providers that treat this patient population should recognize the benefits of implementing a policy that substitutes straight catheterization for indwelling Foley catheters.

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Should Urinary Catheter Be Retained Preoperatively in Osteosynthesis of Pertrochanteric Fractures? A Prospective Randomized Clinical Trial Direk Tantigate, MD; Thippatai Chaichompoo, MD; Yuwarat Monteerarat, MD; Theerawoot Tharmviboonsri, MD; Kongkhet Riansuwan, MD Department of Orthopedic Surgery Faculty of Medicine, Siriraj Hospital Mahidol University Bangkok, Bangkook, Thailand

Purpose: This study was undertaken to compare rates of urinary tract infection (UTI) and perioperative urinary retention (POUR) in patients undergoing osteosynthesis of pertrochanteric fracture with and without preoperatively retaining urinary catheter.

Methods: 105 patients who sustained pertrochanteric fracture and scheduled for osteosynthesis from December 2017 to January 2019 were enrolled. 92 patients were included and randomly allocated into 2 groups. Group 1 was patients who preoperatively did not retain urinary catheter and Group 2 was patients who preoperatively indwelled urinary catheter and removed at 48 hours postoperatively. Urinalysis (UA) was collected on day of admission, day of surgery, 48 hours postoperatively, and 72 hours after urinary catheter removal or day of discharge. Pyuria was diagnosed when positive white blood cell (WBC) >3-5 cells/HPF (high-powered field) in UA and urine culture was subsequently obtained in case of pyuria. Complications including UTI, sepsis, and POUR, which was the inability to void in the presence of full bladder or residual urine by intermittent catheterization more than 300 mL, were collected. Patient demographics, rate of pyuria, and POUR were compared between 2 groups. Patients who were indicated for perioperative ICU admission were retained urinary catheter. Intention to treat and per protocol analysis was employed.

Results: The average age of patients was 81 ± 7.6 years. 65 patients (70.6%) were female. 83 patients (90.2%) were treated by closed reduction and internal fixation (CRIF) with cephalomedullary nail and 8 patients (9.8%) were treated by CRIF with dynamic hip screw. 65 patients (70.6%) underwent spinal anesthesia. There was no statistically significant difference in age, gender, body mass index (BMI), time to surgery, method of anesthesia, type of surgery, operative time, blood loss, and length of stay between 2 groups. There was a statistically significant difference in overall rate of pyuria, which was 71.7% in group 1 and 89.1% in group 2 (P = 0.036) and only urinalysis at day of surgery was demonstrated statistically significant in rate of pyuria, which was 21.7% and 45.7%, respectively (P =0.019). However, per protocol analysis did not demonstrated significant different in positive urine culture between patients with and without retaining urinary catheter, which was 21.6% in group 1 and 32.7% in group 2 (P = 0.246). POUR was significantly higher in group 1, which was 30.4% preoperatively and 21.7% postoperatively.

Conclusion: Preoperative retaining urinary catheter in patients who sustained pertrochanteric fracture can prevent perioperative urinary retention. On the other hand, it may increase the rate of asymptomatic pyuria but not UTI.

Thrombelastography Identifies Hypercoagulability in Hip Fracture Patients Despite Thromboprophylaxis

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Purpose: Venous thromboembolism (VTE) is the second most common complication and pulmonary embolism (PE) is the fourth most common cause of death after a hip fracture. Despite thromboprophylaxis, deep vein thrombosis (DVT) is detected in up to 45% of hip fracture patients. Thrombelastography (TEG) is a whole- blood, point of care test capable of providing clinicians with a global assessment of the clotting process, from fibrin formation to clot lysis. Maximal amplitude (mA) from TEG analysis is a measure of clot strength. Elevated admission mA values of \geq 65 mm and \geq 72 mm have been determined to be independent predictors of in-hospital PE. The coagulation index (CI) is calculated based on TEG parameters and defines hypercoagulable state as CI >3. This study aimed to use serial TEG analysis to determine the duration of hypercoagulable state after hip fracture.

Methods: A prospective cohort of hip fracture patients >50 years of age amenable to surgical treatment (AO 31A1-A3 and 31B1-B3) were enrolled at a Level-I trauma center. Serial TEG analysis (TEG 6S) was performed every 24 hours from admission until 5 days postoperatively and at 2- and 6-week follow-up visits. All patients received a minimum of 28 days of thromboprophylaxis. Results were summarized using descriptive statistics and single sample t-tests were used to compare mean mA values to the 65-mm threshold.

Results: 35 patients (26 female) with a median age of 83 years (interquartile range [IQR] = 71-86 years) were included. On admission, 34.3% and 82.9% of patients were hypercoagulable based on mA \geq 65 mm and CI, respectively. At 2 weeks, all patients remained hypercoagulable; however, mA \geq 72 mm showed that 17 patients (50.0%) were at even higher risk for VTE. At 6 weeks, 65.7% and 97.1% of patients were hypercoagulable based on mA \geq 65 mm and CI, respectively. When compared with the mA \geq 65-mm threshold, patients were hypocoagulable at the time of admission (mean 62.2, standard deviation [SD] 6.3; P = 0.011) but became significantly more hypercoagulable at 2 weeks (mean 71.6, SD 2.6; P <0.001), followed by continued hypercoagulability at 6 weeks; however, not significantly elevated above 65 mm (mean 66.2, SD 3.8; P = 0.058). One patient developed a symptomatic DVT at 2 weeks and had an mA of 72.9 and a CI of 5.9.

Conclusion: This is the first study to demonstrate that >50% of hip fracture patients remain hypercoagulable 6 weeks postfracture despite thromboprophylaxis, and there are individual hypercoagulable responses. This is critical, as guidelines only recommend 28 to 35 days of thromboprophylaxis in this high-risk population. Previously determined mA thresholds may be a more sensitive test for risk-stratifying patients' VTE risk than the CI threshold. Additionally, assessing Δ mA using serial TEG may better predict VTE risk.

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Can We Predict Failure of Percutaneous Fixation of Femoral Neck Fractures? *Christina Kane, MD; Jacob Jo, BA; Judith Siegel, MD; Paul Edward Matuszewski, MD; Eric F. Swart, MD University of Massachusetts, Worcester, MA, United States*

Purpose: This study evaluated a series of geriatric femoral neck fracture treated with closed reduction and percutaneous pinning (CRPP) at a single Level-I trauma center to determine if there are any simple, reliable, radiographic characteristics that can be used to predict increased risk of postoperative failure in nondisplaced and valgus-impacted fracture patterns.

Methods: We conducted a retrospective cohort study of all patients with femoral neck fractures (AO/OTA 31B) who underwent CRPP over a 12-year period at a single Level-I trauma center. Failure was defined as radiographic failure within the first year after the index operation requiring revision surgery. Common patterns identified on initial review were the presence of a visible medial transcervical line (MTL) felt to indicate a tension-sided failure, a straight inferior calcar (SIC) indicating severe valgus impaction, and quality of intraoperative screw positioning. Radiographs of patients were then reviewed for these characteristics in a blinded manner by 3 different trauma fellowship-trained orthopaedic surgeons. Interrater reliability was calculated using Fleiss' Kappa Coefficient. Comparisons of failure rates between groups were made using a Fisher exact test.

Results: 139 patients who underwent CRPP for a femoral neck fracture and follow-up for at least 90 days were identified and reviewed. There were a total of 19 failures (13.6%) within 1 year. The patients with a varus fracture had a failure rate of 9/24 (37.5%). Of the valgus/ nondisplaced fractures, MTL was identified in 42/115 patients (36%). Interrater agreement was high for the presence of an MTL (84%, Kappa 0.69). Patients with an MTL had a fourfold increase in risk of failure (7/42 = 17% with an MTL vs 3/73 = 4% without, P = 0.03). The presence of an SIC and quality of screw placement were not predictive of failure.

Conclusion: Varus femoral neck fractures have a high rate of failure (37.5%). Nondisplaced or valgus-impacted fractures with the presence of a visible medial transcervical line on preoperative radiographic imaging resulted in a fourfold increase in the risk of failure after CRPP. Identification of the MTL will help treating surgeons better counsel patients when making preoperative decisions between arthroplasty and CRPP.
Fri., 9/27/19 AM19: Geriatric, PAPER #120

Should All Garden I and II Femoral Neck Fractures in the Elderly Be Fixed? Effect of Posterior Tilt on Rates of Subsequent Arthroplasty *Kanu M. Okike, MD*; *Ugo Udogwu, BA; Marckenley Isaac; Sheila Sprague, PhD;*

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Purpose: Internal fixation is the standard of care for Garden I and II femoral neck fractures in the elderly. However, the outcomes following this procedure are not uniformly positive, as prior studies have documented rates of reoperation ranging from 8% to 23%. One factor commonly considered as a potential predictor of failure is the degree of posterior tilt on the preoperative lateral radiograph. Prior research on this topic has been contradictory, however, and there is currently no consensus as to whether there is an amount of posterior tilt on the preoperative lateral radiograph above which failure is likely, and primary arthroplasty would be preferred. The purpose of this study was to determine whether the degree of posterior tilt on the preoperative lateral radiograph predisposes to failure (in the form of subsequent arthroplasty) following internal fixation of Garden I and II femoral neck fractures in the elderly.

Methods: This study represents a secondary analysis of data collected in a prior international multicenter randomized clinical trial comparing the sliding hip screw to cannulated screws in the management of femoral neck fractures in patients age 50 years or older. For each patient with an adequate preoperative lateral radiograph (n = 555), the image was reviewed to categorize the amount of posterior tilt as $\geq 20^{\circ}$ or $<20^{\circ}$. This review was done in duplicate with discrepancies resolved by a third reviewer. Multivariable Cox proportional hazards analysis was used to assess for an association between posterior tilt and failure (defined as subsequent arthroplasty during the 2-year follow-up period) while controlling for potential confounders as identified by prior studies (age, sex, quality of implant placement, and prefracture functional status). Results were reported as hazard ratios (HRs), 95% confidence intervals (95% CIs), and P values. Tests were 2-tailed with $\alpha = 0.05$.

Results: Of 555 patients in the study sample, posterior tilt was classified as $\geq 20^{\circ}$ for 67 (12.1%) and $< 20^{\circ}$ for 488 (87.9%). Reviewer agreement in the assessment of posterior tilt was substantial (89.7% agreement, $\kappa = 0.61$). Overall, 13.2% (73/555) of patients underwent subsequent arthroplasty in the 24-month follow-up period. In the multivariable analysis, patients with posterior tilt $\geq 20^{\circ}$ had a significantly increased risk of subsequent arthroplasty compared to those with posterior tilt $< 20^{\circ}$ (22.4% [15/67] vs 11.9% [58/488], HR 2.22, 95% CI 1.24-4.00, P = 0.008). The other factor associated with subsequent arthroplasty was age ≥ 80 years (P = 0.03).

Conclusion: In this study of patients with Garden I and II femoral neck fractures, posterior tilt $\geq 20^{\circ}$ was associated with a significantly increased risk of subsequent arthroplasty. Primary arthroplasty may be considered for Garden I and II femoral neck fractures with posterior tilt $\geq 20^{\circ}$, especially among older patients.

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Fri., 9/27/19 AM19: Geriatric, PAPER #121

Early Weight Bearing After Distal Femur Fractures in the Elderly: A Prospective, Cohort Pilot Study

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Purpose: This study was conducted to determine if early weight bearing in distal femur fractures in the geriatric population maintains fracture reduction and allows early return to function.

Methods: We performed a prospective cohort pilot study (NCT #02475941) involving 5 Level-I trauma centers. Patients 65-90 years of age with an OTA 33 distal femur fracture were eligible for inclusion. All patients were household ambulators or higher at time of the injury. The patients were treated with surgical stabilization. Following surgery the surgeon decided if patients would be weight-bearing as tolerated (EWB) or protective (toe-touch)/non-weight-bearing (PWB). Patients were followed at regular intervals clinically and with radiographs until healed. Complications were evaluated. The Oxford knee score was obtained. Analysis of variance was performed within each group to detect differences between time points. T-tests and $\chi 2$ were performed to detect differences between the groups at each time point.

Results: There were 46 patients with an average age of 75. 11 years (24%) were in the EWB group. There were 8 with diabetes and 14 obese patients (body mass index [BMI] >35). There were 37 33A, 2 33B, and 7 33C fractures (9-0-2 EWB; 28-2-5 PWB). 5/11 in the EWB and 18/35 in PWB group had periprosthetic fractures. Most patients were treated with a knee immobilizer prior to surgery. 44 of 46 patients were injured in ground level falls. 42 patients were treated with locking plates and the majority had mostly nonlocking screws above the fracture. In the PWB group, 69% of patients were healed at 12 weeks and at 6 months; there were 2 hardware failures. One patient in the PWB group went on to revision surgery. In the EWB group, 64% were healed at 12 weeks and there were no hardware failures or additional surgeries. The average Oxford knee score was 37 (range, 17-47). There were no significant differences between the groups in any variables.

Conclusion: We investigated a prospect cohort of geriatric patients with distal femur fractures to determine efficacy of early weight bearing. Weight-bearing as tolerated as been proven in the hip, whereas the distal femur has been treated with non/protected weight bearing. We chose a prospective cohort design so the surgeon felt comfortable with wight-bearing choice after surgery in this patient population. The majority of surgeons chose PWB. Our results demonstrate EWB can be safely done in a small cohort study for geriatric distal femur fractures. Early mobilization has the advantage of a more rapid return to function for the geriatric patient with minimal complications. A randomized clinical trial could be useful in geriatric distal femur population.

Δ Tightrope versus Screw Fixation of the Tibiofibular Syndesmosis: A Long-Term CT Evaluation of Maintenance of Reduction

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Purpose: Flexible fixation techniques combined with anatomic (open) syndesmosis reduction have demonstrated improved functional outcomes and rates of malreduction. Suture-button devices allow physiologic motion of the syndesmosis without need for implant removal, which may lower the risk of recurrent syndesmotic diastasis. There is limited longer-term assessment of the maintenance of reduction between static and flexible syndesmotic fixation using bilateral ankle CT evaluation.

Methods: This is an a priori planned subgroup analysis of a multicenter, randomized clinical trial comparing static syndesmosis fixation (two 3.5-mm screws, Group S) with flexible fixation (single knotless Tightrope, Group T) for patients with AO-OTA 44-C injuries. Patients who completed bilateral ankle CT scans at 3 and 12- month follow-up were included. The primary outcome measure was syndesmotic malreduction based on bilateral ankle CT scans, using the uninjured, contralateral ankle as a control. Anterior (ASD), middle (MSD), and posterior (PSD) syndesmosis distance were calculated to measure syndesmosis reduction. Secondary outcomes included reoperation, adverse events, and functional outcomes including the EuroQol 5 Dimensions (EQ-5D), Olerud-Molander Ankle Score (OM), Foot and Ankle Disability Index (FADI), and Work Productivity Activity Impairment Questionnaire (WPAI). Paired samples t-tests were used to compare injured to control ankles (R, v 3.5.1).

Results: 42 patients (24 Group S, 18 Group T) were included. ASD for Group T was 5.22 mm (95% confidence interval [CI] 4.69-5.77) at 3 months compared to 4.26 mm (95% CI 3.82-4.71; P = 0.007) in controls and 5.38 mm (95% CI 4.72-6.04) at 12 months compared to 4.44 mm (95% CI 3.73-5.16; P = 0.048) in controls. ASD for Group S was 4.63 mm (95% CI 4.17-5.10) at 3 months compared to 4.67 mm (95% CI 4.24-5.10; P = 0.61) in controls, but significantly increased to 5.73 mm (95% CI 4.81-6.66) at 12 months compared to 4.65 mm (95% CI 4.15-5.15; P = 0.04) in controls. MSD results were similar; Group T had a larger MSD than control ankles at 3 months (P = 0.03) and 12 months (P = 0.01), while the MSD in Group S was not different at 3 months (P = 0.80) but increased at 12 months (P < 0.01). 88% (21/24) of Group S had broken or removed screws by 12 months. Unplanned reoperation was 15% in Group S and 4% in Group T (P = 0.02), with an overall reoperation rate of 30% in Group S. There was no significant difference between treatment groups for EQ-5D, OM, FADI, or WPAI at 3 or 12-month follow-up.

Conclusion: Tightrope fixation resulted in greater diastasis of the ASD and MSD compared to contralateral, uninjured ankles at 3 and 12 months post-fixation. Group S initially had syndesmotic reduction similar to control ankles, but between 3 and 12 months post-fixation, there was significantly increased syndesmosis diastasis compared to controls. The majority of Group S (88%) had either broken screws or scheduled screw removal, which may explain the increased tibiofibular diastasis seen at 12 months.

 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.

Better Outcome for Suture Button Compared to Single Syndesmotic Screw for Syndesmosis Injury: 5- Year Results of a Randomized Controlled Trial Benedikte W. Raeder, MD; Wender Figved, MD, PhD; Jan Erik Madsen, MD, PhD; Frede Frihagen, MD; Silje Berild Jacobsen, MD; Mette Renate Andersen, MD Bærum Hospital and Oslo University Hospital, Oslo, Norway

Purpose: Two years after surgery, patients treated with suture button (SB) for acute syndesmotic injury had better outcomes than patients treated with syndesmotic screw (SS); higher American Orthopaedic Foot & Ankle Society Ankle-Hindfoot Scale (AOFAS), higher Olerud-Molander Ankle score (OMA), and less pain on walking and in rest measured on a visual analog scale (VAS). The SB group also had a lower malreduction rate. This is a report of the results after 5 years.

Methods: 97 patients with acute syndesmotic injury were randomized to SS or SB. Patients were evaluated at 6 weeks, 6 months, and 1, 2, and 5 years. The 5-year follow-up rate was 84%. The primary outcome was AOFAS score. Secondary outcome measures included OMA score, VAS, EuroQol 5 Dimensions (EQ-5D), range of motion, complications, reoperations, and radiologic results. We used the Mann-Whitney U test for AOFAS and OMA data analyses. CT scans of both ankles were obtained after surgery, and after 1, 2, and 5 years.

Results: At 5 years, the SB group had higher AOFAS scores (100 [interquartile range (IQR) 92 to 100] vs 90 [IQR 85 to 100], P =0.006) and OMA score (100 [IQR 95 to 100] vs 95 [IQR 75 to 100], P = 0.006). The SS group had a higher prevalence of ankle osteoarthritis (OA) (65% v. 35%, odds ratio [OR] 3.5, confidence interval [CI]: 1.3 to 8.7, P = 0.009), and talar osteophytes (66% vs 34%, OR 3.4, CI: 1.3 to 8.8, P = 0.009). On axial CT we measured a significantly smaller mean difference in the tibiofibular anterior distance between injured and noninjured ankles in the SB group (0.1 mm vs 1.2 mm, P = 0.02). We did not find significant differences in EQ-5D or VAS, and there was no difference in reoperations between the groups.

Conclusion: Five years after syndesmotic injury treated with either SB or SS, we found better AOFAS and OMA scores, and lower incidence of ankle OA, in the SB group. These long-term results favor the use of suture buttons when restoring an acute syndesmotic injury.

Immediate Improvement in Physical Function After Symptomatic Syndesmotic Screw Removal

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Purpose: The purpose of this study was to investigate the immediate impact of syndesmotic screw removal on PROMIS (Patient-Reported Outcome Measurement Information System) outcomes and ankle range of motion (ROM) in patients who had previously undergone ankle fracture open reduction and internal fixation (ORIF) and syndesmotic fixation with symptomatic syndesmotic screws and decreased function.

Methods: A total of 58 ankle fractures with syndesmotic injury that required ORIF with syndesmotic fixation and subsequent syndesmotic screw removal met criteria for inclusion from February 2015 to May 2018. We analyzed PROMIS scores collected just prior to syndesmotic screw removal and at the first postoperative visit. A retrospective chart review was performed to collect demographic and ankle ROM data. Cohort data were collected for 71 patients who underwent ORIF with syndesmotic fixation, but without screw removal during the same study period.

Results: The PROMIS physical function (PF) T-score was 35.2 at an average of 106 days after ORIF just prior to syndesmotic screw removal at a mean 184 days after ORIF. There was a statistically significant improvement in the PF T-score to 44.5 (P <0.01) in the immediate postoperative period after screw removal, which met minimal clinically important difference (MCID). There was a statistically significant improvement in ankle ROM after screw removal (P <0.01). In a cohort comparison group of 71 patients during the same time period who did not undergo syndesmotic screw removal, the PF T-score was 41.6 at a mean 150 days after surgery, similar to the PF T-score (44.5) for patients after syndesmotic screw removal (P = 0.06) (Table 1).

Conclusion: In our study, there was an immediate clinically meaningful improvement in physical function outcomes and ankle ROM after symptomatic syndesmotic screw removal for patients who underwent ankle fracture ORIF with syndesmotic fixation, similar to asymptomatic patients who did not require syndesmotic screw removal within the same postoperative time frame.

Table 1: Demographic and PROMIS Data for Patients Undergoing Ankle Open Reduction and
Internal Fination (ORIF) with Syndesmotic Fination

Syndesmosis Screw Removal Group (N-58)	Mean (5.0) [Range]
Mean Age at ORIF (Years)	42.6 (37.6) [34,69] years
Gender	Male: 31/Female: 29
Mean Days Between ORIF & Screw Removal (Days)	183.8 (134.3) [50,381] days
Mean Days Between ORIF & Evaluation (Days)	105.9 [43.9] [18,198] days
Mean Days Between Screw Removal & Evaluation (Days)	48.3 (39.5) (8,200) days
Pre-Screw Removal Mean PROMIS IV T-Score	55.2 (8.0) [39.3.61.7]
Pre-Screw Removal Mean PROMIS PI T-Score	56.5 (9.6) [32.2,75.7]
Pre-Screw Removal Mean PROMIS Depression T-Score	46.2 (9.6] [31.9,65.7]
Fre-Screw Removal Mean Dorsifiexion	3.5*(4.75)(-5.14)
Fre-Screw Removal Mean Plantarflexion	23.2* (12*) [5,50]
Pre-Screw Removal Mean Total Arc of Motion	35.4*(357) [5.44]
Post-Screw Removal Mean PROMIS PF T-Score	44.5* (7.7) [26.9,61.7]
Post-Screw Removal Mean PROMIS PLT-Score	\$4.1* (9.2) [32.2,71.6]
Post-Screw Removal Mean PROMIS Depression T-Score	45.4* (10.1) [31.9,87.8)
Post-Screw Removal Mean Dorolflexion	10.3**(4.4*) [0.25]
Post-Screw Removal Mean Plantarflexion	31.0** (11.4*) (10,55)
Post-Screw Removal Mean Total Airc of Mation	41.8** (14.3*) (20,70)
Centrol Group (N=71)	
Mean Age at ORF (Years)	44.4 (18.3) [16,88] years
Gender	Male: 41/Female: 30
Mean Days between ORM & Evaluation (Days)	145 6 [17.6] [120,140] day
Post-Op Mean PROMIS IF 1-Score	41.6** (8.9) [21.3,67.3]
Post-Op Mean PROMS PI T-Score	55.1 (9.4) [38 2,83.8]
Past-Op Mean PROMIS Depression 7-Scave	47.1** (10.8) [14.2,78.1]
ORIF: open reduction, internal fixation; PF: physical func	tion; Pt: pain Interference

^{*}p<0.05 in Wilcowor-Signed Kark test for pre- and post-screw removal

^{**}p<0.05 in Wilconon Rank Sum test between screw removal group after syndesmotic screw removal and control group

Tourniquet Use During Ankle Fracture Fixation Does Not Affect Rates of Wound Healing and Infectious Complications

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Purpose: Use of a tourniquet during ankle fracture fixation varies at the discretion of the treating surgeon. Many surgeons prefer the bloodless field provided with tourniquet use; however, others fear the ischemic insult to tissues with tourniquet use can have deleterious effects to the soft-tissue envelope, theoretically setting the stage for wound healing issues and infection. The purpose of this study was to evaluate the effect of tourniquet use on postoperative wound healing complications, superficial infections, and deep infections after ankle fracture fixation.

Methods: 995 adult patients treated surgically for a torsional ankle fracture (OTA 44B and C) at a single Level-I trauma center were reviewed. Demographic information, comorbidities, injury characteristics, complications, and secondary procedures were recorded. Analysis was performed initially on the whole group of included patients, followed by subgroup analysis on patients who might be more sensitive to the transient tissue ischemia encountered with tourniquet use (including those with diabetes, obesity, tobacco users, age >65 years, and open fracture). Multiple logistic regression analysis was performed.

Results: A tourniquet was used in 571 (57.4%) of cases. 22.2% of patients had open fractures in the group with no tourniquet, versus 11.6% (P <0.001), but no differences in fracture pattern were noted. There were no differences in demographics or medical comorbidities except tobacco use was more frequent in the no tourniquet group (52.3% vs 45.5%, P = 0.04). No significant difference in rates of postoperative complications between the no tourniquet and tourniquet groups was found, including superficial infection (4.0% vs 5.1%), deep infection (both 2.1%), and wound healing problems (5.7% vs 3.9%, P = 0.18). Similarly, subgroup analysis failed to reveal any difference in postoperative complication rates based on diabetes, obesity, tobacco, age, or open fracture. However, patients with open fractures or diabetes were more likely to experience deep infection (odds ratio [OR] 4.05 and 5.01, respectively, P <0.01).

Conclusion: Tourniquet use during ankle fixation did not affect rates of wound healing problems or infections. Although patients with open fractures or diabetes are at higher risk, tourniquet use was not associated with increased rates of postoperative complications. Surgeons should be aware that the tissue ischemia produced by a tourniquet does not appear to result in more wound healing or infectious complications.

Closed Reduction and Percutaneous Fixation versus Open Reduction and Internal Fixation of Intra- Articular Calcaneal Fractures

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Purpose: Both percutaneous fixation and open reduction and internal fixation are used for the surgical treatment of intra-articular calcaneal fractures. However, there is no general consensus as to which method is preferred. There has been an association with increased risk of wound complications when treating these fractures with open techniques, such as wound dehiscence and deep infections. Percutaneous techniques allow the surgeon to restore calcaneal anatomy in a minimally invasive fashion, therefore avoiding wound complications especially in the context of extensive soft-tissue damage. Our hypothesis is that the group treated by percutaneous fixation will have similar outcomes in addition to decreased incidence of wound complications.

Methods: We generated a list of patients who were treated surgically for a calcaneus fracture at a Level-I trauma center by the senior author from July 2003 through March 2013. Patients were then divided into 2 groups based on surgical treatment received: (1) group 1 consists of patients treated by closed reduction and percutaneous pinning (CRPP), and (2) group 2 consists of patients treated by open reduction and internal fixation (ORIF). Data analysis for each group included demographics, fracture classification, open versus closed fractures, complications, and reoperations. We included all adult patients treated over the course of 10 years (2003-2013) by CRPP or ORIF at a single Level-I trauma center by a single orthopaedic surgeon (fellowship trained in foot and ankle) with at least 1 month follow-up. We excluded pediatric patients. Patients with less than 1 month of follow-up were also excluded.

Results: There were a total of 57 patients who met the inclusion criteria. 32 patients underwent CRPP (average follow-up 22.17 months) and 25 patients underwent ORIF (average follow-up 17.5 months). Seven patients from the ORIF group developed a postoperative wound complication (all 7 required a reoperation for an irrigation and debridement) compared to only 1 patient from the CRPP group (who also required an irrigation and debridement). This difference was statistically significant (P = 0.0073). Eight patients in the CRPP group developed symptomatic subtalar arthritis requiring intervention (cortisone injection or subtalar fusion) compared to 5 patients in the ORIF group (P value = 0.655).

Conclusion: Both procedures may be considered for the surgical treatment of intra-articular calcaneal fractures; however, it appears that closed reduction and percutaneous fixation leads to less postoperative wound complications while also having a similar incidence of posttraumatic subtalar joint arthritis.

 Δ The Impact of Skin Suture Pattern on Incision Perfusion Using Intraoperative Laser Angiography: A Randomized-Clinical Trial of Ankle Fracture Patients

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Purpose: Maximizing perfusion to skin edges is an important modifiable variable in wound closure, but there is little evidence to suggest the superiority of 1 technique over another. Indocyanine green laser angiography (ICGLA) is a vascular imaging tool that provides real-time objective measurements of soft-tissue perfusion. The purpose of this research was to assess which primary wound closure technique- simple interrupted (SI), vertical mattress (VM), horizontal mattress (HM), Allgöwer-Donati (AD), or running subcuticular (SubQ)-enables the greatest degree of perfusion as measured by ICGLA following open reduction and internal fixation (ORIF) of ankle fractures.

Methods: 75 patients undergoing ORIF of ankle fractures (AO/OTA 44-A, B, or C) via a lateral or posterolateral approach were prospectively randomized to SI, VM, HM, AD, or SubQ closure (n = 15 per group). After ORIF, wounds were closed in layers in a standardized fashion. Immediately after skin closure, perfusion was evaluated intraoperatively using the ICGLA device and software system, which quantifies perfusion in fluorescent units on a scale of 0-255. 30y points were assessed: 10 along the incision and 10 pairs anterior and posterior to the incision. Mean incision perfusion was calculated as the average of the 10 points along the incision, with higher values indicating greater blood flow. Mean perfusion and the 10 points along the incision. Lower values indicate incision perfusion is closer to that of the surrounding tissue. These parameters were compared with 1-way analysis of variance (ANOVA) and pairwise comparisons using the Tukey method.

Results: The mean patient age was 46.5 years (range, 19-81) and the majority were female (n = 43, 57%). There was no significance difference in patient demographics (age, gender, body mass index [BMI], tobacco use, diabetes mellitus, and PVD [peripheral vascular disease]) or operative parameters (time to surgery, incision length, tourniquet time, and fracture classification) between patient cohorts. SubQ closure had significantly better perfusion compared to the other techniques studied. Mean incision perfusion in fluorescent units was as follows: SubQ, 57; AD, 41; VM, 41; HM, 36; and SI, 32 (ANOVA P <0.0003). Pairwise comparisons showed a statistically significant difference in mean incision perfusion between SubQ and all other closure patterns (SI, P<0.0002; HM, P <0.003; VM, P <0.03; AD, P <0.03). Mean perfusion impairment was as follows: SubQ, 17; AD, 20; VM, 28; HM, 29; and SI, 30 (ANOVA P <0.003). Pairwise comparisons showed SubQ closure had significantly lower mean perfusion impairment than all other suture patterns except AD (SI, P <0.01; HM, P<0.03; VM, P <0.04; AD, P <0.1).

Conclusion: Running subcuticular suture pattern best enables incision perfusion compared to simple interrupted, horizontal mattress, vertical mattress, and Allgöwer-Donati techniques following ORIF of ankle fractures.

What Is Too Swollen? Correlation of Soft-Tissue Swelling and Timing to Surgery with Acute Wound Complications for Operatively Treated Lower-Extremity Fractures

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Purpose: Considerable debate exists regarding how soft-tissue edema should influence timing of surgery for lower-extremity fractures. Assessment of swelling is subjective and timing varies among surgeons. However, timing of surgery is one of the few modifiable factors in fracture care. Ultrasonography can objectively measure swelling and help determine optimal timing. The purposes of this study are: (1) determine whether objective measures of swelling, timing to surgery, and patient-specific risk factors correlate with wound complications; and (2) create a prediction model for postoperative wound complications based on identified modifiable and nonmodifiable risk factors.

Methods: Patients with closed lower-extremity fractures requiring surgery with an uninjured, contralateral extremity were included. Demographic information and sonographic measurements on both lower extremities were obtained preoperatively. Subjects were followed for 3 months and wound complications were documented. A predictive algorithm of independent risk factors was constructed, determining wound complication risk.

Results: 93 subjects completed the study, with 71 of 93 sustaining ankle fractures. The overall wound complication rate was 18.3%. Timing to surgery showed no correlation with wound complications. A heel-pad edema index >1.4 was independently associated with wound complications. Subgroup analysis of ankle fractures demonstrated a 3.4× increase in wound complications with a heel-pad edema index >1.4. Tobacco history and body mass index (BMI) >25 kg/m2 were independent predictors of wound complications. An algorithm was established based on heel-pad edema index, BMI >25, and tobacco history. Patients with none of the 3 factors had a 3% probability of a wound complication. Patients with 1 of 3, 2 of 3 and 3 of 3 factors had a 12%-36%, 60%-86%, and 96% probability of a wound complication, respectively.

Conclusion: Timing to surgery had no correlation with wound complications. Heel-pad edema index >1.4, BMI>25, and tobacco use correlated with wound complications. Risk of wound complications significantly increased with each factor. In patients with increased BMI and/or tobacco use, resolution of heel-pad edema may significantly reduce wound complications in lower-extremity trauma. Level of Evidence: II – Prognostic, prospective cohort study

Mid-Term 5-Year Follow-up of a Novel Algorithm for Nonoperative Weber B Ankle Fractures

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Purpose: Several different radiographic guidelines have been used to understand the stability of lateral malleolus fractures. The current authors previously described a novel algorithm used to assess stability and the ability to treat the stable injuries nonoperatively. One year results demonstrated favorable outcomes of these nonoperative patients; however, there is a question about the durability of these results and whether these patients developed posttraumatic degenerative changes. We hypothesize that 5-year outcome scores will not degrade over time (as compared to 1-year scores) and there will be no signs of significant osteoarthritis on follow-up radiographs.

Methods: An observational study based on a previous cohort of 51 patients studied from 2010 to 2013 with isolated Weber B ankle fractures was performed. These were defined as stable at the time of injury when the medial clear space (MCS) was less than 7 mm on the initial gravity stress radiographs along with a normal mortise relationship on weight-bearing radiographs. 27 patients who were treated nonsurgically were brought back for a mid-term follow-up with a mean of 6.8 years. American Orthopaedic Foot & Ankle Society (AOFAS) Hindfoot scores, Olerud-Molander Ankle (OMA) Score, and visual analog scale (VAS) pain score were collected in accordance with the prior study. Patient-Reported Outcome Measurement Information System (PROMIS) scores were also collected including lower extremity, physical function, depression, and pain interference. Standing bilateral ankle radiographs were obtained, and assessed for MCS widening, and ankle arthritis using the Kellgren-Lawrence grading scale.

Results: Average functional score results were (in comparison to 1-year outcomes): AOFAS Hindfoot, 95.7 (93.2); OMA Score, 95.2 (91.0); and VAS pain score, 0.24 (0.57). Using a Wilcoxon Signed Rank Test, there was a statistically significant increase in 5-year AOFAS Hindfoot scores as compared to 1-year scores in those same patients (P = 0.005) There is no evidence of significant posttraumatic osteoarthritis based on the Kellgren- Lawrence grading scale.

Conclusion: The previously described, novel at the time, algorithm for assessing stability of isolated Weber B ankle fractures and nonsurgical treatment with protected weight bearing has been shown to produce excellent results for mid-term follow-up with an average of 6.8 years. Additionally, these patients are not at increased risk for rapid progression of posttraumatic osteoarthritis. This further supports initial weight-bearing radiographs as a reasonable assessment of ankle stability and validates the aforementioned algorithm as a safe and cost-effective functional treatment regimen.

Is Routine Radiography in the Follow-up of Trauma Patients with Ankle Fractures (Cost) Effective?

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Purpose: The clinical consequences of follow-up radiographs in ankle fractures are unclear and indications for these radiographs are seldom well-defined. Routine radiographic imaging in the follow-up of patients with an ankle fracture adds to treatment costs, although recent retrospective studies dispute its usefulness. The aim of this study was to assess whether a protocol with a reduced number of routine radiographs would lead to cost savings, without compromising clinical outcomes.

Methods: A multicenter randomized controlled trial was conducted. Patients were randomly assigned in a 1:1 ratio to the usual-care follow-up protocol (consisting of routine radiography at 1, 2, 6, and 12 weeks) or a reduced-imaging strategy (radiographs only obtained for a clinical indication at 6 and 12 weeks). Functional outcome was assessed using the OMAS (Olerud-Molander Ankle Score) and AAOS (American Academy of Orthopaedic Surgeons) ankle score questionnaires, Quality of lfe was measured with the EQ-5D-3L (EuroQol 5- Dimensions 3-Level) and Short Form (SF)-36 questionnaires. Other outcome measures included complications, pain, the number of radiographs and the indications to obtain them, health perception, and self-perceived recovery. Costs were measured with self-reported questionnaires and include primary and secondary health-care costs, the cost of radiographic imaging, and costs of lost productivity.

Results: The studied group consisted of 247 participants, of whom 154 (63%) received operative treatment. Patients in the reduced-imaging group received a median 4 radiographs, while patients in the usual care group received a median 5 radiographs (P <0.005). OMAS, AAOS scores, quality of life, pain levels, health perception, and self-perceived recovery did not differ between groups. We observed 32 complications in the reduced imaging group. This did not differ significantly from the usual care group (29 complications, P = 0.51). A significant reduction in radiographic imaging costs was observed (–€48 per patient, 95% CI [confidence interval] –72 to –25). Overall costs per patient were comparable between groups (€130, 95% CI –2975 to 3723).

Conclusion: Implementation of a reduced-imaging protocol in the follow-up of ankle fractures leads to cost savings and more importantly does not lead to worse functional outcomes. Given the large number of people who suffer from an ankle fracture annually, this reduction in routine follow-up radiographs could have a substantial economic impact.

Two-Year Functional Outcomes After Adolescent Clavicle Trauma: A Multicenter Comparison of Operative Versus Non-operative Treatment *Benton E. Heyworth, MD*; Elizabeth Savika Liotta, MBBS; Brittany Dragonetti, BA; David Neil Williams, PhD; Andrew Tennant Pennock, MD; G. Ying Li, MD; Henry Bone Ellis, MD; Jeffrey J. Nepple, MD; Samuel Clifton Willimon, MD; David D. Spence, MD; Nirav Kiritkumar Pandya, MD; Mininder S. Kocher, MD, MPH; Eric William Edmonds, MD; Philip L. Wilson, MD; Michael T. Busch, MD; Coleen S. Sabatini, MD, MPH; Donald S. Bae, MD Boston Children's Hospital, Boston, MA, United States

Purpose: We sought to investigate the 2-year functional outcomes and complications following operative versus nonoperative treatment of completely displaced midshaft clavicle fractures in adolescents.

Methods: Patients 10-18 years old treated for a midshaft clavicle fracture between August, 2013 and August, 2018 at 1 of 8 geographically diverse, high-volume, tertiary-care pediatric centers were enrolled, with treatment decisions determined by individual providers. Patients with completely displaced fractures were followed for >2 years. Clinical course, complications, validated patient-reported outcome measures (PROs), quality of life, and satisfaction scores were analyzed. The ceiling effect of PRO/satisfaction data following clavicle injuries prompted establishment of a priori threshold for 'suboptimal' scores (ASES [American Shoulder and Elbow Surgeons] <90, QuickDASH [an abbreviated version of the Disabilities of the Arm, Shoulder and Hand] >10, EQ-5D [EuroQol 5-Dimensions] <0.80, EQ-VAS [visual analog scale] <80). To create comparable cohorts, PRO analysis was performed between operative patients and those nonoperative patients with shortening greater than the mean cohort value. According to 'intention to treat' statistical principles, 1 postoperative complication (and subsequent secondary operation) was analyzed within the nonoperative cohort.

Results: Of the 909 patients enrolled, 431 (47%) demonstrated completely displaced fractures and maintained enrollment over the study period, 410 (95%) of whom attained 2-year follow-up, and 227 (55%) of whom provided adequate PRO data. Of these patients, 75 (33%) underwent operative treatment, while 153 (67%) were treated conservatively. Those treated surgically showed no difference in sex (82% males, P = 0.17), but were older (mean age 15.3 vs 13.6 years, P <0.001). There was no difference in shortening in the subset compared for PROs. Complications were less common in nonsurgical patients (P <0.001), but this difference did not reach significance when sensory deficits were excluded (P = 0.17). There was no difference in secondary surgeries (P = 0.43). Greater percentages of operative patients reported suboptimal PRO/satisfaction scores (ASES: 11% vs 5%, QuickDASH: 9% vs 6%, EQ-5D: 8% vs 5%, EQ-VAS: 8% vs 7%, satisfaction 5% vs 3%), but these differences did not reach significance (P = 0.16, 0.40, 0.38, 0.38, and 0.61, respectively).

Conclusion: At 8 large pediatric centers with independent treatment decisions made by over 40 orthopaedic surgeons, nonoperative treatment of adolescent clavicle fractures demonstrated lower complication rates and similar satisfaction and functional outcomes than operative treatment. These data for adolescents, the subpopulation most affected by this common condition, demonstrate contrasting findings to those of several adult studies, which suggest superiority with operative treatment.

Δ General Health Outcomes Following Distal Clavicle Fractures: Results From a Previous Randomized Controlled Trial Christine Schemitsch, BS; Michael D. McKee, MD,FRCSC; Niloofar Dehghan, FRCSC, MD, MSc; Emil H. Schemitsch, MD; Aaron Nauth, MD; Milena Vicente, RN; Jeremy Hall, MD, FRCS (ORTHO), MEd

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Purpose: The decision whether to operate on or to treat distal clavicle fractures conservatively remains controversial. The purpose of this study was to examine general health outcomes in patients who were randomized to operative or nonoperative treatment for distal clavicle fractures.

Methods: The Short Form (SF)-36 scores from a previous randomized controlled trial were analyzed. Patients who had sustained a displaced, type II distal clavicle fracture were randomized to either conservative treatment or surgical intervention. Patients completed the SF-36 at baseline, 6 weeks, 3 months, 6 months, 12 months, and 24 months. Both the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores were calculated from the SF-36 questionnaire. A linear mixed model was used to predict the PCS and MCS scores over time and between groups. A regression analysis was conducted to determine if any baseline characteristics predict general health status at 2 years.

Results: 57 patients were randomized: 27 patients to the operative group and 30 to the nonoperative group. There were no significant differences in the baseline characteristics between the 2 groups. Analysis of the PCS scores demonstrated no difference between the operative and nonoperative groups at any time point (P = 0.88). The PCS scores decreased significantly between baseline and 6 weeks (P < 0.001); however, by 2 years the scores were not significantly different from patients' preinjury scores (P = 0.09). Analysis of the MCS scores demonstrated that there were no significant differences between the 2 groups at any time point (P = 0.15). The mean PCS score at 2 years was 55.9 and the mean MCS score was 54.7. Male sex (P = 0.039) and the injury occurring on the dominant side (P = 0.044) were both associated with higher PCS scores in the conservative group. In the operative group, only male sex was associated with higher MCS scores (P = 0.003). There were no significant predictors of the PCS scores in the operative group or MCS scores in the conservative group. The SF-36 scores from this study were compared to a previous trial performed by our group that randomized patients who had sustained an acromioclavicular (AC) joint dislocation to operative or conservative treatment. No difference in general health status was found between the groups at preinjury or 2 years after the injury (P>0.05).

Conclusion: The results of this study demonstrated that there was no difference in general health outcomes between operatively and nonoperatively treated distal clavicle fractures at 1 and 2 years. By 2 years, general health outcome scores were similar to preinjury scores. Moreover, our findings suggest surgical intervention for both distal clavicle and AC joint injuries appears to have uncertain benefits.

 Δ OTA Grant

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Predictors of Patient-Reported Function Following Operative and Non-operative Treatment of Acute Distal Clavicle Fractures

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Purpose: A 2017 randomized controlled trial (RCT) comparing open reduction and internal fixation (ORIF) of acute distal clavicle fractures with nonsurgical treatment found no significant differences in functional outcomes using the Disabilities of the Arm, Shoulder and Hand (DASH) score between groups at 1 year postfracture. The purpose of this study was to utilize these RCT data to assess predictors of patient-reported outcomes in each group.

Methods: Data from a previously presented RCT were analyzed. Patients aged 16-60 years with a displaced, closed fracture of the distal third clavicle were included. Functional outcomes were assessed using the DASH scores at 1 year, where a higher score indicates worse symptoms and disability. Stratified by treatment type, bivariate analyses were used to evaluate unadjusted relationships between patient demographics and DASH scores, while multivariable linear regression was used to identify independent predictors of DASH scores while adjusting for other relevant covariables. Variables with P value <0.20 on bivariate analysis were included in the multivariable models.

Results: 53 patients with complete DASH scores at 1 year postfracture were analyzed (28 treated nonoperatively, 25 treated with ORIF). In the nonoperative group, older age and current smoking were associated with worse DASH scores. Each 1-year increase in age increased DASH scores by 0.56 points (95% confidence interval [CI] 0.13-0.98 points), while current smokers scored 9.83 points (95% CI 0.54-19.13 points) higher than nonsmokers. In the ORIF group, only female sex was associated with worse DASH scores. Females scored 10.12 points (95% CI 3.7-16.7) higher on the DASH compared to males, P = 0.004.

Conclusion: These data indicate that older patients and current smokers have worse outcomes following nonoperative treatment of distal clavicle fractures, while female patients have worse outcomes following ORIF of distal clavicle fractures. These data can be used to inform patients and providers regarding outcomes following treatment of these injuries.

Predicting Humeral Shaft Fracture Nonunion: The Radiographic Union Score for HUmeral fractures (RUSHU)

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Purpose: Nonunion complicates up to 20% of nonoperatively treated humeral shaft fractures and avoiding delay in the diagnosis may allow early intervention and reduce morbidity. Radiological scoring systems have been used to predict nonunion in other fractures, but we are unaware of such a score for the humerus. The primary aim of this study was to develop a reliable and effective radiological score-the Radiographic Union Score for HUmeral fractures (RUSHU)-to assess humeral shaft fracture healing. The secondary aim was to assess the predictive ability of the RUSHU in identifying patients at risk of nonunion following a humeral shaft fracture.

Methods: Patients were retrospectively identified from a trauma database held at the study center. 20 randomly selected patients with AP and lateral radiographs taken 6 weeks following their humeral shaft fracture were rated by 3 observers, with scoring based on the Radiographic Union Scale for Tibial fractures (RUST) system, to assess the reliability of the RUSHU score. After refinement of RUSHU scoring criteria, 60 sets of 6-week AP and lateral radiographs (40 patients who achieved fracture union, 20 who developed nonunion) were rated by 2 observers blinded to patient outcome. A receiver operating characteristic (ROC) curve was used to determine the optimal RUSHU cut-off score in predicting eventual nonunion.

Results: The interobserver intraclass correlation coefficient (ICC) was 0.68 (95% confidence interval [CI] 0.46 to 0.85). This improved after refinement to 0.79 (95% CI 0.67 to 0.87), indicating substantial agreement. At 6 weeks postinjury, patients who went on to unite (n = 40, median RUSHU = 10) had a significantly (P < 0.001) higher score than those who developed nonunion (n = 20, median RUSHU = 7). ROC curve determined a RUSHU cut-off of <8 to predict nonunion (area under the curve 0.84, 95% CI 0.74 to 0.94). Sensitivity was 75%, specificity 80%, positive predictive value (PPV) 65%, and negative predictive value 86%. Patients with a RUSHU <8 (n = 23) were 12 times more likely to develop nonunion than those with a score ≥8 (n = 37, odds ratio 12.0, 95% CI 3.4 to 42.9). Five of the 20 patients who developed a nonunion had a RUSHU ≥8 (false negative rate 25%). Based on a PPV of 65%, if all patients with a RUSHU <8 underwent fixation, the number of fixation procedures needed to avoid 1 nonunion would be 1.5.

Conclusion: The RUSHU is reliable and effective in identifying patients at risk of developing humeral shaft fracture nonunion at 6 weeks postinjury. The RUSHU requires validation in other centers, but has the potential to enhance decision-making in patients with a fracture of the humeral shaft and reduce the morbidity associated with delayed treatment of an established 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.

Radial Head Replacement for Acute Fractures: A Study of Long-Term Outcomes Thomas Carter, MBChB; Caroline D. Cristofaro, BS; Neil Ranjan Wickramasinghe, MBBS; Margaret M. McQueen, MD; Timothy O. White, MD, FRCS; Andrew David Duckworth, FRCS, MBCHB, MSc, PhD Edinburgh Orthopaedic Trauma, Edinburgh, United Kingdom

Purpose: The evidence for treatment of acute complex radial head fractures with radial head replacement (RHR) predominantly comprises short to midterm follow-up. The aim of this study was to report the long-term complications and patient-reported outcomes following RHR for acute complex fractures of the radial head.

Methods: We retrospectively identified from our single-center trauma database all skeletally mature patients over a 16-year period managed acutely for a complex fracture of the radial head with primary RHR. Electronic records were used to document postoperative complications, including prosthesis revision and removal. Patients were contacted to confirm complications and long-term patient-reported outcomes. The primary outcome measure was the QuickDASH (QD, an abbreviated version of the Disabilities of the Arm, Shoulder and Hand [DASH]). Secondary outcome measures included the Oxford Elbow Score (OES), EuroQol-5 Dimensions (EQ- 5D), return to function, and treatment satisfaction.

Results: There were 119 patients with a mean age of 50 years (range, 16-94) and 63 (53%) were female. There were 102 fractures (85.7%) classified as Mason type III injuries (AO/ OTA: 2R1 C2), with 28 injuries associated with a dislocation of the elbow (19 terrible triad injury) and 32 associated with a fracture of the proximal ulna. 11 patients had an isolated coronoid fracture and there were 3 Essex-Lopresti type injures. Apart from 2 patients, all implants were uncemented, loose-fitting, monopolar prostheses, of which 86% (n = 102) were metallic and 14% were silastic (n = 17). 30 patients (25%) required revision surgery (n = 3) or prosthesis removal (n = 27) at a median interval of 7 months (range, 0-125), with 70% (21/30) of these occurring within the first year after implantation. 80% of patients (80/100; 19 deceased) were contacted at a mean of 12 years (range, 7.5-23.5). The median QD was 6.8 (interquartile range [IQR], 2.3-19.1), the median OES was 46 (IQR, 41-48) and the median EQ-5D was 0.8 (IQR, 0.4-1.0). Overall satisfaction was high with a median of 10 (IQR, 10-10). Median return to sport was 20 weeks (IQR, 12-30) and return to work was 6 weeks (IQR, 4-14). There was no significant difference in any outcome measure for those patients requiring revision or removal surgery (all P >0.05).

Conclusion: This is the largest series in the literature documenting the long-term patientreported outcomes after acute RHR. Despite a quarter of patients requiring further surgery, RHR is supported by positive long-term results for the treatment of complex radial head fractures. The peak incidence of prosthesis revision or removal occurs within the first year following implantation.

Δ Simple Decompression versus Anterior Transposition of the Ulnar Nerve: 2-Year Follow-up of a Randomized Trial

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Purpose: Ulnar nerve dysfunction is common after operative fixation of distal humerus fractures. A previously presented prospective randomized trial comparing ulnar nerve simple decompression (SD) to anterior transposition (AT) after bicolumnar plate fixation of acute distal humerus fractures was unable to demonstrate any significant difference in outcome at 1 year. We present here the 2-year follow-up results for that study.

Methods: Participants who were between 16 and 80 years of age, sustaining a displaced, distal humerus fracture (OTA 13A or 13C), and \leq 28 days postinjury with a closed or grade I/II open fracture were included. Participants were randomized to receive either SD or AT of the ulnar nerve, with a similar postoperative protocol. The primary outcome was the ulnar nerve entrapment score of Gabel and Amadio. Secondary outcomes included: Mayo Elbow Performance score (MEPS), Short Form (SF)-36 PCS (Physical Component Summary) and MCS (Mental Component Summary), grip and pinch strength, Jebsen hand function test, nerve conduction test, and the visual analog scale (VAS). Follow-up appointments occurred until 2 years postoperatively.

Results: Of the 61 patients enrolled in the study, 27 were randomized to AT, 31 to SD, and 3 withdrew preoperatively. There were 35 females and 23 males with a mean age of 52.7 years. There were no differences in the ulnar nerve entrapment scores, MEPS, SF-36 PCS and MCS, VAS, or 2-point discrimination scores between treatment groups from baseline to any time point. Both groups did show significant improvement over time.

Between 1 and 2 years postoperatively, the mean ulnar nerve entrapment scores, MEPS, VAS satisfaction, and moving 2-point discrimination scores did not significantly improve. From baseline to 2 years, moving 2-point discrimination scores significantly improved from 8.83 mm to 5.81 mm, but remained abnormal. By the 2-year follow-up, general health outcome scores were similar to preinjury scores for both the SF-36 PCS and MCS. At the end of the follow-up period, there were 11 revision surgeries, 5 superficial infections, 2 deep infections, and 4 nonunions. Complications were equal across groups.

Conclusion: At 2-year follow-up, SD and AT were shown to be equally effective methods for displaced, distal humerus fractures treated with plate fixation. Both treatment methods demonstrated significant improvement in all outcome measures over time with similar rates of complications, ulnar nerve symptoms, and functional outcomes. No outcome measure significantly changed from 1 to 2 years postoperatively. At 2-year follow-up, there continued to be residual ulnar nerve dysfunction in both groups despite recovery of general health outcome scores.

 Δ OTA Grant

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Is There a Correlation Between Functional Results and Radiographic Findings in Patients with Distal Radius Fractures AO Type A3 Treated with a Volar Locking Plate or an External Fixator?

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Purpose: Volar locking plates (VLPs) and external fixation (EF) are the most commonly used methods for treating distal radius fractures. The goal of the operation is to restore normal anatomy and improve function. The aim of this study was to assess the correlation between functional results and radiographic findings in patients with extra-articular distal radius fractures treated with VLPs or EF after 1 year.

Methods: A multicenter, randomized controlled trial was initiated in 2013 and was completed in 2018. 156 patients with dislocated distal radius fractures, AO type A3, age 18-70 years, were included. 142 patients (91%) completed 1-year follow-up, among whom 69 were allocated to VLPs and 73 to EF. 128 patients (90%) were women. The mean age was 56 years. The primary functional outcome was the Patient-Rated Wrist and Hand Evaluation (PRWHE) score. Radiographically we assessed volar tilt, radial inclination, radial length, and ulnar variance. An additional ulna fracture, if present, was also registered. The Pearson correlation analysis was used to estimate correlations between parameters.

Results: At 1-year follow-up the mean difference in radiographic findings compared to uninjured side (minimum, maximum) was: volar tilt 5.3° (-15° , 25°), radial inclination 2.3° (-6° , 12°), radial length 1.3 mm (-4 mm, 7 mm), and ulnar variance -0.5 mm (-6 mm, 3 mm). Overall, we found no correlation between radiographic parameters and the PRWHE at 1-year follow-up within the whole group, regardless of which treatment was chosen (volar tilt P = 0.95, radial inclination P = 0.34, radial length P = 0.62, and ulnar variance P = 0.43). We found no significant difference in radiographic parameters between the 2 surgical methods considering volar tilt (MD [mean difference = 0.908, P = 0.34), radial inclination (MD = -0.97, P = 0.10), and radial length (MD = 0.468, P = 0.30). However, the ulnar variance was significantly smaller in the VLP group (MD = -0.819, P = 0.01). At the time of injury 52.6% (N = 80) had sustained an additional fracture of the styloid ulna. After 1 year the fracture was still radiographically present in 30.9% (N = 43) of the patients. No correlation between PRWHE score and the presence of an ulna fracture at 1-year follow-up (MD = 2.24, P = 0.37) was found.

Conclusion: In this study we found no correlation between functional outcome (PRWHE) and radiographic findings (volar tilt, radial inclination, radial length, ulnar variance, or ulna styloid fracture) after 1 year in patients with AO type A3 distal radius fractures operated with a VLP or EF.

Scaphoid Waist Internal Fixation for Fractures Trial (SWIFFT): A Randomized Controlled Trial, Economic Evaluation, and Nested Qualitative Study of Cast Immobilization versus Surgical Fixation for the Treatment of Adult Patients with a Bicortical Fracture of the Scaphoid Waist

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Purpose: Scaphoid fractures account for 90% of carpal fractures, and despite insufficient evidence of its effectiveness, immediate surgical fixation of this fracture has been increasing. We set out to establish whether there was a clinically meaningful difference between early surgical fixation using standard CE marked headless compression screws compared with below-elbow cast treatment for 6 to 10 weeks (with early fixation of CT- confirmed nonunion) of these fractures in adults.

Methods: We compared clinical and cost-effectiveness of these 2vtreatment pathways in a multicenter, pragmatic, randomized controlled trial using remote randomization with an economic evaluation and nested qualitative study. Adults (\geq 16 years), presenting within 2 weeks of injury with a clear, bicortical fracture of the scaphoid waist seen on scaphoid series radiographs were recruited in 31 UK hospitals from July 2013 with final follow-up in September 2017. The primary outcome and end point was the Patient-Rated Wrist Evaluation (PRWE) total score at 52 weeks, with a clinically relevant difference of 6 points. Secondary outcomes included PRWE total scores at other time points (6, 12, and 26 weeks), PRWE pain and function subscales, Short Form (SF)-12 questionnaire, bone union, range of movement and grip strength, complications, and return to work.

Results: The mean age of the 439 participants was 32 years, 363 were men (83%), and 269 had an undisplaced fracture (61%). The primary analysis was on 408 participants (surgery n = 203 of 219, 93%; cast n = 205 of 220, 93%) using intention to treat. There was no clinically relevant difference in the total PRWE at 52 weeks: cast group mean 14.0 [95% confidence interval [CI] 11.3 to 16.6] and surgery group mean 11.9 (95% CI 9.2 to 14.5); adjusted mean difference of -2.1 in favor of surgery (95% CI –5.8 to 1.6, P = 0.27). Nonunion rate was very low in both groups. Eight participants in the surgery group had 11 reoperations, and 1 participant in the cast group required a reoperation for nonunion. The base-case economic analysis of a lifetime extrapolated model confirmed that the initial use of cast with immediate fixation of nonunions was the most cost-effective option. The nested qualitative study identified patients' desire to have a "sense of recovering," which surgeons should address at the outset.

Conclusion: Adult patients with an undisplaced or minimally displaced scaphoid waist fracture should have the wrist immobilized in cast and all suspected nonunions immediately investigated and those confirmed urgently fixed.

Immediate Weight Bearing of Plated Both-Bone Forearm Fractures in the Polytrauma Patient Is Safe

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Purpose: Rehabilitation of trauma patients is facilitated by surgical stabilization permitting immediate weight bearing (WB) of the fractured extremity. Both-bone forearm fracture (BBFx) plate osteosynthesis is an accepted technique with high union and low complication rates, yet postoperative WB protocols have not been amply investigated. The increased load placed upon BBFx plate fixation in the polytrauma patient raises concern regarding increased complication risk for patients permitted immediate WB. We hypothesized that immediate WB of operatively treated BBFx results in acceptable rates of complication for isolated and polytrauma patients.

Methods: Patients presenting to a Level-I trauma center from 2007-2016 with an operatively treated BBFx (AO/OTA 2R2/2U2) were identified retrospectively. Included patients were: skeletally mature, prescribed immediate WB protocol, and followed for 6 months or until fracture union. Collected data included: demographics, fracture characteristics, associated injuries, and WB protocols for all extremities. A WB score was created to stratify lower extremity injuries: WB as tolerated, 0; partial WB, 1; and non-WB, 2 (WB score = sum of each lower extremity). Complications recorded included: nonunion, hardware failure, and infection.

Standard statistical comparisons were used to evaluate the risk of complication in polytrauma patients with modified lower extremity WB protocols (polytrauma group) and patients with no lower extremity WB restrictions (isolated group). 213 patients were included with 75 (35%) females and 138 (65%) males, mean age was 40 years (17-82 years), and mean follow-up was 46 weeks (12-504 weeks). There were 142 (67%) patients in the isolated and 71 (33%) patients in the polytrauma groups. In the polytrauma group, 21 patients (10%) had bilateral lower extremity WB restrictions. Open fracture occurred in 67 patients (31%) and 12 (6%) complications noted: 3 nonunions, 4 hardware failures, and 5 infections. Demographic data did not vary between the isolated and polytrauma groups (P > 0.05 for all).

Results: There was no difference in complications in the isolated (5.7%) versus polytrauma groups (5.0%) (P = 1.00). The risk of individual complication also did not vary: nonunion (isolated: 1.4% vs polytrauma: 0.7%; P = 0.55), hardware failure (isolated: 4.3% vs polytrauma: 0.7%; P = 0.10), and infection (isolated: 0% vs polytrauma: 3.5%; P = 0.17). The risk of complication based on the WB score was similar (P = 0.77), in patients with complications (mean: 0.91, standard deviation [SD]: 1.38) and without (mean: 0.79, SD: 1.32).

Conclusion: Immediate WB rehabilitation following BBFx plate osteosynthesis appears to be safe, and is associated with low nonunion and complication rates. Our results demonstrate polytrauma patients who require ambulatory aid for lower extremity injury can immediately bear weight without increased complication risk compared to isolated BBFx.

SCIENTIFIC POSTER #1 Basic Science

Involvement of Androgen-Mediated Osteopontin in Bone Remodeling via Regulation of Osteoclast-Specific Actin Ring

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Purpose: Osteoporosis and secondary fracture in men cause significant morbidity and mortality, due to the global trends of increased longevity. Although the direct role of androgens independent of estrogen in bone growth was demonstrated by mouse models, the underlying molecular mechanism in periosteal bone formation and remodeling remains elusive. In the present study, we performed a quantitative proteomics analysis to comprehensively investigate the differential expressed proteins during osteoclast and osteoblast differentiation in the presence of 17 β -estradiol (β -E2) or testosterone. In addition, we emphasize the pivotal role of osteopontin (OPN) in androgen-mediated bone remodeling.

Methods: The osteoclast and osteoblast differentiation were induced standard differentiation medium. The mature cells were digested to proteins and labeled by tanden mass tags. After the high performance liquid chromatography separation, the labeled samples were dissolved for subsequent liquid chromatography with tandem mass spectrometry (LC-MS/MS) analysis. Proteins were identified using Proteome Discoverer 2.1 software with the SEQUEST search engine. Gene ontology (GO) analysis, pathway mapping, and protein networks were performed. The MS results for the identified proteins were validated by Western blotting and representative mass spectral analysis. The relation between testosterone and OPN in human serum was measured by enzyme-linked immunosorbent assay (ELISA), and the effects of OPN on regulation of actin ring were identified by in vitro studies.

Results: Bioinformatics analysis and in vitro studies confirmed that testosterone additionally attenuated osteoclast differentiation with the upregulation of STAT1-associated immune responses. In contrast, testosterone strongly promoted osteoblast formation with the enhancement of focal adhesion and indirectly suppressed osteoclast differentiation in the later stages of osteogenesis. Additionally, the OPN expression was continued repressed in mature osteoblast by testosterone, which is a key factor for regulating the osteoclast precursors to accelerate their differentiation to actin ring-enriched bone-resorbing cells.

Conclusion: This information will be helpful in elucidating the functions of androgen in mediation of bone remodeling as well as providing a basis for the development of strategies for osteoporosis prevention and therapy in men. Despite the rapid advances in our knowledge regarding the regulation of bone remodeling, the specific roles of androgen on cells of the osteoclast and osteoblast lineage await future studies.

SCIENTIFIC POSTER #2 Basic Science

Infraspinatus Tenotomy Improves Glenoid Visualization with the Modified Judet Approach

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Purpose: Operative treatment of glenoid and scapular fractures are challenging due to the limited visualization of the glenoid articular surface despite extensive exposures and dual approaches. While the addition of an infraspinatus tenotomy to the modified Judet approach (MJA) has been suggested to improve glenoid visualization, no study has specifically investigated this technique. The objective of this study was to quantify and compare the square area of the glenoid seen through the MJA with and without an infraspinatus tenotomy.

Methods: An MJA was performed on 14 human cadaveric shoulders. Margins of glenoid exposure were marked with a surgical drill before and after adding an infraspinatus tenotomy. The humerus was disarticulated, and the marked margins were confirmed and traced with a surgical pen. The area of the entire glenoid and each of the 4 quadrants (anterior-superior [AS], anterior-inferior [AI], posterior-superior [PS], and posterior-inferior [PI]) were analyzed using a custom image processing program to quantify the amount of glenoid exposure and percentage of area visualized before and after the tenotomy.

Results: Adding a tenotomy to the MJA significantly increased total glenoid area (cm2) exposure by 33%, P<0.0001. Three of 4 glenoid quadrants (PS, AS, and AI) had a significant increase in glenoid visualization after the tenotomy, P <0.0001. The AS quadrant had the most significant increase in square area visualized (66%, P<0.0001).

Conclusion: This is the first study to quantify glenoid visualization with and without the addition of an infraspinatus tenotomy to the MJA. The AS quadrant is the most difficult to see using the MJA. The addition of an infraspinatus tenotomy improves glenoid exposure, especially to the AS quadrant. With the addition of an infraspinatus tenotomy and its improved visualization of the AS quadrant, the need for a secondary anterior approach may be unnecessary.



See the meeting app for complete listing of authors' disclosure information.

SCIENTIFIC POSTER #3 Basic Science

Δ Weightbearing CT Scan After Pilon Fracture Fixation Demonstrates Significant Early Joint Space Narrowing

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Purpose: Intra-articular fractures (IAFs) of the distal tibia reliably develop posttraumatic osteoarthritis (PTOA). We need objective tools that can detect cartilage loss. Weight-bearing CT (WBCT) scan allows for 3- dimensional (3D) assessment of joint space. The purpose of this study was to assess the reliability of a measurement technique and to determine patterns of joint space narrowing at 6 and 12 months after pilon fracture.

Methods: 14 individuals who sustained pilon fractures were enrolled. All subjects underwent bilateral ankle WBCT scans at 6 and 12 months. Three sagittal slices of the CT were selected equally spaced across this width of the distal tibia articular surface. On each sagittal slice, the joint space from the tibia to the talus was measured in 3 locations. Four reviewers used this technique to independently measure joint space on the injured and uninjured ankles at 6-month follow-up with repeated measurements 2 weeks later. The same measurements were performed on the 12-month WBCT scans. Interrater correlation coefficient (ICC) estimates were calculated based on a mean rating ($\kappa = 4$), absolute agreement, 2-way mixed-effects model. Test-retest reproducibility was calculated based on a single rating, absolute agreement 2-way mixed-effect model. An independent-samples Student t-test was used to compare means between measurements of interest, and P <0.05 was deemed statistically significant.

Results: The ICC of the measurement technique was 0.88. The test-retest reproducibility at 2 weeks was 0.8. Figure 1 demonstrates the joint space measured for each region of the

ankle. The mean joint space in the uninjured ankles at all points was 2.58 mm, compared to 1.88 mm at 6 months and 1.92 mm at 12 months in the injured ankles (P = 0.001). The difference was not significant comparing 6-month to 12-month scans.

Conclusion: Joint space can be reliably measured on WBCT scans in multiple clinically relevant locations of the ankle. Significant joint space narrowing was seen after pilon fracture at 6 and 12 months.



Location in the Joint Figure 1: Demonstrates mean joint space at each region comparing uninjured

6 and 12 months after pilon fracture fixation. * Indicates significant difference comparing injured to uninjured ankles.

 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.

SCIENTIFIC POSTER #4 Basic Science

Artificial Intelligence for Automated Segmentation of CT Scans of Intra-Articular Fractures

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Purpose: Artificial intelligence (AI) is believed to change the scope of medicine, as the introduction of smartphones changed our day-to-day life. In orthopaedic trauma, AI shows promising results and already performs on a human level in recognizing fractures on plain radiographs taken in the emergency department of patients with wrist , hand, and ankle injuries with 83% accuracy. To the best of our knowledge, AI has not been studied in the setting of more advanced imaging (ie, CT). The purpose of this study was to evaluate accuracy of a first AI algorithm to automatically segment and reconstruct CT scans into 3-dimensional (3D) surface rendered models.

Methods: All CT scans were manually segmented and reconstructed into 3D surface rendered models according to current standards and served as the reference standard for the current study. The AI algorithm automatically segmented all 348 2D CT scans by using 2 AI deeplearning algorithms into 3D surface rendered models. The deep-learning model for automatic segmentation consisted of two 2D convolutional neural networks: 1 segmentation model and 1 shape model. Both of them used a popular U-Net architecture for segmentation, which is structured in an hourglass shape with an encoder and decoder part. Because the details of raw predictions were too crude for our medical application, we used another neural network on top in order to refine edges of the bone predictions. The refinement architecture was motivated by Deep Image Matting. To get the final result, we used another U-Net network as a shape model, motivated by Anatomically Constrained Neural Networks. The goal of this autoencoder model was to learn an internal representation of the anatomic shape of segmentation masks and use it as a regularization of our segmentation model. Accuracy of 3D-CT surface rendered models of the respective intra-articular fractures using automated segmentation were compared to the manually segmented Q3DCT models, serving as a reference standard for all consecutive cases according to the Jaccard index.

Results: In total, 346 of 348 CT scans were automatically segmented and reconstructed into Q3DCT models of intra-articular fractures (99%). In 2 cases, the deep-learning algorithm could not reproduce a 3D model. According to the Jaccard index, the AI deep-learning algorithm (Healthplus.ai) had an accuracy of 93% compared to manual for the remainding 346 cases.

Conclusion: Our AI algorithm could automate segmentation of 2D-CT images and reconstruct 3D surface rendered models in 99% of cases with 93% accuracy. However, additional research with thousands of cases are needed to further "feed" the algorithm in order to increase accuracy. These results are a promising first step in this field. However, additional research with thousands of cases are needed to further "feed" the algorithm in order to increase accuracy.

Does Sagittal Plane Alignment and Surgical Approach Affect Pilon Fracture Outcomes?

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Purpose: The purpose is to evaluate the postoperative anterior distal tibial angle (ADTA) and lateral talar station (LTS) based on the surgical approach, and the effect on outcomes. Our hypothesis was that the anterolateral approach (AL) would improve the sagittal plane parameters due to the primary plate placement.

Methods: A retrospective review was performed on patients undergoing open reduction and internal fixation (ORIF) of pilon fractures at 2 academic trauma centers between September 2005 and September 2016. Inclusion criteria included AO/OTA 43 acute fractures with clinical follow-up to healing. Clinical data points included: demographics, comorbidities, AO/OTA fracture classification, surgical approach, and complications. Quality of reduction was measured using the ADTA, lateral distal tibial angle (LDTA), and LTS from radiographs.

Results: 576 pilon fractures were reviewed. Primary surgical approaches included 205 modified anteromedial (AM), 154 AL, and 217 consisted of additional/other approaches. When compared to the AL approach, the modified AM approach had decreased rates of local wound care (13.2% vs 14.9%), and unplanned reoperations (23.4% vs 27.9%). However, the modified AM approach had increased rates of superficial infection (18.1% vs 13.0%), deep infection (13.7% vs 12.3%), and amputations (4.4% vs 3.3%). There was no difference in ADTA, LDTA, or LTS between the modified AM and AL approach (P = 0.49, P = 0.41, P = 0.85), respectively. There was a significant difference in LDTA when comparing AM and posterolateral (PL) as well as AL and PL (P = 0.03, P = 0.01). There was no difference in ADTA or LTS with AM versus PL (P = 0.44, P = 0.50) and AL versus PL (P = 0.27, P = 0.47). 243 patients reported tobacco use, while 333 reported no tobacco users (P = 0.01). When comparing age (>65 years vs <65) there was no difference in ADTA, LDTA, or LTS (P = 0.61, P = 0.80, P = 0.19, respectively). There was no significant difference in ADTA, LDTA, or LTS (P = 0.61, P = 0.80, P = 0.19, respectively). There was no significant difference in ADTA, LTDA or LTS (P = 0.61, P = 0.80, P = 0.19, respectively).

Conclusion: The sagittal plane alignment does not appear to be affected by the surgical approach. Therefore, the surgical approach to pilon fractures should be based on the fracture pattern. Our study shows that the modified AM approach compared similarly to the AL approach with regard to complications, unplanned operations, and quality of reduction. Tobacco use may impact quality of reduction; however, age (>65 years) and diabetes do not appear to significantly impact the quality of reduction. This study shows that the modified AM is a safe and effective approach to complex fractures and the surgeon should consider the specific fracture pattern when choosing the specific approach.

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

SCIENTIFIC POSTER #6 Foot, Ankle, Pilon

Supination Adduction Ankle Fractures Develop Early Posttraumatic Arthrosis Kimberly Jacobsen, MD; Justin Haller, MD; Reza Firoozabadi, MD; Hunter Ross, BS; Julie Agel, ATC; Michael Githens, MD

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Purpose: Supination adduction (SAD) ankle injuries, as characterized by a tension failure fibula fracture and vertical shear medial malleolar fracture, have not been well studied. These injuries can be associated with medial tibial plafond impaction and talar dome injuries. The incidence of tibial plafond impaction in SAD ankle fractures is unknown, as are rates of posttraumatic arthrosis, secondary operations, and treatment failure. The primary purpose was to identify the rate of tibial plafond articular impaction associated with SAD ankle fractures. Secondary purposes include identifying rates of posttraumatic arthrosis, secondary operations, and treatment failure arthrosis, secondary operations of posttraumatic arthrosis, secondary operations of posttraumatic arthrosis.

Methods: A retrospective review of a prospectively collected data base at a Level-I trauma center was performed. Fractures associated with OTA codes 44A-C and 43B from 2005-2015 were screened for SAD ankle injuries. Patient demographics and injury characteristics including coronal and sagittal articular impaction of the medial tibial plafond were analyzed using injury CT scans. Treatment strategies including whether the impaction was addressed, implant choice, and duration of non-weight-bearing were analyzed. Posttraumatic arthrosis was graded using the Kellgren-Lawrence (KL) scoring system at 6 months, 1 year, and final follow-up.

Results: 777 ankle fractures were identified, 81 of which were SAD patterns. Of those patients who underwent CT scan, 84% had medial tibial plafond impaction. The mean sagittal impaction was 6.6 mm and coronal impaction was 6.1 mm. 88% of impaction injuries were multifragmentary. 30% had associated talar dome injuries. For those fractures with talar impaction, the maximum sagittal impaction was significantly larger than those without talar impaction.45 patients had at least 6 months follow-up and 25 had over 1 year follow-up (average 25.4 months). At 6 months, 84% of patients had developed posttraumatic arthrosis, increasing to 95% at 1 year. Five patients progressed 1 grade of arthritis between 6 months and 1 year and 2 patients progressed 2 grades at 1 year. 20 patients had progressed at least 1 grade from their 6-month to final follow-up. The presence of impaction was not associated with development of arthrosis. 13 patients underwent removal of implants for pain, 2 patients went on to fusion, and 1 went on to a total ankle arthroplasty.

Conclusion: SAD ankle injuries have a high rate of medial articular impaction and development of early posttraumatic arthrosis. The presence of articular impaction did not effect the development of arthrosis. Secondary operations for implant removal were common, while treatment failure in this cohort was rare. Functional outcomes and long-term prognosis after SAD ankle injuries remain unclear and should be the focus of further study.

See the meeting app for complete listing of authors' disclosure information.

SCIENTIFIC POSTER #7 Foot, Ankle, Pilon

Outcomes Following Salvage of Extruded Talus Injuries

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Purpose: The purpose of this study was to describe fracture characteristics, treatment, and clinical outcomes of extruded talus injuries.

Methods: The study included 46 patients with extruded talus injuries enrolled in a prospective multicenter study between 2011 and 2016. Patients were between 27 and 53 years of age and 56% were female. Injury classification and treatment characteristics were documented. Hospital readmissions and complications along with function using the Short Musculoskeletal Function Assessment (SMFA), and pain using the Brief Pain Inventory (BPI) were evaluated 18 months after injury. All results are descriptive. Readmissions were estimated using a Poisson model with offset for follow-up time. Complication rate was calculated using a Kaplan-Meier non-parametric estimator.

Results: Of the 46 patients, 5 underwent primary amputation, leaving 41 treated with limb salvage. None of the 41 salvage patients had a subsequent amputation. Injuries were primarily open (88%) and included type IIIA (n = 35) and type IIIB (n = 1) fractures. 11 were severely contaminated, 3 had bone loss >2 cm, 1 required split-thickness skin graft, 1 required free tissue transfer, and 1 patient had heel-pad degloving. Associated injuries included fractures of the talus (n = 28), calcaneus (n = 8), tibia shaft (n = 10), pilon, and ankle and multiple foot injuries (n = 2). Patients were treated with external fixation (n = 29) or screws/ plates (n = 12). There were 14 complications in 8 salvage patients; 10 infections required debridements, 1 wound dehiscence, and 3 fixation failures required revision surgery. The probability of remaining complication free at 18 months was 0.80 (95% confidence interval [CI]: 0.67, 0.93). The estimated annual rate of injury-related hospitalization among salvage patients is 0.47 (95% CI: 0.31, 0.67). 87% of patients are estimated to be free of deep infection at 18 months (95% CI: 0.77, 0.99). SMFA scores were available on 37 patients. Scores were high across all domains (bother = 30, dysfunction = 31, mobility = 42, daily activities = 37, and emotional = 39) relative to published population norms. Pain severity and interference were 3.5 and 4.0, respectively, on a scale of 0 to 10 (higher scores are worse).

Conclusion: Extruded talus injuries are uncommon injuries, usually open, and present with associated extremity injuries. Complications consist of infection and fixation failure. Self-reported function, physical performance, and pain are poor more than 1 year out from injury.

SCIENTIFIC POSTER #8 Foot, Ankle, Pilon

Supination Adduction Ankle Fractures Are Associated with Complications and Poor Outcomes

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Purpose: Ankle fractures resulting from a supination adduction (SA) mechanism are uncommon and have been infrequently described in prior literature. Damage to the medial tibia plafond may be associated with these injuries and could portend poor function. The purpose of this study was to compare complications and outcomes for SA injuries versus torsional ankle fractures.

Methods: 1545 consecutive adult patients treated for an ankle (OTA 44) or simple tibial plafond (OTA 43B) injury at a single Level-I trauma center over 16 years were reviewed. Complications included superficial infection, deep wound infection, deficient wound healing, nonunion, malunion, and posttraumatic arthrosis (PTA: radiographic presence of osteophytes, joint space narrowing, or subchondral sclerosis/cysts at minimum 1-year follow-up). Patient-reported outcomes, as measured by the Foot Function Index (FFI) and Short Musculoskeletal Function Assessment (SMFA), were obtained after minimum 12 months. The most recent 200 consecutive patients treated for torsional ankle injuries (OTA 44, not SA) served as controls for comparison to SA patients.

Results: 50 patients with SA injuries were identified (3.2%). They were younger (41 vs 48 years, P = 0.016), with no other differences in other demographic or social characteristics. 62% of those with SA injury were involved in a motorized collision (vs 18.5%, P <0.001). Higher rates of other hindfoot injury (28% vs 4.5%), other orthopaedic injury (68% vs 25%), and other nonorthopaedic injury (46% vs 9.5%) were seen in the SA group (all P <0.001). 50% of those with an SA injury experienced at least 1 complication, versus 24% in the control group (P <0.001). Those with SA injury had more PTA (78% vs 40%, P = 0.006), but no differences were noted in infection, malunion, or nonunion. SA patients more often underwent unplanned secondary procedures (20% vs 4.0%, P <0.001), including ankle arthrodesis (6.0% vs 0, P = 0.008) and removal of painful implants (12% vs 1.0%, P = 0.001). FFI disability (56.5 vs 39.7, P = 0.046) and total scores (48.4 vs 34.2, P = 0.059) were higher (worse) after SA injures, as were SMFA dysfunction scores (39.0 vs 28.2, P = 0.052).

Conclusion: SA injuries represented 3.2% of all ankle injuries, occurring in younger patients and via higher energy mechanisms more often associated with polytrauma. Functional outcomes are worse after SA injuries. Almost 80% of patients developed PTA, and SA patients more often had secondary procedures for pain relief, warranting counseling to patients about long-term sequelae of their injury.

SCIENTIFIC POSTER #9 Foot, Ankle, Pilon

High-Energy Midfoot Fracture-Dislocations: Does Staged Treatment with External Fixation Help?

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Purpose: High-energy Lisfranc fractures are often associated with significant malalignment and soft-tissue trauma leading to delayed fixation. The purpose of this study is to analyze the clinical outcomes of patients treated for high-energy midfoot (Lisfranc) injuries with temporary surgical stabilization prior to definitive surgical fixation, with particular detail to soft-tissue complications compared to a control group treated initially with splint only.

Methods: We evaluated patients at 3 Level-i trauma centers with high-energy Lisfranc injuries reduced and temporized (TS) with an external fixator (EF) or percutaneous pinning (PP) prior to definitive fixation. We then compared to a matched control group (C) of high-energy Lisfranc injuries treated with splint only. The definitive surgical stabilization was either open reduction and internal fixation (ORIF) or arthrodesis at the discretion of the surgeon. Clinical parameters, complications, and need for additional surgery were evaluated. Descriptive statistics and nonparametric tests were used.

Results: There were 15 patients in group C and 29 patients with temporary stabilization (TS). The average age of both groups was 36 years (range, 17-78). The average time to definitive surgical stabilization was 10 days in the C group and 21 days in the TS group (P < 0.01). 12 of 15 patients in group C were treated with ORIF while 21 of 29 patients in the TS group were treated with ORIF (NS [nonsignificant]). The nonunion rate was 2/15 in group C and 5/29 in the TS group (NS) (P = 0.55). The average time to full weight bearing was 3.2 months in group C and 4.2 months in the TS group (P < 0.02). There were 13 additional surgeries in the C group, including 8 for removal of hardware (ROH) and 1 conversion from ORIF to fusion. There were 23 additional surgeries in the TS group including 16 ROH and 3 conversions from ORIF to fusion. There was no significant difference in additional operations between the C and TS groups (P = 0.35).

Conclusion: High-energy Lisfranc injuries treated with TS resulted in a longer delay to definitive surgery and full weight bearing compared to controls. This may be due to higher energy injury and skin compromise in those patients who had TS. Definitive stabilization with either ORIF or arthrodesis produced similar results in treatment of these injuries. Both the TS and C groups demonstrated no significant difference in the number of additional operations, infection rate, incidence of deep vein thrombosis, nonunion, or need for orthotics postoperatively (P >0.05). The most common secondary surgery was ROH for both groups.

SCIENTIFIC POSTER #10 Foot, Ankle, Pilon

Redislocation After Splinting for Ankle Fracture-Dislocation: Is a Temporizing External Fixator a Better Care Plan?

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Purpose: Temporizing management of ankle fractures has traditionally been closed reduction and splintage. Unstable ankle fracture-dislocations, however, may have an increased propensity for loss of reduction/redislocation causing further chondral damage and/or softtissue complication. The purpose of this study was to determine the rate of complications with the traditional care paradigm consisting of closed reduction and splinting of unstable ankle fracture-dislocations. Further, we determined the efficacy of immediate external fixation as an alternative to splinting in cases too swollen for acute operation.

Methods: This retrospective chart review analyzed all ankle fracture-dislocations that came through a large health care system (2 Level-I trauma centers and 3 community hospitals) from 2008-2018. Ankle fracture- dislocation was defined as >50% subluxation of the talus in relation to the tibia. Patients managed with acute open reduction and internal fixation (ORIF) and open fractures were excluded. In patients with delayed management, patient cohorts were divided into those temporized with closed reduction/splinting versus external fixation. Rate of complications was analyzed including loss of reduction and soft-tissue compromise. Two-tailed Fisher exact test was used to compare rates of redislocation and rates of development of skin necrosis with significance set at P <0.05.

Results: 354 closed ankle fracture-dislocations were identified. 298 patients (84%) underwent ORIF within 48 hours and were excluded. 28 (15F/13M, average age 46.8 years) were placed in an external fixator and 28 (22F/6M, average age 57.2 years) were reduced, splinted, and discharged. The external fixator cohort was composed of 23 44B-3 and 5 44C-2 fractures, and the splint cohort was composed of 24 44B-3 and 4 44B-2 fractures. At follow-up, 14 of the patients (50%) in the splint group developed loss of reduction and 5 of these patients (17.6%) developed anteromedial skin necrosis from skin tenting. Patients in this subgroup experienced an average delay to definitive surgery of 27 days. None of the patients in the external fixator cohort developed pin-site infection requiring intravenous antibiotics. The rate of redislocation and the rate of development of skin necrosis was significantly higher in cases temporized with a splint versus an external fixator (P<0.01 and P = 0.05, respectively).

Conclusion: In ankle fracture-dislocations not treated with acute ORIF, splint immobilization is associated with an increased rate of complications, including redislocation and skin necrosis, when compared to a temporizing external fixator.

Safety and Cost-Efficacy of Surgical Fixation of Isolated Ankle Fractures in a Free-Standing Ambulatory Surgical Center (ASC) /versus Hospital-Owned Outpatient Facility (HOPD)

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Purpose: Free-standing ambulatory surgical centers (ASCs) typically provide uncomplicated surgical procedures in a non-hospital setting, and function as "focused factories" that replicate the delivery of quality care while achieving lower costs as compared to hospital-owned outpatient facilities (HOPDs). Despite an increasing interest toward outpatient foot and ankle surgery, few studies have compared the safety and cost-savings associated with surgical fixation of isolated ankle fractures in a free-standing ASC versus an HOPD.

Methods: The 2007-2014 Humana Administrative Claims (HAC) database was queried using CPT codes to identify patients undergoing open reduction and internal fixation (ORIF) for unimalleolar (27766, 27769, 27792), bimalleolar (27814), and trimalleolar (27822, 27823) ankle fractures. Patients with polytrauma or those undergoing a concurrent surgical fixation of the upper extremity, hip, femur, knee, or tibia were removed from the study to capture a relevant cohort of isolated ankle fracture patients. Location of surgery was identified using service location codes 22 (HOPD) and 24 (ASC). Propensity-score matching and multivariate regression analyses were used to compare differences in 90-day complications, emergency department (ED) visits, and readmissions between the 2 groups. A 90-day cost comparison was also carried out to assess savings associated with surgery in an ASC versus HOPD.

Results: A total of 4832 (80.1%) ankle fractures treated in an HOPD and 1198 (19.9%) in a freestanding ASC were included in the study. Following propensity-score matching to account for differences in baseline demographics and clinical characteristics, each group consisted of 1138 patients. Following multivariate analyses, undergoing surgery in a free-standing ASC versus an HOPD was not associated with a higher rate of 90-day complications (0.73 [95% confidence interval (CI) 0.54-1.00]; P = 0.05), ED visits (odds ratio [OR] 0.86 [95% CI 0.64-1.16]; P = 0.331), and readmissions (0.79 [95% CI 0.53-1.18]; P = 0.251). Furthermore, undergoing surgery in a free-standing ASC was associated with nearly \$2500 cost-savings/ case over the 90-day episode of care (ASC = \$8058 vs HOPD = \$10,619; P < 0.001).

Conclusion: Using national administrative claims of commercial insurance beneficiaries, the results of the study show that performing surgical fixation of ankle fractures in a free-standing ASC is a safe and cost-effective option in a carefully selected patient population.

SCIENTIFIC POSTER #12 Foot, Ankle, Pilon

How Do Pilon Fractures Heal? An Analysis of Dual Plating, Biomechanically Matched Fixation, and Callus Formation

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Purpose: Recent literature has suggested the use of multiple implants and supplemental dual column plating of pilon fractures, either to support fragments on the opposite side of the bone or to provide additional mechanical support to the comminuted metaphyseal region. It is uncertain whether supplemental plating augments or impairs healing in pilon fractures. It is also unclear whether this fixation is rigid enough to negatively impact callus formation. The purposes of this study were: (1) to determine the effect of single versus dual plate metaphyseal fixation for pilon fractures on callus formation and reoperation rates, (2) to determine the effect of biomechanically optimal versus mismatched fixation on callus formation and reoperation rates, and (3) to determine whether any patient or surgical factors were independent predictors of callus formation or need for reoperation.

Methods: A retrospective comparative study was designed, which included 50 patients with AO/OTA type C2 or C3 pilon fractures treated with plate fixation over a 12-year period at a single institution. Comparisons were made between patients with single versus dual plate metaphyseal spanning fixation, and patients treated with biomechanically optimal (eg, medial implant for a varus injury) or mismatched fixation. Modified Radiographic Union Score for Tibial fracture (mRUST) scores at 3 and 6 months were calculated, and reoperation rates were determined.

Results: At 6months, mean mRUST scores were significantly lower in patients treated with dual metaphyseal plates compared to those with a single plate (8.7 vs 10.4, P = 0.046). In the multivariate analysis, presence of an open fracture (OR [odds ratio] 51.05, P = 0.008) was the only risk factor for reoperation. Screw density between 0.4 and 0.5 was a protective factor against reoperation (OR 0.03, P = 0.026). Biomechanically mismatched fixation did not affect mRUST scores or reoperation rates.

Conclusion: Pilon fractures treated with a single plate formed more callus 6 months after surgery compared to those treated with dual plate fixation, and there was no difference in reoperation rates. Screw density between 0.4 and 0.5 was a protective factor against reoperation. Open fractures were more likely to require a revision operation. This data may serve as the basis of future work to determine the ideal fixation construct for the frequently comminuted metaphysis in pilon fractures. Data on screw density and reoperation rates may inform surgeons who treat these injuries.

SCIENTIFIC POSTER #13 Foot, Ankle, Pilon

Comparison of Infection Rates Between Early Primary and Delayed Fixation of 478 Complete Articular Pilon Fractures

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Purpose: Tibial pilon fractures typically occur from high energy axial loading or torsional injuries. Historically, outcomes following surgical fixation have been poor, fraught with high rates of wound infection and dehiscence. Staged open reduction and internal fixation (ORIF) has been advocated to reduce the risk of infection and wound complication. However, there are some reports that early ORIF may be safe when the soft tissues appear appropriate. At our institutions, some surgeons treat pilon fractures with urgent early fixation while others prefer a staged fixation strategy. We sought to compare the infections between early, primary ORIF and delayed fixation.

Methods: Records of 644 patients (19-87 years old) with pilon fractures from 2001-2018 were reviewed. 478 OTA type 43C fractures were identified and included in the study. Patients were divided into three groups based on timing of definitive fixation from initial injury: acute (<48 hours), intermediate (48 hours to 1 week), and delayed (>1 week). Univariate and multivariate logistic regression analyses were performed.

Results: The study population included 478 patients (66% male), mean age of 45.1 years and mean follow-up of 2.8 years. 282 (59%) were initially treated with external fixation (exfix) and underwent definitive ORIF at a mean of 14.2 days from time of ex-fix. Regarding timing of ORIF, 140 (29.2%) were fixed within 48 hours, 81 (16.9%) were fixed between 48 hours and 1 week, and 257 (53.4%) were fixed over 1 week from injury. Overall infection rates (early 28.6%, intermediate 33.3%, delayed 28.8%, P = 0.71) and deep infection rates (early 16.4%, intermediate 25.9%, delayed 21.0%, P = 0.23) did not significantly differ between groups. Smoking (odds ratio [OR], 1.9), open fractures (OR, 1.7), and use of an external fixator (OR, 1.7) were found to be independently associated with an increased risk of deep infection. Diabetes (OR, 3.2) was independently associated with an increased risk of superficial infections.

Conclusion: The risk of deep infection following fixation of tibial plafond fractures does not appear to be related to time to definitive fixation. When the soft-tissue envelope presents with limited swelling and blistering, early primary ORIF appears to be a safe strategy. Patients with open fractures, external fixation, and smoking are at increased risk of deep infections while diabetics are at increased risk of wound infections. The increased risk of infection in patients treated with external fixators likely represent patients with higher-energy injuries with open injuries and/or significant soft-tissue damage.

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

Reduction Quality of Intra-Articular Calcaneal Fractures with Sinus Tarsi versus Extensile Lateral Approach on Postoperative CT Scans and Radiographs

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Purpose: Calcaneal fractures require accurate joint reduction to minimize the risk of subtalar arthritis. The extensile lateral approach (EL) and the sinus tarsi approach (ST) are widely utilized. Most studies comparing ST versus EL approaches use plain radiographs for reduction assessment. Our goal was to evaluate calcaneus fractures with postoperative CT scans and plain films to determine differences in reduction quality based on fracture pattern and approach

Methods: All operative calcaneal fractures from 2012-2018 at our Level-I center were reviewed. Exclusion criteria were: extra-articular fractures, malunion repair, percutaneous fixation, acute fusion, and no postoperative CT scan. Sanders classification was utilized. Cases were split into 2 groups based on EL versus ST approach. CT parameters were step-off or gap within the posterior facet, and tuberosity varus angulation: excellent (E) was no gap, no step, and no angulation; good (G) was <1 mm step, <5 mm gap and/or <5° of angulation; fair (F) was 1-3 mm step, 5-10 mm gap, and/or 5-15° angulation; and poor (P) was >3 mm step, >10 mm gap, and/or >15° angulation. We also evaluated Bohler's angle and Gissane's angle on plain radiographs and graded them as normal (20-40° and 120-145°, respectively), high, or low.

Results: 77 patients with 83 fractures were included. Average age was 42 years, with 57 males. Four fractures were open. There were 37 Sanders II, 43 Sanders III, and 3 Sanders IV. 36 were ST and 47 were EL. Average days to surgery were 5 for ST and 14 for EL (P <0.001). Normal Bohler's angle was achieved more often with EL (91.5%) than with ST (77.8%) (P <0.001). There was no difference by approach for Gissane's angle (P = 0.5). EL had better overall reduction quality (P = 0.02). ST reduction was: E, 19.3%; G, 36.1%; F, 22.2%; and P, 22.2%. EL reduction was: E, 14.9%; G, 57.4%; F, 25.5%; and P, 2.1%. For Sanders II, there was no difference in reduction quality with ST versus EL (P = 0.51). ST reduction was: E, 35.7%; G, 50%; F, 7.1%; and P, 7.1%. EL reduction was: E, 26.1%; G, 69.6%; F, 4.3%; and P, 0%. For Sanders III/IV, EL trended toward better reduction quality (P 0.06). ST reduction was: E, 9.1%; G, 27.3%; F, 31.8%; and P, 31.8%. EL reduction was: E, 4.2%; G, 45.8%; F, 45.8%; and P, 4.2%.

Conclusion: EL had better overall reduction quality on postoperative CT scan and Bohler's angle on plain films. However, for Sanders II there was no difference between ST and EL. For Sanders III/IV, EL trended toward better reduction quality. In addition to fracture pattern, early wound complications and long-term outcomes must also be considered in future studies comparing the EL and ST approaches.

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Refining Risk Adjustment of 90-Day Costs Following Surgical Fixation of Ankle Fractures: Moving Toward Bundled Payments in Orthopaedic Trauma *Azeem Tariq Malik, MBBS; Carmen E. Quatman, MD, PhD; Thuan V. Ly, MD; Laura Phieffer, MD; Safdar N. Khan, MD The Ohio State University Wexner Medical Center, Columbus, OH, United States*

Purpose: Current literature revolving around understanding determinants of 90-day costs following ankle fractures is limited to single-institution studies. As the current health-care model transitions from fee for service to value-based payments, risk adjustment of 90-day costs will be a key factor driving success of these bundled payment models. The current study utilizes a national Medicare database to understand patient-level, procedure- level, and state-level variation in 90-day costs following open reduction and internal fixation (ORIF) of isolated ankle fractures.

Methods: The 2005-2014 5% Medicare SAF (Standard Analytical Files) database was queried using CPT codes to identify patients undergoing ORIF for unimalleolar (27766, 27769, 27792), bimalleolar (27814), and trimalleolar (27822, 27823) isolated ankle fractures. All payments/reimbursements starting from day 0 of surgery up to day 90 postoperatively were used to calculate 90-day costs. Patients with missing data were excluded. Multivariate linear regression modeling was used to derive marginal cost-impact of patient-level (age, gender, comorbidities), procedure-level (fracture type, morphology, location of surgery, concurrent ankle arthroscopy, and syndesmotic fixation), and state-level factors on 90-day costs following surgery.

Results: A total of 6499 patients were included in the study. The risk-adjusted 90-day cost of a non-geriatric (age <65 years) female patient undergoing outpatient ORIF for a closed unimalleolar ankle fracture was \$8915 \pm \$1054. Individuals aged 65-69 years versus <65 had significantly lower costs (-\$1967). Procedure-level factors associated with significant marginal cost increases were inpatient surgery (+\$5577), trimalleolar fracture (+\$1082), and syndesmotic fixation (+\$2822). The top 5 comorbidities with largest marginal cost increases were chronic kidney disease (+\$8897), malnutrition (+\$7908), obesity (+\$5362), cerebrovascular disease/stroke (+\$4159), and anemia (+\$3087). Significant state-level variation in 90-day costs was seen with Nevada (+\$6371), Massachusetts (+\$4497), Oklahoma (+\$4002), New Jersey (+\$3802), and Maryland (+\$3,043) having the highest marginal cost increase and Idaho (-\$6025) having the lowest.

Conclusion: The current study identifies numerous patient-level, procedure-level, and state-level factors that significantly contribute to the cost variation seen in 90-day costs following ORIF for ankle fractures. Risk adjustment of 90-day costs will become a necessity as bundled-payment models begin to take over the current fee-for-service model in fracture patients.

SCIENTIFIC POSTER #16 Foot, Ankle, Pilon

Are Orthopaedic Surgeons Being Adequately Compensated for Ankle Fractures? An Analysis of Relative Value Units

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Purpose: Trimalleolar fractures, as compared to simple unimalleolar fractures, are technically more challenging cases, have longer operative times, and require a higher effort. No study has evaluated whether the current relative value units (RVUs) reflect an appropriate compensation per unit time following open reduction and internal fixation (ORIF) for unimalleolar versus bimalleolar versus trimalleolar ankle fractures.

Methods: The 2012-2017 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) files were queried using CPT codes for patients undergoing ORIF for unimalleolar (CPT 27766, CPT 27769, CPT 27792), bimalleolar (CPT 27814), and trimalleolar (CPT 27822, CPT 27823) ankle fractures. A total of 7830 (37.2%) unimalleolar, 7826 (37.2%) bimalleolar, and 5,391 (25.6%) trimalleolar ankle fractures were retrieved. Total RVUs, mean RVU/min, and mean reimbursement/min were calculated. Mean reimbursement/case was calculated by multiplying the reimbursement rate by the operative time. Kruskal-Wallis tests were used to compare RVUs, operative time, and reimbursements between the 3 fracture groups.

Results: The mean total RVUs for each fracture type was as follows: (1) unimalleolar, 9.99; (2) bimalleolar, 11.71; and (3) trimalleolar, 12.87 (P <0.001). A statistically significant difference was noted in mean operative time (unimalleolar = 63.2 vs bimalleolar = 78.6 vs trimalleolar = 95.5; P <0.001) between the 3 groups. Reimbursement rates (\$/min) decreased significantly as fracture complexity increased (unimalleolar = \$7.21/min vs bimalleolar = \$6.75/min vs trimalleolar = \$6.10; P <0.001). The average reimbursement/case was \$358, \$420, and \$462 for unimalleolar, bimalleolar, and trimalleolar fractures, respectively. Based on a hypothetical scenario, an orthopaedic surgeon spent 190 minutes fixing 2 trimalleolar fractures and earning \$924 in the process. Within a total operative time of 190 minutes, 3 unimalleolar ankle fractures and 2 bimalleolar ankle fractures could be managed completely with an associated earning of \$1074 and \$840, respectively.

Conclusion: Orthopaedic surgeons are reimbursed at a higher rate (\$/min) for treating a simple unimalleolar fracture as compared to bimalleolar and trimalleolar fractures, despite the higher complexity and longer operative times seen in the latter. The study highlights the need of a change in the RVUs for bimalleolar and trimalleolar ankle fractures to ensure that surgeons are adequately reimbursed per unit time for treating a more complex fracture case.
SCIENTIFIC POSTER #17 Foot, Ankle, Pilon

Effects of Obesity on Complications and Functional Outcomes After Fixation of Torsional Ankle Injuries: A Matched Cohort Study

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Purpose: Obesity is a growing public health concern in developed countries. While diabetes mellitus is associated with obesity and is a risk factor for infection and other complications following ankle fracture, effects of obesity on outcomes after ankle fracture remains less clear. The purpose of this study was to determine effect of obesity on complications, secondary operations, and functional outcomes after torsional ankle fracture.

Methods: 985 adult patients treated surgically for a torsional ankle injury (OTA 44B, 44C) between 2003 and 2015 were reviewed. Demographic information, comorbidities, injury characteristics, complications, and secondary procedures were recorded. Obese patients were identified (body mass index [BMI] >30), and patients without obesity were selected from the same population as controls, matched for age, sex, race, diabetes, and fracture pattern (44B, 44C). Patient-reported outcomes, as measured by the Foot Function Index (FFI) and Short Musculoskeletal Function Assessment (SMFA), were obtained after a minimum of 12 months.

Results: 465 patients had BMI >30. After matching, 632 patients (316 obese [mean BMI, 36.7] and 316 non- obese controls [mean BMI, 25.5]) with mean age 44.6 years (range, 18-94 years) were analyzed. Each group was 52.5% female, and 6.6% of patients in each group had diabetes. 75.6% of fractures in each group were 44B, and 24.4% were 44C. Non-obese patients were more likely to be tobacco users (63.3% vs 40.2%, P <0.001). Obese patients trended toward sustaining more dislocations (41.8% vs 35.4%, P = 0.10), with no differences in frequency of open fracture (15% vs 14%). A trend toward more obese patients requiring syndesmotic fixation (25.9% vs 20.6%) was observed (P = 0.11). 30% of obese patients had at least 1 complication versus 23.4% of controls (P = 0.059), with a trend for more wound healing problems (4.7% vs 2.2%, P = 0.08). Total FFI scores were higher (worse) among obese patients (35.2 vs 26.9, P = 0.008); subcategory scores for disability and activity limitation were also higher (P <0.01) with a similar trend for the pain subcategory (36.4 vs 29.6, P = 0.062). Obesity was associated with worse SMFA bothersome (31.0 vs 23.6, P = 0.018) and mobility scores (41.8 vs 32.5, P = 0.008) and trend for worse dysfunction scores (29.7 vs 24.7, P = 0.06).

Conclusion: Obesity is associated with worse functional outcomes after ankle fracture. Contributions of baseline limitations to these poor scores in obese patients remain unclear. Injury characteristics were similar between obese and non-obese patients, although obese patients may be more prone to dislocation due to large BMI. Overall, there was a trend for obese patients to experience more complications and wound healing issues, although rates of secondary operations were no different.

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

SCIENTIFIC POSTER #18 Foot, Ankle, Pilon

Diagnosing Fractures of the Distal Tibial Articular Surface in Tibia Shaft Fractures: Is CT Always Necessary?

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Purpose: Tibia shaft fractures are commonly associated with fractures of the distal tibial articular surface, with reported rates as high as 43%. Such fractures can be difficult to identify on plain radiographs, and controversy exists regarding indications for CT. The purpose of this study is to identify the incidence of articular fractures in a large series of tibial shaft fractures and to determine the utility of CT scan for diagnosis.

Methods: We conducted a retrospective review of all adult patients with tibia shaft fractures who underwent operative fixation over a 10-year period at a Level-I trauma center. Tibial shaft fracture location, type of articular fracture (extension of primary fracture vs separate malleolar fracture), and time of diagnosis (pre-, intra-, or postoperatively) were determined. Preoperative imaging modalities used and techniques for reduction and fixation were also recorded.

Results: Of the 565 tibial shaft fractures treated operatively during the study period, 106 (19%) had an associated fracture of the distal tibial articular surface. 41 fractures (39%) represented an extension of the primary fracture line, and 64 (60%) were separate malleolar fractures, including 42 fractures of the posterior malleolus (40% of articular fractures) and 22 of the medial malleolus (21%). There was 1 fracture of the anterolateral tibial plafond (1%). 99 of the 106 articular fractures (93%) were identified preoperatively, and 7 were identified intraoperatively (7%). Of the 99 articular fractures identified preoperatively, 90 (91%) were identified on plain radiographs, and 9 (9%) were diagnosed by CT scan (4 malleolar fractures and 5 cases of intra-articular fracture line extension). After excluding 24 CT scans performed for preoperative planning of previously identified articular fractures, a total of 59 preoperative CT scans were performed in search of an intra-articular fracture. In 50 patients (85%), no articular fracture was present, representing a yield of 15% among CT scans performed to rule out an articular fracture. There was no difference in distance from the primary fracture line to the articular surface between articular fractures diagnosed on plain radiographs versus CT (6.1 cm vs 7.9 cm, P = 0.21). Of the 7 articular fractures identified intraoperatively, 5 (71%) were posterior malleolus fractures and 2 were extensions of the primary fracture line. All 7 fractures were nondisplaced.

Conclusion: In a large series of tibia shaft fractures, the incidence of fractures of the distal articular surface was 19%. Plain radiographs alone identified 85% of all articular fractures. CT scans performed in search of articular fractures had a low yield (15%). The majority (71%) of fractures not identified preoperatively were nondisplaced fractures of the posterior malleolus. Widespread use of CT scans to diagnose fractures of the distal tibial articular surface in the setting of tibia shaft fractures does not appear warranted.

SCIENTIFIC POSTER #19 Foot, Ankle, Pilon

Outcomes of Tibiotalocalcaneal Hindfoot Fusion Nails in the Setting of Acute Lower Extremity Trauma

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Purpose: This study was undertaken to evaluate unexpected return to the operating room within 2 years of surgery.

Methods: This Level-IV retrospective case series was conducted at a Level-I academic trauma center. 54 patients with significant comorbidities with acute lower extremity trauma were treated with a tibiotalocalcaneal hindfoot fusion nail. Injuries included 28 (52%) tibial pilon fractures, 9 (17%) bimalleolar ankle fractures, 9 (17%) trimalleolar ankle fractures, 7 (13%) tibial shaft fractures, and 4 (7%) talus fractures; 27 (49%) were open injuries. The average age was 63 years, 32 patients (59%) had diabetes, 46 (85%) cardiovascular disease, 16 (30%) psychiatric disorder, 7 (13%) chronic kidney disease, and 8 (15%) peripheral neuropathy. Average body mass index (BMI) was 32. Patients were followed over a 2-year period, with an average follow-up of 12.5 months.

Results: Of 54 patients included in this study, 22 had an unexpected return to the operating room including 19 for hardware removal, 13 for irrigation and debridement and / or placement of an antibiotic delivery device, 4 for amputation, and 4 for revision fusion. Comorbidities most prevalent in patients requiring reoperation were cardiovascular disease (n = 19, 86%), diabetes mellitus (n = 15, 68%), and psychiatric disorders (n = 10, 45%). Chronic kidney disease (n = 3, 14%) and peripheral neuropathy (n = 5, 23%) were found less commonly in those requiring reoperation.

Conclusion: There was a high rate of return to the operating room for patients in this series, but a relatively low rate of amputation. Since patients were indicated for this course of treatment on the basis of comorbidities felt to put them at high risk for loss of limb with traditional treatment, acute hindfoot fusion nailing may represent a viable option in a select group of high-risk patients and injuries.

SCIENTIFIC POSTER #20 Foot, Ankle, Pilon

Early Definitive Care Is as Effective as Staged Treatment Protocols for Open Ankle Fractures from Rotational Mechanisms: A Retrospective Cohort Study *Rahul Vaidya, MD*; *Muhammad Padela, MD, MSc* Detroit Medical Center, Detroit, MI, United States

Purpose: This study was conducted to compare immediate internal fixation with primary wound closure versus temporary stabilization with delayed fixation and wound closure protocols for management of open ankle fractures from rotational mechanisms.

Methods: A total of 88 consecutive Gustilo-Anderson (GA) type I (7), II (23), and IIIa (58) open ankle fractures from rotational mechanisms were retrospectively analyzed at a single institution. Patients were divided into an immediate internal fixation with primary wound closure (EARLY) cohort and a temporary stabilization with delayed fixation and wound closure (STAGED) cohort. The decision to perform EARLY versus STAGED treatment was dependent on the staff surgeon as 1 surgeon performed definitive treatment EARLY while all other surgeons opted for the STAGED protocol. We compared demographics, radiographic classification, and outcome measures including infection, length of stay, number of operations. Clinical measures included pain levels out of 10 at all clinic visits. Radiographs were also taken at every clinical visit and we rated joint changes as none, degenerative changes present, or severe degenerative changes consistent with posttraumatic osteoarthritis. Ambulation was recorded and divided into limited or unlimited.

Results: 40 patients were treated with the EARLY protocol (45%) and 48 patients (55%) were STAGED. Groups were comparable with regard to age, gender, comorbidities, ASA (American Society of Anesthesiologists) classification, fracture type, mechanism of injury, GA classification, and time to initial operation. Mean length of follow-up was 14.0 ± 16.6 months (range, 6-78 months) for the EARLY cohort and 16.6 ± 22.9 months (range, 6-105) for the STAGED cohort (P = 0.57). Overall, 6 patients were diagnosed with infection, corresponding to an incidence of 6.8%. There were 2/40 cases in the EARLY cohort (5%) and 4/48 in the STAGED cohort (8.3%). No significant difference was found between these cohorts (P = 0.68). Mean number of reoperations was significantly greater in the STAGED cohort (121; mean 2.5 \pm 2.90; range, 0-13) as compared to the EARLY cohort (25; mean 0.6 \pm 1; range, 0-4) (P <0.0001). The STAGED cohort had a significantly longer length of hospital stay (10.6 \pm 7.1 days; range, 3-35) versus the EARLY cohort (6.4 \pm 4.7 days; range, 2-25) (P = 0.0003). Clinical outcomes were compared for patients (52) with greater than 12 months of follow-up. Categories included pain, ambulation, or osteoarthritis. There were no significant differences between cohorts for pain ambulation or osteoarthritis. However 30% of patients ranked their pain >4/10, 60% of patients felt that they had some limitation in ambulation, and 37% of patients had evidence of osteoarthritis at their latest follow-up.

Conclusion: Our study showed that early definitive treatment compared to a staged protocol for GA type I, II, and IIIa open ankle fractures from rotational mechanisms has similar rates of infection, shorter hospital stay, fewer surgical interventions, and similar clinical outcomes.

SCIENTIFIC POSTER #21 Foot, Ankle, Pilon

Tibial Shaft and Pilon Fractures with Associated Syndesmotic Injury: A Matched Cohort Assessment

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Purpose: Distal tibiofibular syndesmosis injury and treatment have been extensively studied in association with rotational ankle fractures. However, the incidence and clinical implications of syndesmotic disruption with tibial shaft or pilon fractures is less well defined. The purpose of this study is to define the incidence and severity of tibial shaft and pilon fractures with syndesmotic injury and compare their outcomes to a matched cohort of tibial shaft and pilon fractures without a syndesmotic injury.

Methods: A retrospective review was performed of all patients with tibial shaft or pilon fractures and associated distal tibiofibular syndesmotic injuries over a 5-year period at a Level-I trauma center. A best-fit, 2:1 control group was identified from a trauma database matching the study group for age, OTA fracture classification, and Gustilo-Anderson (GA) classification. Charts and radiographs were reviewed for demographics, neurovascular injuries, incidence of compartment syndrome, and fracture pattern. Outcomes assessed included deep infection, nonunion, unplanned reoperation, and need for amputation. Descriptive statistics, unpaired t-test and χ^2 analysis were used for statistical evaluation.

Results: 30 patients, including 15 tibial shaft and 15 pilon fractures, were found to have associated syndesmotic injuries and were followed until fracture union. The comparison cohort was comprised of 60 patients. In the study period, the incidence of syndesmotic injury in all tibia shaft fractures was 2.3% and in pilon fractures 3.4% (P = 0.292). The incidence of GA 3A fractures was 43% and GA 3B fractures was 20%; no GA 3C fractures were included. The syndesmotic injury group had more neurologic injuries (23% vs 6%, P = 0.03), more vascular injuries not requiring repair (30% vs 16%, P = 0.13), and a higher rate compartment syndrome (6.7% vs 0%, P = 0.13). Segmental fibula fracture was significantly more common in patients with a syndesmotic injury (37% vs 17%, P = 0.005). Average fracture follow-up was 446 days. 50% of the syndesmotic injury group underwent an unplanned reoperation with significantly more unplanned reoperations (1.3 vs 0.5, P = 0.01). The injury group had a significantly higher deep infection rate (27% vs 9.8% P = 0.046), and a significantly higher rate of amputation (26% vs 4%, P = 0.002), while the nonunion rate was similar (17% vs 16%, P = 0.86).

Conclusion: While syndesmotic injuries with tibial shaft or pilon fractures are rare, they are a marker of an incredibly devastating injury. The presence of a segmental fibula fracture should alert clinicians to evaluate for syndesmotic injury, if not clearly identified on plain radiographs. Patients with tibial shaft/pilon fractures and associated syndesmotic injuries have high rates of reoperation, deep infection, and amputation. Clinicians should counsel patients on the negative impact syndesmotic injury has on outcomes in tibial shaft and pilon 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.

Variation in Implant Selection for Ankle Fractures: Identifying Cost-Drivers

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Purpose: There is significant variability in the cost of implants in orthopaedics without evidence of improved outcomes for more expensive constructs. The purpose of this study is to identify cost-drivers and determine if specialty training is linked to implant selection.

Methods: A 2010-2017 review was performed on 1278 patients at a Level-I trauma center. Patients were excluded for skeletal immaturity, open fractures, and concurrent surgeries. Variables assessed included demographics, OTA and Weber classifications, surgeon specialty, and use of locking plates and cannulated screws. Cost was determined via implant model numbers cross-referenced with the chargemaster database. Analysis involved intergroup comparative tests, regression, and goodness-of-fit analyses.

Results: Mean patient age was 46.1 years among 613 males and 665 females. Costs differed among OTA patterns (P <0.01), highest among 43C (\$3771) and lowest with 44A (\$819). OTA pattern prevalence was 44B (74%), 44C (16%), 44A (8%), and 43A-C (2%). Costs were comparable across Weber patterns (P = 0.15), with Weber B being the highest (\$1494). Weber pattern prevalence was B (74%), C (17%), and A (1%). Costs were highest among reconstructive, foot and ankle, and podiatric surgeons, with mean costs of \$1804, \$1404, and \$1357, respectively. Traumatologists offered the lowest price (\$987). 433 procedures (33.8%) utilized locking plates with 512 (40.0%) utilizing at least 1 cannulated screw. Locking plates averaged a larger total implant cost (\$1547) than nonlocking plates (\$1313). Use of a cannulated screw had a higher cost (\$1633 vs \$1245).

Conclusion: There was significant variation in implant costs used for surgical management of the reviewed ankle fractures. Cannulated screws and locking plates were independent cost-drivers. Traumatologists offered significantly more cost-effective constructs than other specialties.



Scatterplot visualizing the total construct cost for ankle fracture between 2010 and 2017, between a metropolitan level I trauma center and an accompanying ambulatory surgery center (N=1281). Implants are sorted by increasing fracture fixation methodology and date of procedure within each fixation method.

SCIENTIFIC POSTER #23 Foot, Ankle, Pilon

The Impact of Regional Anesthesia for Postoperative Pain Following Ankle Fracture Surgery

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Purpose: Trauma patients with ankle fractures often receive a nerve block to help with postoperative pain following open reduction and internal fixation (ORIF) of their fracture. However, readmissions and patient experience related to rebound pain after the nerve block wears off are a large concern. The objective of this study was to determine if complications and/or readmission rates are greater in patients who received a supplemental regional anesthesia after ORIF of their ankle fracture compared to patients who underwent general anesthesia alone (GA).

Methods: Using the National Surgical Quality Improvement Plan Participant Use Files, a comparative study was done on patients who underwent ORIF of an isolated closed ankle fracture during 2014-2016 and received GA or general anesthesia plus supplemental regional anesthesia (RA). These patients were further stratified by an inpatient or outpatient surgery setting. Demographic data, operative duration, length of hospital stay (LOS), postoperative complications, and 30-day readmissions were compared between the 2 groups.

Results: A total of 9459 patients were identified (1602 RA and 7857 GA). Patients in the RA group had significantly longer operative duration in both inpatient (79 vs 71 min; P = 0.0024) and outpatient setting (72 vs 66 min; P < 0.0001), shorter LOS overall (1.1 vs 1.7 days, P < 0.001), and a trend in shorter outpatient LOS (0.2 days vs 0.4 days, P = 0.067). There was no significant difference in overall complications. Readmission rates for pain in the outpatient setting was significantly higher in the RA group (P = 0.004).

Conclusion: The results emphasize that those who received supplemental regional anesthesia had significant increased operative time, decreased LOS, and higher readmission rates for pain. Patients who choose to receive a supplemental nerve block after ORIF of ankle fracture should be counseled about the phenomenon of rebound pain and higher likelihood of readmission for postoperative pain control.

SCIENTIFIC POSTER #24 Foot, Ankle, Pilon

Gunshot Wounds to the Foot and Ankle: A Multicenter Study with 264 Patients William L. Shelton, MD; Peter C. Krause, MD; Claudia Leonardi; Rabun Samuel Fox, MD; Samuel Harry Klatman, MD; Laura De Latin; Mallory Lowe, BS; Anna Noel Miller, MD; Brian Mullis, MD; Heather A. Vallier, MD; Clay A. Spitler, MD; Kevin Francis Purcell, MD; Jonathan Carr Savakus, BS; Emily Wichern, BA, BS; Justin U. Tilan, MD LSUHSC - New Orleans, New Orleans, LA, United States

Purpose: There is a paucity of research evaluating outcomes of ballistic injuries in the foot and ankle. We aim to report the characteristics, demographics, treatments, outcomes, and complications of fractures of the foot and ankle due to firearms in a multicenter retrospective study.

Methods: Patients who sustained gunshot wounds (GSWs) resulting in ankle or foot fracture (OTA 8, 43, 44), over a 10-year period, were identified at 5 trauma centers. Patient charts and radiographs were reviewed and demographics, fracture characteristics, initial management, additional procedures, and subsequent infection, malunion, or nonunion were collected. Data were analyzed using SAS/STAT software. Univariate and multivariate analyses were performed. Multivariate logistic regression included risk factors that were associated with infection in univariate analysis.

Results: 264 patients met inclusion criteria. 95.5% were males, averaging 30 years old (range, 12-73 years). 15.3% of the GSWs were high velocity, and 84.7% were low velocity (n = 216). Bullet fragments were retained in 58.7% of patients. Antibiotics were given to most patients (79.5%), and 41.8% of patients were managed surgically at time of injury (n = 263). Nerve injury was found in 8.8% of cases (n = 263), and vascular injury was found in 7.3% of cases (n = 262). Malunion and nonunion were observed in 8.3% and 1.9% of the patients, respectively. Infection was observed in 17.4% of patients, and was associated with GSW velocity (P = 0.002) as well as retained bullet fragments (P = 0.009). Infection was not associated with antibiotics on arrival (P = 0.227), initial surgical management (P = 0.070), nerve injury (P = 0.145), or vascular injury (P = 0.053), in unadjusted analysis. In our multivariable model, which included ballistic velocity, retained bullet fragments, vascular injury, and surgical management, the odds of infection were 3.47 times higher for high-velocity GSWs compared to low-velocity GSWs (95% confidence interval [CI]: 1.38, 8.75) and 3.33 times higher when the ballistic was retained versusnot retained (95% CI: 1.42, 7.84).

Conclusion: In this multicenter, retrospective study evaluating fractures secondary to gunshot to the foot and ankle, we found subsequent infection associated with high-velocity GSWs and retained bullet fragments. In fractures due to high-velocity GSWs, managed operatively, we recommend caution regarding the increased chance of infection. In all GSW fractures of the foot and ankle, we recommend consideration for removing retained bullet fragments when feasible. Further prospective studies will be needed to validate this finding.

SCIENTIFIC POSTER #25 Foot, Ankle, Pilon

Is One Screw Adequate to Secure the Medial Malleolus in an Unstable Ankle Fracture?

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Purpose: Ankle fractures are among the most common orthopaedic injuries encountered. The purpose of this study is to analyze any differences in outcomes following fixation of a medial malleolar fracture with 1 versus 2 lag screws.

Methods: Between April 2013 and February 2017, 752 patients who presented at 2 hospitals within 1 academic institution with an unstable rotational ankle fracture and were treated operatively by a trained orthopaedic surgeon were identified. Data collected included patient demographics, injury information, and operative management. Inclusion criteria for analysis included patients who underwent open reduction and internal fixation of an ankle fracture that included fixation of the medial malleolus. Data regarding radiographic outcomes, pos-operative complications, and need for revision surgery were collected. Medial malleolus fragment size was assessed by 1 investigator (J.M.) on the AP and lateral views of the initial injury radiograph. Functional outcome was assessed using the Maryland Foot Score (MFS). Data were analyzed using Fisher's exact tests and Independent t-tests with SPSS version 23 (SPSS Inc).

Results: Out of the 201 patients who met inclusion criteria, 52 patients (25.9%) received 1 medial malleolar screw and 149 patients (74.1%) received 2 screws. Of the patients with 1 medial malleolar screw, 5 patients (9.6%) received additional fixation of the malleolus with 1 Kirschner wire. Our cohort was 62.1% male with an average age at initial injury of 48.0 + 17.8 years. At a mean of 3.8 + 2.6 months, all patients had united their fracture. The average malleolar fragment size on AP radiographic views for patients with 1 screw was smaller than those with 2 screws (14.7 mm + 3.9, 16.4 mm + 3.4, respectively, P = 0.009). Fragment size was also smaller for patients with 1 screw when measured on the lateral view of the radiograph (21.4 mm + 4.7, 26.2 mm + 2.9, respectively, P = 0.001). There was no difference between groups in ankle dorsiflexion or plantar flexion at 1 year postoperatively (P = 0.451, P = 0.581). Patients who received 1 screw did not differ from those who received 2 screws with respect to MFS (P = 0.924). Furthermore, time to healing, postoperative complication rate, and rate of revision surgery did not differ between groups.

Conclusion: The use of a single screw for medial malleolar fixation does not appear to be problematic. This information is especially important in situations when the fragment is too small to accommodate multiple fixation points. The decision of whether to utilize 1 or 2 screws in larger fragments is based upon the orthopaedic surgeon's discretion.

The FDA has stated that it is the responsibility 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 Study: Mental Health Support May Reduce Postinjury Opioid Use in Orthopaedic Trauma Patients Who Screen Positive for PTSD

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Purpose: The perception of pain is multifactorial. Evidence suggests that psychiatric conditions, such as posttraumatic stress disorder (PTSD), reduces coping with painful stimuli and may be associated with catastrophizing. The purposes of this pilot study were to assess the viability of a program providing PTSD screening and offering mental health services to adult trauma patients, and whether such interventions can reduce overall postinjury opioid use.

Methods: This study included adult trauma patients admitted to a Level-I trauma center over a period of 12 months. Demographic and injury information were collected. Patients were screened for PTSD with the PCL-5 (PTSD Checklist for DSM-5) survey during their first outpatient clinic visit (n = 411). For patients who screened positive, a counselor attempted to contact them to offer counseling, support groups, and/or services of a psychologist or psychiatrist. A subset of this population included patients with operatively managed orthopaedic fractures (n = 152). Those who screened positive for PTSD were evaluated in 2 groups: those who received mental health support, and those who did not. The amount of opioid pain medication dispensed from discharge to 1 year following injury was collected from the automated state prescription reporting system and compared between the 2 groups. All opioid medication was converted to morphine milligram equivalents (MME). Patients on long-term opioid maintenance therapy prior to injury were excluded.

Results: 90 patients (21%) screened positive for PTSD. Of those who screened positive, 34 patients (38%) were able to be contacted and accepted 1 or more of the offered mental health services (12 for coaching, 9 for group support, 15 for rehabilitation psychology referral). In the orthopaedic fracture group (N = 152), 32 (21%) screened positive for PTSD, and 14 patients (44%) received 1 or more of the offered mental health services. At 1 year postinjury, total opioid use in patients receiving mental health services was 956 MME, compared to 1534 MME in patients who screened positive but did not undergo mental health interventions (P = 0.36).

Conclusion: Psychiatric conditions may influence pain perception following traumatic injury. This pilot study demonstrates that a program to screen for PTSD in trauma patients, and offer mental health interventions, is viable. Although underpowered to see statistically significant differences, this study also suggests that providing mental health services to trauma patients who screen positive for PTSD may reduce postdischarge opioid use. Further study, including multivariable statistical analysis in a larger sample, appears worthwhile.

Preoperative Opioid Use Is Associated with Many Preoperative Predictors of Poor Outcome in the Trauma Patient Population

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Purpose: Preoperative opioid use increases the risk of poor outcomes after orthopaedic trauma. However, the relationship between this poor predictor and other factors that can also affect outcome have not been well established. The purpose of this study was to investigate if preoperative opioid use is associated with other predictors of poor outcome and the effect of these factors on postoperative complications. We hypothesized that preoperative opioid use is associated rates of postoperative complications.

Methods: An IRB-approved retrospective review of patients with traumatic lower-extremity injuries treated at our Level-I trauma center for 2 consecutive years was performed. Patient demographics (age, sex, body mass index [BMI], tobacco use, history of substance abuse (HSA), medical history, ISS, treatment, and return for further medical care including postoperative hospital admissions, emergency room (ER) visits, and reoperations were collected. These values were then compared between patients considered opioid naive (ON) and those who had prior opioid use (POU). Regression analysis was used to determine the additive of effects of combined risk factors on complications.

Results: The final study cohort consisted of 452 patients of whom 81% were ON and 19% had POU. Patients who had POU were predominantly male (P <0.001), older (ON 36.8 \pm 19.6 vs POU 43.5 \pm 16.9, P = 0.004), smoked tobacco (ON 36.3% vs POU 70.6%; P <0.001), higher American Society of Anesthesiologists (ASA) class (ASA >3, POU 8.2% vs ON 2.5%, P <0.001) and higher BMI (ON 27.2 \pm 7.1 vs POU 29.5 \pm 8.6, P = 0.01). HSA was more common in the POU cohort (ON 14.5% vs POU 30.1%, P = 0.001). 71.8% of POU smoked tobacco or had an HAS, while 27.1% had both. The POU patient cohort had prolonged opiate use at 6 months (56.2%) and 1 year (26.0%), higher rates of postoperative readmissions, ER visits, reoperations, and increased rate of complications (odds ratio [OR]: 2.5, P <.01). The risk of complications increased with the addition of other predictors: less than a high school education (OR: 3.6, P = 0.01) and ASA grade >2 (OR: 3.8, P = 0.004). All 3 increased risk of complication significantly (OR: 7.5, P = 0.004). In combination with preoperative smoking, POU and increased BMI were predictive of postoperative ER visits (r2 = 0.14, P <0.001).

Conclusion: Our study demonstrates that many commonly known predictors of poor outcome (male gender, age, tobacco use, BMI, HSA, ASA \geq 3) frequently accompany POU. POU combined with many of these predictors independently increases the risk of complication. Patients with POU should be targeted with multidisciplinary interventions aimed to modify these risk factors to prevent complication and ultimately improve 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.

Is Post-Discharge Patient Satisfaction Concordant with the Reported Inpatient Experience? A Prospective Qualitative Cohort Study with a Nested Randomized Controlled Trial

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Purpose: Patient satisfaction measures, such as those collected by the Press Ganey survey, are now commonly used to evaluate clinical performance and are often linked to payment models. However, research on the correlation between patient satisfaction scores and actual patient experience in trauma patients is limited. This study aimed to quantify the correlation between patient satisfaction reported as an inpatient with that reported post-discharge. The secondary objectives were to identify hospital experiences that affect patient satisfaction, as well as the effect of the survey method (mail vs phone interview) on response rates.

Methods: The study was performed on the orthopaedic unit of a Level-I trauma center. Adult patients with an orthopaedic injury were eligible after 48 hours post-admission. Study participants were asked to rate their overall inpatient experience on a scale of 1 to 10, followed by open-ended questions on their hospital experience. Participants were then randomized to a second interview by either phone or mail at 4-6 weeks post-discharge, as this date corresponds with the time Press Ganey is given by mail. Inpatient and follow-up patient satisfaction scores were correlated using Spearman's correlation coefficient. Agreement between inpatient codes and follow- up codes was assessed using Cohen's kappa (κ). Multivariable regression determined the association between the hospital experience themes and the patient satisfaction scores.

Results: 231 patients consented and participated in the study. The median overall patient satisfaction scores were 9.5 as inpatients (interquartile range [IQR]: 8-10) and 10 at follow-up (IQR: 8-10), with a moderate positive correlation between scores at the 2 time points (r = 0.52, P <0.001). There was fair to no agreement between the themes reported at the 2 time points. Negative experiences with pain management (κ : 0.2, odds ratio [OR]: 0.4), the environment (κ : 0.2, OR: 0.6), and staff responsiveness (κ : 0.3, OR: 0.6) had fair agreement between the 2 data collection time points and were associated with a significantly lower patient satisfaction score. The response rates were significantly higher in the phone follow-up group compared to the mail follow-up group (69% vs 27%, P <0.01).

Conclusion: Surprisingly, we found that post-discharge patient satisfaction scores were only moderately correlated with inpatient satisfaction scores. Fair to no agreement was observed between the themes discussed by study participants in their inpatient and post-discharge interviews. The response rate for mail surveys was markedly inferior to phone call surveys (P < 0.01). These findings all suggest that current patient satisfaction surveys, such as the Press Ganey, may have limited correlation with inpatient experience. In addition, the results question the ability of scores like Press Ganey that is mailed 4-6 weeks after discharge to accurately reflect inpatient patient satisfaction.

See the meeting app for complete listing of authors' disclosure information.

The Economic Impact of Work and Productivity Loss Following High-Energy Lower-Extremity Trauma

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Purpose: Our objective was to estimate the 1 year economic impact of high-energy lowerextremity trauma (HELET) using the Work Productivity and Activity Impairment (WPAI) questionnaire. The WPAI assesses productivity by documenting lost employment, missed hours of work ("absenteeism"), and productivity loss while working ("presenteeism") attributable to injury.

Methods: The study included patients aged 18-65 years surgically treated for HELET of the tibia, ankle, or foot enrolled in 3 prospective multicenter studies between 2011 and 2017. The analysis was restricted to 859 individuals employed prior to injury. Work status was assessed using the WPAI at 3, 6, and 12 months after injury. Total work and productivity loss were estimated using a Markov model based on time-dependent transition probabilities in work status over 1 year. Adjustments were made for absenteeism and presenteeism based on survey responses. The number of work hours lost together with the number of unproductive hours while working was converted to dollars using the mean wage plus fringe benefits rate reported by the U.S. Bureau of Labor Statistics in 2018: \$36.63 per hour or \$76,190 annually assuming 2,080 work hours per year. Average wages lost due to injury were computed by type of productivity loss and subgroups thought to impact return to work.

Results: Of 859 patients, 20%, 28%, and 51% returned to work by 3, 6, and 12 months, respectively. The estimated 1-year productivity loss due to injury was 1616 hours per patient (1358 hours attributed to lost employment; 62 hours to reduced time at work, and 196 hours due to presenteeism). The average impact per patient was \$58,547 in lost productivity, representing 77% of expected annual wages. The economic impact varied by injury (type IIIB tibia fractures: \$68,115; open pilon/ankle: \$65,536; below-knee amputation: \$64,246; type IIIA open tibia: \$56,697; other foot: \$51,583; open talus/calcaneus \$49,959), gender (men: \$61,099; women: \$52,517), and age (<40 years: \$62,375; \geq 40 years: \$53,517).

Conclusion: The impact of HELET on work and productivity the year after injury is substantial. Our analysis estimates that patients in the year following their injury will produce only 23% of what we would expect of a healthy individual, with the majority of lost productivity attributable to lost employment.

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SCIENTIFIC POSTER #30 General Interest

Does Gastric Bypass Surgery Increase the Risk of Complications for Fracture ORIF? *Brett D. Crist, MD*; Conor Alan Smith, BS University of Missouri, Columbia, MO, United States

Purpose: Our objective was t determine the rate of complications in patients' status after gastric bypass surgery who undergo fracture open reduction and internal fixation (ORIF). We hypothesize that these patients will have a higher risk of complications due to their relative malnutrition.

Methods: After IRB approval, 30 patients were identified who had previous gastric bypass surgery and subsequently had ORIF of a fracture. Retrospective chart review including date of gastric bypass, body mass index (BMI) at time of gastric bypass, type of fracture and mechanism of injury (high vs low-energy), date of fracture, BMI at time of fracture, and presence of comorbidities-nicotine and nonsteroidal anti-inflammatory drug (NSAID) use, and immunotherapy. End points included any unplanned surgery related to their fracture-infection, nonunion, etc.

Results: Patients' average age at the time of fracture was 49 years with an average BMI of 30.66 kg/m2. At the time of fracture, the average BMI decrease after gastric bypass was 15.1 kg/m2. The average time between gastric bypass and fracture was 1461 days. Type II diabetes was noted in 33.3% of patients (10/30). Fractures sustained included distal radius fractures 30% (9/30), and ulnar, tibia/fibula, and femur fractures at 13.33% (4/30) each. Fall from standing was the most common mechanism of injury–55.2% (16/30), followed by MVC (motor vehicle collision) at 27.6% (8/30). Seven patients (23%) experienced complications requiring operative management including nonunion (4/30, 13.3%), secondary fractures (2/30, 6.67%), and deep infection (1/30, 3.3%).

Conclusion: Our anecdotal experience made it seem like gastric bypass patients had a much higher complication rate after fracture ORIF than the average patient. Our review revealed that although these patients were on average less than 50 years old, their injuries were more consistent with osteoporotic patients-ie, mechanism of injury and distal radius fractures. Furthermore, all of the complication rates exceeded those expected for non- gastric bypass patients–infection, nonunion, and secondary fractures. This study adds to the available literature that can be discussed with patients preoperatively regarding their risks with fracture surgery.

SCIENTIFIC POSTER #31 General Interest

OTA 2019

Standardized Pain Regimen in Orthopaedic Trauma Patients Reduces Opioid Use and Length of Stay: A Prospective Pilot Study

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Purpose: Appropriate pain management in orthopaedic trauma patients is important, particularly in the setting of the opioid crisis. Very few studies have prospectively evaluated a standardized multimodal pain management strategy. We implemented a standardized multimodal analgesia regimen for patients with isolated orthopaedic injuries to assess short-term outcomes and opioid use.

Methods: This study was a single-center, prospective, observational study on orthopaedic trauma patients requiring surgery in an urban Level-I trauma center. Patients with isolated orthopaedic injuries between the ages of 18 and 65 years recruited from February 2018 to April 2018 were placed on a standardized pain regimen postoperatively consisting of scheduled celecoxib, acetaminophen, and gabapentin, with tramadol then oxycodone as needed. At discharge, patients received standardized prescriptions for meloxicam, acetaminophen, and tramadol, with or without additional oxycodone depending on inpatient morphine equivalent use. Patients with a prior history of opioid use were excluded. A post-discharge follow-up call was conducted within 72 hours of discharge to assess for pain control and complications. The primary end points were pain scores at 12, 24, 36, and 48 hours postoperatively and morphine milligram equivalents (MME) on postoperative day 1, day 2, and day 3. Secondary end points included hospital length of stay (LOS) and readmission rates on post-discharge day 7 and day 14. Patients were compared to a historical cohort of opioid-naïve orthopaedic trauma patients from August 2017 to October 2017. A Mann-Whitney U test was used to calculate significance for continuous data and a Fisher's exact test was used for categorical data.

Results: A total of 62 patients were screened for inclusion. Of these, 30 patients were enrolled. Demographic and injury characteristics were not significantly different. There was no difference between the historical group and the protocol group in the number of nerve blocks (70% vs 77%, P = 0.77). The MME on postoperative day 1 was 89.4 ± 67.6 mg in the historical group and 38.2 ± 37.8 mg in the protocol group (P = 0.003). Average pain scores at 12, 24, 36, and 48 hours were no different postoperatively between the 2 groups. LOS was 3.5 ± 2 days in the historical group and 2.6 ± 1.6 days in the protocol group (P = 0.08). 63% of patients had successful post- discharge follow-up calls. Of these, 100% reported a pain level between 2 and 4, and 30% had stopped taking opioids. There were no readmissions in either group.

Conclusion: Our standardized pain management regimen was safe and effective in reducing opioid use with equivalent pain management, and a trend towards reduced LOS. Multimodal analgesia should be considered in the management of pain in orthopsedic trauma patients. Larger studies are needed to determine cost- effectiveness and efficacy.

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SCIENTIFIC POSTER #32 General Interest

Contribution Margins for Ankle Fractures: Why Hardware Choice Matters *John J. Wixted, MD*; *Paul T. Appleton, MD*; *Christopher Miller, MD*; *John Y. Kwon, MD*; *Aron Lechtig, MD*; *Edward Rodriguez, MD Beth Israel Deaconess Medical Center, Boston, MA, United States*

Purpose: Hospitals and health-care systems of all sizes face complex financial pressures. Generally, hospitals are high volume, low margin businesses. One financial productivity measurement commonly employed by health-care systems is contribution margin. Operating expenses on a system-wide basis can be categorized as fixed or variable; contribution margin can be defined as revenue minus variable costs. This can be calculated for service lines, departments, surgeons, or procedures. We sought to determine the contribution margin for routine ankle fracture fixation. Further, we hypothesized that the variable costs of implants used during these cases might explain variations in contribution margin when such margins were compared among individual surgeons.

Methods: 289 cases from 5 surgeons over a 2-year period and classified as open reduction and internal fixation ankle were reviewed after IRB exemption was obtained. Only isolated rotational ankle injuries were included. Cases with a length of stay greater than 6 days were excluded, as these cases would have generated increased revenue not related to the ankle fracture surgery. After review, 239 cases remained, representing 5 surgeons. Revenues, indirect costs, and implant costs were calculated for each of these cases and contribution margins were calculated. The overall contribution margins were compared relative to implant cost and surgeon.

Results: Average collections were \$11,671. Average direct costs were \$5780. Average contribution margin was \$3894. Average implant costs per case were \$842. Implant costs varied widely by the surgeon, ranging from an average of \$588 for the lowest cost surgeon to \$1572 for the highest cost surgeon. This corresponded to a variation of 26% in the contribution margins attributable only to discretionary implant usage. The highest drivers of cost were the use of locked fibular plates over nonlocking implants, and the use of suture-based syndesmotic fixation over screw-only fixation.

Conclusion: Contribution margins are commonly used by hospital administrators and health-care systems to quantify the relative value of both overall service lines and individual surgeons. In this study, variations in implant usage directly correlated with relative contribution margins when compared among surgeons performing similar cases. Direct implant costs varied nearly 5-fold from the least expensive to the most expensive average implant usage. The variation largely demonstrated a lack of standardization among the surgeons, resulting in variable implant costs of over \$240,000 during the study period.

SCIENTIFIC POSTER #33 General Interest

Factors Predicting Recurrence After Treatment of Fracture-Related Infections

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Purpose: Deep surgical site infection after fracture fixation is a costly and potentially devastating complication that presents a therapeutic challenge. Little work exists that describes risk factors for failure in attempts to clear the infection once it develops. The purpose of this study is to determine if factors can be identified that are associated with recurrent infection after treatment of a deep surgical site infection.

Methods: We identified all patients treated for deep surgical site infection at a Level-I trauma center from March 2006 to December 2015. Details of the patient, injury, implants, culture results, and antibiosis were recorded. The primary outcome was the occurrence of an unplanned return to the operating room for recurrence of infection. Descriptive and bivariate statistics were used to identify covariates relevant to the primary outcome. Backward, stepwise logistic regression was applied to investigate the multivariate effects on the outcome. Additional exploratory analyses were used to determine if potential interactions or confounders were present and subsequent regression analyses adjusted accordingly, as needed.

Results: In total, 451 patients with deep surgical site infection after fracture fixation met inclusion criteria. Of these, 156 patients (35%) failed initial surgical management. Risk factors associated with recurrent infection included initial culture results positive for polymicrobial organisms (OR [odds ratio] 1.7, 95% confidence interval [CI] 1.1-2.6,), removal of orthopaedic implants in the initial series of debridements (OR 1.8, 95% CI 1.1-2.9,), or Gustilo IIIB or IIIC injury (OR 2.0, 95% CI 1.1-3.8). Increased albumin levels at baseline also showed a trend toward increased risk of failure as did fulfilling the criteria to have a methicillin-resistant Staphylococcus aureus (MRSA) nasal swab performed.

Conclusion: Recurrence of deep surgical site infection was relatively common (35%). We found 3 distinct factors associated with failure to eradicate the infection in the first series of surgeries and antibiotics. None of these factors are obviously modifiable except implant removal, which might be a surrogate for the surgeon perceiving a more severe infection. These data may help guide clinicians as they counsel patients on the risk of treatment failure.

SCIENTIFIC POSTER #34 General Interest

Composite Markers of Economic Distress Predict Complications and Loss to Follow-up in Orthopaedic Trauma

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Purpose: As US health care transitions to value-based models, social determinants of health play a key role in both risk-adjustment models and in supporting interdisciplinary posttrauma care. To examine socioeconomic distress or well-being, the Economic Innovations Group has produced a Distressed Communities Index (DCI) from the US Census Bureau's data set that incorporates 7 metrics into a single measure of economic well-being. The purpose of this study was to examine the relationship between DCI, health-care utilization, and complications in an orthopaedic trauma population.

Methods: 139 patients aged 18-89 years presenting for a new operative orthopaedic injury to a large, Level-I urban trauma center were enrolled. Socioeconomic status, environment/ housing, and health-care access/utilization were assessed as part of a large social determinants survey on initial inpatient admission. DCI score is divided into quintiles: prosperous, comfortable, mid-tier, at-risk, and distressed. The specific 7 metrics were also looked at individually. Follow-up surveys were performed at routine trauma intervals, and medical records were reviewed retrospectively for any complication following initial hospitalization. Loss to follow-up was defined as never contacting the orthopaedic department after discharge. Using SPSS, t-tests were performed to compare DCI variables and patient outcomes.

Results: 139 patients were enrolled in a 3-month period. 54.8% of patients live in a ZIP code categorized as distressed by DCI (compared to 30.7% of Atlanta population). The average community in this population reported: 86% high school graduation rate, 20% living under the poverty line, and 31% unemployment. Only 55% of patients treated lived in the 2 counties immediately adjacent to the hospital. Loss to follow-up was associated with living in a community with low rates of high school graduation (P = 0.004) and Hispanic populations (P = 0.04). The likelihood of posthospitalization complication was inversely associated with total population of the ZIP code of residence (P = 0.04). In our catchment area from 2011 to 2016, the percent of people in distressed ZIP codes within Atlanta city limits reduced from 46.4% to 30.7%, but the adjacent ZIP codes have experienced greater economic hardship.

Conclusion: In the orthopaedic trauma population, composite measures of economic distress or well-being, based on residence, are predictive of loss to follow-up and complications. Interdisciplinary postoperative care after orthopaedic trauma may allow for targeted interventions based on social determinants. Our data imply that more rural communities with limited access to public transportation and health care may contribute to complications. Further, areas with poor educational status and language barriers had a worse rate of postoperative return for routine follow up, which may be due to communication limitations.

SCIENTIFIC POSTER #35 General Interest

How Safe is "Safe"? Radiation Exposure From Intraoperative CT in Traditionally Safe Operating Room Zones

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Purpose: Radiation exposure is an occupational hazard for all operating room staff. The NCRP (National Council on Radiation Protection and Measurements) recommends a maximum occupational whole-body radiation exposure of 5,000 mrem/year, with lower limits of 100 mrem/year for the general public and a 100- mrem prenatal total for pregnant women. Intraoperative CT has many applications within orthopaedic surgery. During a scan, safety measures may be taken to decrease exposure, including wearing lead aprons and increasing the distance from the source by moving to the substerile room or to the outside of the operating room. The purpose of this study is to quantify the amount of radiation exposure that occurs in areas of the operating room that are generally believed to be safe.

Methods: The experiment was conducted in a standard operating room at a Level-I tertiary referral center. The Medtronic O-arm surgical imaging system was used, and a phantom comprised of a lucite block simulated a 70- kg body. Inovision 451P-RYR radiation survey instruments were used to measure exposure rate and integrated dose per scan. Six locations were measured, including the position of the anesthesiologist (80 cm), the position of the radiation technologist (180 cm), the substerile room (500 cm), the operating room door (600 cm), the next-room nursing station (960 cm), and the hallway (1000 cm).

Results: Mean exposure rate was highest at the anesthesiologist (2200 mrem/hr), followed by the door (25.33 mrem/hr), the technologist (21.0 mrem/hr), the substerile room (8.2 mrem/hr), the hallway (2.633 mrem/hr), and then the next-room nursing station (1.557 mrem/hr). The mean integrated doses per scan were 15.03 mrem for the anesthesiologist, 0.170 mrem for the technologist, 0.136 mrem at the door, 0.033 mrem in the substerile room, 0.014 mrem in the hallway, and 0.005 mrem at the next-door nursing station.

Conclusion: Reaching the annual nonoccupational maximum would take 6 scans at the anesthesiologist's position, 588 scans at the technologist's position, 735 scans at the door, 3030 scans in the substerile room, 7142 scans in the hallway, and 20,000 scans in the adjacent operating room. Exposure at the operating room door is equivalent to 1.7% that of a chest radiograph. Although there is measurable radiation exposure outside of the operating room, the magnitude is low enough to be clinically insignificant for the 1-time accidental exposure. This study provides data that reinforce the need to wear protective gear or leave the room during the use of intraoperative CT, but unsuspecting next-door operating room staff need not worry about uninformed exposure.

SCIENTIFIC POSTER #36 General Interest

"Found Down" Compartment Syndrome: Experience From the Front Lines of the Opioid Epidemic *Lydia Parzych, MD; Jacob Jo, BA; Anna Diwan, MD; Eric F. Swart, MD University of Massachusetts, Worcester, MA, United States*

Purpose: With the worsening of the opioid epidemic, the incidence of patients who are "found down" from drug overdose is increasing. Some of these patients, after being down for a prolonged period, develop muscle necrosis, rhabdomyolysis, and elevated compartment pressures in a unique circumstance of compartment syndrome. Although this frequently contrasts sharply with the presentation of acute traumatic compartment syndrome, there exist no treatment guidelines beyond those developed for acute traumatic compartment syndrome. The purpose of this study is to summarize our experience at a trauma center in a region with a high endemic rate of opiate abuse, to describe the outcomes of patients with "found down" compartment syndrome.

Methods: We performed a retrospective chart review to identify patients who were found unconscious due to overdose where orthopaedics was involved to evaluate for compartment syndrome. Patients were treated with fasciotomy or with observation at the discretion of the surgeon. Data regarding initial presentation, intubation, ICU admission, dialysis, repeat surgeries, and laboratory values were extracted.

Results: Over 12 years, we identified 30 "found down" patients who had an examination concerning for compartment syndrome, 25 of whom were taken for emergent fasciotomy. Fasciotomy patients required an average of 4.2 operations and had an infection rate of 20% and amputation rate of 12%. Lactate, creatine phosphokinase, and creatinine levels were typically elevated at time of presentation, but did not correspond to muscle viability or return of function. At initial debridement, 56% of patients had muscle that appeared nonviable, although muscle function returned in 28% of those patients. Four patients had no function at all on initial examination, and none had meaningful return of function at final follow-up. Of 10 patients with partial neurological deficits at time of presentation, half had some improvement in ultimate function

Conclusion: Patients who are "found down" from overdoses with crush injuries have a high surgical complication rate and poor recovery of function. Limited data suggests that those with absent function on presentation are unlikely to gain function after fasciotomy, and the risk/benefit ratio of fasciotomy in this patient population may be different than for traumatic compartment syndrome.

SCIENTIFIC POSTER #37 General Interest

What Is the Long-Term Impact of an Implant Stewardship Program on Orthopaedic Trauma Implant Pricing?

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Purpose: In 2013, an implant stewardship program was implemented at our institution in an effort to reduce overall implant expenditure while also maintaining surgeon autonomy. The purpose of this study was to longitudinally analyze the effectiveness of this implant stewardship program by tracking changes in implant pricing over the course of 5 years.

Methods: The implant stewardship program at our statewide trauma referral center consisted of a "red-yellow- green" (RYG) implant selection tool that classified 5 lower-extremity trauma constructs (tibial and femoral nails, lower-extremity external fixator, proximal tibia and distal femoral plates) from 4 vendors based on cost and categorized each construct as "Green" (least expensive), "Yellow" (midrange), or "Red" (most expensive). The color-coded RYG chart showing these constructs and vendors was posted, without prices, in each operating room. Procedures performed by 10 fellowship-trained orthopaedic trauma surgeons were monitored from April 2012 to September 2017. The minimum and mean prices were collected for each month of the study. The number and magnitude of price changes were calculated.

Results: There were 2468 procedures included over this 65-month study period. The overall mean price per construct decreased by \$66 (95% confidence interval [CI]: 36-96) per year over the study period; however, more pronounced price declines are observed when analyzing each construct in isolation. All constructs experienced an overall mean price decrease, with the greatest annual price decrease exhibited by the distal femoral plate construct at \$476 per year (95% CI: 404-549) followed by external fixators (-\$197 per year, 95% CI: -258 to - 136). The smallest annual price decrease was seen in tibial nails (-\$98 per year, 95% CI: -124 to -89). These price decreases were all statistically significant (P <0.001). The minimum price per construct decreased by \$131 per year (95% CI: -155 to -111). All contructs saw statistically significant decreases in minimum price (P<0.001). The largest decreases in the minimum price per construct were found for distal femoral plates (-\$436 per year, 95% CI: -516 to –354) and external fixators (–\$122 per year, 95% CI: –258 to –136). The smallest decreases in minimum price were seen with femoral (-\$46 per year, 95% CI -56 to -35) and tibial nails (-\$46 per year, 95% CI: -59 to -33). A total of 35 price changes occurred during the course of the study, 28 of which were price decreases. The median price decrease was \$407 (range, \$6-\$2491) or 12.5% of the previous price.

Conclusion: Our implant stewardship program was able to show perennial decreases in all studied construct prices over a 5-year period in the face of a mean inflation rate of 1.8%. Further research should be directed at determining the applicability of this type of stewardship program at other trauma centers.

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

SCIENTIFIC POSTER #38 General Interest

Quantifying Patient Resilience Following Trauma Using the Short Musculoskeletal Function Assessment

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Purpose: Psychological factors have established effects on outcome after orthopedic trauma. Tools exist for quantification of these factors but involve extensive questioning and prospective use. The purpose of this study was twofold: (1) to propose a retrospective technique to measure patient resilience using the Short Musculoskeletal Function Assessment (SMFA) and (2) to demonstrate that poor resilience is associated with worse functional outcome in patients undergoing operative fracture repair, both acutely and in cases of nonunion.

Methods: From separate prospective registries, patients were identified who underwent repair of either acute tibial plateau fracture or long bone fracture nonunion (these cohorts were chosen as representative samples of orthopaedic trauma). Patients had visual analog scale (VAS) pain scores and SMFA data available at 3, 6, and 12 months postoperatively. Resilience refers to a patient's ability to adapt to adverse conditions or pain. To quantify resilience for each cohort, a linear trend line was calculated from a scatterplot of SMFA Bothersome Index (BI) versus VAS pain score at 3 months postoperatively. Using this trend line and each patient's true BI at 3 months, patients were split into 3 groups: patients whose BI was >20 points above expected for their pain level were said to have poor resilience, patients whose true BI was between 0 and 20 points above expected were said to have adequate resilience, and patients whose BI was less than expected were said to have excellent resilience. Univariate and multivariate analyses were performed to evaluate the effect of resilience on functional outcome. Outcome was assessed using SMFA Function Index, which does not overlap with SMFA BI.

Results: 215 tibial plateau patients were included. Of these, 39 had poor resilience (18.1%), 65 (30.2%) had adequate resilience, and 111 had excellent resilience (51.6%). 255 nonunion patients were included. Of these, 49 had poor resilience (19.2%), 30 had adequate resilience (11.8%), and 176 had excellent resilience (69.0%). In both cohorts, SMFA Function Index at 6 and 12 months postoperatively was significantly different among resilience levels (P <0.0005). Furthermore, worse resilience was associated with worse SMFA Function Index at 6 and 12 months postoperatively when controlling for age, sex, Charlson comorbidity index, tobacco use, injury pattern, and Workers' Compensation status (P <0.0005).

Conclusion: Poor resilience is associated with worse functional outcome following operative fracture repair. Surgeons can use this method to identify patients at risk for poor outcomes and intervene early in the recovery.

Quantitative Difference in Embolic Load Between Femoral and Tibial Shaft Fractures Treated with Reamed Intramedullary Nail Fixation

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Purpose: Intramedullary nail (IMN) fixation of femoral and tibial shaft fractures is considered the standard of care in adults. However, few studies have compared the quantitative difference in embolic load between femoral and tibial shafts undergoing definitive fixation. The purpose of this study was to compare the volume of embolic load during IMN fixation of femoral and tibial shaft fractures.

Methods: This prospective study enrolled patients treated for isolated femoral and tibial shaft fractures with IMNs. All patients underwent continuous transesophageal echocardiography intraoperatively, and embolic load was measured during 5 stages: preoperative, initial guidewire, reaming, nail insertion, and postoperative. A mixed effects model was used to compare embolic load across these stages and between femurs and tibias.

Results: 19 patients (11 femur, 8 tibia) with a mean age of 43 years (range, 18-71) were enrolled. In both groups, reaming was associated with a significant increase in embolic load when compared to preoperative measures (mean difference: 6.9, 95% confidence interval [CI]: 3.9-15.9, P <0.01) (Fig. 1). Similarly, embolic load was higher during nail insertion (mean difference: 3.1, 95% CI: -0.17 to 6.3, P = 0.06). There was no observed difference when preoperative values were compared to guidewire insertion (mean difference: -2.2, 95% CI: -5.5 to 1.0, P = 0.18) or postoperatively (mean difference: -2.8, 95% CI: -6.8 to 1.2, P = 0.17). The mean point estimate for embolic load was higher in femur patients than tibia patients (mean difference: 2.5, 95% CI: -1.0 to 6.0, P = 0.15), although this was not statistically significant.

Conclusion: Fat emboli and their resulting sequelae are well-recognized complications associated with IMN fixation. The results of this study challenge prior evidence that peak showers occur during initial cannulation of the intramedullary canal, and suggest greater embolic load with fixation of femoral shaft fractures in comparison to tibial shaft fractures.



Figure 1. The comparison of embolic load (Luminosity Units) preoperatively (Pre), during guidewire insertion (GW), reaming (Ream), nail insertion (Nail), and postoperatively (Post) during intramedullary nailing of the femur or tibia. * signifies pc.0.05

SCIENTIFIC POSTER #40 General Interest

Predicting Hospital Quality Measures Following High-Energy Orthopaedic Trauma *Sanjit R. Konda, MD*; Erin Arlene Kelly, BA, MS; Joseph Robert Johnson, BS; R. Jonathan Robitsek , PhD; Kenneth A. Egol, MD NYU Langone Orthopedic Hospital, New York, NY, United States

Purpose: The Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA) is a novel inpatient mortality risk tool that has been validated by the National Trauma Databank. Our Level-I rrauma center has prospectively utilized this tool to reliably predict inpatient mortality upon emergency department arrival as well as functional outcomes and mortality up to 1 year for general orthopaedic trauma patients aged 55 years and older. This study sought to determine if the STTGMA tool can also accurately predict ICU length of stay and days spent on ventilation for patients aged 18 years and older who experienced a high-velocity orthopaedic trauma.

Methods: A retrospective chart review of all patients ≥18 years old who were treated for an orthopaedic trauma injury at a Level-I trauma center between December 31, 2014 and November 10, 2018 was performed. Patients met inclusion criteria if they experienced a highenergy orthopaedic trauma injury following a fall from height or a motor vehicle, motorcycle, bicycle, or pedestrian struck accident. An STTGMA score was calculated using demographic, injury, physiologic, and comorbidity characteristics. Inpatient outcomes including length of stay, ICU length of stay, days spent on ventilation, and inpatient mortality were recorded for each patient. Binomial logistic regression and linear regression were performed to assess STTGMA's ability to accurately predict inpatient outcomes for this cohort of orthopaedic trauma patients. The efficacy of each predictive model was assessed using area under the receiver operating characteristic curve (AUROC) analysis.

Results: Out of 875 patient who were treated for an orthopaedic trauma injury at our Level-I trauma center during the study period, 455 had been injured in a high-energy accident. The logistic regression model for STTGMA predicting inpatient mortality in our cohort was statistically significant $\chi 2(4) = 17.453$, P <0.001 and had an AUROC of 0.824 (95% confidence interval [CI]: 0.728-0.921). In addition, a linear regression model demonstrated that the STTGMA tool can significantly predict ICU length of stay, F(1,453) = 27.516, P <0.001 with a mild positive correlation between STTGMA score and ICU length of stay (r = 0.239; P <0.001). The STTGMA score also significantly predicted days spent on ventilation, F(1,453) = 18.547, P < 0.001 with a small positive correlation between STTGMA score and days spent on ventilation (r = 0.198, P <0.001).

Conclusion: This study demonstrates that the STTGMA tool, which had previously been limited to use in patients aged 55 years and older, can be applied to patients of all ages who experience a high-velocity orthopaedic trauma injury. By expanding the age range for which STTGMA can be utilized, this study highlights novel internal quality control measures that trauma centers can implement to better characterize risk of inpatient mortality while anticipating days spent in the ICU and on ventilation.

SCIENTIFIC POSTER #41 General Interest

Purpose: As the United States moves toward value-based care, there has been increasing emphasis on collecting and reporting patient-reported outcome measures (PROMs). However, PROMs are based on subjectively collected data with the potential for unreliable measurement and response bias. Importantly, the relationship between PROMs and clinical/real-world outcomes remain unclear. Further investigation on interpreting PROMs is required prior to utilizing them to drive clinical practice and prior to incorporating them into alternative payment models. The purpose of the present study is to identify the time course of recovery after traumatic injury and to identify variables independently associated with patient-reported outcome that account for the variation in recovery.

Methods: 720 patients who underwent fracture fixation from 2011 to 2018 who filled out PROMIS (Patient- Reported Outcome Measurement Information System) General Health (including Physical Component and Mental Component Scores) were identified from the medical record at 1 Level-I trauma center. The medical record was reviewed for demographic, treatment and admission characteristics. The trend in PROMIS Physical Component Score (PCS) during recovery was documented and linear regression was performed to identify variables accounting for variation in recovery.

Results: In this cohort, patients made the most rapid recovery during the first 6 months, at which time the mean PCS scores plateaued or worsened. There was an independent association between time after surgery (coefficient 0.30, 95% confidence interval [CI] 0.23 to 0.37), PROMIS Mental Component (between-persons coefficient 0.30, 95% CI 0.23 to 0.36, within-persons coefficient 0.17, 95% CI 0.13 to 0.22), BMI (body mass index) (coefficient –0.06, 95% CI –0.12 to –0.01), 2 or more psychiatric diagnoses (coefficient –1.32, 95% CI –2.40 to –0.24), readmission within 1 year (coefficient –2.14, 95% CI –3.24 to –1.04), lower extremity injury (coefficient –2.68, 95% CI –3.71 to –1.65), and multiple fractures (coefficient –2.41, –4.21 to 0.60).

Conclusion: Independent drivers of variation in PROMIS Physical Component Scores can be explained by PROMIS Mental Component Scores, BMI, having 2 or more psychiatric diagnoses, having a complication resulting in readmission within 1 year, lower extremity or multiple extremity injury (as compared to upper extremity injury). Appropriate risk adjustment of the above associations will aid in the use of PROMs in musculoskeletal patients.

OTA 2019



SCIENTIFIC POSTER #43 General Interest

OTA 2019

Value-Based Care in Orthopaedic Trauma: Are Traumatologists Ready to Ride the Wave of Changing Economics?

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Purpose: As health-care expenditures rise, government and private payer policy continue to focus on reducing costs without compromising patient outcomes. Value, defined as the ratio of patient-reported outcomes (PROs) over cost, has emerged as a way to apply cost containment strategies while maintaining quality of care. Although seen frequently in other subspecialties, value-based policy has been slow to disseminate in orthopaedic trauma. With value-based payment models on the horizon, this study was designed to examine the perceptions of value- based care among orthopaedic traumatologists and how it influences their practice.

Methods: After approval was granted by the OTA research committee, all active and associate North American OTA members were e-mailed a 38-question survey. OTA members could also access it online November 7, 2017, to October 25, 2018, through the OTA site. The survey was designed using an orthopaedic staff focus group. Questions focused on demographics, training, experience, and practice, along with 5 areas of value-based care: understanding value, assessing interest, barriers, perceptions around implementing value-based strategies, and policy.

Results: Of 1106 OTA members, 252 members responded for a response rate of 22.7%. Less than a third (28.7%) reported they were comfortable with their knowledge of value and their knowledge level did not grow with increasing years of practice (P = 0.12). Consideration around cost was not different between hospital, academic, and private practice setting (P = 0.47), and neither was rating if patients thought value of care was important (P = 0.79). Prior reported experience in finance increased the amount surgical decision-making influenced by cost (P < 0.01), along with reported understanding of implant cost (P < 0.01). Over half (59.4%) believed value-based payments are coming to orthopaedic trauma, with less than half (45.4%) indicating their institution was preparing for it. The vast majority (88.5%) believed bundled payments would be unsuccessful or only partially successful. Over half (61%) reported collecting PROs only 25% of the time or less. A third (34.7%) indicated accurate cost data preventing implementation of programs that track and maximize value, another third (31.5%) attributed it to limited ability to collect PROs, and the remaining 33.8% were split between lack of institutional interest and access to funding.

Conclusion: Our study indicated the understanding of value in orthopaedic trauma is limited and practice integration is rare. Reported experience in finance was the only factor associated with increased consideration of value-based care in practice. Our results highlight the need for increased exposure and resources to changing health-care policy, specifically for orthopaedic traumatologists.

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

SCIENTIFIC POSTER #44 General Interest

What Patient-Reported Outcome Should I Use?

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Purpose: As the call for evidence-based medicine has increased, the medical community has placed emphasis on the use of patient-reported outcomes (PROs). However, little consensus exists in the orthoapedic trauma literature with regard to which PROs should be used when studying orthopaedic trauma patients. The purpose of this study was to identify and characterize the use of PROs utilized in the orthopaedic trauma literature.

Methods: All articles from 5 well respected orthopaedic journals (Journal of Orthopaedic Trauma [JOT], The Journal of Bone & Joint Surgery [JBJS], Clinical Orthopaedics and Related Research (CORR), Journal of Hand Surgery [JHS], and the Journal of Shoulder and Elbow Surgery [JSES]) published between 2011- 2015 were reviewed to identify trauma-related publications that utilized at least 1 PRO. Publication year, location of injury, number of PROs used, use of visual analog scale (VAS), and which specific PROs were reported were recorded and analyzed.

Results: A total of 6269 articles were reviewed, 1929 (31%) articles pertaining to trauma. 27% of articles that related to orthopaedic trauma utilized at least 1 PRO. An average of 107 trauma-related studies with PROs were published per year across all 5 journals. There was no increase in PRO use observed across 5 years. An average of 2 PROs were reported per publication. The percentage of trauma studies that included PROs varied by journal. 40% of trauma-related articles published in JSES included PROs, 35% of applicable trauma articles in JHS and JOT, 30% in CORR, and 29% published in JBJS. The most commonly used PROs included: VAS, 30% (n = 164); Disabilities of the Arm, Shoulder and Hand (DASH) score, 30% (n = 161); Constant score, 14% (n = 76); Short Form-36 survey, 11% (n = 58); American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), 8% (n = 45); Mayo Elbow Performance Index, 8% (n = 42), QuickDASH (an abbreviated version of the DASH questionnaire), 8% (n = 40); and the Short Musculoskeletal Function Assessment (SMFA), 6% (n = 34).

Conclusion: The use of PROs in orthopaedic trauma studies represented a minority of publications across major orthopaedic journals between 2011 and 2015. Furthermore, standardization is lacking with the use of a variety of PROs, making comparison between studies challenging. The VAS was the most commonly reported PRO followed by PROs for the upper extremity.

Is There Evidence to Initiate Gram-Negative Antibiotic Prophylaxis Against Fracture-Related Infection?

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Purpose: Our objective was to evaluate risk factors for gram-negative (GN) fracture-related infection (FRI) in patients undergoing fixation and determine if perioperative GN antibiotic prophylaxis is warranted.

Methods: A retrospective review of all fracture patients at a Level-I trauma center from February 2012-June 2017 was performed. Inclusion criteria were (1) age >18 years, (2) open or closed fracture with internal fixation, and (3) deep, acute to subacute (<6 weeks), culture-positive FRI. Exclusion criteria were patients who had internal fixation at another hospital. Infections were classified as gram-positive (GP), gram-negative (GN), or polymicrobial (PM). Demographic, surgical, and postoperative characteristics were recorded and compared between groups.

Results: Of 3360 operative fracture cases, 43 (1.3%) patients developed an FRI (15 GN, 14 GP, and 14 PM FRIs). See Table 1 for cohort comparisons. Risk factors for developing an FRI with a GN organism included: (1) external fixation prior to definitive surgery (P = 0.019), (2) soft-tissue coverage of surgical site (P = 0.039), (3) increased number of operations at the surgical site (P = 0.014), (4) any ICU stay (P = 0.036), and (5) lower albumin at time of infection (P = 0.005).

Conclusion: GN organisms are found in equal distribution to GP organisms in FRIs. Preoperative GN antibiotic prophylaxis for fracture fixation surgery should be considered in those who have been staged with external fixation, require soft-tissue coverage, spend time in the ICU, need multiple surgeries at the site in question, and have a low albumin.

Table 1. Comparison of patients who developed gram negative, gram positive or polymicrobial infections.								
Characteristics	Gram Negative (n=15)	Gram Positive (n=14)	Polymicrobial (n=14)	p-value				
Sex								
Male	7 (47%)	10 (71%)	10 (71%)					
Female	8 (53%)	4 (29%)	4 (29%)	0.278				
Age (years)	55 ± 20	57 ± 18	48 ± 17	0.387				
BMI (kg/m2)	31 ± 8	28 ± 7	33 ± 9	0.337				
Medical Comorbidities								
DM	6 (40%)	2 (14%)	2 (14%)	0.164				
PVD	4 (27%)	2 (14%)	2 (14%)	0,610				
ESRD	4 (27%)	2 (14%)	1 (7%)	0.352				
Active Smokers	3 (20%)	3 (21%)	1 (7%)	0.527				
Mortality	2 (10%)	1 (7%)	1 (11%)	0.94				
Iniury Location	- ()	- (- ()					
Pelvis/Femur	6 (40%)	7 (50%)	4 (29%)					
Tibia/Ankle	7 (47%)	6 (43%)	9 (64%)	0.748				
Humerus/Elbow	2 (13%)	1 (7%)	1 (7%)					
Open Fracture	2 (13%)	2 (14%)	4 (29%)	0.505				
Gustilo and Anderson Class	- (- ()					
Closed injury	12 (80%)	12 (86%)	7 (50%)					
Grade I or II	1 (7%)	1 (7%)	1 (7%)	0.175				
Grade III or Morell-Lavallee	2 (13%)	1 (7%)	6 (43%)					
External fixation prior to	2 (1576)	1 (776)	0 (4570)					
definitive fixation	6 (40%)	1 (7%)	8 (57%)	0.019*				
Infected prior to hospital	5 (33%)	2 (14%)	10 (71%)	0.007*				
discharge Banning diamagna								
Time from admission to	2 (13%)	2 (14%)	7 (50%)	0.039*				
definitive fixation (davs)	7.7 ± 9	3.3 ± 4	5.4 ± 5	0.212				
Time from ex-fix to definitive fixation (days)	17.3 ± 9	10.9 (no SD, n=1)	7.4 ± 6	0.387				
LOS in ICU prior to infection	2.0 ± 4	- (n=0)	4.5 ± 7	0.036*				
Post-operative LOS until infection or discharge	16.2 ± 13	9.1 ± 7	14.1 ± 5	0.103				
Number of trips to OR	3.9 ± 2	3.0 ± 1	5.9 ± 4	0.014*				
Number of OR visits before infection	1.9 ± 1	1.3 ± 0.5	2.1 ± 1	0.107				
Albumin at time of admission (g/dL)	3.9 ± 0.5	4.2 ± 0.4	3.8 ± 0.5	0.192				
Albumin at time of infection (g/dL)	$\textbf{2.9} \pm \textbf{0.9}$	3.9 ± 0.5	$\textbf{2.6} \pm \textbf{1.1}$	0.005*				
Albumin Difference (admission to infection) (g/dL)	0.80 ± 0.9	0.34 ± 0.5	0.88 ± 0.8	0.215				

BMI, Body Mass Index, DM, Diabetes Mellitus, PVD, Peripheral Vascular Disease, ESRD, End-Stage Renal Disease, LOS, Length of Stay, ICU, intensive care unit, OR, operating room * Significant p value < 0.05</p>

SCIENTIFIC POSTER #46 General Interest

Self-Reported Feelings of Disability Following Lower-Extremity Orthopaedic Trauma *David Neil Kugelman, MD*; Jack Haglin, BS; Sanjit R. Konda, MD; Kenneth A. Egol, MD NYU Langone Medical Center, New York, NY, United States

Purpose: Nearly 20% of Americans consider themselves disabled. A common cause of disability is unexpected orthopaedic trauma. The purpose of this current study, assessing common lower-extremity trauma (tibial plateau and ankle fractures), is threefold: (1) to assess the prevalence of self-reported feelings of disability following these injuries; (2) to determine if self-reported feelings of disability impact functional outcomes, following these injuries; and (3) to understand if patient demographics or socioeconomics are associated with self-reported feelings of disability, following these injuries.

Methods: The functional status of patients with tibial plateau fractures and ankle fractures were prospectively assessed at baseline, 3, 6, and 12 months posttreatment. Patient-reported feelings of disability, acquired from validated functional outcome surveys, were compared with overall patien-reported functional outcome and emotional status at each follow-up visit. Patients who felt disabled before a fracture of the lower extremity were excluded from this study. Analysis was conducted, at short-term (3-month) and long-term (12-month) follow-up, to assess the association between feelings of disability and the patient demographics of age and gender. Independent t-tests were used for dichotomous variables. χ 2 analysis was used to assess if a correlation existed between feelings of disability and functional outcomes.

Results: A total of 710 patients were included in our analysis. 435 patients sustained ankle fractures and 275 patients sustained tibial plateau fractures. At short-term follow-up (3 months), a strong positive correlation existed between self-reported feelings of disability and worse functional outcomes (rs = .744, P <0.001). At long-term follow-up (12 months), a strong positive correlation existed between self-reported feelings of disability and worse functional outcomes (rs = .741, P <0.001). Self-reported feelings of disability were associated with increased age at both short-term (P = 0.015) and long-term (P = 0.003) follow-up. Self-reported feelings of disability declined at each follow-up visit, from 48.1% at short-term follow-up.

Conclusion: Self-reported feelings of disability, following lowe- extremity trauma, had strong positive correlations with worse outcomes, at both short-term and long-term follow-up. At long-term follow-up, self- reported feelings of disability significantly decreased. Patients who felt disabled were of older age. Orthopaedic trauma surgeons should be aware of the percentage of patients who feel disabled following lower-extremity fractures, and know that this is associated with suboptimal outcomes.

SCIENTIFIC POSTER #47 General Interest

OTA 2019

Can Psychosocial Screening Predict the Transition to Chronic Pain 6 Months After Lower-Extremity Trauma?

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Purpose: Approximately 200,000 Americans who sustain a lower-extremity fracture (LEF) requiring surgical fixation develop chronic pain each year. It is well described that psychosocial characteristics can drive poor outcomes. However, no studies have determined if psychosocial factors can predict the development of chronic pain. The purpose of this study was to determine whether early psychosocial screening can predict chronic pain and pain severity at 6 months. We hypothesized that high pain catastrophizing, fear of movement, and low pain self-efficacy are associated with the development of chronic pain in operative orthopaedic trauma patients with LEF.

Methods: 57 subjects with LEFs requiring operative intervention and without a past history of chronic pain (age 47.3 ± 15.5 years) were recruited from a Level-I trauma center. Pain catastrophizing (Pain Catastrophizing Scale [PCS]), pain self-efficacy (PSEQ [Pain Self-Efficacy Questionnaire]), and fear of movement (TSK [Tampa Scale for Kinesiophobia]) were assessed 1 week, 6 weeks, 3 months, and 6 months after fixation. At 6 months we recorded pain intensity and chronic pain, defined by the National Institutes of Health as reporting pain as an ongoing problem over the last 4-6 months and the pain as bothersome at least half the days over the last 6 months. Changes in psychosocial scores at each time point were compared via a 2 x 4 analysis of variance. Odds ratios for adverse 6-month pain outcomes were calculated.

Results: Patients who reported chronic pain at 6 months had elevated PCS, PSEQ, and TSK scores at each time point compared to the group without chronic pain. Individual psychosocial profiles changed significantly between 1 and 6 weeks (P <0.001), and remain stable between 6 weeks and 3 months (P = 1.0) indicating 6 weeks as the optimal time frame to screen patients. Individuals with a 6-week PCS ≥12 were 6.3 times more likely to develop chronic pain at 6 months (odds ratio [OR]: 6.3; 95% CI [confidence interval]: 1.6-25.5, P <0.01) and 11.0 times more likely to report severe pain intensity at 6 months (OR: 11.0; 95% CI: 2.4-49.8, P <0.01). Subjects with a 6-week PSEQ ≤40 were 20.7 times more likely to report severe pain intensity at 6 months (OR: 20.7; 95% CI: 2.4-176.7, P <0.01). Finally, subjects with a TSK ≥42 at 6 weeks were 10.6 times more likely to develop chronic pain at 6 months (OR: 10.6; 95% CI: 2.6-43.0, P <0.01).

Conclusion: Chronic pain after LEF is common. Early identification of patients at risk for chronic pain is paramount. Our results demonstrate that low self-efficacy, high pain catastrophizing, and high fear of movement 6 weeks after surgical fixation are predictive of chronic pain. Physicians can utilize these short screening tools early in recovery to develop meaningful interventions to prevent chronic pain in patients with LEF.

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

SCIENTIFIC POSTER #48 General Interest

Patients with End-Stage Renal Disease Are at Increased Risk of Postoperative Complications Following Lower-Extremity Fracture Surgery

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Purpose: End-stage renal disease (ESRD) leads to multiple systemic effects and patients suffer from multiple comorbidities including fractures. While previous studies have examined complications following hip fracture surgery in ESRD patients, there are no studies evaluating other lower-extremity injuries. This study aimed to identify postoperative complication risk in patients with ESRD who had lower-extremity fractures.

Methods: Using our database from 2000 to 2015 at 2 Level-I trauma centers, we collected data on patients over age 40 years, who had lower-extremity fractures and surgical fixation. Diagnosis of ESRD was made before the injury. Each ESRD patient was matched by 2 non-ESRD patients regarding age, gender, American Society of Anesthesiologists (ASA) score, and AO/OTA fracture classification. Postoperative outcomes were nonunion, mechanical failure, and infection. The number of outcome events was compared between the ESRD and non-ESRD cohorts.

Results: Our study cohort included a total of 195 patients (65 ESRD patients matched to 130 non-ESRD patients). Postoperative complications of nonunion, mechanical failure, or infection occurred in 14 patients (9 in ESRD and 5 in non-ESRD) during a median follow-up of 31 months (range, 12 to 141 months). The ESRD cohort had significantly higher mechanical failure rate compared to the non-ESRD (relative risk [RR] = 8, P = 0.003). The composite outcome was also higher for the ESRD cohort (RR = 3.6, P = 0.02).

Conclusion: ESRD was associated with higher complication rates of nonunion, mechanical failure, and infection after lower-extremity fracture surgeries.

	ESRD (N=65)	Non-ESRD (N=130)	RR*	P Value	
Non-union - no. (%)	3 (5)	2 (2)	3	0.34	
Mechanical failure - no. (%)	8 (12)	2 (2)	8	0.003	
Post-op infection - no. (%)	4 (6)	3 (2)	2.7	0.22	
Composite - no. (%)	9 (14)	5 (4)	3.6	0.02	

Table 2. Post-operative Complications

*RR = Relative Risk

SCIENTIFIC POSTER #49 General Interest

There's an App for That! How Mobile Technology Changes Reporting of Morbidity and Mortality

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Purpose: Morbidity and mortality (M&M) conferences are critical to medical education and have been mandated by the Accreditation Council for Graduate Medical Education (ACGME) in surgical programs since 1983. Despite the patient safety improvements and educational benefits of these conferences, many adverse events are underreported. The objective of this project was to compare the reporting of adverse events before and after the dissemination of a HIPAA (Health Insurance Portability and Accountability Act)-compliant mobile M&M reporting application.

Methods: An anonymous, web-based, HIPAA-compliant, M&M reporting mobile application based on REDCap (Research Electronic Data Capture) was instituted in August of 2017. The list of possible complications was based on the ABOS (American Board of Orthopaedic Surgery) complication list for part II. The interface is accessible through all mobile platforms and all residents were encouraged to use the app for real-time reporting of complications. Prior to its use, M&Ms were reported in response to a monthly e-mail reminder. Using an unpaired t-test, we compared reporting before and after the implementation of the mobile application.

Results: All reported events were tallied from August 2016 through July 2018. Prior to the implementation of the application, there were 54 adverse events reported, with a mean of 4.0 per month. After launch of the app, a total of 176 adverse events were reported over this period, with a mean of 14.67 events per month. In an unpaired t-test comparison, there was a statistically significant difference in events reported with P <0.0001. Additionally, adverse events such as death, reoperation, pulmonary embolus, cardiac arrest, and reintubation were categorized as either major or minor. Before the implementation of the application, 31/54 (57%) were major events. After the implementation of the application, 104/176 (59%) were major events.

Conclusion: An anonymous mobile reporting method for M&M significantly increased the reporting of both major and minor complications. This suggests that traditional methods of M&M reporting may grossly underestimate complication rates that can negatively impact patient safety and quality improvement efforts. Further research is needed to determine if an anonymous mobile reporting app can improve patient safety.

Skeletal Stem Cell in Iliac Crest Bone Graft and Clinical Implications in Fracture Nonunion Repair

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Purpose: Autogenous bone graft contains skeletal stem cells (SSCs) and is an essential tool in the treatment of fracture nonunions. The purpose of this study was to determine if SSC composition in iliac crest bone graft is related to patient characteristics and to determine its clinical significance in the healing of fracture nonunions.

Methods: Human skeletal stem cell analysis: Bone marrow was aspirated from iliac crest from subjects undergoing repair of fracture nonunions from the same site as autogenous graft harvest. Bone marrow samples were prepared for flow cytometric analysis by staining for CD45 and CD271 antibodies to quantify CD45- CD271+ cells. These markers have been used in previous studies for the identification of skeletal stem cells.

Radiographic analysis: Subjects who underwent operative repair of nonunions were prospectively followed with serial radiographs to monitor fracture healing. Radiographs were read by 2 independent observers, and time to union was determined by presence of bridging callus formation. Data are expressed as means \pm SEM (standard error of the mean) and analyzed by unpaired, 2-tailed Student t-test.

Results: 33 subjects (15 females, 18 males) were enrolled into the study. Subjects younger than 50 years of age had a significantly higher percentage of SSCs compared to those older than 50 year (P = 0.0497). Obese patients with a body mass index (BMI) >30 had a lower

percentage of SSsC than those with BMI under 30, although this difference did not reach significance (P = 0.0633). Of the 33 subjects, 29 (16 male, 13 female) were able to be assessed for radiographic union. Patients who healed in under 6 months had a greater percentage of SSCs in their bone marrow than those who those who took 6 months or longer to heal (P = 0.0495).

Conclusion: Our data demonstrate that there is a higher concentration of SSCs in iliac crest bone graft in younger patients than in older ones. Furthermore, stem cell frequency in bone graft may be a predictor for time to union following nonunion repair using autogenous bone graft.



SCIENTIFIC POSTER #51 General Interest

OTA 2019

Compliance with Weight-Bearing Precautions: A Prospective Observational Study *Michael Murphy*; Andres Redondo; William J. Davis; Dimitri Joseph Mabarak; Hobie D. Summers, MD; Joseph Bowman Cohen, MD; William Dean Lack, MD Loyola University Medical Center, Maywood, IL, United States

Purpose: Patients are instructed on weight-bearing restrictions after orthopaedic trauma based on historical norms, clinical intuition, and biomechanical research, but there is limited understanding of how compliance varies by restrictions.

Methods: We prospectively identified 45 lower-extremity trauma patients (27 male, 18 female) instructed on non-weight-bearing (NWB, n = 30), touchdown weight-bearing (TDWB, n = 11), and as tolerated (WBAT, n = 4). Compliance was determined with Strydalyzer INSIGHT insole pressure sensors as inpatients (n = 45) and at 2-week (n = 34) visits. Patients completed questionnaires in addition to assessment of age, gender, weight, educational level, fracture pattern, step count (home pedometers), Timed Up and Go, pain, Charlson Comorbidity Index (CCI), ASA (American Society of Anesthesiologists) score, drug use, distance ambulated, disposition, therapy visits, caloric intake, handedness, concurrent injuries, and grip strength (dynamometer).

Results: Mean age was 47.7 years (range, 21-84). Inpatient noncompliance was associated with preinjury exhaustion (P < 0.02). Noncompliance at 2 weeks was associated with TDWB (P < 0.01), difficulty ascending 12 stair flights prior to injury (P = 0.02), disorientation (P < 0.01), poor recall (P < 0.05), and a lesser distance ambulated as inpatient (P < 0.01). Median (maximum) weight borne as an inpatient was 100 (163), 29 (191), and 0 (99) lbs for the WBAT, TDWB, and NWB groups, respectively. This progressed to 137 (191), 29 (154), and 0 (12) lbs at the 2-week follow-up for the WBAT, TDWB, and NWB groups, respectively. Within the TDWB group, the median weight (range) borne by those exceeding instructions was 177 (117-191) and 117 (84-154) lbs as inpatients and 2 weeks, respectively.

Conclusion: Inpatient compliance was similar for different restrictions; however, TDWB instructions were associated with postdischarge noncompliance. This was most likely to occur in the setting of frailty and mental limitations. We recommend such patients be best treated with dichotomization to either NWB or WBAT.

SCIENTIFIC POSTER #52 General Interest

Outpatient Fracture Surgery: Should We Be Concerned?

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Purpose: With rising health-care costs and insurance-carrier push against non-emergent hospital admission, treatment of lower-extremity fractures is shifting towards outpatient procedures rather than inpatient hospitalizations. Lower-extremity fractures distal to the hip do not always require inpatient level care, but rather can be discharged from the post-anesthesia care unit (PACU). This study seeks to compare complications and readmissions between patients treated for similar lower-extremity fractures as outpatient versus inpatient.

Methods: This study was a retrospective review of 500 consecutive patients with a lower-extremity fracture distal to the hip treated by 1 surgeon between January 2012 and December 2017 at 1 academic medical center. Patients were identified using International Classification of Diseases (ICD)-9 and 10 codes. Chart review was conducted to identify patient demographics, injury information, length of stay, readmission, and complication data. Patients staying 24 hours or less including their procedure were considered to be outpatient. Patients staying longer than 25 hours including their procedure were considered to be inpatient. Binary logistic regression and χ^2 analyses were performed using IBM SPSS to assess for differences between inpatients and outpatients in regard to readmissions and complications after controlling for demographics and injury characteristics.

Results: We identified 127 patients (25.4%) who met inclusion criteria. Of these 5, (3.9%) had foot fractures, 37 (29.1%) had ankle fractures, 29 (22.8%) had fractures of the tibial or fibular shaft, 48 (37.8%) had fractures affecting the knee, and 8 (6.3%) had distal femur fractures that did not interrupt the articular surface. There was no difference in the proportion of patients receiving spinal anesthesia between inpatient and outpatient groups (P = 0.173). After controlling for age, Charlson Comorbidity Index (CCI), wound status, and fracture type, we found that there was no difference between inpatient and outpatient cohorts in terms of complications, infection, readmission, or mortality (P = 0.564, P = 0.232, P = 0.718, P = 0.999). When the cutoff for inpatient classification was raised to 36 hours, still no significant difference existed in complications, infection, readmission, or mortality (P = 0.117, P = 0.138, P = 0.077, P = 0.997).

Conclusion: Outpatient fracture surgery for isolated lower-extremity fractures distal to the hip is safe and effective. As the population both increases and ages, more low-risk surgeries should be considered outpatient procedures rather than inpatient hospital admissions to lower costs, save resources, and reduce risk to both the hospital and the patient.
SCIENTIFIC POSTER #53 General Interest

Costs of Care for Low-Energy Extremity Gunshot Injuries Are Reduced with Standardized Treatment

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Purpose: Civilian low-energy gunshot wounds (GSWs) are common and generate substantial morbidity. Previous work demonstrated that limiting antibiotics to a single intravenous (IV) dose, without formal debridement in the operating room, effectively mitigates the risk of infection after extremity GSW or arthrotomy secondary to GSW. The goals of the current study were to determine treatment costs associated with isolated low-energy GSWs to the extremity and to estimate cost savings associated with a single-dose antibiotic strategy.

Methods: The registry at an urban Level-I1 trauma center was queried for low-energy GSWs over 4 years. A series of 380 patients with extremity-only GSW were reviewed. Treatment was recorded including type and duration of antibiotics. Costs were calculated including facility services in the emergency department, operating room, and hospital. Direct expenses had fixed and variable components for staffing (nonphysician) salaries, benefits, and other expenses, and medical supplies. Indirect expenses included overhead costs for personnel and facilities. Professional services were not included.

Results: There were 460 GSWs in 380 patients with mean age was 30.3 years; 95.3% were male. The rate of infections requiring IV antibiotics or surgical debridement was 1.3%. There were 309 admissions, 273 operations performed, and 1010 days of antibiotics prescribed. The estimated total facility cost to treat all patients was \$1,801,554; this translated to \$3916/GSW and \$4741/patient. In contrast, treating patients with a single dose of antibiotics would cost \$77/patient with all costs incurred in the emergency department. Excluding patients with fracture fixation, compartment syndromes, vascular and or nerve repairs, there were 108 unnecessary admissions, 26 unnecessary debridement surgeries, and 630 days of unnecessary antibiotics, oral and/or IV, for uncomplicated GSWs. Besides eliminating invasive procedures, the single-dose antibiotic protocol would save the health-care system \$187,879 in actual expenses (\$46,970/year), not including additional costs related to orthopaedic and other professional services.

Conclusion: The cost of gunshot-related medical treatment to our trauma center is high. Actual charges were not determined but would be much higher and wound also include professional charges. Notably, this population has a large proportion of uninsured and Medicaid patients, effectively shifting monetary costs directly to the hospital. Limiting antibiotics to a single IV dose in the emergency room can reduce treatment expenses substantially, while maintaining a low infection rate after extremity GSW.

Targeted Dosing of Low Molecular-Weight Heparin (LMWH) for Deep Vein Thrombosis (DVT) Prophylaxis in Orthopaedic Trauma Patients Does Not Reduce Thromboembolic Events

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Purpose: Low molecular-weight heparin (LMWH) is commonly used to prevent venous thromboembolism (VTE) in orthopaedic trauma patients. However, differences in body habitus, medical comorbidities, and creatinine clearance may affect LMWH bioavailability in the multiply injured patient, and studies have suggested that targeted LMWH dosing as measured by anti-factor Xa (AFXa) levels may reduce rates of VTE. We sought to determine the effect of AFXa level on the rate of deep vein thrombosis (DVT) and pulmonary embolism (PE) in orthopaedic trauma patients with lower-extremity and pelvic fractures.

Methods: This was a comparison between prospectively followed patients from January 2017-July 2018 placed on a targeted LMWH protocol with the goal of an AFXa trough of >0.1 U/mL starting with 30-mg BID (twice daily) dosing to a historical cohort from October 2012-April 2013 who were placed only on 30-mg BID dosing. Patients were included if they had a trauma activation, had a lower extremity injury, were hospitalized for at least 3 days, and had no DVT prophylaxis protocol violations. Patients were excluded if they were <18 years old, had a coagulopathy or prothrombotic condition, or received DVT prophylaxis other than LMWH. Outcomes included transfusion rate, wound complications, bleeding complications, and rates of VTE. One-way analysis of variance, χ 2, and Kruskal-Wallis tests were used for comparison. A P value <0.05 was considered significant.

Results: 174 patients met criteria, 97 patients were in the historical group, and 77 in the in the protocol group. In the protocol group, 53 (69%) of patients were found to be subtherapeutic with 30-mg BID dosing. The median ISS was lower in the historical group (34 vs 45, P = 0.002). There was no difference in VTE between the historical and protocol groups (15% vs 10%, P = 0.559). There was no difference in wound complications (12.7% vs 13%, P = 0.975). Patients in the control group had more units of packed red blood cells transfused (1.64 vs 0.025 units, P <0.01).

Conclusion: Appropriate VTE prophylaxis in patients with lower extremity fractures remains unclear. Many patients are subtherapeutic with commonly used 30-mg BID dosing. However, while targeted AFXa dosing does not increase bleeding complications, it does not appear to reduce VTE rates.

How Much Do Coping Skills Affect the Physical Function of Tibial Plateau and Ankle Fracture Patients?

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Purpose: Our purpose was to examine the effect of patient "coping skills" measured by PROMIS (Patient-Reported Outcomes Measurement Information System) pain interference (PI) on physical function (PF). Our hypothesis was that PI adversely affects PF scores after operative fixation (ORIF [open reduction and internal fixation]) of orthopaedic injuries and that this association decreases with time.

Methods: Patients undergoing ORIF of an isolated tibial plateau or ankle fracture from 2014-2018 at a tertiary referral center with routine healing were included. The plateau cohort was divided into medial unicondylar (41B1-3.2), lateral unicondylar (41B1-3.1), and bicondylar (41C) groups. Similarly, the ankle cohort was divided into isolated fibula (44A1,B1,C1), bi/ trimalleolar (44A2-3, B2-3, C2-3), and pilon (43C) fracture groups. Patients with follow-up <6 months, polytrauma, malunion, nonunion, and infection were excluded from analysis. The PI and PF scores at 2 weeks, 6 weeks, and 3, 6, and 12 months were collected. Linear regression was used to compare the PI and PF association at these time points.

Results: 70 tibial plateau and 134 ankle fractures were included in the study. There was no difference in the ankle or tibial subgroups with respect to age, BMI (body mass index), ASA (American Society of Anesthesiologists) class, Charlson Comorbidity Index, tobacco use, or follow-up. There was no difference in PF scores between subgroups of the ankle or plateau cohort at any time point. PI adversely affected PF scores for each subgroup of the tibial plateau and ankle cohorts and this association increased with time as seen by increasing slopes at 3, 6, and 12 months (Figure). PI had a significantly negative effect on PF scores of medial tibial plateau and isolated fibula fractures compared to the other subgroups in their cohort (P < 0.001 at 3, 6, and 12 months).

Conclusion: Contrary to our initial hypothesis, PI adversely affects PF, but this adverse interaction increases with time. Isolated fibula fractures and medial tibial plateaus ΡF scores were disproportionately affected by PI. Psychosocial interventions directed towards these at-risk groups may optimize their perceived PF.



Steroid Use Is Not Associated with Infection or Wound Complications in Periarticular Fractures

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Purpose: The aim of this study was to determine the impact of systemic steroid use on rates of infection, wound healing, reoperation, and readmission in patients with periarticular orthopaedic trauma.

Methods: The National Surgical Quality Improvement Program (NSQIP) database was queried via CPT codes for patients aged 18-89 years who sustained a periarticular fracture of the ankle, knee, or elbow from 2006-2015. Those presenting with preadmission systemic sepsis and disseminated cancer were excluded. Those in the steroid group are defined as patients who require the regular administration of oral or parenteral corticosteroid medications or immunosuppressant medications, within 30 days prior to the principle operative procedure for a chronic medical condition. Chi-square, univariate, and multivariate logistic regression was performed to determine the association between steroid use for a chronic condition, reoperation, and readmission.

Results: 534 patients (2.0%) received corticosteroids for a chronic condition unrelated to their injury on admission. The rates of deep infection, superficial infection, and wound dehiscence did not vary between the steroid group and nonsteroid group: 0.2% versus 0.4% (P = 0.38), 0.9% versus 0.8% (P = 0.79), and 0.2% versus 0.3% (P = 0.64). In distal femur, tibial plateau, tibial pilon, and distal humerus fractures (6211, 23.6%), there was no increase in deep infection (0% vs 0.7%, P = 0.24), superficial infection (0% vs 1.1%, P = 0.15), or wound dehiscence (0% vs 0.4%, P = 0.41). Reoperation rates did not differ between the groups, as 2.2% of patients requiring steroids returned to the operating room versus 1.9% of the nonsteroid population (P = 0.57). Readmission rates were significantly different, with higher readmission in the steroid group (8.1% vs 3.3%, P <0.001). After controlling for covariates, deep infection (P = 0.26), superficial infection (P = 0.74), wound dehiscence (P = 0.40), and reoperation (P = 0.51) remained insignificant on multivariate regression between groups, while those requiring chronic steroid administration had increased risk of 30-day readmission (odds ratio 1.64, 95% confidence interval 1.15-2.34, P = 0.006).

Conclusion: Administration of systemic corticosteroids in the orthopaedic patient has been proposed as a means of improving analgesia via a multimodal approach, and potentially accelerating definitive surgical timing by reducing soft-tissue swelling. This study demonstrates that in traumatic periarticular fractures, those who receive corticosteroids for a chronic condition are not at an increased risk of developing infection, wound dehiscence, or reoperation. This provides sufficient equipoise to help direct future prospective studies to evaluate potential steroid benefits.

SCIENTIFIC POSTER #57 General Interest

Doc, I Can't Sleep! (How Prevalent Are Sleep Disturbances in Orthopaedic Trauma Patients at 3 Months Postinjury?

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Purpose: The purpose of this prospective study was to determine the spectrum of sleep disturbances in orthopaedic trauma patients for 3 months following surgery and to identify patients at risk for prolonged sleep disturbance.

Methods: Patients at a Level-I trauma center were screened at their initial postoperative visit. Inclusion criteria were patients 18-75 years with an orthopaedic injury requiring surgery. Exclusion criteria were concussion and / or history of narcotic medication. Eligible patients completed validated outcome measures: the Pittsburgh Sleep Questionnaire Index (PSQI) and Insomnia Severity Index (ISI). A score of >5 on the PSQI indicates poor sleep quality and a score of >15 indicates insomnia. Baseline data, patient demographics, and injury details were collected. The patients were seen in clinic 3 months later. The same 2 investigators performed all patient interviews. Descriptive statistics, χ 2, paired t-tests, and Mann Whitney nonparametric tests were utilized for analysis with SPSS 24.0 (IBM).

Results: 44 males and 22 females with an average age of 44 years (range, 18-74) were included. 28 patients (43%) were injured in a fall, 26 (39%) in motor vehicle (MVC)/motorcycle collisions (MCC), and 12 (18%) other causes. There were 39 lower-extremity fractures and 15 upper-extremity fractures. 12 patients had more than 1 fracture. Analysis of PSQI data revealed that at baseline, 39% of patients reported a sleep disturbance (PSQI >5); this increased to 56% 3 months postoperatively (P <0.05). Subsequent gender-stratified analysis revealed significant differences in females. Analysis of the PSQI subcategories pertaining to the 7 domains of sleep revealed significant differences in disturbance, latency, efficiency and quality. Female patients also showed the most significant decrease in sleep efficiency and sleep quality. At baseline, 36% of patients reported at least some degree of insomnia per ISI, while at 3 months, 45% of patients reported some degree of insomnia (P <0.05). Three months postoperatively, 14 patients (21%) were still taking narcotic medications (not significant). No patients required revision surgery in the first 3 months.

Conclusion: This study is the first to describe the prevalence of sleep disturbances in orthopaedic trauma patients as far as 3 months postoperatively. There was a significant increase in females who reported poor sleep quality and insomnia. This may be potentially explained by possible posttraumatic stress disorder, which is more common in females. These findings demonstrate that sleep disturbances merit attention throughout the entire recovery process. As providers, we need to begin viewing postoperative sleep disturbances not only as a common problem but also as an opportunity to improve patients' recovery process.

SCIENTIFIC POSTER #58 General Interest

Effect of Extended Prophylactic Antibiotic Duration in the Treatment of Open Fracture Wounds Differs by Level of Contamination

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Purpose: The role of longer antibiotic courses in preventing surgical site infections (SSIs) has not been explored in large studies. In this secondary analysis of a large clinical trial, we aimed to determine the association between prophylactic antibiotic duration after the definitive wound closure of an open fracture and SSI.

Methods: For 2400 patients with open fractures of the extremities, we calculated the number of continuous days of antibiotic use after surgery for definitive wound closure. Using logistic regression, we estimated odds ratios (ORs) for the association between the duration of postclosure antibiotic use and SSI. Several covariates, including wound contamination severity, and interaction terms were included in adjusted models.

Results: 42% of participants received extended antibiotic prophylaxis, defined as 4 or more days of use after definitive wound closure. A significant interaction between antibiotic duration and wound contamination led us to report stratified adjusted ORs for each level of contamination. In open fractures with mild contamination, patients with extended antibiotic use had increased odds (OR = 1.41; 95% confidence interval [CI]: 1.05, 1.95) of SSI compared to those with shorter use. No association was found among patients with moderate contamination (OR = 1.08; 95% CI: 0.61, 1.90). In contrast, extended antibiotic prophylaxis was strongly protective (OR = 0.30; 95% CI: 0.12, 0.78) against SSI in patients with severely contaminated open fractures. Propensity score sensitivity analysis results were consistent with these findings.

Conclusion: This evidence suggests a differential effect of extended post-closure antibiotic duration on the likelihood of an SSI contingent upon the degree of contamination of open fracture wounds.

POSTER ABSTRACTS

SCIENTIFIC POSTER #59 General Interest

OTA 2019

The OTS: 5 Years of Driving Change in UK Trauma Care

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Purpose: The Orthopaedic Trauma Society (OTS) was launched in 2013; its primary goal is to advance standards of orthopaedic trauma care in the United Kingdom

Methods: Now 5 years old with an increasingly recognizable voice, we present the output from the OTS and the impact it has had in the UK and beyond.

Results: The National Institute for Health Research (NIHR) clinical trials day has been adopted into the annual meeting. The society is linked to some of the major recent multicenter randomized controlled trials (RCTs), eg, DRAFFT (distal radius), FIXdT (distal tibia), and WOLFF (negative pressure wound therapy). The UK now leads the way in trauma research. At our annual meeting, members can propose new research via the Dragon's Den; winning ideas are adopted by NIHR Clinical Trials Units and worked into full funding proposals. Eight projects were funded in the last 5 years. The society engages with the NIHR on trauma research prioritization. A joint OTS/NIHR workshop generated 4 commissioned calls for multicenter trials. The OTS also engages patients/public in research prioritization via the James Lind Alliance-the most powerful way to influence the research agenda for major funders. In the last 5 years, on the back of the above success, 5 clinical trials have been published in major general medical journals (JAMA, BMJ). A further 16 trials are in progress. The OTS hosts an annual meeting aimed at the trauma specialist surgeon and delivers all trauma content at the British Orthopaedic Association (BOA) annual meeting, for the generalist. International guests included Pierre Guy (Vancouver) and Mike McKee (Arizona) in 2018. The annual meeting has become a powerful forum for decision-making around the way trauma care is delivered in the UK.Systems / Policy:Since major trauma networks beagn in the UK in 2012, there has been an increase in survivorship & transformation in patient care. The OTS has become the representative voice for driving evolution of trauma care even further. Regional complex orthopaedic trauma networks are now evolving in the UK supported by the OTS & NHS England. The OTS has national representation & influence on policy at the highest level, including NHS England & NICE (National Institute for health and Care Excellence). The OTS is now the official specialist society for trauma of the BOA. Multiple standards of practice for trauma have been developed in partnership between the OTS & other specialist societies, including those for open fractures & hip fractures. These are recognised around the world & are seen as aspirational targets in many health care systemsRepresentation: In the UK, the society works with the BOA & other specialist societies focussing on trauma care & injury prevention. Internationally, the society has links with the global fragility fracture network, & has become a member of IOTA

Conclusion: In 5 years, the OTS has evolved into the leading body representing orthopaedic trauma in the UK. We are proud of what the society has achieved and are excited to see what the next 5 years bring.

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

SCIENTIFIC POSTER #60 Geriatric Fractures

Early Operative versus Nonoperative Management in the Treatment of Fragility Fractures of the Pelvis: A Propensity-Matched Multicenter Study

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Purpose: We sought to compare early operative treatment of geriatric pelvis fractures with nonoperative treatment regarding mortality and functional outcome.

Methods: In a retrospective propensity-score matched study, 230 consecutive patients with an isolated low- energy fracture of the pelvis aged 60 years or more and with a follow-up of at least 24 months were recruited from 1 of 2 trauma centers. In center 1, treatment consisted of a nonoperative attempt and early operative fixation if mobilization was not possible. In center 2, all patients were treated nonoperatively. Mortality was assessed using a national social insurance database. Hospitalization time and in-hospital complications were documented and a modified Majeed Score was obtained by phone interview from those who could be contacted. Unadjusted comparison, matched comparison (age, gender, and ASA [American Society of Anesthesiologists]), and a propensity score-matched analysis were conducted.

Results: One year after the initial hospitalization 34/148 patients (23%, 95% confidence interval [CI]: 17% to 31%) of the early operative group and 14/82 patients (17%, 95% CI 10% to 27%) of the nonoperative group had deceased (P = 0.294) and nonoperative treatment also had a protective effect on survival during the first 2 years (hazard ratio of the non-linear effect: 2.86, 95% CI 1.38 to 5.94, P <0.001). However, patients in the early operative treatment group who survived the first 2 years had a better long-term survival. The functional outcome at the end of follow-up as measured by a modified Majeed score was not different between the 2 groups (early operative: 66.1, standard deviation [SD] 12.6 vs nonoperative: 65.7, SD 12.5, P = 0.910).

Conclusion: A treatment concept with early operative fixation of patients who cannot be mobilized within 3 to 5 days has a beneficial effect on long-term survival. Patients with a life expectancy of less than 2 years, however, may not benefit from surgery regarding survival.



SCIENTIFIC POSTER #61 Geriatric Fractures

Short-Term Complications of Proximal Femur Fractures Treated Within 24 Hours Konrad Schütze, MD; Alexander Eickhoff; Florian T. Gebhard, MD, PhD; Peter H. Richter, MD Ulm University, Ulm, Germany

Purpose: Management of unstable proximal femur fractures in osteoporotic patients is a rising challenge in orthopaedic trauma. Treatment within 24 hours has been shown to decrease mortality and complications. Our objective was to determine the effect of a treatment within 24 hours despite oral anticoagulation in patients with proximal femur fractures treated with proximal femur nail. Furthermore, the effect of cement augmentation was investigated.

Methods: A retrospective chart review of 338 patients (mean age 80 ± 13 years; 230 women and 108 men) with a sub- or intertrochanteric fracture between January 2012 and December 2017 was performed. Solely patients treated within 24 hours after admission were included. Augmentation was performed with Traumacem V+ Cement in 152 cases. Primary outcome measures were the transfusion rate and pre- and postoperative hemoglobin (Hb) difference. Secondary outcome measures were mortality, cut-out rate, and rate of complications like infection, hematoma, and acute cardiovascular events.

Results: Patients undergoing treatment with direct oral anticoagulants (DOACs) had a 3.8-fold increased risk for intraoperative blood transfusion. The risk for blood transfusion for patients taking other oral anticoagulants did not differ from the control group. Patients without an intraoperative blood transfusion on oral anticoagulation showed no increase in the pre- and postoperative Hb difference compared with controls. The risk for a vasoactive intervention was 3.6-fold higher for the cement augmented patients. Mean blood pressure change after augmentation was 8 ± 7,4 mm Hg. Still, augmentation or treatment with oral anticoagulation showed no significant effect on complication rates or mortality in patients operated within the first 24 hours.

Conclusion: There was no increase in mortality or rate of complications in patients treated with oral anticoagulation when operated within the first 24 hours. Treatment with DOACs showed a higher risk for the need of a blood transfusion intraoperatively. Augmentation of the proximal femur nail antirotation proved to be a safe procedure. In osteoporotic patients treatment within 24 hours with a proximal femur nail with cement augmentation if needed and despite oral anticoagulation proved to be a safe procedure.

SCIENTIFIC POSTER #62 Geriatric Fractures

Is Social Isolation an Important Predictor of Adverse Events and Patient-Reported Outcome Measures (PROMs) in Elderly Hip Fracture Patients?

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Purpose: Our objective was to determine whether prefracture social isolation, assessed by the Lubben Social Networks Scale-18 (LSNS-18), predicts adverse events (AEs) and patient-reported outcomes at 1 year in patients undergoing surgical repair of a primary, low-trauma hip fracture.

Methods: Low-trauma hip fracture patients \geq 65 years old admitted to a tertiary care center for surgical repair were enrolled in a prospective cohort study. Patients with active cancer or dementia were excluded. Patient- Reported Outcomes Measurement Information System (PROMIS-29) and LSNS-18 were administered 2-4 days postoperatively to assess prefracture, then again at 3 months and 1-year postoperatively. AEs were recorded 1 month, 3 months, and 1 year postoperatively. PROMs and AEs were compared across patients stratified by social isolation prior to fracture with Wilcoxon rank-sum and Fisher exact tests, respectively (2-tailed P values reported). Analyses were performed using SAS 9.4.

Results: 257 patients enrolled; 72.8% were female, 89.1% white, 66.8% college-educated, median age 81.5 years. 165 patients completed 3-month follow-up; 7 patients died before 3 months. 110 patients completed 1- year follow-up, by which time 3 additional patients died. Patients who were socially isolated prior to fracture had a higher mortality rate than those who were not socially isolated prefracture (7 vs 3, P = 0.022). Number of 1-year AEs did not differ significantly between groups stratified by prefracture social isolation status. Prefracture socially isolated patients reported statistically significantly and clinically meaningfully worse 1-year PROMIS scores in their ability to participate in social activities compared to those not socially isolated prefracture (median T-score 55.6 vs 64.1, P = 0.043). No statistically significant differences in 1-year PROMIS anxiety, depression, fatigue, or pain scores were observed. 43 out of the 110 patients who completed 1-year follow-up were hospitalized within the year, although there was no difference when stratified by prefracture social isolation status.

Conclusion: Prefracture socially isolated patients had a statistically significantly higher mortality rate and worse self-reported participation in social activities 1 year after hip fracture repair than those not socially isolated prefracture. These results support the viability of enhancing social integration as an intervention to decrease mortality and morbidity, and improve function in low-trauma hip fracture patients.

SCIENTIFIC POSTER #63 Geriatric Fractures

Effectiveness of Local Anesthetic Injection in Geriatric Patients Following Operative Management of Proximal and Diaphyseal Femur Fractures Brian M. Fisher, MD; Ida Leah Gitajn, MD

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Purpose: Geriatric fracture patients are at risk for poor pain control and side effects of opioid medications. The arthroplasty literature has demonstrated infiltration of long-acting local anesthetic improves pain control and reduces postoperative opioid use resulting in better postoperative mobility without the deleterious effects of narcotics. Despite a higher risk for adverse events, there are limited data among geriatric trauma patients in this realm. The aim of this study was to evaluate whether local anesthetic infiltration (LAI) into soft tissues within the surgical field reduces narcotic use or pain scores in patients undergoing surgical management of proximal and diaphyseal femur fractures.

Methods: A retrospective review was performed of patients age >65 years undergoing operative intervention for proximal and diaphyseal femur fractures. The electronic record was utilized to determine if local anesthetic was injected into the surgical wound, the amount of narcotics administered over the 48 hours postoperatively, and visual analog scale (VAS) pain scores for patients pos-operatively in 4-hour intervals. The amount of narcotics was converted to morphine milligram equivalents (MME).

Results: Among 477 patients included, 359 did not receive LAI and 118 patients received LAI. Baseline demographics, fracture types, and surgical procedures were equivalent between the groups. In the first 4 hours, patients receiving LAI received 14.03 MME compared to 41.91 MME in those receiving no LAI (P = 0.0039). The cumulative narcotic use continued to be statistically significant for the first 28 hours postoperatively; 57.82 MME in the LAI group compared to 94.31 MME for those with no LAI (P = 0.034). From 28-48 hours postoperatively, there was no significant difference in MME between the groups. Despite decreased narcotics, the patient cohorts had equal pain scores (mean difference 0.37, P = 0.22). Multivariate analysis demonstrated a significant negative association between age and MME usage (Est. = -6.31, SE [standard error] = 1.17, P < 0.001) as well as LAI administration and MME utilization (Est. = -42.55, SE = 21.94, P = 0.05). Admission to an orthopaedic surgery service was positively associated with increased MME usage (Est. = 77.16, SE = 38.54, P = 0.045). There was no significant difference in hospital length of stay between the LAI and non-LAI groups (7.05 days vs 6.40 days, P = 0.369). There was no difference in rates of postoperative complications.

Conclusion: LAI into soft tissues appears to be effective at decreasing narcotic use in geriatric patients undergoing surgical treatment for proximal and diaphyseal femur fractures while maintaining equally satisfactory pain control. Further research is needed to identify effective ways to optimize pain management in this at-risk patient population.

SCIENTIFIC POSTER #64 Geriatric Fractures

Femoral Neck Shortening and Varus Collapse in "Stable" Pertrochanteric Femur Fractures *David Ciufo, MD; Jason Lipof, MD; Catherine A. Humphrey, MD; John P. Ketz, MD University of Rochester, Rochester, NY, United States*

Purpose: Pertrochanteric hip fractures are common injuries affecting elderly patients. Comparative studies of cephalomedullary nails (CMN) and sliding hip screws (SHS) have demonstrated superiority of cephalomedullary implants in unstable fracture patterns. There is a lack of evidence for implant selection in simpler stable fracture patterns, and the implant is routinely determined by surgeon preference. This study compares these 2 implants in stable pertrochanteric fractures, evaluating varus collapse and femoral neck shortening in the horizontal and vertical dimensions. These parameters are important for abductor tension and gait mechanics, with previous studies demonstrating poor quality of life correlated with greater shortening and varus collapse. We also evaluate implant failure in this cohort.

Methods: A retrospective review was performed of pertrochanteric femur fractures (AO/ OTA 31A1,2,3) treated with a trochanteric entry CMN or SHS from January 2003 through January 2014 at our institution. Inclusion criteria were patients 55 years or older, low-energy fracture mechanism, stable pertrochanteric fracture pattern (AO/OTA 31A1-2.2), and follow-up until fracture healing or failure. Pathologic and periprosthetic fractures were excluded. Injury radiographs were classified according to 2018 AO/OTA criteria. Imaging from the immediate postoperative period was analyzed for femoral neck-shaft angle at fixation and films from the most recent follow-up were analyzed for neck-shaft angle as well as femoral neck shortening in the horizontal and vertical dimensions. Implant failure was recorded. Univariate statistical analysis was performed.

Results: A total of 300 subjects met inclusion criteria. Average patient age was 82 years (range, 55-102) with average follow-up of 27 months (range, 3-142). Both implants allowed varus collapse during healing. The SHS group contained significantly more fractures that progressed to varus collapse $>5^{\circ\circ}$ (P = 0.02), mild horizontal shortening >5 mm (P <0.01), and severe horizontal shortening >10 mm (P <0.01). There was no difference in vertical shortening (P = 0.5) or implant failure (P = 0.8) between groups.

Conclusion: In the setting of stable pertrochanteric fracture fixation, for which there is currently no clear evidence for preferential use of a CMN or SHS, the hip screw allows development of greater deformity after fixation. The SHS group experienced greater varus collapse and horizontal shortening. There was no difference in overall implant failure. This set of parameters correlates with poorer quality of life and physical function scores. These findings suggest that a CMN is a superior construct for maintenance of reduction in stable pertrochanteric fractures, which may lead to improved functional outcomes as patients recover.

SCIENTIFIC POSTER #65 Geriatric Fractures

Fragility Fractures of the Pelvis Treated with Transsacral Bar Fixation: Retrospective Study of 79 Cases

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Purpose: Epidemiological changes lead to an increasing prevalence of fragility fractures of the pelvis (FFPs). In up to 90%, there is a lesion of the posterior pelvic ring. An operative therapy is indicated in cases of prolonged or immobilizing pain or in a displaced dorsal fracture. If anatomically there is a corridor available, minimally invasive stabilization with a transsacral bar in S1 is possible.

Methods: All consecutive patients with an FFP treated with a transsacral bar through S1 in a Level-I trauma center from 2009 to 2017 were included. The patient's record and radiographs were analyzed. The patients or their relatives were contacted in 2018 to ask about the mortality, the present mobility, and place of residence. Except for 3 patients (4%), all patients still alive could be included in follow-up.

Results: 79 patients with a mean age of 76.7 ± 9.5 years (range, 50-95) were included-73 females and 6 males. Dorsally, 63% patients were stabilized additionally to the transsacral bar with uni- or bilateral sacroiliac screws. A concomitant stabilization of the anterior pelvic ring was performed in 53%. 16.5% underwent an operative revision (5% evacuation of hematoma, 5% peri-implant infection, 10% hardware removal; combinations possible). The transsacral bar was removed in 1 case due to malpositioning. The length of stay was 20 ± 12 days. At discharge, 46% were mobile on the ward, 14% in their room, 35% for transfer to sitting position, and 5% were bedridden. 24% were discharged to their home, 49% in geriatric rehabilitation unit, the remaining to other rehabilitation or to a nursing home. There was a mortality of 27% during follow-up; 1 patient died during hospital stay. The patients died an average 158 ± 109 weeks after discharge. The reason of death was not related to the pelvic operation. After a follow-up of 206 ± 151 weeks, 52% lived at their home, one third with assistance. 63% needed a walking aid, 16% were mobile without walking aid, 21% were bedridden or only mobile to sitting position.

Conclusion: The transsacral bar in S1 is a valuable minimally invasive stabilization method to recover mobility in elderly with an FFP. A relatively long in-hospital stay could be explained by the initial trial of conservative treatment and due to intra- and interdepartmental cogeriatric services. The high mortality and need for assistance reflects this geriatric, multimorbid patient collective.

The FDA has stated that it is the responsibility 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 Olecranon Osteotomy with an Olecranon-Sparing Technique for Fixation of Geriatric Intra-Articular Distal Humerus Fractures: The Enhanced Bag of Bones

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Purpose: Intra-articular distal humerus fractures (IADHFs) are disabling injuries and difficult to treat in the elderly population. Nonoperative treatment, also referred to as the "bag of bones" (BoB), has been associated with poor functional results and unreliable pain relief but avoids the complications of surgery and prolonged hospital stays. Common surgical treatments for IADHFs include open reduction and internal fixation (ORIF) with olecranon osteotomy (OcO) and total elbow arthroplasty (TEA). The outcomes of a more limited ORIF without OcO or anatomic joint reduction and fixation referred to as the "enhanced bag of bones" (EBoB) has not been formally compared to the traditional ORIF of the distal humerus (ORIF + OcO). We hypothesized there would be no difference in pain scores or clinical outcomes in elderly patients treated with ORIF + OcO compared to those who underwent the EBoB technique.

Methods: 56 elderly patients (\geq 65 years old) with IADHFs, classified as AO humeral 13-C type fractures, who underwent surgical fixation with at least 12 months of follow-up were retrospectively reviewed. 30 patients were treated with ORIF + OcO and 26 patients were treated with the EBoB technique. Patients in the EBoB group typically underwent single or dual distal humerus columnar plating without anatomic joint reduction and fixation. The primary outcomes of this study were final elbow range of motion (in the coronal plane), complications, and the need for additional elbow surgery. Secondary outcomes included patient-reported outcome measurement tools for pain and function.

Results: The average final elbow range of motion in the coronal plane was 97° (range, 40°-155°) in the ORIF + OcO and 86.5° (20°-145°) in the EBoB group (P = 0.2313) at the time of final follow-up. The average final elbow extension (degrees short of full extension) was 22.5° (0°-45°) and 26.9° (0°-90°) in the ORIF + OcO and EBoB groups, respectively (P = 0.5389). In the ORIF + OcO group there were 11 complications in the follow-up period and 10 patients underwent additional surgery. In the EBoB group there were 4 complications in the follow-up period and 4 patients underwent additional surgery (P = 0.1218) in the ORIF + OcO group. PROMIS (Patient-Reported Outcomes Measurement Information System) scores for pain were 53.1 and 52.14 in the ORIF + OcO and EBoB and groups, respectively (P = 0.8668) and PROMIS function scores were 41.7 and 41.4, respectively (P = 0.9569).

The average operative time was 168 minutes and 138 minutes in the ORIF + OcO and EBoB groups, respectively (P = 0.0406).

Conclusion: Treatment with the EBoB technique demonstrated equivalent outcomes with regards to range of motion, function, and pain in elderly patients with IADHFs compared to the traditional ORIF + OcO. Surgical times were longer in the ORIF + OcO group with a trend toward more complications and need for additional surgery. The EBoB technique should be strongly considered in the treatment algorithm of elderly patients with IADHFs.

See the meeting app for complete listing of authors' disclosure information.

POSTER ABSTRACTS

SCIENTIFIC POSTER #67 Geriatric Fractures

Treatment of Distal Radial Fractures in the Elderly with the Photodynamic Bone Stabilization System Paul Alexander Vegt, MD Albert Schweitzer Hospital, Dordrecht, Netherlands

Purpose: Our purpose was to evaluate the clinical outcomes of osteoporotic distal radial fractures in the elderly treated with a photodynamic bone stabilization system.

Methods: A total of 73 patients were included in this study. They were treated with the photodynamic bone stabilization system polymeric implant. All patients underwent a dualenergy x-ray absorptiometry (DXA) scan to evaluate the bone density. The photodynamic bone stabilization system intramedullary balloon implant is introduced through a 1-cm incision and positioned in the intramedullary canal across the fracture through a percutaneous technique. The balloon is filled with a light curable monomer, expanding to achieve cortical wall contact and then exposed to visible blue light (436 nm), polymerizing the monomer and forming a patient customized implant. The median age was 79 years (range, 66- 91 years); 95% were female. Patients were eligible for inclusion if they met the following criteria: age 60 years or older, bone density T-score <-2.0, and AO type 23-A2 or 23-A3 fracture. All patients were treated in day care. Patients were discharged with a low-pressure stocking for 24 hours, followed by a double bandage for 1 or 2 weeks. There were no mobility restrictions. They went to physiotherapy and used their wrist as tolerated.

Results: Functional abilities: 60% (44/73) were able to resume normal activities of daily living (ADLs) within 1 week and 85% (62/73) within 2 weeks of surgery. Four of the 73 patients (5%) suffered a complication: superficial skin infection (n = 2) and postoperative complex regional pain syndrome (n = 2). Postoperative pain related to the use of the system was reported in 1 patient. Irritation of the extensor pollicis longus tendon in this patient was resolved by resecting 4 mm of the introducing catheter, which had been left a bit prominent. Five patients showed a collapse of the distal radius up to 4 mm. This, however, did not limit the overall function, range of motion, or ADLs. There were no secondary procedures or delayed unions. Visual analog scale scores for pain had a median of 0. All had an unrestricted range of motion within 3 months of the procedure.

Conclusion: The photodynamic bone stabilization system has been shown to be a viable treatment method for fixation of distal radial fractures in osteoporotic elderly patients. The ability to fully fill the trabecular space in percutaneous manner results in excellent stabilization of the distal radial fracture and a rapid return to full ADLs, important in the elderly population and a reduction in the cost of Medicare.

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

POSTER ABSTRACTS

SCIENTIFIC POSTER #68 Geriatric Fractures

Outcomes in Elderly Patients with Hip Fracture and Concomitant Fractures *Franco De Cicco, MD*; *Fernando Fiorentini; Bruno Rafael Boietti; Guido Sebastian Carabelli, MD; Javier Benchimol, DMed; Cristina Maria Elizondo; Carlos F. Sancineto, MD; Jorge Daniel Barla, MD Hospital Italiano de Buenos Aires, Buenos Aires, Argentina*

Purpose: The purpose of our study is to determine if the presence of concomitant fractures in patients with hip fracture affect length of hospital stay, complications, functional scores, readmissions, and rate of survival at 1 month and 1 year of follow-up.

Methods: We performed a prospective cohort study in our institution with consecutive incident cases capture and standardized evaluation at 1 month and 1 year of follow up. A basic statistical evaluation. Between 2014 and 2018 we included patients older than 65 years with hip non pathologic fracture. Patients demographics characteristics were recorded as well as length of hospital stay, readmission rate, complications, functional scores (Parker) and survival rate at 1 month and 1 year of follow up. We defined 2 groups: concomitant fracture group (CFG) and non-concomitant fracture group (NCFG).

Results: 1429 patients were included. Patients with and without concomitant fractures had similar demographic characteristics. 82 patients (5.7%) had concomitant fractures. The mean age in CFG was 85.9 years (standard deviation [SD] \pm 6.4) and in NCFG was 84.6 (SD \pm 6.7); P = 0.968. In CFG, 79% were female, and 85% in NCFG; P = 0.168. The most frequent concomitant fracture was distal radius fractures (n = 34) and proximal humeral fractures (n = 22). Length of hospital stay was approximately 6 days (interquartile range [IQR], 5-10) for CFG versus 6 days (IQR, 5-9) in NCFG, P = 0.44. The 1-year survival rate was 85% (confidence interval [CI], 75-92) in CFG versus 82% (CI, 79-84) in NCFG, P = 0.738. The median of the difference between Parker baseline and Parker at 12 months in the CFG was -2 (IQR, -4 to 0) and in the NCFG was -2 (IQR, -3 to 0); P = 0.756. Having a concomitant fracture did modify the following variables: complication rate at 12 months was 55% (CI, 43%-67%) in CFG versus 40% (CI, 37%-43%) in NCFG; P = 0.029. Principally, complications were infections, followed by thromboembolic disease. The rate of readmission at 12 months was 49% (CI, 37%-62%) in CFG and 33% (CI, 30%-36%) in NCFG; P = 0.031.

Conclusion: Patients with hip and a concomitant fracture were mainly females. Concomitant fractures did not influence length of hospitalization, survival rate, and functionality. Nevertheless, complications and readmission rates were modified by the presence of concomitant upper limb fractures. These values showed the negative impact of having a concomitant fracture in a hip fracture event.

SCIENTIFIC POSTER #69 Geriatric Fractures

Length of Stay Following Geriatric Hip Fracture Surgery: Do Physical Therapy Availability and Day of Surgery Matter?

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Purpose: Management of geriatric hip fractures requires a multidisciplinary approach, and multiple factors impact hospital length of stay (LOS) after surgery. Day of surgery and availability of physical therapy (PT) have been shown to be independent predictors of LOS following total joint arthroplasty. The purpose of this study was to investigate the impact of day of surgery and postoperative PT sessions on LOS following hip fracture surgery.

Methods: We performed a retrospective analysis of all surgically treated geriatric hip fractures (age >60 years) at a Level-I trauma center over a 2-year period. The primary outcome variable was hospital LOS. Patient demographics, American Society of Anesthesiologists (ASA) scores, and medical comorbidities were recorded, as were surgical characteristics and day of the week of surgery. Hospital unit, admitting and discharging service, and number of PT sessions received in the first 3 postoperative days (PODs) were also recorded. All variables associated with hospital LOS were identified by Kruskal-Wallis tests. A multivariable negative binomial regression analysis was then performed to adjust for patient age and medical comorbidities.

Results: 315 geriatric hip fractures were identified, with an average age of 79.8 years. 71% of patients were female. On univariable analysis, LOS was significantly associated with day of surgery, ASA score, hospital unit, discharging service, discharge disposition, surgical procedure, and number of PT sessions during PODs 1-3. Results of the multivariable analysis are shown in Table 1. After adjustment, patients who had surgery Thursday/Friday/

Saturday stayed in the hospital 15% longer than those who had surgery on another day (P = 0.02). Patients not seen by PT on the first 3 PODs stayed 2.37 times longer than patients seen all 3 days (P<0.001).

Conclusion: Day of surgery and availability of PT during the first 3 postoperative days significantly impact length of stay following geriatric hip fracture surgery. Table 1: Multivariable Negative Binomial Regression for Length of Stay Following Geriatric Hip Fracture Surgery

	Incidence	95% Confidence	P-value
Variable	Rate Ratio	Interval	
Patient Age at Surgery (unit = 10 years)	0.93	0.88, 0.99	0.03
ASA Score (unit = 1 point)	1.18	1.07, 1.30	0.001
Discharge Service			< 0.001
Orthopaedic Surgery	REF		
Medical Service	1.47	1.25, 1.73	< 0.001
Other Surgical Service	0.99	0.61, 1.60	0.96
Trauma Surgery	1.26	0.97, 1.64	0.08
Discharge Disposition			< 0.001
Home	REF		
Acute/Long-Term Acute Care Rehab	1.96	1.32, 2.92	<0.001
SNF/Swing Bed	1.87	1.39, 2.51	< 0.001
Other	1.25	0.55, 2.83	0.59
Weekend Surgery (Thurs/Fri/Sat)	1.15	1.02, 1.29	0.02
Surgical Procedure			0.15
CMN	REF		
CRPP	0.82	0.67, 1.01	0.058
SHS	0.99	0.82, 1.19	0.88
Hemiarthroplasty	0.94	0.81, 1.08	0.36
Number of PT session within first 3 PODs	<0		< 0.001
0	2.37	1.48, 3.79	< 0.001
1	0.84	0.70, 1.00	0.053
2	0.96	0.84, 1.11	0.60
3	REF		

*ASA: American Society of Anesthesiologists; SNF: Skilled Nursing Facility; CMN: Cephalo-Medullary Nail; CRPP: Closed Reduction Percutaneous Pinning; SHS: Sliding Hip Screw; PT: Physical Therapy; POD: Post-Operative Day

Variable Performance of Evidence-Based Guidelines for Echocardiography in Patients with Hip Fractures

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Purpose: Osteoporotic hip fractures typically occur in frail, elderly patients with multiple medical comorbidities. The preoperative evaluation process sometimes involves transthoracic echocardiography (TTE) to screen for significant heart disease that would alter perioperative management. Evidence suggests that use of guidelines and care pathways can improve the effectiveness of care delivered, but it is unclear which guidelines/pathways are the most useful in patients with hip fractures.

Methods: We performed a retrospective chart review based on a prospective registry of osteoporotic hip fracture patients to identify all patients who underwent preoperative TTE. The history, physical examination findings, and listed indications for TTE were compared to those given in 5 commonly utilized clinical practice guidelines (CPGs): American College of Cardiology (ACC/AHH), British Society of Echocardiography (BSE), European Society of Echocardiography (ESC/ESE), Association of Anesthesia of Great Britain and Ireland (AAGBI), and Scottish Intercollegiate Guidelines Network (SIGN). The performance of these guidelines (sensitivity, specificity) for identifying which patients would have TTEs with information with potential to change perioperative management was calculated.

Results: 100 patients were identified receiving preoperative TTE, and the patients met criteria for TTE 32%-66% of the time, based on the individual CPG used. TTE revealed new information with the potential to change management 14% of the time. As a screening tool, the ACC/AHH and SIGN guidelines performed the best, both with 100% sensitivity for identifying which patients may benefit from TTE.

Conclusion: Prior to fixation of osteoporotic hip fractures, TTE can be a useful tool for identifying pathology that may directly lead to changes in perioperative medical or anesthesia management. Based on these data, established CPGs can be safely used to identify which patients should receive preoperative TTE with low risk or missed pathology. The guidelines that were the most sensitive tended to focus on a change in clinical status in patients with known disease, or clinical concern for new onset disease of at least moderate severity.

SCIENTIFIC POSTER #71 Geriatric Fractures

Effect of Multidisciplinary Treatment Approach for Geriatric Hip Fractures Kenji Shigemoto; Takeshi Sawaguchi, MD, PhD; Kenichi Goshima, MD, PhD; Shintaro Iwai, MD; Kenji Fujita, MD Toyama Municipal Hospital, Toyama, Japan

Purpose: We report the results of the multidisciplinary treatment approach for geriatric hip fractures and evaluate its effectiveness.

Methods: The multidisciplinary treatment approach has been applied in our hospital since 2014. Elderly patients who were admitted to the orthopaedic department with fragility hip fractures were included in the integrated pathway. 597 hip fracture patients were admitted with an acute hip fracture over a 4-year period. We excluded 69 patients: all those aged <65 years, those with pathological fractures, those undergoing conservative treatment, and those with multiple injuries. Time to surgery, hospital stay length, perioperative complications, osteoporosis treatment, and functional recovery were evaluated. The medical costs were compared with those in other acute phase hospitals every year.

Results: The average days from patient admission to surgery in 2014, 2015, 2016, and 2017 were 1.3 days, 1.5 days, 1.3 days, and 1.6 days, respectively; those were about 3 days shorter than the annual national average. The average duration of hospital stay was 18.4 days, 19.7 days, 20.0 days, and 21.1 days, respectively; those were more than 14 days shorter than the annual national average. The most frequent complication was deep venous thrombosis (17.0%), followed by dysuria (13.9%). In addition, as serious complications, pneumonia was 3%, heart failure 0.8%, and pulmonary embolism 0.8%, and the inhospital mortality rate was 0.9%. The rate of patients who had antiosteoporosis pharmacotherapy at the time of admission was only 23%, but the rate at discharge was 88%, and the continuation rate of pharmacotherapy was 95% at 1-year follow-up thanks to the fracture liaison service. At the time of their discharge from rehabilitation hospital, the proportion of patients who recovered to preinjury functionality was increased to 47% from 35% before the multidisciplinary treatment approach. The total hospitalization medical cost per person for the multidisciplinary treatment was lower than other hospital costs every year.

Conclusion: We have organized a multidisciplinary team for geriatric hip fracture, and this approach resulted in shorter time to surgery and hospital stay than the national average. The multidisciplinary treatment has kept a high rate of osteoporosis treatment at discharge and at follow-up, and better functional recovery. Furthermore, the total medical cost per person was less than national average. Multidisciplinary treatment approach for geriatric hip fractures is possible to conduct in Japan and was effective.

SCIENTIFIC POSTER #72 Geriatric Fractures

The Humeral Head Push-Pull Plate Technique Significantly Diminishes Secondary Screw Penetration in the Treatment of Osteoporotic Varus-Displaced Proximal Humeral Fractures *Guy Putzeys, MD*

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Purpose: Osteoporotic varus-displaced fractures of the proximal humerus treated with an angular stable plate have a high risk of recurrence and/or screw penetration. This comparative study investigates if a pulling humeral head subchondral anchor fixed to an angular stable plate with inferiorly directed angular-stable screws can decrease the complication rate. [JA1]

Methods: This study is a comparison between 2 groups of a consecutive case series, prospectively collected, treated by a single surgeon. Inclusion criteria are a minimum age of 70 years, varus-displaced 2- or 3-part fractures of the proximal humerus (11A2 and 11B1.1) treated with an angular-stable plate osteosynthesis. The first group was treated with a common proximal humeral locking plate technique with rotator cuff tension- reducing sutures. The second group was treated with 1 or 2 humeral head apex subchondral anchor(s) tightened to a proximally molded locking plate with inferiorly directed variable angle locking screws. Penetration of the screws to the humeral head, recurrence of varus displacement, and reoperation were compared using the χ 2 test.

Results: The first group consisted of 12 cases. Mean age was 82.4 years. Mean follow-up was 5.5 months (range, 3-11 months). There were 5 cases of recurrence, 3 cases of screw penetration, and 3 revision plate osteosynthesis. The second group consisted of 23 cases. Mean age was 78 years. Mean follow-up was 6 months (range, 3-14). There were 4 cases of recurrence, no secondary screw penetration, and 1 revision plate osteosynthesis. The statistical analysis showed a significant difference in screw penetration (P = 0.012) and a nonsignificant difference in recurrence (P = 0.119) and reoperation rate (P = 0.068).

Conclusion: This humeral head push-pull plate technique using apical subchondral anchors and inferiorly directed angle-stable screws significantly decreases secondary screw penetration and appears to decrease secondary recurrence and reoperation rate in the treatment of osteoporotic varus-displaced proximal humeral fractures.



SCIENTIFIC POSTER #73 Hip and Femur

Can Patients with Cognitive Impairment Be Included in a Randomized Controlled Trial on Hip Fractures: A Feasibility Study

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Purpose: One in 3 patients with a hip fracture is known to have a degree of cognitive impairment. A recent systematic review has shown that patients with cognitive impairment are rarely included in randomized controlled trials (RCTs) and as a result a significant subpopulation of the patients with hip fractures may be overlooked. The purpose of this study was to evaluate the recruitment, retention, and completion of patients with and without cognitive impairment in a high-quality clinical trial.

Methods: This was a prospective, single-center RCT approved by the local research ethics committee. Patients aged between 55 and 95 years with a low-energy intertrochanteric unstable proximal femoral fracture (OTA/AO 31A2) were randomized to either a dynamic hip screw (DHS) or a short intramedullary nail (EBA2; Citieffe). Permuted block randomization was stratified by Abbreviated Mental Test Score (AMTS). Patients were asked to perform the timed "Up and Go" (TUG) test, the proposed primary efficacy assessment measure at each follow- up (FU) visit (2, 4, and 12 weeks).

Results: 60 patients were recruited and randomized in the study. The average age was 84.9 years (range, 56-95). 48 were females and 12 males. 31 patients were randomized to a nail and 29 to a DHS. 22 (37%) patients had AMTSs <8. From the 38 patients with AMTS ≥8, 35 (92%) completed the study (2 were withdrawn by the research team and 1 was lost to FU). From the 22 patients with AMTS <8, 14 (64%) completed the study (6 died, 1 withdrew consent, and 1 was withdrawn by the research team). Attendance in each FU visit was lower for patients with AMTS 8 (2-week FU: 82% vs 89%, 4-week FU: 73% vs 89%, 12-week FU: 59% vs 87%). Patients with AMTS <8 were less likely to be able to perform the TUG test at each FU visit (TUG test was performed by 33%, 80%, and 75% of the patients with AMTS <8 and by 76%, 85%, and 94% of the patients with AMTS ≥8 at 2, 4, and 12 weeks of FU, respectively).

Conclusion: This study showed that patients with cognitive impairment are less likely to complete an RCT and they are less likely to be able to perform the clinical outcome assessments than patients with normal cognition. This differentiates them from the normal population and may mean that they should be considered a separate subpopulation, unless suitable surrogate outcomes can be identified that can be captured early in the treatment process in both groups. Including patients with cognitive impairment in clinical trials, although they may require separate assessment and tailored outcomes, will ensure that the results are applicable to this sizeable subpopulation.

Comparison of in Situ Fixation versus Fixation with Reduction for Treating Impacted Valgus Femoral Neck Fractures (OTA Classification 31-B1.1) in Young Patients: A Case-Control Study

Kyuhyun Yang Prof; **Kyusub Um, MD**; Young-Chang Park Yonsei University, Gangnam Severance Hospital, Seoul, Korea, Republic of

Purpose: Disimpaction of valgus-impacted fracture has been avoided due to fear of instability and fixation failure after internal fixation. This study aimed to compare in situ fixation versus fixation with reduction for treating valgus-impacted femoral neck fracture in young patients.

Methods: 33 femoral neck fractures with valgus deformity of 15° or more (AO-OTA classification 31-B1.1) in patients younger than 65 years were treated with internal fixation. 16 patients were treated with in situ fixation (in situ fixation group) and 17 were treated with internal fixation after disimpaction (reduction group). The resultant femoral neck shortening vector at the angle of the femoral neck (z) was calculated using θ as the corresponding angle to the neck-shaft angle. Femoral neck length of the fractured side was measured and compared with the intact side.

Results: Demographic findings showed no statistically significant difference between the groups. The average follow-up period was 33 months, and bony union occurred in all cases. Femoral neck shortening at the last follow-up was lesser in the reduction group (x-axis abductor lever arm/z-axis-neck length, 3.4 mm/3.2 mm) than in the in situ fixation group (x-axis/z-axis, 5.6 mm/6.0 mm) (P = 0.024 and P = 0.002, respectively). Reduction loss was minimal during the follow-up (Fig. 1). The mean Harris hip scores were 85.8 and 90.8 for the in situ fixation and reduction groups, respectively (P = 0.038).

Conclusion: Disimpaction and internal fixation of valgus-impacted femoral neck fractures in patients younger than 65 years can decrease femoral neck shortening without reduction loss and improve the clinical outcome.



Femur neck shortening (Z axis)

Efficacy and Safety of Reducing Posttraumatic Hidden Blood Loss with Early Tranexamic Acid Intervention in Elderly Patients with Intertrochanteric Fracture: A Retrospective Analysis

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Purpose: Elderly patients with intertrochanteric fractures exhibit posttraumatic hidden blood loss (HBL). This study aimed to evaluate the efficacy and safety of reducing posttraumatic HBL via early intravenous (IV) tranexamic acid (TXA) intervention in elderly patients with intertrochanteric fracture.

Methods: A retrospective study was conducted with 77 patients (age ≥ 65 years, injury time ≤ 6 hours) who presented with intertrochanteric fracture from November 2016 to April 2018. Patients in the TXA group (n = 39) received 1 g of IV TXA at admission, whereas those in the normal saline (NS) group (n = 38) received an equal volume of saline. Hemoglobin (Hgb) and hematocrit (Hct) were recorded at posttraumatic admission (PTA) and on posttraumatic day (PTD) 1-3. HBL was calculated using the Gross formula. The preoperative transfusion (POT) rate was recorded. Lower-extremity venous ultrasound was performed to detect venous thrombosis.

Results: Hgb and Hct on PTD 2 and 3 were significantly higher in the TXA group than in the NS group (P <0.05). HBL on PTD 2 and 3 was significantly less in the TXA group than in the NS group (P <0.05). The POT rate was significantly lower in the TXA group than in the NS group (P = 0.036). Preoperative hospital stay was significantly shorter in the TXA group than in the NS group (P = 0.014). There were 4 cases of venous thrombosis in the TXA group and 3 in the NS group.

Conclusion: Early IV TXA intervention potentially reduces posttraumatic HBL in elderly patients with intertrochanteric fractures without increasing the risk of venous thrombosis.

Items	TXA group $(n = 39)$	NS group $(n = 38)$	р
Hgb (gl L)		<u> </u>	
Il gb PTA	116.18 ± 4.58	$114\;.79\pm 6.\;6\;5$	0.288'
Hgb PTD 1	111.28 ± 5.25	$108.6\ 1\pm 7.28$	0.068'
Hgb PTD 2	105.44 ± 6.60	100.26 ± 7.77	0.002"
Hgb PTD 3	98.74 ± 9.39	88.57 ± 8.24	< 0.001'
Hct (ll/o)			
Hct PTA	43.26 ± 2.44	42.42 + 2.19	0.118'
Ik t PTD 1	39. I H 2.50	$38.6\ 1\pm 1.69$	0.24 11"
Hct PTO 2	$35.82\pm J.04$	34.29 .L 2.55	0.019′
Hct PTO 3	32.62 ± 3.75	$26.95 \pm J$ OJ	< 0.00 1 '
HBL(mL)			
HBLPTD I	$1\ 73.95 \pm 16\ .0\ 3$	182.32 ± 20.95	0.053″
HBL PTD 2	238.46 + 25.61	254.74 ± 29.16	0.011'
HBL PTD 3	$28\ 1.23 \pm 23.22$	360.05 .L 40.45	< 0.001"
POT rnlc ({,)	4 (10.26)	1 1 (28.95)	0.036'
POT units (U)	12	30	
Preoperative stay (h)	87.38 ± 27.25	$10 \ 4. \ 21 \pm 3 \ 1.21$	0.014'
Vein thrombosis			0.515§

Table I: Comparison of post-traumatic outcomes between the TXA and NS groups

- Two-sided Student's/-test; §c hi-squared test; Hct, hematocrit; Hgb, hemoglobin; HBL, hidden blood loss; TXA, tranexamic acid; NS, normal saline; PTA, post-traumatic admission; PTO, posttraumatic day; POT, preoperative transfusion

SCIENTIFIC POSTER #76 Hip and Femur

Implant Cut-out Following Cephalomedullary Nailing of Intertrochanteric Femur Fractures: Are Helical Blades to Blame?

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Purpose: Implant cut-out remains a common cause of cephalomedullary nail (CMN) failure and patient morbidity following surgical treatment of intertrochanteric femur fractures. Recent studies have suggested an increased rate of CMN cut-out with helical blades as opposed to lag screws. We compared rates of overall cut- out between helical blades and lag screws and used bivariate and multivariate analysis to determine the role of proximal fixation method among other variables on risk for cut-out. Subgroup analysis was performed on the basis of failure mechanism; superior migration versus medial perforation.

Methods: 313 patient charts were retrospectively reviewed over an 8-year period; 245 patients were treated with helical blades and 68 with lag screws. Radiographs were reviewed for fracture pattern, tip-apex distance (TAD), Parker's ratio (PR), and reduction quality. Rate of implant cut-out was compared between groups and multiple logistic regression was used to analyze the ability of several independent variables to predict implant cut-out.

Results: 20 cut-outs occurred: 15 with helical blades and 5 with lag screws. No difference in the rate of cut-out was observed between the 2 groups (P = 0.45). Poor fracture reduction was found to be a significant predictor of implant failure via bivariate and multiple logistic regression analysis (P < 0.01, odds ratio [OR] 23.573). Helical blade fixation, fracture instability, TAD \geq 25, and PR \geq 0.45 were not predictive of implant cut-out during multivariate analysis. Similarly, patient smoking status and surgeon trauma fellowship training did not significantly increase the odds of implant cut-out. Failure by medial perforation occurred in 12 instances, all involving helical blades. Failure by superior migration occurred at a significantly higher rate with lag screws than helical blades (P = 0.02).

Conclusion: CMN cutout is likely multifactorial. A direct association between helical blade fixation and implant cut-out was not observed in our study. Among modifiable risk factors for implant failure, poorer fracture reduction was predictive of failure by cut-out. Subgroup analysis highlights differing modes of failure between lag screws and helical blades that warrants further investigation. Ideal TAD during helical blade fixation remains unknown.

SCIENTIFIC POSTER #77 Hip and Femur

Predictors of Excessive Lag Screw Sliding and Cutout After Cephalomedullary Nail Fixation of Intertrochanteric Fracture

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Purpose: The vast majority of intertrochanteric fractures treated with cephalomedullary nailing (CMN) will heal. Occasionally, even though bony union occurs, excessive lag screw sliding can cause persistent pain and soft-tissue irritation and require return to surgery for hardware removal. The purpose of this study was to evaluate if fracture stability, lag screw tip-apex distance (TAD), and quality of reduction have any impact on excessive lag screw sliding and potential cutout.

Methods: As part of our Level-I trauma center's institutional hip fracture registry, a retrospective analysis identified 199 intertrochanteric fractures fixed with CMN between 2009 and 2015 with a minimum follow-up of 3 months. The mean follow-up was 22 months (range, 3-94 months). Mean patient age was 75 years (range, 50- 97 years) and 72% were women. Postoperative radiographs were used to measure the TAD, quality of reduction, neck-shaft angle (NSA), and lateral lag screw prominence. Follow-up radiographs were reviewed to assess fracture union, displacement, and progression of lateral lag screw prominence. Complications and reoperations were recorded.

Results: The average lag screw sliding was 5 ± 5 mm. Excessive lag screw sliding (defined as >10 mm; 1 standard deviation above the mean) was present in 12% of patients. Lag screw sliding was more common in unstable fracture patterns (21% vs 5%, P <0.01) and patients with calcar fracture gapping >4 mm (26% vs 4%, P <0.01). Lag screw sliding was not associated with age (P = 0.9), sex (P = 0.4), TAD (P = 0.3), implant (P = 0.8), distal interlocking screws (P = 0.3), or NSA (P = 0.2). There were 7 patients (3%) with prominent lag screws that required removal. These patients experience more lag screw sliding than those that did not require removal (9 mm vs 5 mm, P <0.01). There were 2 cutouts (1%). The average TAD was larger in the cutout group (26 vs 17 mm, P <0.01). 15 patients (7%) had TAD of 25 mm or more.

Conclusion: Excessive lag screw sliding was associated with unstable fracture patterns, calcar fracture gapping, and more reoperations for symptomatic hardware. Careful attention to calcar fracture reduction may minimize excessive lag screw sliding. The incidence of cutout was low and associated with a larger TAD.

Routine Screening for MRSA and Decolonization of Hip Fracture Patients Significantly Reduces MRSA and Superficial Wound Infection, But Not Deep Infection

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Purpose: Surgical site infection (SSI) remains a serious complication after hip fracture surgery with a negative effect on mortality, morbidity, and health-care costs. Methicillin-resistant Staphylococcus aureus (MRSA) SSI increases both health-care costs and 1-year mortality compared to non-MRSA SSI. During 2008 our hospital implemented routine MRSA screening and decolonization of trauma patients. We sought to establish the effect of this screening program in our local hip fracture population.

Methods: Using prospectively collected data for all hip fracture admissions to our hospital, we compared a cohort of consecutive patients admitted before the implementation of screening (from 1999 to 2004, n = 3563) to another post-screening cohort (consecutive patients from 2009 to 2016, n = 6581). Rates of MRSA SSI and overall deep and superficial SSI (from all organisms) were compared pre- and post-change. The diagnosis of SSI was verified from hospital notes and microbiology records and grouped into superficial or deep infection using the Centers for Disease Control and Prevention (CDC) criteria. Demographics of the cohorts were compared and multiple logistic regression analysis was used to investigate potential risk factors of infection. One-year mortality with and without infection was compared between the 2 groups.

Results: Overall 39 cases of MRSA SSI were detected in the pre-screening group, compared to 10 in the post- screening group (P < 0.0001). Overall superficial SSI decreased (1.4%)vs 0.4%, P <0.001); however, deep SSI did not (1.15% vs 1.11%, P = 0.6). We observed a significant increase in coagulase-negative staphylococcus SSI in the post-screening group (0.36% vs 0.08%, P = 0.016). It is possible that the targeted elimination of 1 organism may allow other organisms an opportunity to cause SSI. Multivariate logistic regression analysis demonstrated several significant risk factors for developing SSI: surgery with an Austin Moore (odds ratio [OR] 3.175, P = 0.005) or Dynamic Condylar Screw (OR 5.888, P = 0.036), anticoagulation with warfarin (OR 2.117, P = 0.004), or the presence of sacral pressure sores (OR 3.058, P = 0.02). One-year mortality without SSI was lower post-screening (33% vs 25%, P <0.001) showing a continuous improvement in neck of femur care. However, despite the reduction in MRSA SSI, mortality at 1 year after deep SSI remains high (50% pre-screening vs 46% post screening, P = 0.56).

Conclusion: The routine screening for MRSA and decolonization of hip fracture patients significantly reduces MRSA and superficial SSI, supporting the implementation of screening programs. However, rates of, and survival after, deep SSI have not improved over a 17-year period, demonstrating that deep SSI remains a serious and unsolved problem.

POSTER ABSTRACTS

SCIENTIFIC POSTER #79 Hip and Femur

Which Surgical Approach Provides Maximum Visualization and Access for Open Reduction and Internal Fixation (ORIF) of Femoral Neck Fractures? Keerat Singh, MD; John Weitlich, MD; Kyle Schweser, MD; James L. Cook, DVM, PhD; Brett D. Crist, MD University of Missouri, Columbia, MO, United States

Purpose: We sought to objectively identify which surgical approach provides the maximal exposure for subcapital, transcervical, and basicervical femoral neck fracture ORIF. Our hypothesis is that the Hueter approach provides maximum exposure.

Methods: 15 fresh-frozen cadaveric hips were utilized to compare 4 different surgical approaches to the femoral neck (n = 5 hips/approach): Watson-Jones, Smith-Petersen (with and without rectus release), and Hueter approach. Data were captured before and after rectus release for the Smith-Petersen approach to make the fourth group. After surgical exposure, standardized and calibrated digital images were captured and analyzed using a computer software program to determine the % area visualized. Three trained investigators separately assessed each specimen to determine visualization and ability of the surgeon to physically outline the subcapital and basicervical anatomical femoral neck regions and included the superior, inferior, and anterior halves. If the subcapital and basicervical components could be visualized and palpated, the transcervical region could be accessed. Data were analyzed for significant (P <0.05) differences using analysis of variance and Fisher exact tests.

Results: Femoral neck visualization (digital camera evaluation and direct visualization) for all regions was significantly higher (P < 0.029) for Smith-Petersen without rectus release. The ability to outline the femoral neck with a Freer elevator was significantly better (P < 0.049) with Smith-Petersen without rectus release and Heuter compared to Smith-Petersen with rectus release. There was no significant difference compared to Watson-Jones.

Conclusion: When comparing common surgical exposures utilized for femoral neck fracture ORIF, including the Hueter approach used for anterior total hip arthroplasty, the Smith-Petersen approach without rectus release provides the best visualization for the entire femoral neck. Furthermore, when considering femoral neck regions that are accessible with palpation, Smith-Petersen without rectus release and Heuter approaches provide the greatest access.

SCIENTIFIC POSTER #80 Hip and Femur

Predictors of Nonunions in Young Patients with Femoral Neck Fractures

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Purpose: Femoral neck fractures (OTA 31B) in young patients can be difficult injuries to treat, with 20%-40% of patients developing nonunions or early fixation failures. These complications are debilitating in young patients with the potential for significant morbidity. The factors that contribute to the development of nonunions in these patients are poorly understood. The purpose of this study was to determine if specific patient factors, fracture characteristics, or surgical treatments contributed to higher rates of nonunion in young patients with femoral neck fractures.

Methods: We conducted a retrospective review of patients who underwent operative treatment for femoral neck fractures from 2013-2017 at a single institution. Inclusion criteria consisted of patients between ages 15-65 years, operative management of the femoral neck fracture, and a minimum clinical follow-up of 3 months. We recorded patient demographics, injury mechanisms, concomitant injuries, fracture characteristics, bone quality, reduction quality, fixation implants, and postoperative outcomes. A univariate analysis was performed on all variables measured, using Wilcoxon-rank sum for continuous variables and χ^2 or Fisher's exact test for categorical variables. A simple logistic regression was also performed for each variable in order to present odds ratios. Adjusted odds ratios were calculated along with their respected 95% confidence intervals.

Results: 70 patients were included in the study. Average patient age was 41.3 years (range, 15-65). 19 of the 70 patients (27.1%) developed a nonunion. When comparing patients who healed their fracture and those who developed a nonunion, age, sex, smoking status, body mass index, bone density, time to surgery, reduction quality, fracture location, and Pauwels' angle did not show significance in predicting nonunions. In our cohort, fracture displacement (P = 0.004), comminution (P = 0.003), Garden classification (P <0.001), and open reduction technique (P = 0.001) were significant predictors for femoral neck nonunions. When controlling for age and sex, patients with severe displacement had 22.2 times increased odds of nonunion compared to those fractures without severe displacement (P = 0.007).

Conclusion: Femoral neck fractures in young patients can have high rates of nonunion, which can lead to significant patient morbidity. In this study, fracture characteristics can be significant predictors of patients who subsequently progressed to nonunions, while patient and injury factors were not predictive. Determining which patients are high risk for femoral neck nonunions may provide the opportunity for additional measures to optimize bone healing in this subset of patients and minimize the potential for future complications.

The Use of Mobility Technicians to Deliver Mobility Therapy as an Effective Means of Decreasing Cost in Hip Fracture Patients

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Purpose: Early ambulation has well-documented benefits in patients with surgically treated acute hip fractures. Ambulation in the inpatient setting is typically performed by a physical therapist; however, given their time, cost, and resource constraints, many patients are sparingly seen. A possible solution is the implementation of a mobility technician program (MTP), in which a mobility technician (MT) mobilizes patients after they have been evaluated by a physical therapist. MTs demand less training and compensation, and are more widely available throughout the hospital. As the health-care system moves toward bundled payments, minimizing inpatient costs becomes vitally important. The purpose of this study was to assess the impact and cost- effectiveness of postoperative mobilization delivered via MT in hip fracture patients.

Methods: All patients admitted between June and November of 2018 with acute hip fractures were screened for potential inclusion in the study group. The control group consisted of acute hip fracture patients, time matched to the previous year. A retrospective chart review was performed to determine patient demographics, length of stay (LOS), and discharge disposition. Total costs of therapy services were based on cost of 2 sessions per day, extrapolated from LOS. Minitab software was used to perform bivariate statistical analysis of the data.

Results: The study group contained 32 patients treated with intramedullary nail (n = 12), hemiarthroplasty (n = 8), total hip arthroplasty (n = 7), and screw fixation (n = 3). The control group consisted of 88 patients. The therapy cost of the study group was \$14 per patient per day, compared to \$98 in the control group. Both groups exhibited an identical median LOS of 4 days (P = 0.8002). 77/88 patients (87.5%) in the control group were discharged to a skilled nursing/rehabilitation facility while 12/32 patients (37.5%) in the study group were discharged to a skilled nursing/rehabilitation facility (P = 0.627).

Conclusion: Employing mobility technicians is a cost-effective strategy for providing postoperative ambulation in patients with acute hip fractures without sacrificing quality of care. Enrollment of the control group patients to the mobility technician program in this setting would have resulted in an average total savings of \$29,568. With the transition to bundled payments looming, mobility technicians may play an important financial role in the care of 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.

Association Between the Reduced Position in Lateral View and Postoperative Early Excessive Neck Shortening After Intramedullary Nailing of Intertrochanteric Fracture: A Retrospective Cohort Study

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Purpose: Excessive neck shortening after internal fixation of intertrochanteric fracture potentially associates the postoperative impairment of ambulance and quality of life. However, little is known whether the reduced position of the fragments associates the postoperative neck shortening. We hypothesized that the inappropriate reduction caused excessive neck shortening particularly in unstable fractures such as lack of posteromedial support. The purpose of this study was to investigate the association between the reduced position evaluated in lateral view and postoperative neck shortening among the intertrochateric fractures fixed by cephalomedullary nail.

Methods: At a single hospital from November 2010 to August 2017, all intertrochanteric fracture patients fixed by cephalomedullary nail over the age of 65 years were retrospectively evaluated. We divided the patients into 2 groups according to the reduced position of the anterior cortex between neck and shaft fragments. We defined Subtype P as the neck fragment placed posteriorly from lateral view of postoperative radiograph. The other types of position were defined as Subtype AN. Neck shortening was defined as the amount of lag screw sliding by radiograph measured several times after surgery. The primary outcome was whether the sliding was more than 8 mm after 3 weeks from surgery or not. As primary analyses, we estimated the influence of Subtype P on the primary outcome using logistic regression model stratified by lesser trochanter fracture to adjust the confounding factors. As sensitivity analyses, we imputed the missing outcomes using multiple imputation by chained equation with panel data of the sliding and we analyzed in the way as the primary analyses. In addition, to evaluate the validity of the outcome, we compared the occurence of postoperative cutout and the primary outcome by $\chi 2$ test with significance set at P <0.05.

Results: Of the 995 patients, 182 had Subtype P and 813 had Subtype AN. Primary outcome was measured in 496 patients. Among the fractures with posteromedial support (n = 196), there was no significant difference (adjusted odds ratio [AOR]: 1.9, 95% confidence interval [CI]: 0.61 to 6.1, P = 0.26). On the other hand, among the fractures without posteromedial support (n = 300), excessive neck shortening significantly increased in Subtype P (AOR: 2.5, 95% CI: 1.1 to 5.7, P = 0.03). Sensitivity analyses showed similar results as primary analyses, with posteromedial support (AOR: 1.4, 95% CI: 0.50 to 4.1, P = 0.50) and without posteromedial support (AOR: 2.1, 95% CI: 1.1 to 4.2, P = 0.03). The occurrence of cut-out was significantly associated with the primary outcome (risk ratio 8.2, risk difference 6.3%, P<0.01).

Conclusion: In the nailing of unstable intertrochanteric fractures, orthopaedic surgeons should be careful that the reduced position in lateral view does not become Subtype P to avoid early excessive neck shortening.

SCIENTIFIC POSTER #83 Hip and Femur

Optimal Intramedullary Nailing for Trochanteric Fractures: The Importance of Distal Locking Screw and Reduction Position *Takahiro Waki Akashi Medical Center, Akashi, Japan*

Purpose: The biomechanical advantages of nails have led to a rapid global increase in their use. When addressing the distal locking issue, some authors have stated that distal locking is not necessary for most trochanteric fractures (AO 31A1 + A2). On the other hand, others advocated distal locking screws. Therefore, the purpose of this study was to investigate the complications using a Gamma nail without distal locking screws. Further, the relationships were evaluated between these complication rates and their reduction positions after operation.

Methods: 365 operations were performed for trochanteric fracture (AO 31A1 + A2) at our clinic from 2012 to 2018. Of these, patients with follow-up periods >3 months were 218. The Gamma3 IM (intramedullary) Nailing System was used for all patients. 146 patients (Unlocked group) from 2012 to 2016 were operated without distal locking screws. 72 patients (Locked group) from 2016 to 2018 were operated with distal locking screws. We retrospectively analyzed those patients who suffered complications such as delayed healing and postoperative peri-implant fractures and cut-out of the lag screw. Further, in lateral view of their radiographs, we evaluated the position of the proximal fragment compared with distal fragment just after operation and at 1 week after operation to investigate what positions affected complications. The reduction positions were divided into 3 groups: anterior (subtype A), neutral (subtype N), and posterior (subtype P) according to the Ikuta classification.

Results: The mean age of the sample of 218 patients was 84.0 ± 5.2 years. The sample was comprised of more women than men (76.5% vs 23.5%). Tip-apex distance (TAD) was 15.45 \pm 3.69 in Unlocked group and 16.22 \pm 2.97. Canal filling ratio was 0.804 \pm 0.081 and 0.733 \pm 0.091. And, there was also no significant difference in fracture pattern between these groups. In Unlocked group, complications were shown in 94 patients (Complication group). Delayed healing was shown in 94/146 (64.4%) in Unlocked group and 12/72 (16.7%) in the Locked group. Peri-implant fracture was shown in 3/146 (2.1%) in Unlocked group and 0/72 (0%) in Locked group. Cut-out of the lag screw was shown in 4/146 (2.7%) in Unlocked group and 1/72 (1.3%) in Locked group. In the Complication group, subtype P was more than in the Non-complication group. And, most cases in the Complication group lost their reduction position from just after operation to 1 week after operation. There was a statistically significant difference between these group as for subtype P just after operation.

Conclusion: In the current study, a higher number of complications was seen in the distal unlocked group compared with the distal locked group. Our study showed the position of the proximal fragment might be associated with the complications such as delayed healing and postoperative peri-implant fractures and cut-out of the lag screw. Without distal locking, a tip of the nail can swing in a femur canal, which may lead to the instability associated with complications. We concluded that nailing without distal locking screws might be dangerous and subtype P should be avoided.

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

SCIENTIFIC POSTER #84 Hip and Femur

Thromboelastography in Orthopaedic Surgery of the Pelvis and Lower Extremity: A Matched Controlled Study

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Purpose: Thromboelastography (TEG) is a method of measuring whole blood coagulation, including plasma and cellular components. Research is scarce regarding the utility of TEG in orthopaedic trauma patients. The purpose of the study was to determine if there was a difference in the rate of transfusions between patients who had a perioperative TEG versus patients who did not have a TEG and who sustained similar operative injuries to the lower extremity and pelvis.

Methods: This matched controlled study was a 2-year, single institution retrospective chart review. Patients with pelvis, femur, and/or tibia fracture and who underwent a TEG study within 24 hours of surgical intervention composed the study group. The matched group was composed of patients with similar injuries, age, and ISS who did not undergo a TEG. All adult patients were included.

Results: A total of 89 patients met inclusion criteria (40 in the study group and 49 in the control group). The median (range) age was 70 years (18-98). There were nosignificant differences in the mean age or ISS between groups. There were no significant differences in the preoperative use of anticoagulation between groups. The TEG group had a longer median length of stay (7.5 days) than the control group (5 days), P = 0.008. 75% of patients in the study group and 51% of the control group patients received a blood product transfusion, P = 0.02. The TEG and control groups had a median of 3 and 1 units of blood products, respectively, P = 0.002. When considering packed red cells (pRBCs) alone, the median number of units for the study and control groups was 3.5 and 2, P = 0.076. There was no difference in the rate of deep vein thrombosis, pulmonary embolism, or infections between groups. The transfusion practices in the control group were almost exclusively pRBCs, in contrast to the study group where plasma, platelets, and cryoprecipitate were also used.

Conclusion: In the current study, patients who underwent a perioperative TEG received more blood product transfusions than those in the control group. Although the ISS was not significant between groups, the median ISS and length of stay were larger in the study group, which may explain the increased number of transfusions. It is also plausible that orthopaedic trauma patients may be underresuscitated. Prospective control trials are needed to validate the utility of TEG in orthopaedic surgery trauma.

SCIENTIFIC POSTER #85 Hip and Femur

OTA 2019

Preoperative "Computed Tomography Capsular Sign" for the Detection of Occult Ipsilateral Femoral Neck Fractures Associated With Femoral Shaft Fractures Young-Chang Park; Jun Young Kim; Ji-Sup Kim, MD; Kyuhyun Yang, Prof Gangnam Severance Hospital, Seoul, Korea, Republic of

Purpose: Ipsilateral femoral neck fractures (FNFs) associated with femoral shaft fractures often appear nondisplaced and are missed even on the preoperative CT. We aimed to evaluate the "CT capsular sign", which refers to anterior capsular distension of the hip with intraarticular fluid, as an additional clue for detecting occult ipsilateral FNF. We hypothesized that the preoperative CT capsular sign would strongly predict the presence of ipsilateral FNF.

Methods: From January 2006 through December 2017, records of 166 consecutive patients who underwent surgical fixation for femoral shaft fracture after high-energy trauma were retrospectively reviewed. To evaluate the diagnostic performance of the CT capsular sign, we excluded patients who had no preoperative CT scan, concurrent acetabulum and/or femoral head fracture, and displaced FNFS. Finally, 79 patients were included in this study. The FNF group included 13 patients, whose fractures were not detected in the initial plain radiographs but confirmed on the preoperative CT or during and/or after operation. The remaining 66 patients were included in the femoral neck intact group. Side-to-side difference of >1 mm of capsular distension was considered a positive CT capsular sign.

Results: Among 13 ipsilateral FNFs, 6 and 12 cases showed a definite fracture line and positive CT capsular sign, respectively, on the preoperative CT scan. The association with the presence of ipsilateral FNF was significantly higher in CT capsular sign than in definite fracture line (92% vs 46%, P = 0.031). Among the 66 patients without FNF, 4 had a positive CT capsular sign. The CT capsular sign could predict ipsilateral FNF with sensitivity of 92% (12/13), specificity of 94% (62/66), positive predictive value of 75% (12/16), negative predictive value of 98% (62/63), and accuracy of 94% (74/79).

Conclusion: Surgeons should highly suspect for ipsilateral FNF when the CT capsular sign is present.



SCIENTIFIC POSTER #86 Hip and Femur

Prediction of Inpatient Complications in Elderly Patients with Fractures of the Femur *Sanjit R. Konda, MD*; Joseph Robert Johnson, BS; Erin Arlene Kelly, BA, MS; Kenneth A. Egol, MD

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Purpose: Hospitals and orthopaedic surgeons should be aware of factors that can predict patient complications. We sought to determine whether an inpatient mortality risk stratification tool used in the emergency department can predict inpatient complications in elderly orthopaedic trauma patients who sustain fractures involving the femur.

Methods: Patients aged 55 years and older who presented with fractures of the femur (hip, femoral shaft, and distal femur) at 1 academic medical center between October 1, 2014 and September 1, 2017 were identified. On admission, a trauma triage risk score (STTGMA [Score for Trauma Triage in the Geriatric and Middle-Aged]) was calculated using patient demographics, injury characteristics, and preinjury functional status. Patients were stratified by their calculated risk of inpatient mortality into minimal, low, moderate, and high-risk quartiles of

<0.87%, 0.87%-1.43%, 1.43%-2.23%, and >2.23%. Information on inpatient complications was recorded. Logistic regression analyses were performed to assess the predictive capacity of STTGMA risk stratification on inpatient complications.

Results: Of the 1064 patients (266 per risk quartile) included in this analysis, 933 (87.7%) had hip fractures, 59 (5.5%) had femoral shaft fractures, and 72 (6.8%) had distal femur fractures. The majority of injuries occurred from low-energy mechanisms (93.7%). Mean age was 80.7 ± 10.4 years. Mean length of stay was 7.4 ± 5.3 days with a total complication rate of 45.5%. Logistic regression revealed that STTGMA risk stratification was a significant predictor of total, major, minor, septic shock, pneumonia, myocardial infarction, cardiac arrest, and urinary tract infection complications (Table).

Conclusion: Risk stratification with a reliable tool is a valuable method to identify patients at risk of developing inpatient complications following fractures of the femur. This tool can help physicians identify high-risk patients for complications at the outset of treatment to improve patient care and reduce health-care costs.

Table. Inpatient Complications Predicted by STTGMA Risk Quartiles (Reference = Minimal Risk)					
Outcome	Low Risk	Medium Risk	High Risk		
Total Complications	1.37 (0.97, 1.93)	1.61 (1.14, 2.28)**	1.88 (1.33, 2.65)***		
Major Complications	2.02 (1.17, 3.50)*	2.14 (1.24, 3.70)**	4.04 (2.42, 6.75)***		
Septic Shock	3.05 (0.61, 15.23)	3.05 (0.61, 15.23)	6.24 (1.38, 28.14)*		
Pneumonia	1.13 (0.43, 2.98)	1.39 (0.55, 3.52)	3.05 (1.34, 6.95)**		
Acute Respiratory Failure	1.27 (0.58, 2.76)	1.91 (0.92, 3.94)	1.54 (0.73, 3.26)		
Myocardial Infarction	8.22 (1.02, 66.20)*	4.05 (0.45, 36.44)	4.05 (0.45, 36.44)		
Deep Vein Thrombosis	1.83 (0.60, 5.53)	1.41 (0.44, 4.50)	1.00 (0.29, 3.50)		
Cardiac Arrest	1.00 (0.06, 16.01)	7.14 (0.87, 58.41)	11.35 (1.45, 88.51)*		
Minor Complications	1.34 (0.94, 1.91)	1.52 (1.07, 2.16)*	1.59 (1.12, 2.26)**		
Decubitus Ulcer	1.00 (0.32, 3.14)	1.34 (0.46, 3.93)	1.69 (0.61, 4.73)		
Urinary Tract Infection	1.79 (0.90, 3.53)	2.46 (1.28, 4.73)**	3.76 (2.02, 7.03)***		
Blood Loss Anemia	1.07 (0.74, 1.55)	1.21 (0.84, 1.74)	0.78 (0.73, 1.52)		

* p < 0.05, ** p < 0.01, *** p < 0.001

Table values represent odds ratios (95% confidence intervals)

SCIENTIFIC POSTER #87 Hip and Femur

Liposomal Bupivacaine for Postoperative Pain Control in Fragility Intertrochanteric Femur Fractures

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Purpose: The purpose of this study is to determine whether intraoperative liposomal bupivacaine (1) reduces postoperative opioid requirements, (2) reduces postoperative pain scores, and (3) reduces postoperative length of stay in patients with fragility intertrochanteric femur fractures.

Methods: IRB approval was obtained for a retrospective chart review. A retrospective chart review was conducted identifying patients admitted to 1 of 2 hospitals with a diagnosis of intertrochanteric femur fracture beginning June 2016 when the senior authors began using liposomal bupivacaine intraoperatively. Inclusion criteria included patients sustaining a low-energy intertrochanteric femur fracture treated with an intramedullary nail implant. Exclusion criteria included polytrauma, dementia, delirium, or a chronic pain diagnosis or fixation with a dynamic hip screw. A retrospective chart review was then performed retrospectively identifying patients treated without liposomal bupivacaine for comparison. Primary end points were oral mean morphine equivalents (MME) received postoperatively and mean NRS (numerical pain rating score) postoperatively. Secondary end points included postoperative time, and home discharge.

Results: Retrospective chart review identified 46 patients who received intraoperative liposomal bupivacaine and 56 patients who did not. Demographic data including age, sex, and American Society of Anesthesiologist (ASA) level were similar between groups. The liposomal bupivacaine group received significantly more MME in the first 24 hours after surgery compared to the non-liposomal bupivacaine group (0.34 mg/h/kg vs 0.92 mg/h/kg, P = 0.04). NRS was also significantly less in the first 24 hours (2.89 vs 5.13, P = 0.04). Both oral morphine equivalents and NRS were similar at the 36-hour mark (1.18 mg/h/kg vs 1.37 mg/h/kg, P = 0.27; 3.61 vs 5.51, P = 0.34). The liposomal bupivacaine group had reduced length of stay (3.2 days vs 4.8, P = 0.003), more discharges home (7 vs 2, P = 0.001), and a longer operative time (73.4 min vs 67.2 min, P = 0.004).

Conclusion: Intraoperative liposomal bupivacaine use reduced opioid use and postoperative pain for the first 24 hours following fixation of intertrochanteric femur fractures. Significant reductions in postoperative length of stay and more discharges to home may present an opportunity for cost savings.

Coagulopathy in Traumatic Pelvic and Lower-Extremity Fractures Measured by Thromboelastography with Platelet Mapping

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Purpose: Conventional coagulation tests have not been shown to be effective in determining the rate of blood loss as they only assess the role of plasma components in coagulation. Thromboelastography (TEG) is a method of measuring whole blood coagulation, including plasma and cellular components. The purpose of the study was to evaluate the rate and morphology of coagulopathy in patients with fractures to the pelvis and lower-extremity long bones using TEG.

Methods: This was a single-institution retrospective chart review over a 2-year period of patients who sustained a pelvis, femur, and/or tibia fracture and who underwent a TEG study within 24 hours of surgical intervention. All adult patients were included.

Results: A total of 40 patients met inclusion criteria. The median (range) age of patients was 70 years (18-98 years). A total of 47% of the cohort was on anticoagulation therapy preinjury, with antiplatelet agents being most common (32.5%). The clots' mean (standard deviation [SD]) reaction time (R) and maximal amplitude (MA) were 4.3 min (1.2 min) and 61.1 mm (6.6 mm), respectively. The clots' median (range) kinetic (K) time and alpha angle were 1.3 min (0.9-4.0 min) and 72.3° (45.6°-78.0°), respectively. The coagulation index (Co-I) mean (SD) was 3.9 (0.99) and 82.5% demonstrated a hypercoagulable state. When available, the median (range) admission international normalized ratio (INR), prothrombin time (PT), and partial thromboplastin time (PPT) were 1.2 (0.9-4.6), 14.9 (12.1-41.5), and 29 (4.8-80), respectively. 75% of patients required a blood product transfusion. Of the 33 patients with a hypercoagulable state, 10 did not require a blood product transfusion, while 7 patients without hypercoagulability by Co-I required a transfusion, relative risk (RR) (95% confidence interval [CI]) 0.69 (0.56, 0.87). 39 patients had platelet mapping performed. 22 of them demonstrated platelet dysfunction. In patients with platelet dysfunction, 10 patients were on an antiplatelet agent prior to admission.

Two patients on antiplatelets did not demonstrate platelet dysfunction by platelet mapping, RR (95% CI) 1.86 (1.15, 3.07). Although not significant, being on an anticoagulant prior to admission resulted in increased odds ratio (OR) of needing a blood product administration, OR (95% CI) 1.5 (0.35, 6.4). Desmopressin and tranexamic acid were used as adjuncts to correct coagulopathy in 9 and 2 of the patients, respectively.

Conclusion: The majority of patients within this cohort presented with coagulopathy and required blood product administration. More commonly, patients were hypercoagulable with platelet dysfunction. TEG could lead to better resuscitation strategies intraoperatively and in the perioperative period, and may prevent surgical delays in patients who are perceived to be coagulopathic due to outpatient anticoagulation therapy.
SCIENTIFIC POSTER #89 Hip and Femur

Decreased Complications But a Distinctive Failure of Fully Threaded Headless Cannulated Screw (FTHS) Fixation for Femoral Neck Fractures: A Prospective Cohort Study with Historical Controls

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Purpose: Our objective was to investigate complication rates and failure mechanisms of the FTHS fixation for femoral neck fractures (FNFs) versus the partial threaded cannulated screw (PTS) and to identify predictors of failure.

Methods: A total of 75 FNF patients (18-65 years) were prospectively treated by closed reduction and internal fixation (CRIF) with 3 parallel FTHSs. After at least 2 years of follow-up, the clinical results were compared to the parameters obtained in a historical control case-matched group (75 patients) treated by PTS fixation from the same institution, a Level-I trauma center. The demographic, follow-up information, and radiological images were assessed by independent blinded observers. The complication rates, especially fixation failure, defined by screw loosening (including screw migration, penetration, or withdrawal), varus collapse, obvious fracture displacement, or shortening were compared between the 2 groups based on different classifications and fracture morphologies.

Results: The overall complication rate of fixation failure, nonunion, and head necrosis

was 21.3% (16/75) in the FTHS group and 50.6% (38/75) in controls, respectively. Six atypical screw migrations with varus collapse (8%) contributed significantly to the overall failure rate of FTHS fixation. Four screw "medial migrations" resulted from the lateral migration of the femoral head and subsequent medial penetration of the construct, while 2 resulted from screw superior cutout.

Conclusion: The results showed that FTHS fixation could significantly reduce the complication rate and supported use of FTHS fixation, especially for high-energy FNFs (Garden III-IV, Pauwels III, or VN angle [angle between the fracture line and the vertical of the neck axis] $\geq 15^{\circ}$). In addition, some atypical modes of failure, screw "medial migration" and superior cutout, which were apparently different from screw withdrawal in PTS, have been confirmed.



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

OSTER ABSTRACTS

SCIENTIFIC POSTER #90 Hip and Femur

Displaced Femoral Neck Fractures in Workers' Compensation Patients Aged 45-65 Years: Is It Best to Fix the Fracture or Replace the Joint? Joshua T. Anderson, MD; David Lynn Rothberg, MD; Jeremy Gililland, MD

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Purpose: Optimal surgical management of displaced femoral neck fractures (dFNFs) in patients 45-65 years old is poorly understood. We evaluated how treatment selection between internal fixation (IF), hemiarthroplasty (HA), and total hip arthroplasty (THA) impacted days out of work (dOOW), indemnity, and medical costs at 2 years within a Workers' Compensation (WC) population with dFNFs.

Methods: Using the Ohio Bureau of WC's database, we retrospectively reviewed patients with subcapital dFNFs aged 45-65 years, with 2 years follow-up and no additional injuries. 105 patients who underwent IF (37), THA (23), or HA (45) from 1993-2015 were included. dOOW was compared between each group using t-tests. Linear regression was used to determine if a specific treatment choice was predictive of dOOW. dOOW was evaluated at 6 months, 1, and 2 years postoperatively. Gamma regression was used to evaluate net medical and indemnity costs paid by the Bureau adjusted to 2017 Consumer Price Index at 2 years.

Results: Subjects who underwent THA had the lowest mean dOOW at 6 months, 1, and 2 years postoperatively. At each time point, THA means were significantly lower than IF. THA had a lower mean dOOW than HA at 2 years (see attached figure). Using linear regression, relative to THA, IF was a significant predictor of higher dOOW at 6 months (P <0.001, beta coefficient (β) 45.4), 1 year (P = 0.002, β 82.0), and 2 years (P = 0.032, β 120.7). HA was a significant predictor of higher dOOW at 1 (P = 0.039, β 53.3) and 2 years (P = 0.016, β 131.7). At 2 years, mean medical costs were not different. Relative to THA (mean \$4213.3), IF (P <0.001, mean \$12,546.5) and HA (P = 0.007, mean \$9909.1) were predictive of higher indemnity costs with gamma regression. Within 2 years, nonunion and avascular necrosis (AVN) rates in the IF group were 10.8% and 16.2%. The IF group had a 5.4% rate of conversion to THA. 11.1% of HAs were revised to THA for pain. One THA was revised for dislocation perioperatively.

Conclusion: Treatment of WC patients aged 45-65 years with dFNFs with THA was associated with fewer dOOW, lower indemnity, and similar medical costs at 2 years. Long-term follow-up is lacking.



95° Angled Blade Plate Fixation of High-Energy Unstable Proximal Femur Fractures Results in High Rates of Union and Minimal Complications

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Purpose: High-energy proximal femur fractures are difficult injuries to treat and certain fracture patterns are less amenable to treatment with an intramedullary device. Recent studies have shown complication rates as high as 40% when unstable proximal femur fractures are treated with a proximal femoral locking plate. The 95° angled blade plate may offer superior results to those seen with locking plate constructs when proximal femoral fracture patterns dictate avoidance of intramedullary devices. The objective of our study is to report clinical outcomes of a consecutive cohort of patients treated in this manner.

Methods: Consecutive patients who sustained high-energy, unstable proximal femur fractures and underwent open reduction and internal fixation with a 95° angled blade plate were retrospectively studied. Minimum follow-up to union was required for inclusion. Patient demographics, injury, and operative details including the use of an articulated tensioning device and fracture pattern were recorded. Postoperative complications were noted. Radiographs were reviewed for evidence of bony union as well as nonunion, malunion, and need for secondary surgeries.

Results: 45 patients were initially identified and 31 had sufficient follow-up for analysis. The mean age of our study cohort was 43 years (range, 22-86) and 81% (25/31) were male. The most commonly treated proximal femur fracture pattern was AO/OTA 31A3.3. Two fractures were open. The articulated tensioner was used in 100% of cases. Average clinical follow-up was 16.7 months (range, 2.5-40). 29 of 31 patients (94%) achieved osseous union with the index procedure. One patient underwent nonunion repair and 2 patients had the blade plate removed as it was symptomatic. No other secondary procedures were performed and no instances of implant failure were seen. No patients had evidence of a superficial or deep infection.

Conclusion: This series of high-energy proximal femur fractures treated with a 95° angled blade plate and articulated tensioning device had a high rate of radiographic and clinical union with minimal postoperative complications. While intramedullary nailing of these fractures remains a preferred technique, the angled blade plate with articulated tensioning device is an excellent option to restore anatomic alignment and obtain bony union in certain fracture patterns.

Characterization of Outcomes with Standardized Hip Fracture Care Programs in the United States

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Purpose: Our objective was to describe treatment characteristics and outcomes of patients undergoing fixation of hip fractures at institutions with and without standardized hip fracture care (SHFC) programs.

Methods: We retrospectively reviewed the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database for patients treated for hip fracture in 2016 and 2017 through CPT codes 27236, 27244 and 27245 as well as appropriate diagnostic codes. Outcomes were reported up to 30 days postoperatively.

Results: A total of 14,049 patients were included in the study. About half (53.7%) were treated at institutions with SHFC programs. Differences in fracture type (P = 0.001) and fixation method (P <0.001) were noted between groups. Time from admission to operation was longer and more variable in the SHFC group (1.4 ± 6.5 days vs 1.2 ± 2.1 days, P <0.001), and these patients were in the hospital on average 1.2 days longer after surgery than non-SHFC patients (6.3 ± 6.9 days vs 5.1 ± 4.9 days, P <0.001). However, SHFC programs were associated with fewer unplanned readmission s(7.5% vs 8.9%, P = 0.009) and deep venous thromboses (DVTs) (1.5% vs 2.3%, P = 0.002) in the 30-day postoperative period. In addition, SHFC programs were associated with fewer unplanned intubations and need for mechanical ventilation (P <0.05). No differences were noted with reoperation or mortality.

Conclusion: To the best of our knowledge, this is the first study to compare outcomes of SHFC and non-SHFC in a large population database. While we were unable to demonstrate lower 30-day mortality rates or earlier time to surgery, SHFC programs result in lower complication rates and fewer unplanned readmissions.

Can We Accurately Predict Which Elderly Hip Fracture Patients Will Experience a Delay to Surgery?

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Purpose: Surgical delays of 48 hours or more for elderly hip fracture patients are associated with increased risks for morbidity and mortality; thus, surgeons continue to pursue opportunities to decrease time to surgery in this cohort. This study sought to determine if a validated risk-stratification tool utilized at the time of admission can predict time to surgery for elderly hip fracture patients and flag patients who are mostly likely to experience a delayed time to surgery.

Methods: Patients aged 55 years and older who underwent hip fracture surgery at 1 academic medical center between September 2014 and October 2017 were identified. On admission, a trauma triage risk score (STTGMA [Score for Trauma Triage in the Geriatric and Middle-Aged]) was calculated using patient demographics, injury characteristics, and preinjury functional status. Patients were stratified by their calculated risk of inpatient mortality into minimal, low, moderate, and high-risk quartiles of <0.87%, 0.87%-1.39%, 1.39%-2.15%, and >2.15%. Patients were followed prospectively throughout hospitalization and information on time to surgery was recorded. Linear regression was performed to assess the predictive capacity of STTGMA risk stratification on operative timing, and logistic regression was utilized to assess the ability of STTGMA to predict surgical delays >48 hours.

Results: Of the 612 patients included in this analysis, 314 (51.3%) had intertrochanteric fractures, 257 (42.0%) had femoral neck fractures, and 41 (6.7%) had subtrochanteric fractures. The majority of injuries occurred from low-energy mechanisms (97.9%). Mean age was 81.1 \pm 10.5 years. Mean time to surgery was 33.7 hours for the minimal, 42.8 hours for the low, 46.9 hours for the medium, and 52.7 hours for the high-risk cohort. Stratification to the high-risk STTGMA group was a significant predictor of a 19.0-hour longer time to surgery (slope coefficient [β]: 19.03, 95% CI [confidence interval]: 4.04-34.01, P = 0.013) when compared to the minimal-risk group. In addition, patients had higher odds of operative fixation occurring after 48 hours if they were in the low-risk (odds ratio [OR]: 1.94, 95% CI: 1.12-3.36, P = 0.019), medium-risk (OR: 2.43, 95% CI: 1.41-4.19, P = 0.001), or high-risk group (OR: 1.92, 95% CI: 1.10-3.35, P = 0.021) when compared to minimal- risk patients.

Conclusion: The STTGMA tool can be utilized upon admission to quickly identify hip fracture patients who are at risk for a delayed time to surgery. Use of this tool may allow the treatment team to target this "at risk" population and proactively optimize higher-risk patients for surgery in a more efficient manner.

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SCIENTIFIC POSTER #94 Post-Traumatic Reconstruction

Diagnosis and Long-Term Outcomes of Posttraumatic Lower Limb Osteomyelitis *Paul Lambton Rodham, MBBS*; Michalis Panteli, MD; Nikolaos K. Kanakaris, MD, PhD; Paul Harwood, MD; Peter Giannoudis, BS, FACS, FRCS, MBBS, MD Leeds General Infirmary, Leeds, United Kingdom

Purpose: Posttraumatic osteomyelitis (PTOM) is an uncommon but potentially devastating complication of trauma. The aim of our study was to describe the demographics, treatment strategies, and long-term outcomes of patients presenting with PTOM.

Methods: All consecutive patients presenting to a Level-I trauma center with a confirmed diagnosis of PTOM of the tibia or femur were retrospectively identified, with a minimum follow-up of 5 years. Patients younger than 18 years and patients presenting without a history of trauma were excluded from further analysis. Treatment was individualized according to the patient needs and the preferences of the operating surgeon. Outcomes were assessed according pain levels and return to function. Limb function was assessed according to the Lower Extremity Functional Index (LEFI), and quality of life with the EQ-5D-3L [EuroQol-5 Dimensions, 3-Levels].

Results: 71 patients (59 male, average age 46 years) were included. PTOM involved the tibia in 45 patients and the femur in 26 patients. 18 patients originally sustained an open fracture. The average time from injury to presentation was 23.6 months (median, 12 months; range, 3-84 months). Patients were followed for an average of 86 months (80 months; 60-186 months) requiring on average 2.8 surgical procedures (2 procedures; 1-12 procedures) and 2.3 readmissions (2 readmissions; 0-10 readmissions). Treatment of PTOM included removal of metalwork, radical soft-tissue and bone debridement as required, and administration of local and / or systemic antibiotics. The reamer-irrigator-aspirator (RIA) technique was utilized in 31 cases. 51 patients received local antibiotics via a cement nail (24), spacer (16), beads (6), or a combination of techniques (5). 20 patients required soft-tissue coverage including a free flap (10), pedicled flap (4), skin graft alone (1), or combination of techniques (5). Patients received, on average, 13.8 days (14 days; 0-47 days) of intravenous and 38.5 days (28 days; 0-365 days) of oral antibiotics. 44% of patients were left with a moderately/severely impaired limb, with 8 patients requiring an amputation (above knee in 1 patient). Recurrence of disease occurred in 16 patients. Both the use of RIA and delivery of local antibiotics were associated with significantly improved outcomes (P < 0.01 and P < 0.05, respectively). LEFI and EQ-5D-3L scores were significantly lower compared to the general population.

Conclusion: PTOM remains a significant cause of morbidity following fracture fixation, carrying devastating long-term effects to both the limb function and quality of life. Aggressive debridement and use of local antibiotic agents may improve patient outcomes.

Clinical and Radiographic Outcomes Following SIGN Fin Nailing for Femoral Shaft Fractures

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Purpose: The Surgical Implant Generation Network (SIGN) intramedullary nail was designed for use in resource-limited settings that often lack fluoroscopy, specialized fracture tables, and power reaming. A newer design iteration, the SIGN Fin nail, was developed to further simplify retrograde femoral nailing by making proximal interlocking screw placement unnecessary. Instead, the leading end of the Fin nail achieves stability through an interference fit within the proximal femoral canal. While the performance of the traditional SIGN nail has been reported previously, no study has examined long-term clinical and radiographic outcomes of femoral shaft fractures treated with the SIGN Fin nail.

Methods: The SIGN online surgical database was used to identify all adult femoral shaft fractures treated with the SIGN Fin nail since its introduction. Patients with minimum 6-month clinical and radiographic follow-up were included in the analysis. Available demographic, injury, and surgical characteristics were recorded. Fracture alignment was evaluated on both immediate postoperative and final follow-up radiographs using a previously validated on-screen protractor tool. Coronal and sagittal plane alignment measurements were recorded as deviation from anatomic alignment (DFAA), with units in degrees. Fracture healing was assessed on final follow-up radiographs, with union defined as any bridging callus and/or cortical continuity on orthogonal views. Clinical outcomes available in the database included knee range of motion (ROM) greater than 90° and weightbearing status at final follow-up. Clinical and radiographic outcomes were then compared between patients with united versus nonunited fractures.

Results: The database identified 249 femoral shaft fractures stabilized with the Fin nail in 242 patients who had minimum 6-month clinical and radiographic follow-up. Final follow-up radiographs were performed at an average of 48 weeks postoperatively. Average coronal and sagittal plane alignment measured on final follow-up radiographs were 2.18° and 2.58°, respectively. The rate of malalignment (DFAA >10° in either plane) at final follow-up was 6%. 229 fractures (92%) were united at final follow-up. Overall, 84% of patients achieved full weight bearing and 86% achieved knee ROM >90° at final follow-up. Compared to patients with united fractures, those with nonunion were less likely to achieve full weight bearing (20% vs 90%, P <0.001) and knee ROM >90° (30% vs 91%, P <0.001). There was no significant difference in mean DFAA between united and nonunited fractures on the AP (2.1° vs 3.8°, P = 0.298) or lateral (2.5° vs 3.5°, P = 0.528) views.

Conclusion: The SIGN Fin nail achieves satisfactory radiographic alignment and clinical outcomes at minimum 6-month follow-up. The overall union rate (92%) is comparable to that achieved with the standard SIGN nail. Ease of implantation makes the Fin nail an attractive option in resource-limited settings.

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

Comparing Clinical Outcomes Between Transosseous Patellar Suture Fixation versus Suture Anchor Repair in the Treatment of Quadriceps Tendon Repair

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Purpose: Repair of quadriceps tendon ruptures aims to restore strength and function to the extensor mechanism. The gold standard surgical treatment of quadriceps tendon injuries remains transosseous suture repair through the patella. However, limited biomechanical literature and small case series have reported use of suture anchor repair techniques. The objective of this study is to compare clinical and functional outcomes, in the largest series to date, of quadriceps tendon ruptures surgically treated with transosseous patellar suture or suture anchor repair.

Methods: A retrospective review was performed for patients undergoing surgical repair of quadriceps tendon injuries between 2007-2018 at a single institution. Patients treated with transosseous patellar suture (TS) repair and suture anchor repair (SA) were identified. Surgical technique included 1, 2, or 3 suture anchors or 2 or 3 transosseous suture patellar tunnels. We analyzed clinical and functional outcomes based on objective measurement of range of motion, graded strength testing, and follow-up duration. Infection, rerupture, deep vein thrombosis, and patella fracture were investigated as complications. Chi-squared, Fisher exact, and independent samples t-tests were used to compare the SA and TS groups, with significance defined as P < 0.05.

Results: This study included 143 patients and 154 quadriceps tendons ruptures: 128 males and 15 females with mean age of 58.4 years (range, 21-90 years). Of these, 91 were left, 63 were right including 10 bilateral injuries. Acute injuries, sustained within 6 weeks of surgery, occurred in 133 quadriceps ruptures and 21 injuries were chronic (>6 weeks). 41 injuries (30 acute, 11 chronic) were treated with the SA repair and 113 injuries (103 acute, 10 chronic) were treated with TS repair. The average follow-up for the SA and TS groups were 8.0 and 7.9 months, respectively (P = 0.92). The groups did not differ significantly in demographic characteristics (age, gender, and body mass index [BMI]). At final follow-up, mean extension was measured at 3.28° versus 1.71° (P = 0.17) and flexion was 121° versus 116° (P = 0.29), and were not statistically different between the SA and TS groups, respectively. Graded strength testing at final follow-up between SA and TS groups (4.35 vs 4.61, P = 0.03) was functionally comparable. There were no significant differences in the rates of complications, including rerupture.

Conclusion: Suture anchor repair of acute or chronic quadriceps tendon ruptures may provide similar clinical results compared to the gold standard transosseous patellar suture repair technique. Range of motion and strength in this short-term follow-up study was comparable among both groups, with no significant difference in complication rates.

SCIENTIFIC POSTER #98

Knee Fix or Replace Trial (KFORT): A Randomized Controlled Feasibility Study Peter Hull, FRCS (Ortho), MBCHB; Daud Chou, FRCS (Ortho), MBBS, MSc; Sophie Lewis; Andrew Douglas Carrothers, FRCS (Ortho), MD; Joseph Martin Queally, MD; Annabel Allison, MSc; Garry Barton; Matthew L. Costa, FRCS Addenbrookes, Cambridge University Hospitals NHS Foundation Trust, Cambridge, United Kingdom

Purpose: Distal femoral fractures (DFFs) in the elderly, osteoporotic population present a significant treatment challenge. The primary objective of this study was to assess the feasibility of conducting a full-scale, appropriately powered randomized controlled trial between internal fracture fixation (IFF) and distal femoral replacement (DFR) for DFFs in this specific patient population.

Methods: A total of 7 centers recruited patients to the study. Inclusion criteria included patients aged over 65 years with a DFF and the treating surgeon felt they were suitable for either IFF or DFR. The primary clinical outcome measure was EuroQol-5 Dimensions (EQ-5D) at 6 months following injury and secondary clinical outcome measures included Oxford Knee Score (OKS) and Disability Rating Index (DRI). Feasibility outcome measures included patients' willingness to participate, clinicians' ability to recruit, dropout rates, ability to capture data, estimates of standard deviation to inform the sample size calculation, and the main cost-drivers. Other outcome measures included surgical time, transfusion requirement, complications, mobility status on discharge, and length of hospital stay.

Results: Between October 2015 and August 2017, 36 patients met the inclusion criteria. Of these, 5 declined to participate and 8 were not recruited, leaving 23-patients to randomize. During the follow-up period 5 of 23 patients (22%) withdrew from the trial and 6 patients (26%) died. At 6 months, the EQ-5D utility index was lower in the DFR group. Mean inpatient costs were around £6,500 more in the DFR group. For a powered trial, a total sample size of 1400 would be required, hence requiring 234 centers, recruiting over 3 years.

Conclusion: This study has found running a full-scale trial not feasible, based on the numbers required to power it. Also, based on this feasibility trial we cannot make any recommendations as to the best treatment modality for DFF in the elderly population.

Cost Reduction for Knee-Spanning External Fixation in the Staged Treatment of Tibial Plateau Fractures: A Practical Intervention

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Purpose: Knee-spanning external fixation is a high-cost intervention with large variation. The purpose of this study is to determine if an education intervention changes the practice of implant selection as measured by total implant costs.

Methods: A retrospective review of 221 tibial plateau fractures treated with initial temporizing external fixation between 2010 and 2016 at 2 Level-I trauma centers was conducted. Factors associated with cost variation were assessed using nonparametric comparative and goodness-of-fit regression tests. No strong correlations were noted between construct cost and patient demographics (r2 = 0.02), fracture characteristics (r2 = 0.02), or injury- independent characteristics (r2 = 0.10). A wide variation in construct cost was noted. An educational intervention was conducted. The above findings were presented with 3 clinical cases of OTA 41-C3 (Schatzker VI) tibial plateau fractures to staff orthopaedic surgeons at 1 institution. Radiographs and external fixator constructs specific to each case including individual pin, bar, and clamp prices were reviewed. Total implant costs ranged from \$2354 to \$11,696 in the 3 cases. Following the intervention, tibial plateau fractures treated with external fixation were prospectively collected for a duration of 1 year. These fractures were matched to similar same-site cases from prior to the intervention for comparison. Comparisons were conducted using t-test and $\chi 2$ tests.

Results: 24 cases were prospectively collected following the intervention and matched to 24 prior-to- intervention cases using Schatzker classification and surgeon. Construct costs were blinded during matching. OTA fracture classifications for the postintervention group were as follows: 41-C3, 14 (58.3%); 41-C2, 4 (16.6%); 41-C1, 2 (8.3%); and 41-B3, 4 (16.6%). Between the 2 matched groups there were no significant differences in patient age (P = 0.74), the length of time external fixators were used (P = 0.77), or the OTA classification (P = 0.78). The mean cost of constructs in the postintervention group was \$4550.20 (95% CI [confidence interval] \$3945.60 to \$5154,) which was significantly different compared to the preintervention group (\$6046.75; 95% CI \$5309.54 to \$6783.97) (t-test P = 0.003).

Conclusion: An educational intervention reduced total implant costs of external fixation constructs in temporizing management of tibial plateau fractures within 1 year. The average cost savings projected is \$35,893.20 at the institution per year. Surgeon awareness of implant component costs and use variation enables clinical practice change.

SCIENTIFIC POSTER #100 Knee and Tibial Plateau

Effect of Surgeon and Hospital Volume on Conversion to Total Knee Arthroplasty After Tibial Plateau Repair

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Purpose: Some orthopaedic procedures exhibit volume-outcome relationships that suggest benefits associated with triage and treatment by higher volume surgeons and hospitals. The purpose of this study was to determine whether this association is present for open reduction and internal fixation (ORIF) of tibial plateau fractures with regard to the outcome of conversion to total knee arthroplasty (TKA).

Methods: The Florida State Inpatient Database was queried to identify patients who underwent ORIF of a tibial plateau fracture between 2006 and 2009. Hospital and surgeon volume were defined as average annual volume of tibial plateau ORIF procedures. The outcome of interest was any subsequent hospitalization for TKA within 5 years. Comparing rates of this outcome, cut-points were established to define high and low volume. Survival analysis, including Cox proportional hazards modeling, was used to estimate the effect of volume on rates of TKA, controlling for age, sex, race/ethnicity, insurance, open fracture, and comorbidities.

Results: In this cohort of 3921 patients, 172 patients (4.4%) underwent TKA within 5 years of ORIF of the tibial plateau. This included 5.0% of patients treated by low volume surgeons versus 2.1% treated by high volume surgeons, and 4.8% treated at low volume hospitals versus 2.0% treated at high volume hospitals. High volume surgeons and hospitals were defined by annual volumes greater than 7 and 29, respectively. After adjusting for patient factors and injury characteristics, treatment at a low volume hospital was associated with a larger hazard of conversion to TKA (hazard ratio [HR] = 2.05; 95% confidence interval [CI] = 1.11, 3.80). Treatment by a low volume surgeon was also associated with a larger hazard of conversion to TKA (HR = 2.17; 95% CI = 1.31, 3.59).

Conclusion: Tibial plateau ORIF exhibits a volume-outcome relationship such that patients treated by the highest volume surgeons and centers exhibit a lower rate of conversion to TKA. This finding suggests that the regionalization of care for these injuries may improve outcomes.



Degree of Articular Injury as Measured by CT Is Associated with Poor Physical Function Following the Treatment of Bicondylar Tibial Plateau Fractures

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Purpose: Clinical outcome of bicondylar tibial plateau fractures (AO/OTA classification type 41-C) has been associated with obtaining leg alignment and restoring condylar width. While intuitive, the degree of direct articular injury has not been linked to outcomes in patients with bicondylar tibial plateau fractures. The aim of the study was to quantify the articular surface disruption on CT and to assess for any correlation between the degree of articular injury and patient-reported physical function.

Methods: This is a retrospective cohort study of patients undergoing surgical repair for bicondylar tibial plateau fractures at 2 Level-I trauma centers between 2013-2016 and who could complete the patient-reported outcome survey. Preoperative CT scans were selected to create a best-fit surface with a 3-mm slice thickness. The articular surface disruption was calculated as the percentage of the entire tibial plateau (Fig. 1). We performed interobserver/ intraobserver calculations and Pearson correlation to assess associations between percentage of disrupted articular surface and PROMIS (Patient-Reported Outcomes Measurement Information System).

Results: 57 patients with an average age of 58 ± 14.3 years and average follow-up of 3.6 ± 1.0 years were included. Intraclass correlation coefficient for the CT measurement was 0.9 (95% confidence interval [CI] 0.79- 0.96). The average PROMIS score was 45.5 (standard error [SE] 3.8). There was a correlation between percentage of articular surface disruption and total PROMIS scores (0.4, CI: 0.2-0.5, P = 0.007).

Conclusion: The calculation of articular surface disruption is a simple, reproducible, and accurate method for assessing the degree of articular damage in patients with bicondylar tibial plateau fractures. We found that the degree of articular injury, as measured by the

percentage of articular surface d i s r u p t i o n, correlates well with patients' physical function as measured by the PROMIS instrument at a minimum of 2-year follow-up.



Figure 1 demonstrating an axial CT scans at 3mm slice (A) outlining the expected normal tibial articular surface and (B) subtraction of any absent/depressed/comminuted articular segments of the joint.

SCIENTIFIC POSTER #102 Knee and Tibial Plateau

Incidence and Risk Factors of Clinically Important Venous Thromboembolism in Tibial Plateau Fractures

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Purpose: There are multiple reports on venous thromboembolism (VTE) for major orthopaedic surgery. The incidence and risk factors of VTE in tibial plateau fractures are reported less commonly. This study aimed to investigate the incidence and risk factors of clinically important VTE (CIVTE) in patients with tibial plateau fractures.

Methods: A total of 462 patients aged 18 years and older were retrospectively identified as undergoing operative fixation of tibial plateau fractures from 2003 to 2018. All the suspected CIVTE patients were examined by ultrasonography or/and CT scan. Univariate and multivariate analyses were used to assess the association in patient demographics between CIVTE and no VTE. Variables that were significant at P <0.05 in univariate analyses entered into a multivariable logistic regression model to evaluate the risk factors.

Results: 39 (8.4%) of 462 patients developed CIVTE in 75.5% (394/462) of patients with the chemical prophylaxis. Pulmonary embolism (PE) and deep vein thrombosis (DVT) were examined in 18 (3.9%) and 21 (4.54%) patient,s respectively. Male (OR [odds ratio], 11.267; P = 0.002), associated with traumatic brain injury (OR, 4.777; P = 0.041), associated with spine injury (OR, 9.506; P < 0.001), associated with extremity injury (OR, 3.695; P = 0.003), the time from injury to definite operation (OR, 1.062; P = 0.004), and length stayed in ICU (OR, 1.101; P = 0.001), were all risk factors for CIVTE. Two patients died in the hospital after the serious injury.

Conclusion: The incidence of CIVTE in tibial plateau fracture was high (8.4%). The males, associated with traumatic brain injury, associated with spine injury, associated with extremity injury, the time from injury to definite operation, and length stayed in ICU were the independent risk factors.

SCIENTIFIC POSTER #103 Knee and Tibial Plateau

The Open Tibial Plateau Fracture: Does Wound Status Portend Poor Outcomes? *Leah Gonzalez, BS*; Timothy Walden, MS; Philipp Leucht, MD; Sanjit R. Konda, MD; Kenneth A. Egol, MD NYU Langone Orthopedic Hospital, New York, NY, United States

Purpose: Open fractures are orthopaedic urgencies that present unique challenges to the treating surgeon. These injuries require timely treatment with antibiotics and debridement. Additionally, they require the evaluation of soft-tissue compromise in order to assess the need for complex closure or soft-tissue flap coverage. This soft- tissue disruption can lead to increased morbidity and mortality. Tibial plateau fractures are associated with soft- tissue disruption even in closed fracture patterns. The aim of this study was to compare the long-term outcomes of open tibial plateau fractures with closed tibial plateau fractures.

Methods: This study was an analysis of a consecutive series of tibial plateau fracture patients treated by one of 3 orthopaedic traumatologists over a 12-year period at a major academic medical center. There were 373 patients with complete follow-up at a minimum of 1 year. Patient data were collected prospectively and included demographics, injury information, and functional outcomes as measured by the Short Musculoskeletal Function Assessment (SMFA) score. Linear regression and binary logistic regression were completed using IBM SPSS, comparing patient outcomes between those with an open tibial plateau fracture to those that were closed.

Results: Of the 373 patients with 376 tibial plateau fractures, 3.5% were open fractures. At final follow-up, at a mean of 11 months (mode of 12 months), open plateau fracture patients had significantly worse bothersome, mobility, functional, and standardized total SMFA scores than their closed fracture counterparts, after controlling for sex, age at injury, body mass index (BMI), and Charlson Comorbidity Index (CCI) (P = 0.012, P = 0.007, P = 0.001, P = 0.011). Infection was more frequent in the open fracture group with open plateau fractures having 136 times the odds of infection as compared to closed fracture patients (P < 0.001). Additionally, open fracture patients were found to have poorer range of motion with respect to flexion than closed fracture patients (P = 0.001). All other outcome measures including patient-reported pain, nonunion rate, operative and inpatient complications, reoperation rate, and range of motion in extension were not significantly different between the open fracture and closed fracture groups (P = 0.275, P = 0.999, P = 0.159, P = 0.289, P = 0.404).

Conclusion: Open fractures of the tibial plateau portend worse long-term functional outcomes. This is likely in part due to the higher energy mechanisms associated with open fractures that can result in neurovascular and musculotendinous injuries in addition to bony injury. As time to fracture healing was not revealed to be different between the open and closed fracture groups, much of the functional deficits noted in the open fracture group are likely soft tissue-related. Patients with open fractures should be appropriately counseled on these potential long- term functional deficits.

Intraoperative Use of 3D Fluoroscopy in Management of Proximal Tibial Fractures *Eline Stroobants, MD*; *Stijn Nelen; Roos JM Havermans; Koen Lansink, MD, PhD ETZ, Tilburg, Netherlands*

Purpose: Intraoperative 3-dimensional fluoroscopy (3DRX) is becoming popular in the management of fractures. Little is known about its consequences in the treatment of intra-articular proximal tibial fractures (TFs). The aim of our study is to evaluate the implementation of 3DRX in the treatment of TFs.

Methods: A retrospective, cross-sectional study was conducted between 2014 and 2018 with inclusion of all patients undergoing surgical treatment of TF. We compared patient, fracture and treatment characteristics. The number of revision surgeries within 6 weeks postoperatively was our primary end point. Secondarily we evaluated the duration of surgery, length of hospital stay, radiation exposure, and postoperative complications. Nominal data were compared using Fisher's exact test and ordinal data with the use of Mann-Whitney U. P values <0.10 were considered statistically significant.

Results: 79 patients were included, of whom 34 were treated with use of 3DRX. Patients in the conventional fluoroscopy (RX) group were significantly older (median 56 vs 47 years; P = 0.02). Remaining characteristics were comparable. Three patients of the RX group (6.8%) underwent a revision surgery within 6 weeks postoperatively. In the 3DRX group intraoperative changes were made in 7 patients (20.6%) and there were no revision surgeries within 6 weeks. A trend toward a shorter length of hospital stay was shown in the 3DRX group (0.5 day; P = 0.12). The average duration of surgery increased up to 24 minutes after the implementation of 3DRX, without a rise in postoperative wound infections (P = 0.77). The 3DRX group had an average radiation exposure of 7.897 mGy versus 0.858 mGy in the RX group (P < 0.01).

Conclusion: After the implementation of 3DRX there was a significant increase in radiation exposure and duration of surgery. Patients in the 3DRX group showed a trend towards a shorter length of hospital stay and required no revision surgery within 6 weeks. The small study population may have caused the nonstatistical significance.

SCIENTIFIC POSTER #105 Pelvis and Acetabulum

Early Operative Treatment of Acetabular Fractures Does Not Increase Blood Loss *Joshua A. Parry, MD*; *Nima Khosravani; Lee E. Weber, BS; George John Haidukewych, MD; Kenneth J. Koval, MD; Joshua Langford, MD Orlando Health, Orlando, FL, United States*

Purpose: The purpose of this study was to compare operative times, intraoperative blood loss, and intraoperative blood transfusions for acetabular fractures undergoing early treatment within 1 day of admission compared to those undergoing treatment 2 or more days after admission.

Methods: A retrospective review of patients who sustained an acetabular fracture treated at a Level-I academic trauma center between 2010 and 2018 initially identified 434 patients. Exclusion criteria included isolated posterior wall fractures (n = 37), concurrent or bilateral open procedures (n = 224), incomplete blood loss records (n = 17), and percutaneous fixation alone (n = 25). The electronic medical records were reviewed to determine the amount of intraoperative estimated blood loss (EBL), intravenous fluids (IVF), cell salvage (CS), and packed red blood products (PRBCs). Time from admission to the index operation in days, operation time, and hospital length of stay were collected. Average time from admission to fixation was 2.7 ± 3.9 days (range, 0- 28 days). Early fixation, defined as within 1 day of admission, was performed in 59 patients (45%). The posterior (Kocher-Langenbeck) approach was utilized in 94 patients (71%) and the anterior intrapelvic approach (AIP), with or without the use of a lateral window, was utilized in 37 patients (28%). Early fixation within 1 day of admission was performed in 46 (48%) of those undergoing posterior approach and in 13 (35%) undergoing the AIP approach.

Results: Early versus delayed fixation through the posterior approach was associated with less intraoperative PRBCs (140 vs 301 mL, mean difference [MD] 161 mL, 95% confidence interval [CI] –25 to –296 mL), less intraoperative total blood products (322 vs 523 mL, MD –201 mL, 95% CI –21 to –380), and a shorter hospital stay (5 vs 16 days, MD 10 days, 95% CI 5 to 16 days). There were no differences in time to surgery, operative time, EBL, or CS. Early versus delayed fixation through an AIP approach did not differ in operative time, EBL, intraoperative blood products, or hospital stay. CS returned blood in 77% of patients for an average of 267 ± 168 mL (range, 105-900 mL) with no difference between AIP and posterior approaches.

Conclusion: Fixation of acetabular fractures within 1 day of admission did not increase blood loss or intraoperative transfusion requirements. Cell salvage was successful in both AIP and posterior approaches.

SCIENTIFIC POSTER #106 Pelvis and Acetabulum

OTA 2019

The Lateral Anteroposterior Pelvis Stress Radiograph for Occult Instability of Lateral Compression Pelvic Ring Injuries

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Purpose: Occult instability is prevalent among minimally displaced lateral compression type 1 (LC1) pelvic ring injuries with complete sacral fractures (AO/OTA 61B2.1). The current gold-standard for diagnosis is examination under anesthesia (EUA). However, EUA is burdensome on the patient and is a time-consuming process that negatively affects the operating room schedule. The purpose of this study was to determine if occult instability could be identified on an AP pelvis radiograph in the lateral decubitus position in an awake patient without the need for anesthesia.

Methods: A retrospective review of 18 consecutive patients with unilateral minimally displaced LC1 injuries with complete sacral fractures was performed. All patients received an AP pelvis radiograph in the lateral position, with the injured side down, while awake prior to going to the operating room for EUA. The lateral AP pelvis radiograph was compared to a supine AP pelvis radiograph for evaluation of displacement. Gross displacement (1 cm or more) of the pelvic ring on EUA was considered an indication for operative fixation. The average age was 36 years (range, 17-72 years).

Results: The lateral AP pelvis stress radiograph demonstrated gross instability in 9 (50%) of the 18 patients. All of these patients subsequently had a positive EUA and underwent surgical fixation (Fig. 1). Transsacral transiliac percutaneous screw fixation was performed

in all positive cases. Two patients remained unstable after posterior fixation and underwent anterior fixation. The 8 patients with no displacement on the lateral AP pelvis stress radiograph also had a negative EUA and were managed nonoperatively.

Conclusion: The lateral AP pelvis stress radiograph correctly identified occult instability of lateral compression pelvic ring injuries and correlated with the formal EUA in all cases.



Mortality Rate of Geriatric Acetabular Fractures Is High Compared to Hip Fractures: A Matched Cohort Study

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Purpose: Using the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) registry we compared the 30-day complication and mortality rates of geriatric patients with acetabular fractures (AF) matched to hip fractures (HF).

Methods: The NSQIP registry was used to identify patients (>60 years old) from 2011-2016 treated for AF (wall or column[s] fractures requiring open reduction and internal fixation [ORIF]) and HF (femoral neck, inter/subtrochanteric) using CPT codes. Elective patients or those with disseminated cancer/infection were excluded. Patient characteristics, comorbidities, functional status, and complications (surgical site infection, pulmonary embolism [PE], death, and readmission) were recorded. Patients were matched 1:5 (AF:HF) based on age, sex, body mass index (BMI), functional status, and American Society of Anesthesiologists (ASA) class. Chi-square, Fisher exact, and Mann-Whitney U tests were used to compare groups and multivariable logistic regression to compare the risk of complications or death while adjusting for relevant covariates.

Results: A total of 303 AF patients (age: 78.2 \pm 9.2 years, 59.7% females, BMI: 25.3 \pm 6.8 kg/m2, ASA III-IV: 75.3%, 27.1% wall, 28.4% 1-column and 45.2% 2 columns) were matched to 1511 HF patients (age: 78.3 \pm 9.1 years, 60.2% females, BMI: 25.3 \pm 6.6 kg/m2, ASA III-IV: 76.2%, 37.2% hemi-arthroplasty, 16.3% ORIF, and 47.4% cephalomedullary nail). Patient demographics were not significantly different. Average length of stay (LOS) of 8.4 \pm 7.1 vs 6.4 \pm 5.9 days and time to surgery (TS) of 2.3 \pm 1.8 vs 1.2 \pm 1.4 days were both significantly longer in the AF group (P <0.01). PE rates were higher in the AF group (2.0% vs 0.5%, P = 0.01). Complications or mortality rates were not significantly different within the AF types and within the HF types. Mortality after adjustment for comorbidities, LOS, and TS was significantly higher for AF versus HF patients (odds ratio: 1.92, 95% confidence interval: 1.08-3.43).

Conclusion: This is the first study comparing acute complication and mortality rates of geriatric AF to HF patients. The high mortality of HF has been well reported and the importance of expedited care emphasized. Geriatric patients with AF pose a significantly higher mortality risk when compared to HF patients. Future studies on strategies to mitigate risk factors in this vulnerable population are warranted.

SCIENTIFIC POSTER #108 Pelvis and Acetabulum

Impact of Intraoperative Hypothermia on Blood Loss and Transfusion Requirements in Patients with Pelvic and Acetabular Trauma

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Purpose: The aim of this study was to explore the association between intraoperative hypothermia and perioperative blood loss and transfusion requirements in patients with intrapelvic trauma.

Methods: This retrospective study includes 374 consecutive patients that presented to a single Level-I trauma center for surgical fixation of an acetabular or pelvic ring injury. Patient temperature was recorded in degrees Celsius (°C) and intraoperative hypothermia was defined as a temperature less than 36.5°C at the completion of procedure prior to extubation. Primary outcome measures included estimated blood loss (EBL), postoperative day 1 (POD1) drain output (mL), and rate of postoperative packed red blood cell (PRBC) transfusion. Covariates used in our regression models included admission hemoglobin level (Hb, mg/dL), preoperative PRBC transfusion requirement, admission acidosis defined at base excess (BE) less than –5.0, and ISS.

Results: The mean age of the cohort was 39 years (range, 16-87). There were 100 acetabular fractures, 234 pelvic ring injuries, and 40 combined injuries. Among the entire cohort, 41 patients (11%) were found to have intraoperative hypothermia and 118 (32%) required a postoperative blood transfusion. Compared to controls, patients with intraoperative hypothermia had a significantly higher EBL, 406 mL versus 296 mL (P = 0.019), and significantly higher POD1 drain output, 197mL versus 132mL (p=0.002). There was also a significant association between intra-operative hypothermia and post-operative transfusion requirement (p=0.016). The rate of postoperative blood transfusion was 42% for patients with intraoperative hypothermia compared to 28% for controls. Regression analyses revealed that patients with intraoperative hypothermia were almost twice as likely to require a postoperative transfusion (odds ratio [OR] 1.8; P = 0.017); however, this relationship became nonsignificant after controlling for admission Hb level, preoperative transfusion, and ISS (P = 0.217). In a subgroup analysis of patients with admission acidosis, the rate of postoperative transfusion remained significantly increased to over 4 times as likely when intraoperative hypothermia was present, even after controlling for admission Hb, ISS, and rate of preoperative transfusion (OR 4.4; P = 0.018).

Conclusion: For patients with intrapelvic trauma who present with an admission acidosis, intraoperative hypothermia is an independent risk factor for increased postoperative blood transfusion requirement. This information is clinically important given the modifiable nature of intraoperative patient temperature and the known complications and sequelae associated with increased transfusion rates.

The FDA has stated that it is the responsibility 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 Current Pelvic Outcome Scores Identify Patient-Reported Symptoms? Long-Term Patient-Reported Genitourinary and Sexual Dysfunction in Males After Operatively Treated Pelvic Ring Injuries

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Purpose: This study was conducted to assess sexual and urological dysfunction in a male cohort of operatively stabilized pelvic ring injuries using validated patient-reported outcomes at a mean of 15 years (range, 11-22) postinjury. We further assessed whether these were identified in standard outcome scores (EQ-5D-3L [EuroQol- 5 Dimensions, 3 Levels]), utilized for this population.

Methods: Between 1994 and 2005 our institution stabilized 177 male patients with unstable pelvic injuries. Surviving, traceable patients were contacted. Participants were asked to complete outcome measures. EQ-5D- 3L) is a standardized instrument used as a measure of general health outcome. MLUTS [Modular Questionnaire for Male Lower Urinary Tract Symptoms] is validated for assessing 2 aspects: Symptoms - Frequency, Voiding, Incontinence Scale 0 (Best) to 52 (Worst) and Bothersomeness Scale 0 (Best) to 130 (Worst). Sexual Health Inventory for men (SHIM) has a score of 1-25, with 1 being the worst indicating severe erectile dysfunction.

Results: A total of 52 males, mean age 59 years (range, 30.2-82.95) participated in the study with mean time from injury 15 years (range, 11 to 22 years), 10 with recorded neurological injury. EQ-5D-3L was completed by all participants with a mean score of 71. MLUTS mean symptom score was 9 (range, 0-26) and bothersome score was 21(range, 0-90). The SHIM had a mean score of 14; 17 patients (37%) reported severe sexual dysfunction and only 9 (19.6%) reported no problems. There was no detectible correlation between urological and sexual dysfunction. Urological dysfunction did not correlate with EQ-5D-3L.

Conclusion: To accurately gain a true understanding of the global functional outcome of patients following a pelvic injury, urological and sexual dysfunction must not be overlooked. Only 19% of the patients had documented neurological dysfunction. 80% report some level of sexual dysfunction with 37% reporting it as severe. Long-standing sexual and / or urological dysfunction can be a source of significant psychological impact that is not identifiable on EQ-5D-3L and other outcome scores used in assessment of pelvic ring injury. Future studies need to recognize and quantify sexual and urological function, and its importance with patient-reported outcome.

SCIENTIFIC POSTER #110 Pelvis and Acetabulum

Does Tranexamic Acid Reduce Blood Loss in Acetabular Fracture Surgery?

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Purpose: Tranexamic acid (TXA) has been shown to reduce blood loss in arthroplasty surgery, but the effect of TXA used during fixation of acetabular fractures remains unclear. The objective of the study is to determine whether intraoperative TXA administration reduces estimated blood loss (EBL) or the required units of packed red blood cells (pRBCs) infused during surgery for acetabular fractures.

Methods: This retrospective cohort study included 412 acetabular fractures requiring operative fixation from 2010 to 2018 at a single Level-I trauma center. Simple posterior wall fractures were excluded. The treatment group comprised 128 patients that received intraoperative intravenous (IV) TXA and were compared to 284 control patients that did not receive intraoperative IV TXA. There were no differences in the observed demographic and injury characteristics between the 2 groups. The treatment group had less time from injury to surgery than the controls (2.0 days vs 2.7 days, P <0.05). The primary outcome was intraoperative EBL as reported in the anesthesia records. The secondary outcome was 1 or more units of pRBCs infused intraoperatively. Multivariable regression models, adjusting confounders that included patient age, sex, time from injury to surgery, and operative time were used to estimate the effect of TXA on study outcomes.

Results: There was no association between intraoperative IV TXA administration and EBL in the unadjusted (TXA: 1001 mL vs no TXA: 980 mL, P = 0.74) or adjusted models (TXA: 1004 mL vs no TXA: 968 mL, P = 0.71). However, intraoperative IV TXA was associated with a 39% reduction in the likelihood of receiving 1 or more units of pRBCs infused intraoperatively (adjusted odds ratio = 0.61, P < 0.05).

Conclusion: These data present a mixed signal regarding the effectiveness of TXA in acetabular surgery. TXA use was associated with a significant decrease in the odds of intraoperative transfusion (39% less, p<0.05). However, there was no evidence that TXA reduced EBL. It is unknown if this finding reflects noise in the outcome measure of EBL or is a valid finding. Further high-quality prospective studies are needed to determine if there is a benefit to TXA in acetabular surgery.

SCIENTIFIC POSTER #111 Pelvis and Acetabulum

Five-Year Experience for Navigated Iliosacral and Transiliac Transsacral Screw Implantation Using a Hybrid Operating Room

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Purpose: Percutaneous sacroiliac (SI) screw fixation is the standard treatment for fractures of the sacrum. Long transiliac transsacral (TITS) screws are being used more frequently for osteoporotic fractures to ensure optimal stability. Yet, visualization remains a major concern during implantation of these screws. New advances in intraoperative imaging and navigation seem to be an essential help during screw placement.

Methods: All percutaneous SI or TITS screws, which were implanted with intraoperative computer navigation in a hybrid operating room in the first 5 years of utilization (June 2012 to June 2017), were included. The hybrid operating room consists of a robotic 3-dimensional (3D) flat panel detector (Artis zeego, Siemens) linked to a navigation system (BrainLab Curve, BrainLab). Intraoperative 3D scans and postoperative CT were examined for screw perforation (grade 0 perforation: no perforation, grade 1: 0-2 mm, grade 2: 2-4 mm, grade 3: >4 mm). All patients were followed for a minimum of 1 year after surgery.

Results: 210 navigated percutaneous screws were placed in the dorsal pelvis of 187 patients (70 male, 117 female; mean age 64 ± 21 years) between June 2012 and June 2017. 127 SI screws and 83 TITS screws were implanted. 43 screws were combined with a supra-acetabular external fixator. 95.7 % of all screws showed either no perforation or a perforation <2 mm (n = 201). Six screws showed a grade 2 perforation (2.9%) and 3 screws a grade 3 perforation (1.4%). No significant difference between both screw types regarding the grade of cortical perforation could be seen. Two SI screws had to be revised in total. One SI screw was changed to a TITS screw due to loosening in osteoporotic bone. The other was replaced due to a deterioration of a preexisting injury of the lumbar plexus in a C-type pelvic ring fracture. Two postoperative parasthesias of the cutaneous lateralis nerve were detected postoperatively. One parasthesia of the ventral thigh was seen after implantation of an additional external fixator. No vascular complications or infections due to percutaneous dorsal screw implantation could be seen.

Conclusion: Computer navigation in a hybrid operating room is a very safe and effective technique for SI and TITS screw implantation. Excellent image quality and large 3D volume leads to a high accuracy of both screw types. There was no prolongation of the operating time of TITS compared to SI screws.

SCIENTIFIC POSTER #112 Pelvis and Acetabulum

Complications Associated with Early versus Delayed Fixation of Pelvic Ring Injuries *David Gonzalo Rojas, MD*; Julia R. Coleman, MD; Ernest E. Moore, MD; Joshua A. Parry, MD; Chase S. Dean, MD; Bryant Elrick, MS; Weston Ryan, BS; Jason Nadeau, MS; Cyril Mauffrey, MD Denver Health Medical Center, Denver, CO, United States

Purpose: This study aims to compare survival, complications, and length of stay between patients with pelvic ring injuries undergoing early definitive fixation, delayed definitive fixation, or temporary damage control external fixation.

Methods: A retrospective chart review of 285 severely injured (ISS >15) patients with pelvic ring fractures at a Level-I trauma center was performed. Early versus delayed definitive fixation was defined by a cutoff of 36 hours and did not require temporary external fixation. Early fixation was performed in 45 patients (16%), delayed fixation in 148 (52%), and damage control external fixation in 92 (32%). The review included associated injuries, admission lactate, pelvic ring injury classification, hospital management, and complications.

Results: Compared to early fixation, delayed fixation had a lower admission Glasgow Coma Scale (GCS) and more Tile C pelvic ring injuries, acetabular fractures, chest injuries, days in the ICU, days on a ventilator, and cases of pneumonia (Table 1). The early and delayed fixation groups did not differ in hospital length of stay, ISS, admission lactate, abdominal and urologic injuries, acute respiratory distress syndrome (ARDS), pulmonary embolism (PE), deep venous thrombosis (DVT), sepsis, multiple organ failure (MOF), or survival. Comparatively, the damage control external fixation group had a higher ISS and presenting lactate, and more cases of ARDS, PE, DVT, sepsis, and MOF compared to both early and delayed fixation groups, but similar survival (Table 1).

Conclusion: Delayed fixation had more chest injuries and consequently more ventilator days and cases of pneumonia than early fixation. However, there was no difference in ARDS, PE, DVT, sepsis, MOF, or mortality between these 2 groups, suggesting that the development of these complications may be more dependent on initial injury severity and other clinical factors than on timing of definitive fixation.

Table 1. Demographics, injury complex and outcomes. ISS - Injury Severity Score, GCS - Glasgow Coma Scale, ICU - Intensive Care Unit, LOS - Length of Stay, ARDS - Acute Respiratory Distress Syndrome, MVC - Motor Vehicle Collision, MCC - Motor Cycle Collision, AP - Auto Pedestrian. *p <0.01 compared to Delayed and Early Fixation, ** p <0.01 compared to Early Fixation.

	Early Fixation	Delayed Fixation	External Fixation
	(n=45)	(n=148)	(n=92)
Age (years)	47±17	41±15	45±17
Injury Mechanism	MVC:18, MCC: 6,	MVC:81, MCC:16, AP:	MVC: 30, MCC: 13, AP:
	AP:11, Fall: 14	29, Fall: 28, Crush: 2	26, Fall: 3, Crush: 8
ISS	24±9	26±9	38±12*
GCS	14±2	12±4**	10±5*
Type C pelvic fracture (%)	38	24**	64*
Acetabular fracture %	15	25**	0*
Admission lactate (mmol/L)	2.8±1.9	3.2±1.9	4.9±3*
Time to fixation (hours)	22±10	104±79**	170±130*
Associated Head/Face (%)	33	29	38
Associated Chest (%)	40	68**	66**
Associated Abdomen (%)	17	27	55*
Associated Urologic (%)	17	16	33*
Hospital LOS (days)	12±12	17±13	29±37*
ICU LOS (days)	3±3	7±8**	12±9*
Ventilator days	0.8±2	4±8**	9±9*
ARDS (%)	17	25	41*
Pneumonia (%)	4	19**	42*
Pulmonary embolism (%)	6	3	14*
Deep vein thrombosis (%)	4	3	17*
Sepsis (%)	4	6	16*
Multiple organ failure (%)	0	5	16*
Survival (%)	91	97	97

SCIENTIFIC POSTER #113 Polytrauma

2019 Can External Fixator Use Influence Patients' Experience of Pain?

Shea Comadoll; Josh Van Wyngaarden; Cale Jacobs, PhD; Kristin Archer, PhD; Arun Aneja, MD; Brian Noehren, PT, PhD; Paul Edward Matuszewski, MD University of Kentucky, Lexington, KY, United States

Purpose: External fixation is a helpful tool used to stabilize complex fractures before definitive fixation for multiple reasons including soft-tissue compromise, physiological status, and timing of definitive surgical procedure. However, little is known regarding the psychological effects of external fixator placement, specifically the effect on a patient's experience of pain. The purpose of this study was to determine whether the use of an external fixator is associated with alterations in patients' psychosocial profiles, which are associated with poor long-term outcomes, when controlling for both injury severity and fracture severity. We hypothesized that patients initially treated with external fixation would have worse pain catastrophizing and pain self-efficacy scores throughout their care compared to those treated without external fixation.

Methods: 88 subjects with lower extremity fractures requiring surgical fixation and without history of chronic pain (age 41.3 ± 14.6 years; 55% M; 18 external fixator) were recruited from a Level-I trauma center. Pain Catastrophizing Scale (PCS) and Pain Self-Efficacy Questionnaire (PSEQ) were assessed at 2, 6, and 12 weeks after definitive fixation. Differences in psychosocial scores at each time point were compared between those who were and were not placed in an external fixator prior to definitive fixation with a 2 x 3 repeated-measures analysis of covariance controlling for ISS and fracture severity (determined using the AO classification system).

Results: Both PCS and PSEQ scores demonstrated statistically significant differences between individuals with and without external fixator placement at 2, 6, and 12 weeks after definitive fixation (PCS mean difference: 5.5; 95% confidence interval [CI]: 0.65-10.2, P = 0.027; PSEQ mean difference: 9.2; 95% CI: 2.1-16.3, P = 0.01). These group differences are clinically meaningful as they exceed the minimal clinically important difference of 5 for PCS and 6 for PSEQ. Interestingly, ISS and fracture severity did not predict PCS and PSEQ following injury (ISS: P = 0.39-0.65; fracture severity: P = 0.32-0.78).

Conclusion: Our results suggest that use of an external fixator may be associated with increased pain catastrophizing and decreased pain self-efficacy. Benefits of external fixator use should be weighed against these apparent effects on the patient's experience of pain, which is associated with poorer outcomes. Patients who require external fixator use may benefit from early cognitive behavioral therapy and / or pain neuroscience education to help improve their overall mental profile and long-term outcomes.

SCIENTIFIC POSTER #114 Polytrauma

Orthopaedic Trauma Patient Compliance with DVT Prophylaxis Post-Discharge from the Hospital

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Purpose: Deep-vein thrombosis (DVT) prophylaxis is commonly utilized to prevent venous thromboembolism (VTE) following orthopaedic injury. However, little is known regarding the adherence to chemoprophylaxis regimens in the trauma population. An understanding of the patterns of adherence and risk factors for nonadherence would be beneficial to identify methods to improve compliance with these medications. The goal of this study was to determine the pattern of compliance as well as identify risk factors for noncompliance in a trauma population. We hypothesized that compliance would deteriorate over time and that patients with hip fractures would have higher compliance compared to other injuries.

Methods: An IRB-approved prospective study to determine patient compliance with DVT prophylaxis protocol was conducted. Adult patients \geq 18 years of age admitted with fractures requiring DVT prophylaxis (enoxaparin) per institutional protocol during a 3-month period were included. After enrollment, patients were contacted within 96 hours post discharge, at 2 weeks, and at therapy conclusion. Patient compliance was assessed using the Morisky 8-item Medication Adherence Questionnaire and were categorized into low, moderate, and high compliance based on score. Repeated-measures analysis of variance was used to compare adherence scores over time for the subset of patients who completed all questionnaires.

Results: 84 patients were enrolled. Average age was 57 years (95% CI [confidence interval] 53.14-61.70), and 56% were female. 93% completed at least 1 survey with 86%, 87%, and 70% completion at the respective time points. At the first time point, 67% reported high compliance, 30% moderate, and 3% low compliance. At 2 weeks, 56% of participants had high compliance, 30% moderate, and 14% low compliance. At the final time point, 53%, 36%, and 11% reported high, moderate, and low compliance, respectively. Compliance significantly dropped from each time point (P = 0.001). Age, fracture type (hip fracture/ other), and discharge disposition did not predict compliance (P > 0.05).

Conclusion: Adherence to DVT prophylaxis medication significantly decays over time. Age, injury, and discharge to rehabilitation do not appear to affect compliance to medication. Nearly half of patients 2 weeks and beyond initiation of therapy are not taking their medication as prescribed. Screening tools should be developed and utilized prior to discharge to identify patients at risk for noncompliance or alternative therapies should be considered.

SCIENTIFIC POSTER #115 Polytrauma

Femur Fractures Are a Risk Factor for Multiple Organ Failure in Critically Injured Trauma Patients

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Purpose: Femur fractures occur frequently after high-energy trauma and reflect significant soft-tissue disruption and inflammation. The role of femur fractures in subsequent posttraumatic multiple organ failure (MOF) is of considerable interest. The purpose of the present study is to examine femur fractures as a risk factor for MOF in critically injured trauma patients. We hypothesize that femur fractures contribute to the risk of MOF in multisystem trauma patients.

Methods: We performed a single-center, retrospective investigation at an academic, tertiary care trauma center. Inclusion criteria were adult patients (age \geq 18 years) with an ISS >15. Patients with a head abbreviated injury scale (AIS) score >2 were excluded. Demographics and injury characteristics were collected. All patients with a femur fracture, defined as occurring between the proximal greater trochanter and the distal metaphyseal flare, were identified. Admission vital signs and serum lactate values during the first 24 hours of hospital admission were evaluated. The primary outcome was MOF, defined by the Denver Organ Failure score. This score requires patients to have an ICU length of stay (LOS) \geq 2 days. Therefore, patients with an ICU LOS <2 days were excluded. The impact of femur fractures on MOF was tested with a Cox proportional hazard model. Interaction terms were created between femur fracture and chest injury (femur_chest), femur fracture and abdominal injury (femur_abd), chest and abdominal injury (chest_abd), and femur fracture, chest injury, and abdominal injury (femur_chest_abd). Results are presented as hazard ratios (HRs) with 95% confidence intervals (CIs).

Results: 737 patients were available for analysis. Median ISS was 26 (IQR [interquartile range]: 21-34) and median age was 47 years (IQR: 29-58). Median admission Glasgow coma scale score was 15 (IQR: 14-15), median chest AIS score was 3 (IQR: 1-4), and median abdominal AIS score was 1 (IQR: 0-3). 104/737 patients (14.11%) sustained a femur fracture and MOF occurred in 70/737 patients (9.50%). After considering injury characteristics and interaction terms, only femur fracture (HR: 1.88, 95% CI 1.06-3.35) and chest_abd injury (HR: 1.05, 95% CI 1.01-1.09) were associated with MOF, after adjusting for age (HR: 1.03, 95% CI 1.01-1.04) and admission lactate (HR: 1.16, 95% CI 1.08-1.23).

Conclusion: Femur fractures are an independent risk factor for MOF in critically injured trauma patients. The risk of MOF increased by 88% in patients with a femur fracture compared to patients without a femur fracture. There was no interaction between a femur fracture and other organ system injuries and the risk of MOF. Future studies are necessary to further define the precise mechanism by which femur fractures impact the risk of MOF.

SCIENTIFIC POSTER #116 Polytrauma

Lower Extremity CT Angiograms and the Effect on Kidney Function in Orthopaedic Trauma Patients

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Purpose: We hypothesize that our institution obtains CT angiograms (CTAs) to evaluate for vascular injury more frequently than indicated and that the likelihood of contrast-induced nephropathy (CIN) increases in patients with GFR (glomerular filtration rate) <60. CTAs are often obtained in lower extremity (LE) trauma to evaluate vascular injury. Commonly accepted indications to obtain CTAs in lower extremity trauma are an ankle-brachial index (ABI) <0.9 or hard signs of vascular injury. There is a paucity of literature regarding risk factors for CIN following LE CTAs in a trauma setting.

Methods: After IRB approval, patients with CTAs following LE trauma were identified using an imaging database between 2010 and 2018. Patients with CTAs following LE trauma with renal function labs were included in the study. Patient charts and imaging were reviewed for demographic data, injuries, kidney function labs, physical examination, treatments, and follow-up. Normality was assessed using Shapiro-Walk test and differences between variables were assessed using Wilcoxon signed rank test and Fisher's exact test.

Results: CTAs were performed on 257 LEs of 199 patients. Of the 257 CTAs, 162 (63%) LE CTAs were not indicated (no hard signs of vascular injury, ABI >0.9). Of the 95 indicated CTAs, 21 limbs (7.4%) had a positive finding on initial CTA (thrombus, occlusion, extravasation, or pseudoaneurysm) concerning for a vascular injury. Of these 21 patients with positive findings, 12 (4.7%) had an LE vascular injury requiring intervention. There was a statistically significant increase in creatinine after obtaining a CTA in these 257 patients (P = 0.010). Patients with initial GFR <60 mL/min were more likely to develop acute kidney injury (AKI) compared to patients with GFR >60 mL/min (P = 0.001). There was no difference in rate of AKI in patients with a higher ISS, in both groups of GFR >60 mL/min (P = 0.15) or GFR <60 mL/min (P = 1.0).

Conclusion: Our study demonstrates that CTAs are obtained more often than indicated. Patients who had CTAs after LE trauma were at an increased risk of developing AKI after contrast. Patients with initial GFR <60 mL/min were at the highest risk of developing AKI. ISS did not correlate to AKI, suggesting that CIN may play a larger role in the insult to the kidneys that we have previously recognized in the trauma patient.

SCIENTIFIC POSTER #117 Polytrauma

Prevalence of Posttraumatic Stress Disorder in Acute Trauma Patients

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Purpose: Posttraumatic stress disorder (PTSD) may be a disabling consequence of trauma. It is recognized that PTSD adversely affects work ability, activities of daily living, and pain. Identification and intervention are paramount to reducing long-term PTSD symptoms. The purpose of this study was to determine the prevalence of PTSD among trauma patients with and without orthopaedic injuries.

Methods: 452 adult patients treated for injuries at an urban Level-I trauma center over 16 months were administered the PCL-5 [PTSD Checklist for DSM-V] survey for PTSD during their first outpatient clinic visit. This included 300 men (66%) and 152 women with mean age 44 years and mean ISS 11, with 83% having a fracture of the pelvis and/or extremities. Mean length of stay was 4.8 days, and 23% had ICU stay. All patients who screened positive for PTSD were offered treatment, including support groups, counseling, and outpatient psychotherapy.

Results: 103 patients screened positive for PTSD (25%) after injury, of whom 97 (94%) had no prior history of PTSD. Patients with PTSD were younger (35 vs 46 years, P <0.001), more often African American (56% vs 43% Caucasian, P <0.001), and were more likely to use recreational drugs (25% vs 17%, P = 0.01). PTSD was more common after gunshot wounds (GSW, 53% positive) and pedestrians struck by motor vehicles (59%).

Over half of all who screened positive for PTSD were victims of crime, and victims screened positive 53% of the time. 69% of patients in the positive PTSD screening cohort sustained orthopaedic injuries, half of whom were treated surgically. Overall, 21% of the patients with orthopaedic injuries had PTSD. There was no association between ISS and PTSD symptoms. Length of hospital stay, an ICU stay, and a history of mechanical ventilation support were also not associated with PTSD.

Conclusion: One-fourth of trauma patients screened positive for PTSD. Predictive factors include victims of crime, and mechanisms of GSW and pedestrians struck by motor vehicles. African-American ethnicity, recreational drug use, and younger age were also associated with PTSD. Given the identified prevalence of PTSD following trauma, adequate screening measures for PTSD must be in place in trauma surgery clinics in order to diagnose and refer these patients for proper evaluation and treatment.

SCIENTIFIC POSTER #118 Polytrauma

Use of a Modified Frailty Index as a Preoperative Assessment Tool for Patients Undergoing Fixation of Long Bone Fractures Dominick Vincent Congiusta, BS, MPH; Shanen Mulles; Aziz Merchant, MD; Irfan H. Ahmed, MD; Michael M. Vosbikian, MD Rutgers New Jersey Medical School, Newark, NJ, United States

Purpose: Frailty is an important predictor of surgical outcomes that can be used in risk assessment for patients with multiple comorbidities and functional impairments. The modified frailty index (mFI) has recently been adapted to a 5-item score and has promise to be a valuable risk assessment tool in orthopaedic trauma patients. As there is an increased incidence of long bone fractures in frail patients, the mFI may be used as a predictor of complications to better inform preoperative planning.

Methods: The National Surgery Quality Improvement Program (NSQIP) 2006-2016 database was queried for cases of surgically managed long bone fractures by using CPT codes. Cases were excluded if they were missing demographic, frailty, or outcome data. The 5-item frailty index was calculated based on the sum of presence of 5 conditions: COPD (chronic obstructive pulmonary disease)/pneumonia, congestive heart failure, diabetes, hypertension, and impaired functional status. Non-routine discharge was defined as discharge to a location other than the patient's home. Chi-square was used to determine variables significantly associated with each outcome. Significant variables were included in multivariate logistic regression. The Bonferroni correction was applied, which yielded a significance threshold of P <0.003.

Results: Of the 140,249 fixation procedures performed on long bone fractures in NSQIP, 109,423 cases remained after exclusion criteria were applied. The majority of patients were between the ages of 61 and 80 years (34.0%), female (65.6%), and Caucasian (86.3%). Multivariate analysis revealed that mFI scores >3 were significantly predictive of mortality (odds ratio [OR] = 4.27), wound disruption (OR = 2.83), unplanned reoperation (OR = 1.57), unplanned readmission (OR = 2.12), surgical site infection (OR = 1.90), major and minor complications (OR = 3.04 and 2.79, respectively), and non-routine discharge (OR = 3.06).

Conclusion: We present data on the relationship between frailty and postoperative complications in patients with long bone fractures. Patients with the highest frailty score had the greatest likelihood of morbidity and mortality, independent of other factors. The mFI may have a role as a simple, easy-to-use risk assessment tool that can inform preoperative discussions in cases of orthopaedic trauma and lead to appropriate precautions to minimize the frequency of these complications. Future studies should investigate the prospective predictive value of the mFI and any prophylactic measures taken.

SCIENTIFIC POSTER #119 Polytrauma

Trauma Care Before and After Optimization in a Level-I Trauma Center: Life-Saving Changes

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Purpose: The implementation of trauma systems has led to a significant reduction in mortality and length of hospital stay. In our Level-I trauma center, 24/7 in-hospital coverage was implemented, and a renovation of the trauma room took place to improve the trauma care. The aim of the present study was to examine the effect of the optimized in-hospital infrastructure in terms of mortality, processes, and clinical outcomes.

Methods: We performed a retrospective cohort study of prospectively collected data. All adult trauma patients admitted to our trauma center directly during 2 time periods (2010-2012 and 2014-2016) were included. Any patients below the age of 18 years and patients who underwent primary trauma screening in another hospital were excluded. Logistic and linear regression were used and adjusted for demographics and characteristics of trauma. The primary end point was mortality. The secondary end points were subgroups of earlier mortality rates and severely injured patients, processes, and clinical outcomes.

Results: In period I, 1290 patients were included; and in period II, 2424. The adjusted mortality in the trauma room (odds ratio [OR]: 0.35; confidence interval [CI]: 0.12-0.98) and the total in-hospital mortality (OR: 0.65; CI: 0.43-0.98) showed a significant reduction in period II. The emergency room (ER) time decreased by 30 minutes (P <0.001), and the time until CT decreased by 22 minutes (P <0.001). The number of delayed diagnoses and complications were significantly lower in the second period, with an OR of 0.2 (CI: 0.1–0.3) and 0.4 (CI: 0.3–0.5), respectively. The hospital length of stay and ICU length of stay decreased significantly, -0.9 day (P = 0.032) and -1.8 days (P = 0.022), respectively.

Conclusion: Optimization of the in-hospital infrastructure related to trauma care resulted in improved survival rates in both severely injured patients as well as in the whole trauma population. Moreover, the processes and clinical outcomes improved, showing a shorter hospital length of stay, shorter ER time, fewer complications, and fewer delayed diagnoses.

SCIENTIFIC POSTER #120

Post-Traumatic Reconstruction

2019 Case Report

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Purpose: Radiographic examination at 3 months after operation showed that the right shoulder fracture block did not heal, and the suspension function of the upper scapula was not restored.

Methods: During the operation, the anterior superior iliac spine was cut into the proximal end 8 cm along the lateral malleolus, and the subcutaneous tissue of the skin was cut to reveal the sputum. Take 3 cm × 6-cm sacral bone block, stop bleeding, suture layer by layer. From the right thigh to the distal end of the greater trochanter, the distal end was cut open 8 cm, the skin subcutaneous tissue was cut, the fascia was revealed, and the 3 × 6-cm fascia was taken out to stop bleeding and suture layer by layer. The patient was placed in the right lateral position, and 13 cm of subcutaneous tissue was cut along the original surgical incision (shoulder scapula of the right scapula) to reveal the scapular and T-shaped plates. See the distal end of the shoulder bone displacement, the end of the hardening. Scar hyperplasia around the shoulder joint, a large number of displaced ossification. The T-shaped bone plate was taken out, and the fracture piece at the distal end of the shoulder was taken out, and the heterotopic ossification lesion were removed, and the shoulder joint was released.

Results: After 6 months of follow-up, radiographic films and CT were reviewed. The results showed that the shoulders were healed, the shoulder joints were in place, the clavicle and the proximal humerus were healed, and the brachial plexus was partially restored.

Conclusion: Intraoperative fixation is beneficial to the early start of shoulder joint function exercise, reduces the occurrence of joint adhesions, and prevent the occurrence of shoulder deformities, pain, and other sequelae. The key to treatment is a good reduction of the fracture and repair of the ligament around the shoulder joint. The 3- dimensional-printed steel plate was used to repair the skeletal structure at the shoulder, and the sandwich technique was used to repair the huge defect of the rotator cuff. At the same time, the problems of bony structure and soft-tissue defect were solved to achieve good results in the treatment of such fractures.

A One-Stage Orthoplastic Approach in the Treatment of Gustilo III Open Fractures of the Lower Limb

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Purpose: The orthoplastic approach in the treatment of Gustilo III open fractures consists of the management of both bone and soft tissue in a simultaneous, coordinated, and organized manner. All of this is done in accordance with the 2015 BOA (British Orthopaedic Association/BAPRAS (British Association of Plastic, Reconstructive and Aesthetic Surgeons) guidelines. The purpose of this treatment is to guarantee both the healing of the lesion as well as maintaining the limb's function, while avoiding infection, in order for patients to be able to return to daily life, work, and conduct a lifestyle that does not limit their social life.

Methods: We conducted a prospective / retrospective study through the collaboration of the Orthopedics and Traumatology Clinic and the Plastic and Reconstructive Surgery Clinic. Our study included 9 patients with 12 Gustillo III open fractures of the lower limb, treated between 2015 and 2018 with the orthoplastic 1-step approach. There were 3 tibial pilon fractures with severe soft-tissue damage and bone loss, treated with plate and screw and a free flap. Five of the fractures were diaphyseal tibial fractures with intramedullary nail and free flap placement. Two of the open fractures were supraintercondylar femur fractures with severe bone loss, treated with a vascularized double-barrel fibular autograft and plate and screw fixation. In some cases, bone grafts with concentrated bone marrow were used. Damage control was performed within 6 hours and the definitive orthoplastic treatment was completed after an average of 10.6 days. Recovery was an average of 44 days, 23 days in patients without associated severe injuries.

Results: We obtained the closure of soft tissue in an average of 27.7 days, with 1 complication 14.2% of partial flap necrosis. In the femur fractures, closure occurred in an average of 40.5 days for a complication in which an infection of a subfascial hematoma developed in a diabetic patient. We had to reintervene 16.6% of the time for soft-tissue complications and 33,3% for delayed consolidation. Radiological healing of bone was obtained in an average of 7 months in the diaphyseal tibial fractures, and full weight bearing at 5. In tibial pilon fractures, radiological healing and weight bearing was achieved in 15 and 6 months, respectively, and in femur fractures 9 and 4 months, respectively. Both clinical and functional results (Short Form [SF]-36, American Orthopaedic Foot & Ankle Society [AOFAS], Knee Society Score) are satisfactory. There were no secondary amputations and no bone infections.

Conclusion: Open fracture management continues to be a challenge for orthopaedic surgeons. Each of these injuries is different, with each segment having its own vascularization. Because of this difficulty, viable tissue must be treated through careful preoperative planning in each step, following the guidelines for patient management to achieve better results.

SCIENTIFIC POSTER #122 Post-Traumatic Reconstruction

Predictors of Failure After RIA Bone Grafting in Lower Extremity Injuries *Reuben C. Lufrano, MD*; *Natasha Simske, BS; Jordan T. Shaw, MD; Ryan M. Graf, MD, MS; Paul S. Whiting, MD; David Goodspeed, MD University of Wisconsin, Madison, WI, United States*

Purpose: The reamer-irrigator-aspirator (RIA) can be used to harvest autogenous bone graft and has been utilized in the treatment of lower extremity nonunions. Proposed advantages of this technique include a larger volume of graft material, less donor site morbidity, and decreased operative time. Existing literature reports mixed results and has not determined any patient- or injury-related variables linked with treatment failure. The aim of this study is to evaluate the efficacy of RIA bone grafting in lower extremity nonunions.

Methods: A retrospective chart review was conducted over a 10-year period at a Level-I trauma center. 65 patients were identified who underwent RIA bone grafting to address bone deficit or nonunion in the femur or tibia. Seven patients with inadequate follow-up (<12 months) following the grafting procedure were excluded. The main outcome measure was union, as defined by radiographic bridging callus and clinical evidence of union. Failure was defined as the need for a surgical procedure to promote union. Demographic, clinical, injury, and surgical characteristics were recorded. Fisher exact tests were utilized to identify variables associated with treatment failure.

Results: 58 patients underwent RIA grafting, with 38 procedures (66%) to the tibia and 20 procedures (34%) to the femur. 41 patients (71%) had open fractures initially (Gustilo-Anderson Type 1, 3; Type 2, 4; Type 3A, 19; Type 3B, 13; Type 3C, 2). 29 of the 58 fractures (50%) utilized an antibiotic cement spacer and the average delay to grafting following spacer placement was 15 weeks (standard deviation [SD] = 8). The overall failure rate was 16% (9 out of 58 fractures). Univariable comparisons showed no association between sex, smoking status, diabetes, body mass index, vitamin D deficiency, or protein malnourishment and treatment failure. Femoral fracture sites were linked to greater failure rates (30% vs 8% in tibia fractures, P = 0.05). Open distal femur fractures (OTA 33) with bone loss had a failure rate of 43%. The time interval between spacer placement and RIA grafting was comparable among patients with treatment failure and those who went on to union (average of 15 weeks for both groups). No other injury characteristics were correlated with subsequent failure.

Conclusion: Our overall failure rate was similar to reported rates in existing literature. Compared to tibial nonunions, failure of RIA bone grafting was significantly more common in femoral nonunions. In particular, nearly half of open distal femur fractures with bone loss went on to treatment failure. Going forward, alternative bone reconstruction techniques may be warranted in this setting.

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

SCIENTIFIC POSTER #123 Post-Traumatic Reconstruction

Evaluation of Intraoperative Fluoroscopic Techniques to Estimate Femoral Rotation: A Cadaveric Study

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Purpose: The intraoperative evaluation of femoral torsion utilizing fluoroscopy is an inexact science. Several methods have been described in order to prevent postoperative malrotation of femur fractures treated with an intramedullary nail. However, minimal data exist comparing these different techniques with regard to accuracy. We sought to compare different fluoroscopic techniques both for estimating rotation of the uninjured femur, as well as establishing rotation of the injured side utilizing a cadaveric model.

Methods: Measurement of native femoral version via CT was performed in 10 cadavers to yield 20 intact femurs. A transverse osteotomy was created in the diaphysis of each right femur. Four surgeons utilized 3 fluoroscopic techniques to match the rotation of the fractured side to uninjured side. These included matching the lesser trochanter profile (LTP), the true lateral (TL), and neck-horizontal (NH) angle techniques, as previously described. The accuracy of each method was assessed via measurement of the angle subtended by 2 Steinmann pins placed into the femur above and below the osteotomy. By comparing this angle to the angle subtended by the same pins prior to the osteotomy, the accuracy of each observation could be assessed. For the TL and NH techniques, each surgeon also estimated the femoral version of the intact femur.

Results: The absolute mean error in estimating the femoral version of the intact femur using the TL and NH method compared to CT was 8.2° (95% confidence interval [CI] 6.5, 10.0), and 4.4° (CI 3.3, 5.4), respectively. The interobserver agreement between surgeons was 0.69° (CI 0.27, 0.91) and 0.72° (CI 0.39, 0.91) for the TL and NH estimations, respectively. The concordance with CT for the TL estimation ranged from 0.37 to 0.83 and the concordance for the NH estimation ranged from 0.65 to 0.80. The absolute mean rotational error in the fractured femur was 6.0° (CI 4.6, 7.6) for the TL method, 6.6° (CI 5.03, 8.15) for the NH method, and 8.5° (CI 6.5, 10.6) for the LTP method.

Conclusion: The NH method was more accurate in estimating the version of the intact femur compared to the TL technique. In the fractured femur, the mean rotational error observed was similar between the TL, NH, and LTP methods and ranged between a mean of 6° and 8.5°. All techniques were within the acceptable clinical margin of error of rotation after femoral fracture, and we recommend that surgeons utilize the technique with which they are most familiar.

Early Outcomes of Osseointegration in Combat-Related Transhumeral Amputations *Archie Overmann, MD*; Benjamin Kyle Potter, MD; Jonathan A. Forsberg, MD, PhD Walter Reed National Military Medical Center, Bethesda, MD, United States

Purpose: Osseointegration (OI) is the direct attachment of an external prosthesis to the skeleton. These implants are well-suited for patients with combat-related amputations, especially those who do not tolerate conventional socket prostheses. However, transdermal implants are at risk for complications, particularly infection. The Transhumeral Amputee Osseointegration Study (TAOS) is an ongoing clinical trial sanctioned by the U.S. Food and Drug Administration (FDA) to study the safety of the Osseointegrated Prostheses for the Rehabilitation of Amputees (OPRA) implant in transhumeral amputees. The purpose of this preliminary report is to (1) evaluate the frequency and severity of surgical, medical, and mechanical complications; and (2) evaluate the changes in functional ability and pain.

Methods: Under an FDA Early Feasibility Study, we performed 2-stage OI surgery using the OPRA implant. Included patients were transhumeral amputees between 22 and 65 years old who could not tolerate or had poor function with conventional socket prosthetics. Contraindications include concurrent diseases that interfere with wound healing, such as peripheral vascular disease or diabetes. Stage 1 consists of implanting a titanium fixture into the medullary canal and bone graft augmentation of the distal bone. Patients also underwent concurrent targeted muscle reinnervation (TMR) during the Stage-1 surgery. Following a 3-month interval, the distal soft tissue is fashioned into a thin cutaneous flap and a transdermal abutment is attached to the underlying fixture during Stage-2 surgery. We collected preoperative shoulder range of motion, applicable Patient-Reported Outcomes Measurement Information System (PROMIS) modules, and other outcome measures at 3, 6, 12, and 24 months after Stage 2.

Results: Six patients with transhumeral amputations have completed graduated loadbearing rehabilitation, and have increased their prosthetic wear time by an average of 72% from baseline. The 12-month post-Stage-2 PROMIS Pain Interference and Pain Behavior scores averaged 45.2 and 48.9 points, respectively. All patients showed improvement in these modules. 12-month post-Stage-2 PROMIS Upper Extremity (UE) scores averaged 34.8, which was a 1.6-point improvement from preoperative scores. There were no surgical, medical, or mechanical complications, and fixtures remain intact radiographically without evidence of loosening, stress shielding, or infection.

Conclusion: The OPRA system shows promising early results for combat-related transhumeral amputations. Improvements in PROMIS pain scores demonstrate that pain is less of a hindrance on life following OI. Improvements in PROMIS functional scores may indicate that patients achieve more independence with OI compared to conventional prostheses. We also observed a low rate of early complications. These results should be taken with caution as transdermal implants remain in their early stages and warrant further study.

323

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

SCIENTIFIC POSTER #125 Tibia

Delay of Antibiotic Administration Greater than 2 Hours Predicts Surgical Site Infection in Open Lower- Extremity Fractures Erika Roddy, MD; Joseph Patterson, MD; Utku Kandemir, MD UCSF, San Francisco, CA, United States

Purpose: Antibiotic administration, severity of injury, and debridement are associated with surgical site infection (SSI) after internal fixation of open fractures. We sought to validate a time-dependent treatment effect of antibiotic administration.

Methods: Consecutive open fracture patients at a Level-I trauma center with minimum 30day follow-up were identified from an orthopaedic registry from 2013-2017. The primary end point was SSI within 90 days. A threshold time to antibiotic administration associated with SSI was ascertained by receiver operating characteristic curve analysis. A multivariate Cox proportional hazards model adjusted for open fracture type, smoking, and drug use determined the treatment effect of antibiotic administration within the threshold period.

Results: 10% of 230 patients developed an SSI. There was a trend for patients who did not develop an SSI to receive antibiotics earlier than those who did develop an SSI (61 minutes, IQR [interquartile range] 33-107 vs 83 minutes, IQR 40-186) (P = 0.053). Intravenous antibiotic administration after 120 minutes of presentation of an open fracture to emergency department was significantly associated with a 2.7-times increased hazard of surgical site infection (P = 0.033) within 90 days. On subgroup analysis, the treatment effect of antibiotic administration within 120 minutes held for lower-extremity fractures (HR [hazard ratio] = 4.16, P = 0.006). No significant treatment effect was observed for upper-extremity fractures (P = 0.932).

Conclusion: Antibiotic administration greater than 120 minutes after emergency department presentation of an open fracture was associated with an increased risk of SSI. This risk was compounded for lower-extremity fractures.
SCIENTIFIC POSTER #126 Tibia

OTA 2019

Have Infection Rates Following Open Tibia Fractures Changed? A Review of 11,000 Open Tibia Fractures Over 4 Decades Isaac Castillo, BS; Jacob Anthony Heiner, BS; James F. Kellam, MD; Stephen James Warner, MD, PhD

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Purpose: Open tibia fractures can be debilitating injuries with relatively high rates of complications. Since the development of Gustilo and Anderson's open fracture classification 40 years ago, much attention has been focused on methods to decrease infection associated with open tibia fractures with improved soft-tissue coverage techniques, modern fixation methods, and novel antibiotics. The purpose of this study was to review the past 4 decades of open tibia infection rates to determine if modern surgical and medical innovations have improved outcomes.

Methods: A systematic review of the literature was performed to identify published articles that reported infection rates for open tibia fractures. The initial query resulted in 647 articles. After implementing exclusion criteria, 165 articles were included in the final analysis. Studies were grouped into 1 of 4 decades based on the year(s) in which the study took place: 1977-1987, 1988-1998, 1999-2009, or 2010-2018. Demographic data, open fracture classifications, and infection rates were collected from each article. Comparisons were then made between studies in each of the 4 decades.

Results: A total of 11,297 patients were included from the 165 studies with 743 patients in the first decade, 3644 in the second decade, 4678 in the third decade, and 2232 in the most recent decade. There was an overall infection rate of 12.1% over the 40-year period with 1910 Gustilo-Anderson type I open tibia fractures, 2837 type II fractures, 2854 type IIIA fractures, 3224 type IIIB fractures, and 472 type IIIC fractures. Overall, the rate of infection following open tibia fractures did not differ between 1977-1987 (9.45%), 1988-1998 (13.12%), 1999-2009 (14.6%), or 2010-2018 (11.2%).

Conclusion: Much focus has been placed on reducing infections following open tibia fractures considering the significant morbidity and cost associated with this complication. Our data on 11,000 open tibia fractures from 1977-2017 suggest that the rate of infection following open tibia fractures has not changed. Further investigations into methods to reduce infection rates in patients with open tibia fractures, such as improved antibiotic prophylaxis, are warranted.

SCIENTIFIC POSTER #127 Tibia

Resident Autonomy and Tibial Intramedullary Nail Operative and Fluoroscopy Times, Reduction Quality, and Postoperative Complications

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Purpose: Much recent media attention has addressed trainee autonomy at academic teaching hospitals. This study evaluates the complication rate, quality of reduction, operating room (OR), and fluoroscopy time based on the degree of resident autonomy during a singular orthopaedic procedure, tibial intramedullary nailing (IMN).

Methods: 192 consecutive acute tibial IM nails at an academic Level-I trauma center between May 2014 and January 2017 were retrospectively reviewed. Resident autonomy was categorized as the attending present and scrubbed, present but not scrubbed, or available but not present. Demographic data, fracture characteristics, resident postgraduate year (PGY), and operative techniques were collected. Outcome measures were malreduction (sagittal or coronal malalignment >5°), operative and fluoroscopy times, and short-term postoperative complications. Univariate analysis identified factors associated with different levels of attending involvement and with the above outcomes. Multivariate regression was used to assess the effect of resident autonomy on outcome measures adjusting for factors identified on univariate analysis.

Results: Attending physicians were scrubbed for 91 patients (47.4%), present for 87 (45.3%), and available for 14 (7.3%). Greater attending involvement was associated with nondiaphyseal fractures (P = 0.004), overnight procedures (P = 0.007), polytrauma cases (P < 0.0005), and earlier PGY level (P < 0.0005). On multivariate analysis, the degree of resident autonomy was not associated with having any complication (P = 0.151) unlike diabetes (P = 0.032), open fractures (P = 0.004), and open reduction (P = 0.012). Resident autonomy was not associated with angular malreduction (P = 0.632). OTA C-type fractures (P = 0.014) were associated with such malreductions. Resident autonomy was not associated with increased fluoroscopy time (P = 0.179) although suprapatellar nails were associated with an increase of 67 seconds of fluoroscopy time compared to infrapatellar nails (P < 0.0005). OR times were 23.5 minutes shorter when attendings were scrubbed versus present but not scrubbed (P = 0.009). OR times were increased for nondiaphyseal (P = 0.015) fractures and ones requiring an open reduction (P = 0.003).

Conclusion: While resident autonomy was associated with modest increases in OR time, graduated autonomy can allow for surgical training without compromising quality of reduction or increasing complication rates and fluoroscopy times.

SCIENTIFIC POSTER #128 Tibia

Comparison of Infrapatellar and Suprapatellar Approaches for Intramedullary Nail Fixation of Tibia Fractures

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Purpose: There are reports of high rates of malunion with intramedullary nailing through an infrapatellar approach in tibia fractures. Some studies have reported a significantly lower incidence of malalignment using a suprapatellar approach. Traditionally supported in proximal tibia fractures, this has also been reported in distal fractures. The objective of this study is to review all tibia fractures treated with intramedullary fixation and compare the rate of malunion, nonunion, and patient outcome between approaches. We hypothesized that the suprapatellar approach would have a lower rate of malunion and nonunion. Additionally we expected a higher rate of knee pain and lower functional outcome associated with an infrapatellar approach.

Methods: A retrospective chart review of tibia fractures treated with intramedullary nail (IMN) fixation from 2008 to 2018 was performed. Patients were included if they were ≥ 16 years of age and had follow-up of at least 3 months. Tibia fractures were separated into infrapatellar and suprapatellar groups and compared. Primary outcome measurements included incidence of malunion, nonunion, and infection. Patient-Reported Outcome Measurement Information System (PROMIS) physical function (PF) and pain interference (PI) were used to assess outcome.

Results: Of 207 tibia fractures, 101 were treated with an infrapatellar approach and 106 were treated with a suprapatellar approach. The malunion rate using the infrapatellar approach was 20% (n = 20 of 101) compared to 7% (n = 7 of 106) with the suprapatellar approach (P = 0.01). There was a trend of lower malunion in distal tibia fractures treated with a suprapatellar approach when evaluated independently (P = 0.06). There was no significant difference in nonunion or infection. The mean infrapatellar PROMIS PI scores were 62.1 ± 6.6 compared to a significantly lower mean PI score with a suprapatellar approach of 53.5 ± 9.3 (P = 0.01). Subjectively, there was significantly less anterior knee pain associated with a suprapatellar approach (P = 0.01). There was no difference in PROMIS PF scores.

Conclusion: The results suggest that IMN fixation of tibia fractures with a suprapatellar approach has a significantly lower rate of malunion regardless of fracture location compared to an infrapatellar approach. Furthermore, subjectively patients have much lower pain incidence and anterior knee pain following suprapatellar IMN fixation.

SCIENTIFIC POSTER #129 Tibia

External Validation of the Radiographic Investigation of the Distal Extension of Fractures into the Articular Surface of the Tibia (RIDEFAST Study)

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Purpose: Distal tibial shaft fractures are often associated with distal intra-articular tibia fractures (DIAs). The RIDEFAST study previously showed utility of radiographs to rule out DIA using the fracture to plafond (FTP) ratio (length of the fracture/distance to plafond). This study tested the external validity of the FTP ratio to rule out DIA at an independent tertiary trauma center.

Methods: All patients presenting Level-I trauma: 2010-2015) with a distal tibial shaft fracture (OTA/AO 42-A1- 3, 42-B1-3, 42-C1-3, and 43-A1-3) formed our model cohort. A similar cohort at an equivalent second center (2013-2017) formed our validation cohort. Presentation radiographs and CT scans were used to confirm DIA. On both the AP and lateral radiographs fracture length, and the distance from the inferior extent of the fracture to the tibial plafond, were measured. The FTP ratio is dimensionless, negating the effects of magnification and patient size. Our prior receiver operating characteristic (ROC) curve for the FTP ratio and absence of DIA was tested against the validation cohort using simple logistic regression.

Results: 217 patients were identified to develop the model. 56 patients (25.8%) had DIAs. The validation cohort included 146 patients; 41 (28.1%) had DIAs. Logistic regression revealed the FTP ratio on AP films performed better in the validation data set than the initial model yet similar on lateral radiographs. The AP FTP ratio ROC area under the curve (AUC) for DIA was 0.83 (95% confidence interval [CI] 0.78 to 0.88) in the model data set versus 0.86 (95% CI 0.80 to 0.91). The previously established AP FTP cut-off of <0.61 had a 93.8% negative predictive

value (NPV) in our model cohort and a 100% NPV in the validation cohort.

Conclusion: Our results suggest that the established AP FTP ratio <0.61, which traded a 50% reduction in CT scans required for a few missed cases of DIA, is actually conservative and unlikely to miss DIAs. The FTP ratio is an effective and externally validated screening tool to rule out DIA in distal tibia shaft fractures.

Evaluation o	f AP and Latera	al FTP ratio as	a diagnostic test t	o rule out DIA
	AP FTP ratio			
	Cutoff	NPV (%)	DIA Missed (%)	CT saved (%)
Model	<0.22	100.0	0.0	12.0
AUC 0.83	<0.61*	93.8	3.2	52.1
Validation	<0.22	100.0	0.0	11.0
AUC 0.86	<0.62 [‡]	100.0	0.0	31.5
		Later	al FTP ratio	
Model	<0.26	100.0	0.0	17.1
AUC 0.82	<0.56*	93.9	3.7	53.5
Validation	<0.26	100.0	0.0	13.0
AUC 0.82	<0.65 [‡]	100.0	0.0	32.9

*Model cohort optimal threshold based on maximal Youden index.

‡Validation cohort cut-off that maintains 100% NPV.

AUC, Receiver operating characterstic area under curve; FTP, fracture to plafond; NPV, negative predictive value; DIA, distal intra-articular fracture; CT computed tomography

See the meeting app for complete listing of authors' disclosure information.

328

SCIENTIFIC POSTER #130 Tibia

Soft-Tissue Management in Open Tibial Shaft Fractures: A Comparison of Institutional Protocols

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Purpose: Our objective was to compare the results of institutional protocols at 2 high-volume trauma centers with regard to the treatment of soft tissues in the setting of open tibial shaft fractures.

Methods: This is a retrospective review at 2 high-volume Level-I trauma centers of all open tibial shaft fractures (OTA 42) identified using a prospectively and retrospectively collected fracture database over a 6-year period.

Providers at Site 1 advocate for attempted acute primary closure while those at Site 2 encourage repeat debridement and delayed coverage for wounds not easily closed. Patient demographics, injury, and treatment characteristics were recorded. Primary outcome was 90-day wound complications including superficial infection, deep infection, and wound dehiscence. Secondary outcomes included reoperation, infection, nonunion, and amputation rates.

Results: 219 patients were included at Site 1 and 282 at Site 2. Cohorts were similar with regard to patient demographics and comorbidities. Site 1 closed significantly more traumatic wounds at index surgery (78% vs 36%, P <0.05) and required a mean of 1.6 procedures for definitive closure compared to 3.5 at Site 2 (P <0.05). No differences were seen in complication, reoperation, nonunion, or amputation rates (Table 1).

Conclusion: Attempted acute closure of open tibial shaft fractures results in a lower number of planned secondary procedures, although conclusions may be limited by injury characteristics not accounted for. No difference was seen in 90-day wound complications, return to operating room, nonunion rates, and need for amputation between Sites 1 and 2. Providers should consider either acute closure or delayed coverage based on comfort level and institutional preferences without concern that the decision at the time of index surgery will lead to an increased risk of complication.

	Site 1	Site 2	p-value
% Closed at index surgery	78%	36%	p < 0.05
Mean number of procedures for closure	1.6	3.5	p < 0.05
% Closed without coverage (flap, STSG)	82%	38%	p < 0.05
% 90-day wound complications	8.7%	7.9%	p = 0.87
% Returned to OR for wound complication	8.1%	7.9%	p = 0.59
% Non-unions (of total patient number)	9.1%	7.1%	p = 0.40
% Amputation	8.8%	8.5%	p = 1.0

Table 1: Comparison of clinical outcomes between Site 1 and Site 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.

SCIENTIFIC POSTER #131 Tibia

Clinical Outcomes Rollowing Intramedullary Nailing of Periarticular Distal Tibia Fractures

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Purpose: With increases in the use of intramedullary nail (IMN) fixation of distal tibia fractures, including periarticular fractures, the objective of this study was to evaluate outcomes of distal tibia fractures following IM nailing. We hypothesized that there would be a higher incidence of ankle arthrosis in fractures with articular involvement. Further we expected that intra-articular fractures would be associated with increased rates of nonunion, malunion, and infection.

Methods: A retrospective chart review of 280 tibia fractures treated with IMN fixation was performed. Of these, 134 fractures were located in the distal-third tibia. Fractures with displacement of the articular surface were treated with additional independent fixation, typically screw fixation. Outcome measures included ankle arthrosis, malunion, nonunion, and infection. These outcomes were compared between distal tibia fractures with and without intra-articular extension.

Results: All fractures (n = 134 of 134) were treated with IMN fixation. Intra-articular extension was present in 36% of fractures (n = 48). There was a 2% (n = 1 of 48) ankle arthrosis rate in the intra-articular group and none in the extra-articular group. There was a 17% (n = 8 of 48) nonunion rate in periarticular fractures, which was not significantly higher than the 11% (n = 9 of 86) nonunion rate in extra-articular fractures (P = 0.18). Similarly there was no significant difference in the incidence of infection in the intra-articular group with 8% (n = 4 of 48) versus 4% (n = 3 of 86) in the extra-articular group (P = 0.25). Malunion was present in 10% (n = 5 of 48) of intra-articular fractures, whereas malunion of extra-articular distal shaft fractures was 20% (n = 17 of 86) (P = 0.01).

Conclusion: This study suggests that IMN fixation of intra-articular distal tibia fractures is an acceptable fixation option. There is no significant increase in nonunion, infection, or ankle arthrosis when intra-articular distal tibia fractures are treated with IMN fixation. The lower rate of malunion following IM nailing of intra- articular fractures potentially is due to indirect shaft reduction with articular reduction and fixation.

SCIENTIFIC POSTER #132 Tibia

Patient and Treatment Factors Associated with Opioid Usage After Tibial Shaft Fracture Fixation

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Purpose: Opioids are often a part of multimodal pain management after operative treatment of tibial shaft fractures. To date, there is no established baseline for narcotic consumption after operative fixation of tibial shaft fractures. This study sought to establish a baseline of inpatient oral morphine equivalents (OMEs) for these injuries and identify factors that influence rates of consumption. Our hypothesis was that younger patients, male sex, and lack of local regional anesthesia (LRA) would be associated with higher inpatient opioid consumption.

Methods: All patients undergoing tibial shaft fracture fixation (CPT codes 27758 or 27759) at a single, Level-I, academic medical center between July 1,2013, and July 1, 2018, were identified (n = 491). Age, sex, race, body mass index (BMI), smoking status, Charlson-Deyo comorbidity score, LRA usage, and prevalent comorbidities were incorporated into multivariable linear regression models of inpatient OME consumption.

Results: Patients consumed a mean (standard deviation) of 40.5 (31.4) OMEs per 24-hour period after surgery. Younger age (P <0.001), male sex (P = 0.007), increased BMI (P = 0.012), smoking (P <0.001), lack of LRA usage (P = 0.019), and psychiatric diseases such as depression and psychosis (P = 0.020) were associated with increased opioid consumption in multivariable models. LRA usage was associated with the largest reduction in opioid consumption (13.3 OMEs/day) while smoking was associated with the greatest increase in opioid consumption (16.3 OMEs/day).

Conclusion: This study is the first to establish a baseline of inpatient opioid consumption for operatively treated tibial shaft fractures and to identify factors associated with increased usage. Younger age, male sex, increased BMI, smoking, lack of LRA usage, and psychiatric diseases were associated with increased narcotic consumption. Smoking and lack of LRA

usage had the largest impact on OME usage. This study is a pivotal step in the effort to predict and reduce narcotic consumption after tibial shaft fractures. Table 1: Patient and treatment factors associated with opioid usage per day from date of surgery to discharge. Individual comorbidities were tested in multivariable models that incorporated age, sex, race, BMI, smoking, Charlson-Deyo comorbidity subscore, and LRA. Pvalues less than 0.05 in multivariable models were considered significantly associated with the outcome.

Patient and treatment factors	Mean (SD) or proportion (%)	Mean adjusted additional OME's (95% CI, p-value)
Opioid consumption (OME's)	40.5 (31.4)	n/a
Age (years)	43.7 (19.3)	40 Transfer (\$ 40 Tra
Female sex	175 / 491 (35.6%)	
Calicasian race	244 / 491 (49.7%)	4 (-1.5, 9.5; 0.152)
BM1 (kg/m2)	28.5 (7.1)	1157 mil #11.03000111
Current smoker	121/488 (24.8%)	10.3 (10.8, 23.8) <0.001)
Charlson-Deyo comorbidity sub-score	1.1 (2.3)	-0.3 / unit (-1.6, 1; 0.66)
Local regional anesthesia	30/491 (6.1%)	12.51.24.5.22.5.9.819T
Hypertension	107/491 (21:8%)	-1.3 (-9.9, 7.4; 0.77)
Depression or psychosis	102/491 (20.8%)	
Cardiac arrhythmia	94 / 491 (19.1%)	-2 (-9.5, 5.5; 0.61)
Depression	92 / 491 (18,7%)	7.3 (-0.3, 14.9; 0.061)
Fluid and electrolyte disorders	837491 (16,9%)	-1.8 (-10.6, 7; 0.69)
Chronic obstructive pulmonary disease	65/491 (13.2%)	6.5 (-2.4, 15.5; 0.151)
Diabetes mellitus	62/491(12.6%)	2.3 (-7.6, 12.3; 0.65)
Deficiency anemia	62/491 (12.6%)	0.1 (-9.7, 9.8; 0.99)
Obesity	58/491 (11.8%)	3.1 (-6.6, 12.8; 0.53)
Peripheral vascular disease	51/491 (10.4%)	-9.4 (-20.5, 1.6; 0.094)
Drug abuse	49 (491 (10%)	3.8 (-5.6, 13.3; 0.43)
Alcohol abuse	46 / 491 (9,4%)	9,4 (-0.2, 19; 0.056)

SCIENTIFIC POSTER #133 Tibia

Incidence, Predictors, and Fracture Mapping of (Occult) Posterior Malleolar Fractures Associated with Tibial Shaft Fractures

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Purpose: The purpose of this study was to (1) evaluate the incidence of posterior malleolar fractures (PMFs) in patients with tibial shaft fractures (TSFs) using advanced imaging; (2) identify predictors for patients at risk for an (occult) PMF; and (3) describe PMF characteristics to guide "malleolus-first" fixation.

Methods: In a Level-I trauma center, 164 patients were treated with intramedullary nailing for TSFs that underwent low-dose postoperative CT-scans to assess rotational alignment. We did an analysis of advanced imaging for presence of PMFs, and used uni- and multivariate analyses to identify predictors. Qualitative analysis of PMFs was undertaken by fracture mapping. Outcome measures were (1) incidence of PMFs in patients with TSFs as diagnosed on postoperative CT-scans, (2) independent predictors for the presence of PMFs, and (3) PMF patterns.

Results: One in 5 patients with a TSF has an associated PMF (22%), increasing to 1 in 2 in patients with simple spiral fractures (56%). In 25% these fractures were occult. Univariate analysis identified simple spiral and distal third TSFs, proximal third and spiral fibula fractures, and low-energy trauma as predictors for PMFs. Multivariate analysis demonstrated that distal third and simple spiral TSFs were the only independent predictors. Haraguchi

Type I and Bartonicek type IV are the patterns specific to PMFs associated with TSF (Fig. 1).

Conclusion: Half of patients presenting with a simple spiral TSF have an associated PMF. In 1 in 4 these are occult. Additional preoperative CT imaging may be considered in patients presenting with simple spiral distal third TSFs, despite negative lateral radiographs, so that PMFs can be identified and managed with "malleolus- first" fixation. Because the PMFs consist of relatively large posterolateral oblique fragments, they seem excellently suited for AP fixation with lag screws. These lag screws may be aimed slightly oblique with reference to the true sagittal plane, in order to lag perpendicular to the fracture line.



Figure 1. Fracture map of 33 Haraguchi type I posterior malleolar fractures. Twenty-one (64%) entered the tibiofibular joint in the middle third of the fibula incisura, corresponding to Bartonicek type 4 (yellow lines); and twelve (36%) entered the tibiofibular joint in the posterior third of the fibula incisura, corresponding to Bartonicek type 2 (blue lines).

SCIENTIFIC POSTER #134 Tibia

Plate-Assisted Intramedullary Nailing of Gustilo Type 3B Open Tibial Diaphyseal Fractures: Does Retained Adjunct Plate Fixation Affect Complication Rate? *Michael Thomas Stoddart, MBBS;* Khalid Al-Hourani, MD; Michael Kelly, MBBS, MD, FRCS (Ortho) North Bristol NHS Trust, Bristol, United Kingdom

Purpose: Open tibial fractures can present both bony and soft-tissue challenges. A 2-stage orthoplastic approach, using a small fragment plate as temporary internal fixation, encourages adequate exposure of the zone of injury at first debridement. If replaced with a fresh implant at the second stage, the plate can also be used for "plate-assisted nailing" and retained as part of the definitive fixation. We aimed to determine if this retained adjunct plate fixation (RAPF) was associated with an increase in infection and nonunion rates.

Methods: This was a retrospective comparative cohort study of 113 patients, over a 4-year period in a Level-I trauma center. The primary outcome measures were deep infection and nonunion rates. The secondary outcomes were flap failure and overall complications. A binary logistic model was utilized for primary and secondary outcomes. Significance was set at P < 0.05.

Results: Median age was 42.9 years (interquartile range [IQR] 37) with a median follow-up of 1.7 years (IQR 0.9). 79 patients had RAPF as part of their reconstruction. Eight patients (8/113, 7.1%) developed a deep infection (RAPF 6/79, non-RAPF 2/34) (P = 0.548). Six patients (6/113, 5.3%) proceeded to nonunion (RAPF 5/79, non-RAPF 1/34). This was not significant (P = 0.413). There was no significant difference in secondary outcomes between groups (Table 1).

Conclusion: In the context of an orthoplastic set-up, use of retained adjunct plate fixation with definitive intramedullary nailing does not increase the rate of deep infection or nonunion in patients with type 3B open tibial shaft fractures.

Complication	Total n (%)	RAPF n (%)	Non-RAPF n (%)	Р	Adjusted Odds Ratio (95% CI)
Deep Infection	8 (7.1)	6 (7.6)	2 (5.9)	0.548*	1.32 (0.252 – 6.87)
Non-union	6 (5.3)	5 (6.3)	1 (2.1)	0.413*	2.23 (0.251 - 19.84)
Infected Flap Failure	4 (3.5)	3 (3.8)	1 (2.1)	0.651*	1.30 (0.131 – 12.99)
Isolated Flap Failure	1 (0.9)	1 (1.3)	0 (0)	0.699*	0.86 (0)
All Complications	11 (9.7)	8 (10.1)	3 (8.8)	0.567*	1.16 (0.289 – 4.69)

Table 1 - Retained adjunct plate fixation vs removed and complications

*not statistically significant

SCIENTIFIC POSTER #135 Tibia

Defining the Intramedullary Axis of the Distal Tibia Using CT *Brad Michael Askam, MD*; Matthew Morin, MD; Haydn Roberts, MD; David Macknet, MD; *Jason Randall Wild, MD; Madhav A. Karunakar, MD Carolinas Medical Center, Charlotte, NC, United States*

Purpose: With the intramedullary (IM) nail constrained by the isthmus, proper nail end position in distal tibia fractures is important in the prevention of malalignment. The purpose of this study was to describe the IM axis of the distal tibia using CT.

Methods: An analysis of CT of uninjured tibias was performed. Coronal images were oriented perpendicular to the transmalleolar axis (axial view) to simulate a mortise view. The tibial isthmus was identified and a plumb line from the center of the isthmus was drawn (coronal) with measurements performed to identify the IM axis. Sagittal images were oriented perpendicular to the talar body to simulate a lateral view. The tibial isthmus was identified (axial view) and a plumb line from the center of the isthmus was drawn (sagittal) with measurements performed to identify the IM axis. The tibial isthmus was identified to a fraction of plafond width and categorized by quadrant.

Results: 85 lower extremity CT scans from 82 patients (pts) were analyzed. In the coronal plane, the mean IM axis as a fraction of plafond width (0-1, lateral to medial) was 0.34 (range, 0.04-0.71). In the sagittal plane, the mean IM axis as a fraction of plafond width (0-1, anterior to posterior) was 0.49 (range, 0.27-0.74). The IM axis in the coronal plane was found to be in the lateral quadrant in 10 pts (12%), lateral-middle quadrant in 74 pts (87%), and medial-middle quadrant in 1 pt (1%). The IM axis in the sagittal plane was found to be in the anterior-middle in 52 pts (61%), and posterior-middle in 33 pts (39%).

Conclusion: The IM axis of the distal tibia in the coronal plane most commonly intersects the plafond at a point one-third (0.33) the width of the plafond from the incisura. 87% of the measurements fell into the lateralmiddle quadrant in the coronal plane. The IM axis in the sagittal plane fell most commonly in the middle 2 quadrants and was grouped near "center-center," (0.49). These findings continue to challenge the concept of a "centercenter" position for tibial nail end point, especially in the coronal plane.



SCIENTIFIC POSTER #136 Upper Extremity

Predictors of Poor Outcomes in Acute Forearm Compartment Syndrome

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Purpose: There is limited literature risk-stratifying patients with acute forearm compartment syndrome. The primary objective of this study is to identify predictors for poor outcomes in patients with acute forearm compartment syndrome.

Methods: In this IRB-approved retrospective study, we identified 130 patients with acute compartment syndrome of 130 forearms treated with fasciotomies from January 2000 to June 2015 at 2 Level-I trauma centers. Poor outcome was defined as a composite variable, including (1) death, (2) limb amputation, (3) persistent neurologic deficit, and (4) contracture. Electronic medical records were analyzed for patient-related factors and treatment-related factors. Bivariate analyses were used to screen for variables associated with poor outcome, and explanatory variables with a P value below 0.05 were included in our multivariable logistic regression analyses.

Results: 43 out of 130 patients (33%) with acute forearm compartment syndrome had poor outcomes, including 5 deaths, 5 limb amputations, 21 persistent neurologic deficits, and 31 contractures. Multivariable logistic regression analyses showed that elevated serum creatine kinase at presentation (P <0.05) was associated with poor outcomes in patients with acute forearm compartment syndrome. ROC (receiver operating characteristic) curve analysis showed that a serum creatine kinase cutoff of 300 U/L yields 92% sensitivity and a serum creatine kinase cutoff of 10,000 U/L yields 95% specificity for poor outcomes in acute forearm compartment syndrome.

Conclusion: Serum creatine kinase level above 300 U/L is a sensitive predictor and above 10,000 U/L is a specific predictor of poor outcomes in acute forearm compartment syndrome. Elevated creatine kinase levels above 300 U/L is a useful screening test for the highest risk patients with acute forearm compartment syndrome. Levels above 10,000 U/L may play a role in informed consent and counseling regarding expectations.

Table: Sensitivity, specificity, and AUC of serum creatine kinase on presentation as a predictor of poor outcome in acute forearm compartment syndrome			
Serum creatine kinase level (U/L) cutoff	Sensitivity (%)	Specificity (%)	AUC (%)
100	97	4	41
300	92	35	58
1,000	65	73	70
3,000	54	82	71
10,000	43	95	74
30,000	30	98	70
100,000	5	100	61

How Quickly Do Patients Return to Function After Nonoperative Treatment of Isolated Humeral Shaft Fractures?

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Purpose: Humeral shaft fractures have a high union rate after nonoperative management. While radiographic union has been well documented, the recovery curve has not. The purpose of this study is to characterize the functional recovery of patients treated nonoperatively for isolated humeral shaft fractures using validated patient-reported outcome measures (PROMs).

Methods: Prospective data from patients with isolated humeral shaft fractures who were followed as part of a multicenter trial (Clinical Trials# 01363518) were analyzed. Patients with a radial nerve palsy and those who went on to surgery were excluded. Outcome measures included the Disabilities of the Arm, Shoulder and Hand (DASH), Short Form-36 (SF-36), and visual analog scale (VAS) pain scores as well as return to work status.

Return to function (RTF) for each PROM was defined as the point at which the patient's score was less than the minimal clinically important difference (MCID) from the population normative values. Patient scores were obtained at 12, 26, and 52 weeks.

Results: 80 patients (47 male, 33 female) aged 18-71 years (average = 40) with isolated humeral shaft fractures treated to union comprised the study cohort. 38 (48%) of the injuries were to the dominant arm and 5 (7%) were work-related. Time to RTF for the VAS pain was 12 weeks, the SF-36 was 24 weeks, and the DASH was 52 weeks from injury. At 24 weeks from injury, 50 patients (62%) returned to work in some capacity.

Conclusion: The recovery from nonoperative management of an isolated humerus fracture is gradual, with pain improving for the first 3 months and DASH requiring 1 year. Patients should be counseled about the lasting consequences of this injury so they may set realistic expectations and modulate functional demands.

SCIENTIFIC POSTER #138 Upper Extremity

OTA 2019

Outcomes of Conservative Management of Humeral Shaft Fractures *Cezary Kocialkowski, MBBS Musgrove Park Hospital, Taunton, United Kingdom*

Purpose: The outcomes of conservatively managed humeral shaft fractures, using a humeral brace, were reviewed in our department; the aims of the study were to identify the proportion of humeral shaft fractures, which were treated successfully with the brace, and to identify the rate of nonunion or delayed union.

Methods: All patients who had sustained a humeral shaft fracture over the past 5 years were identified using an electronic patient database. Medical records and radiographs were reviewed to determine what proportion of patients were treated conservatively with the humeral brace, obtain demographic details, as well as assess fracture pattern and outcome of treatment.

Results: In total there were 66 patients with humeral shaft fractures managed conservatively over the study period. The mean patient age was 63.5 years and 60.5% of patients were female. 77.5% of fractures were sustained following low-energy injuries, 9.5% were sustained following medium-energy injuries, and 13.5% high-energy injuries. The fracture pattern was spiral in 57.5% of cases, transverse in 41.5% of cases, and comminuted in 1% of cases. The mean time to immobilization in the brace was 11.9 weeks. When fracture union occurred this was at a mean 12.9 weeks. There were 3 cases of established nonunion (4.5%) and 20 cases of delayed union (30.3%), of which 18 patients underwent surgical fixation. Risk factors for developing a delayed or nonunion included transverse fracture pattern (1.3 relative risk [RR]), high-energy injury (2.5 RR), male gender (1.3 RR), and increased fracture displacement or angulation.

Conclusion: Our study has demonstrated that although conservative treatment of humeral shaft fractures is an acceptable treatment modality there is a significant rate of delayed or nonunion. Patients at increased risk of this with high-energy and displaced transverse fractures should therefore be considered for primary surgical fixation.

SCIENTIFIC POSTER #139 Upper Extremity

Are All Fracture Dislocations of the Elbow the Same? Leah Gonzalez, BS; Charlotte N. Shields, BS; Philipp Leucht, MD; Sanjit R. Konda, MD; Kenneth A. Egol, MD NYU Langone Medical Center, New York, NY, United States

Purpose: Fracture-dislocations of the elbow are unstable injuries that typically result in poor outcomes, such as limited range of motion, stiffness, and long-term pain. The Monteggia fracture-dislocation is classically described as a fracture of the proximal ulna in conjunction with a radial head dislocation. The "terrible triad" fracture-dislocation is typically characterized by posterolateral elbow dislocation, coronoid fracture, and radial head or neck fracture. Monteggia and terrible triad fracture-dislocations are complex injuries that require operative fixation and careful management to ensure the best possible result. This study seeks to compare complications and patient outcomes associated with these 2 fracture types.

Methods: A retrospective chart review of all adult patients treated by 1 of 3 orthopaedic traumatologists at a major academic center for operative fixation for either a Monteggia or a terrible triad fracture between July 2007 and October 2018 was performed. Data collection included demographics, patient-reported pain and stiffness, range of motion, presence of contracture, nerve injuries, nonunion, and reoperation. Binary and linear regressions were used to compare these 2 fracture patterns in IBM SPSS.

Results: 104 patients, 59 Monteggia and 45 terrible triad, who had complete follow-up and radiographic imaging available were reviewed. Elbow contractures requiring operative release were more commonly associated with terrible triads (P = 0.010). Additionally, the incidence of nonunion was significantly greater in Monteggia fractures compared to terrible triads (P = 0.036). Both groups had similar rates of persistent pain, reoperation, and ultimate range of elbow motion in flexion, extension, pronation, and supination (P = 0.770, P = 0.935, P = 0.579, P = 0.635, P = 0.728, P = 0.855). The mean final range of motion in the Monteggia group was 12.7°-126.9° and pronation to supination 76.7°-69.5°. The terrible triad group was similar at 16.1°-124.4° and pronation to supination of 74.6°- 67.4°. The overall complication rate was 34.5% in Monteggia lesions and 47.8% in terrible triad injuries.

Conclusion: Monteggia and "terrible triad" elbow fracture dislocations are complex elbow injuries that result in loss of elbow extension. Each pattern is associated with specific, and distinct, complication profiles. A Monteggia fracture-dislocation portends a higher risk of nonunion, while the terrible triad makes contracture more likely. Despite their unique complications, both patterns ultimately have high rates of reoperation as their unique complications are both indications for operative repair. Patients should be appropriately counseled on the complication profile of their unique injury pattern.

SCIENTIFIC POSTER #140 Upper Extremity

Comparison of Surgical Fixation versus Nonoperative Management of Closed Geriatric Olecranon Fractures

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Purpose: Operative versus nonoperative management of geriatric olecranon fractures is controversial. Recent comparative Level-I evidence suggests unacceptably high complication rates in operatively treated olecranon fractures when compared to nonoperative management in patients 75 years or older. Therefore, the primary purpose of this study was to compare complication rates between operative versus nonoperatively managed geriatric patients with closed olecranon fractures. Overall cost between the 2 groups was also analyzed as a secondary outcome.

Methods: In a population-based study, we searched a private payer insurance database using diagnosis codes to identify patients over 75 years of age who presented with a closed fracture of the olecranon. Patients were divided into 2 cohorts based on codes for open reduction and internal fixation or closed treatment. The occurrence of a complication within 1 year was determined, including malunion, infection, debridement, revision surgical fixation, ulnar nerve injury, and conversion from nonoperative to operative management. Cost data from the payer perspective, including facility fees, physician fees, physical therapy, and clinic visits, were analyzed to compare total cost between the 2 groups. Prior to our database search, a power analysis was conducted based upon the complication rate profile recently published in a prospective randomized controlled study comparing operative and nonoperative management of geriatric olecranon fractures. We determined that the minimum sample size required to detect a 10% decrease in complication rate from the recently cited rate of 82% was 199 patients managed with surgical fixation. Differences in complication rate between groups were analyzed using a Fisher exact test with statistical significance set at $\alpha < 0.05$.

Results: A total of 3040 patients meeting inclusion criteria were identified. Accordingly, there were 1888 (62%) patients managed nonoperatively and 1152 (38%) patients managed with surgical fixation of their olecranon fracture. The overall complication rate for nonoperative management compared to surgical fixation was 10.5% versus 11.9%, respectively, without significant differences between groups (P = 0.26). There was a significantly lower complication rate in surgically managed patients in this study when compared to the recently published complication rate of 82% in the literature (P <0.0001). The average overall cost of surgical fixation was \$8257 ± \$2625 compared to \$2002 ± \$336 for nonoperative treatment.

Conclusion: Despite recent evidence, this study shows that the overall complication rate is similar between surgical fixation and nonoperatively treated geriatric olecranon fractures, although total cost is higher in the operatively managed group.

SCIENTIFIC POSTER #141 Upper Extremity

Long-Term Outcome of Surgery for Isolated Displaced Fractures of the Olecranon *Thomas Carter, MBChB; Caroline D. Cristofaro, BS; Neil Ranjan Wickramasinghe, MBBS; Margaret M. McQueen, MD; Timothy O. White, MD, FRCS; Andrew David Duckworth, FRCS, MBCHB, MSc, PhD Edinburgh Orthopaedic Trauma, Edinburgh, United Kingdom*

Purpose: There are limited data documenting the short and long-term outcome following the operative management of isolated displaced olecranon fractures. Many series include a heterogeneous group of patients and report high metalwork removal rates from centers where metalwork removal is routine. This study documents both the short and long-term outcome following primary operative management of isolated displaced olecranon fractures.

Methods: We retrospectively identified from a single-center trauma database patients who were managed operatively for an isolated displaced fracture of the olecranon over a 4.5-year period. Inclusion criteria included all isolated fractures with >2 mm of articular surface displacement managed with either tension-band wire (TBW) or plate fixation. Comminuted fractures were included. Demographic data, fracture classification, management, complications, and subsequent surgeries were collected. The primary short-term outcome measure was complications. The primary long-term outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score. Secondary outcome measures included the Oxford Elbow Score (OES), pain score, return to function, and satisfaction.

Results: There were 104 patients with a mean age of 62 years (range, 16-97) and 61 (59%) were female. There were 89 fractures (86%) classified as Mayo type IIa (AO/OTA: 2U1 B1). There were 88 patients (85%) managed with TBW fixation. At a mean of 5 months (range, 1-55; IQR [interquartile range] 1-7) following injury the overall complication rate was 45%, with a 33% (n = 34) removal of metalwork (ROM) rate. Of these cases, 6 patients required ROM as part of treatment for wound infection. The mean Broberg and Morrey score was 83 (range, 46-100; n = 63). 41 patients (39%) were deceased at the point of long-term outcome collection. Follow- up was available in 51 patients (81% of available cohort) at a mean of 9.2 years (range, 6.4-10.8) postinjury. The mean DASH score was 3.5 (range, 0-44), the mean OES 46 (32-48), and the median pain score 0 (0-6; IQR 0-1). Median return to sport was 12 weeks (2-78; IQR 8-12) and return to work 4.5 weeks (0-26; IQR 1-4.5). The mean satisfaction score was 9.4/10 (5-10; IQR 9-10). There was no difference in the DASH score between those patients who underwent ROM and those who did not (mean 4.9 vs 2.4; P = 0.71).

Conclusion: This is one of the largest series in the literature reporting satisfactory short and long-term outcomes following the operative management of isolated displaced olecranon fractures. Given the high ROM rate, further work is needed to define the role of alternative fixation techniques that may be associated with lower reintervention rates and cost. Given the high mortality rate in these patients, the role of nonoperative management in low-demand elderly patients should be considered.

SCIENTIFIC POSTER #142 Upper Extremity

Optimal Surgical Approach for the Surgical Fixation of Extra-Articular Humeral Shaft Fractures to Minimize Iatrogenic Nerve Injury

Jared M. Newman, MD; Lee Bloom, MD; Sarah G. Stroud, BA; Bassel Diebo, MD; Steven Alexander Burekhovich, BS; Karen Paltoo, BA; Sebastian Bustamante, BS; Oscar Krol; Neil Vijay Shah, MD, MS; **Emmanuel Illical, FRCSC, MD** SUNY Downstate Medical Center, Brooklyn, NY, United States

Purpose: We sought to identify if surgical approach and lateral intermuscular (IM) septum release affected incidence of iatrogenic nerve injuries when surgically treating extra-articular distal humerus fractures (EADHFs) with metadiaphyseal extension. We suspect there would be lower incidence of iatrogenic radial nerve palsy when a lateral IM septum release was employed with surgical approach.

Methods: All surgically managed humerus fractures were reviewed from 2010-2018 at a single Level-I trauma center to identify all EADHFs (AO/OTA 12 and 13A2/A3). Two cohorts were compared: Group A, 37 patients treated by 6 different surgeons from 2010-2018 with various approaches (anterior, posterior, or intramedullary nailing) but without release of the lateral IM septum; and Group B, prospectively enrolled cohort of 33 patients treated from 2015-2018 by a single surgeon employing lateral IM septum release for every case. Only 2 approaches were employed in this cohort: lateral paratricipital approach for all distal EADHFs and modified anterolateral approach for all proximal EADHFs with diaphyseal extension.

Results: Preoperative nerve palsy rates (total, radial, and ulnar) were similar between Group A (4/37, 10.8%; 4/37, 10.8%; 1/37, 2.7%) and Group B (3/30, 10%; 3/30, 10%; 0/30, 0%); P >0.05. There were no postoperative nerve palsies in Group B. Group A had higher postoperative nerve palsy rates compared to Group B (0%): total nerve palsy (11/33, 33.3% vs 0/31), radial nerve palsy (7/33, 14.7% vs 0/31), and ulnar nerve palsy (6/36, 10.8% vs. 0/34), all P <0.026. Subgroup analysis by approach demonstrated that the total postoperative nerve palsy rate was higher in the Group A anterior approach versus Group B modified anterolateral approach, but only trended toward statistical significance (2/6, 33.3% vs)0%; P = 0.088). Group A posterior approaches had a statistically significantly higher total postoperative nerve palsy rate than group B (10/23, 43% vs 0%; P = 0.002). Group A posterior approaches were subdivided into the following groups: triceps split, olecranon osteotomy, medial and lateral paratricipital, and lateral paratricipital alone. When compared to the Group B lateral paratricipital, Group A triceps split had higher postoperative nerve palsy rates: total nerve palsy (4/6, 66.7%; P = 0.002), radial nerve palsy (3/6, 50%; P = 0.011), and ulnar nerve palsy (2/7, 28.6%; P = 0.06). Group A medial and lateral paratricipital approach had a higher ulnar nerve palsy rate (3/7, 42.9%; P = 0.012).

Conclusion: For AO/OTA 12 and 13-A2/3 fractures, release of the lateral IM septum during surgical fixation of EADHFs decreases iatrogenic radial nerve injury incidence. Lateral paratricipital approach decreases both radial and ulnar iatrogenic nerve injuries when compared to triceps-split approach. Lateral paratricipital approach decreases iatrogenic ulnar nerve injury rate compared to combined medial and lateral paratricipital approach.

The FDA has stated that it is the responsibility 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 Methods for Posttraumatic Elbow Stiffness Caused by Heterotopic Ossification

Christina Freibott, BA; Henrik Constatin Backer; Samuel Galle, MD; Seth Shoap, BA, BS; Melvin Paul Rosenwasser, MD Columbia University Medical Center, New York, NY, United States

Purpose: Heterotopic ossification (HO) is a common complication of surgically treated elbow fractures, which can inhibit range of motion (ROM) and impair quality of life. While there are many treatment methods for HO, there is a lack of consensus as to the best option. We hypothesized that contracture release combined with Botox injection leads to improved functional outcome scores when compared to current treatment methods.

Methods: A retrospective review was conducted of patients who presented to a single surgeon with HO secondary to elbow fracture between 2005 and 2018. 59 patients were identified who met inclusion criteria. Data were classified into 3 groups: contracture release (control – CR), Botox injection with contracture release (Botox

+ CR), and radiation therapy (RT). ROM measurements were obtained, including flexion, extension, pronation, and supination.

Results: Of the 59 patients, 30 (50.8%) received CR, 23 (40.0%) underwent CR and Botox injection, and 6 (9.2%) were treated with RT. Patients in the Botox + CR group had a significantly worse (P <0.01) preoperative ROM than the CR group. There was a significant difference for all groups in pre- and postoperative ROM, with Botox + CR and RT patients having the most significant difference (P <0.005) (Figs. 1 and 2). The CR group had significantly better postoperative pronation-supination motion (P <0.01), whereas the Botox + CR and RT groups did not.

Conclusion: Botox injection with contracture release is an effective method to treat posttraumatic elbow stiffness secondary to HO. The Botox + CR group had a significantly worse (P < 0.01) preoperative ROM, but their postoperative flexion-extension arc of motion was better than contracture release alone (P < 0.01). Further investigation is necessary to compare the efficacy of CR, Botox + CR, and RT, in groups with more similar preoperative ROM measurements.



SCIENTIFIC POSTER #144 Upper Extremity

Comparing Single-Column versus Dual-Column Fixation in the Surgical Management of Extra-Articular Distal Humerus Fractures: A Retrospective Comparative Review of Surgical Technique and Literature

Brian Ford; Charles Conway, BS; Marine Coste, BA; Cameron Reza Moattari, BS; Neil Vijay Shah, MD, MS; Sarah G. Stroud, BA; Lee Bloom, MD; Jared M. Newman, MD; Bassel Diebo, MD; **Emmanuel Illical, FRCSC, MD** SUNY Downstate Medical Center, Brooklyn, NY, United States

Purpose: Traditionally, surgical management of extra-articular distal humerus fractures (EADHFs) with dual- column, dual-plate fixation has been advocated. The use of a single-column construct has since been reported in studies with excellent results. The purpose of this study is compare single-column fixation with a lateral paratricipital (LPT) approach for comminuted EAHDFs to other approach and fixation strategies undertaken at our institution over a 7-yearperiod. We hypothesized that there would be decreased iatrogenic nerve injury with single-column fixation.

Methods: All surgically managed EADHFs (AO/OTA 12 and 13-A2/A3) performed with a posterior approach between 2010 and 2018 at a single institution were identified. Group A was a retrospectively analyzed multisurgeon cohort of 37 patients from 2010-2018 employing various posterior approaches and both single and dual column and/or plate fixation. Group B was a prospectively collected single-surgeon cohort of 34 patients from 2015-2018 using only the LPT approach with lateral intermuscular septum release and single-column fixation. Group B single-column, dual-plate fixation was only employed if the medial column of the humerus could not be anatomically reduced.

Results: In Group B, 14 patients were treated with single-column, single-plate constructs versus 6 with single- column, dual-plate constructs. In Group A, 9 were treated with single-column, single-plate constructs versus 18 fixated with dual-column, dual-plate constructs. Patients in group B had a lower rate of postoperative ulnar, radial, and total nerve palsy (0/20, 0% for ulnar, radial, and total) than patients in group A (ulnar: 6/26, 23.1%, P = 0.033; radial: 4/23, 17.4%, P = 0.070; total: 8/23, 34.8%, P = 0.007). No patients in Group A/B had plate failures or nonunions.

Conclusion: With optimized surgical protocol and meticulous execution, EADHFs can be treated with single- column fixation via a lateral paratricipital approach. Single-column, dual-plate fixation can be employed for comminuted EADHFs that have traditionally been treated using dual-column, dual-plate fixation with no radiographic complications and fewer iatrogenic nerve complications. This is a promising technique that warrants further studies to determine its efficacy compared to more traditional surgical techniques.

SCIENTIFIC POSTER #145 Upper Extremity

Combined Fixation Via Anterior and Posterior Approach for Treatment of Ulnar Coronoid Fracture of O'Driscoll Type ?B

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Purpose: Our objective was to explore the clinical efficacy of combined fixation via anterior and posterior approach for treatment of ulnar coronoid fracture of O'Driscoll type IIIB.

Methods: 38 patients with ulnar coronoid fracture of O'Driscoll type ?B were treated by combined fixation through anterior and posterior approach. The elbow function was evaluated by Mayo Elbow Performance Score (MEPS) at the last follow-up.

Results: 35 patients were followed up for ~10-24 months, and 3 patients were lost. 35 patients obtained bone union in ~8-18 weeks. According to MEPS, 26 patients were excellent, 4 good, 3 fair, and 2 poor. The excellent/good rate was 85.3%. None of the patients had deep wound infection. One patient had elbow stiffness and 1 patient had elbow heterotopic ossification.

Conclusion: Combined fixation via anterior and posterior approach for treatment of ulnar coronoid fracture of O'Driscoll type ?B can have a satisfactory clinical effect because it allows reduction under direct vision, and leads to rigid fixation and early exercise function.



SCIENTIFIC POSTER #146 Upper Extremity

Reducing Unnecessary Fixation of Midshaft Clavicle Fractures *Nicholas Murray, MBChB*; Toby Johnson, MBBS; Iain Packham, FRCS; Mark A.A. Crowther, MBBS, FRCS; Tim Chesser, FRCS North Bristol NHS Trust, Bristol, United Kingdom

Purpose: Recent evidence has shown displaced midshaft clavicle fractures have a nonunion rate of between 10% and 20% and have led to an exponential increase in operations for fixation. However, those who unite with conservative treatment have similar outcomes to those who undergo operative treatment. Protocols to identify those patients who will go on to a nonunion are important, so that scarce health-care resource can be targeted, and patients do not undergo unnecessary surgery. The aim of this study is to report one such protocol.

Methods: A protocol was introduced, where all isolated closed midshaft clavicle fractures were initially managed nonoperatively in a sling. At up to 2 weeks, all patients were reviewed and those who were struggling with their symptoms, or requested fixation, proceeded to surgery with the remainder mobilized as comfortable. All cases treated at 1 center over a 3-year period, with a minimum follow-up of 1 year, underwent case note review. Data collected included demographics, classification of the fracture, timing of surgery, incidence of nonunion or symptomatic malunion, and the requirement for subsequent surgery.

Results: Between January 2015 and December 2017, 613 clavicle fractures were managed through fracture clinic. 347 were middle third (56%), 255 were distal, and 11 medial fractures. Of the 347 middle third fractures, 75% were male, mean age 41 years (range, 16-97) and 225 (65%) were displaced. 41 middle third clavicle fracture patients underwent early fixation, with 8 of these managed out with the protocol and were excluded. A total of 33 (9.5%) were managed operatively through the protocol with the number of days to operation 4-57 with a median of 15 days. 11 patients required late fixation for symptomatic delayed, non-, or malunion; of these 4 had not been managed through the protocol treated initially elsewhere or were polytrauma patients who did not undergo acute fixation. Of the 7 cases included, time to surgery was 193-494 days with an average of 378 days. Six were symptomatic nonunions (1.7%) and 1 was a symptomatic malunion (0.3%). Using the protocol the early operative rate was 10% (33 of 339 patients or 15% of displaced fractures), the later nonunion or symptomatic malunion rate was 2% (3% of displaced fractures). This led to a total operative rate of 12% (18% of the displaced fractures).

Conclusion: A protocol devised and introduced for managing middle third clavicle fractures in this hospital has demonstrated through this retrospective observational study an effective means of managing these injuries. It is cost-effective, reducing the number of patients requiring fixation with a fixation rate of 10% while reducing the rate of symptomatic non- and malunion (2%). Limitations of the study include lack of functional outcomes and potential to loss of follow-up for symptomatic malunions or nonunion. The management pathway is simple and reduces unnecessary surgery and cost. It could be introduced into any orthopaedic outpatient department with ease.

The FDA has stated that it is the responsibility 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 Intramedullary Screw Fixation Biomechanically Superior to Locking Plate Fixation or Tension-Band Wiring in Transverse Olecranon Fractures? A Cadaveric Biomechanical Comparison Study

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Purpose: Controversy exists regarding the best fixation of transverse olecranon fractures with advocates for 3 techniques: (1) tension-band wire, (2) locking plate, or (3) intramedullary (IM) screw. These implants and techniques vary in cost and hardware removal rate; however, little work has compared their ability to compress the fracture gap or survive cyclic loading. The purpose of this study was to compare clinically important mechanical properties in a realistic loading protocol.

Methods: This study used a fresh-frozen cadaveric transverse olecranon fracture model (n = 18 paired arms, average age: 72 years). Fractures were fixed using standard surgical technique by a resident surgeon under direction of the senior author with a 6.5-mm cancellous screw (IM screw), a Synthes 2.7/3.5-mm VA-LCP olecranon plate (locking plate), or IM 0.062 Kirschner wires and an 18-gauge steel wire (tension band). The primary outcome measure was peak compression at the fracture measured by a sensor (Tekscan). The secondary outcome measure was percent failure after potted samples were loaded through the triceps tendon with a custom linear loading device for 500 cycles of 0-500 N at 1 Hz to simulate the force of pushing up from a chair. Differences in mean compression among techniques were compared with analysis (unadjusted) and a multivariable regression model that adjusted for testing order, age, sex, and DEXA (dual-energy x-ray absorptiometry) T-score of samples. A χ 2 test compared the frequency of implant failure among techniques.

Results: There was no difference (P = 0.89) in mean compression across the fracture between IM screw (mean: 162 N, 95% confidence interval [CI]: 27-297 N), locking plate (mean: 125 N, 95% CI: –9-260 N), and tension band (mean: 163 N, 95% CI: 29-298 N). Similarly, no difference in mean compression was seen between techniques in the adjusted analysis (P = 0.82). However, during cyclic loading, 100% of tension-band constructs failed due to implant failure with fracture gap displacement compared to 0% implant failure with either IM screw or locking plate (P < 0.01).

Conclusion: We found no evidence of differences in compression of the fracture site between 3 techniques in cadaveric bone. This contradicts a prior Sawbones study showing greater compression with locking plate versus tension band. No previous study has reported IM screw compression, and we found no advantage in compression. However, this study demonstrated a higher risk of implant failure with tension band compared to the other methods during cyclic loading. These biomechanical data, in addition to the relatively low cost of IM screw compared to locking plate, may argue for clinical benefit of IM screw in treating transverse olecranon fractures.

See the meeting app for complete listing of authors' disclosure information.

POSTER ABSTRACTS

SCIENTIFIC POSTER #148 Upper Extremity

Radiographic Anatomy of the Proximal Ulna to Avoid Inadvertent Intra-Articular Screw Placement

Thomas Githens, DO; Sean T. Campbell, MD; Brett Peter Salazar, BS; Malcolm DeBaun, MD; Lawrence Henry Goodnough, MD; Julius A. Bishop, MD; Michael J. Gardner, MD Stanford University, Palo Alto, CA, United States

Purpose: Fixation of the proximal ulna often employs placing implants adjacent to the olecranon articular margin. Screw placement is typically verified using intraoperative fluoroscopy. Surgeons often rely on lateral imaging to confirm screw safety. Anatomic nuances of the proximal ulna can be misinterpreted during fluoroscopy, potentially resulting in inadvertent intra-articular screw placement. The purpose of this study was to utilize radiopaque wire to map the proximal ulnar articular margin on lateral fluoroscopy and ensure safe extra- articular placement of implants.

Methods: Ten fresh-frozen adult elbow cadaver specimens were obtained. Radiopaque wire was applied to the articular margin of the anterior and posterior facets and the central trochlear ridge of the proximal ulna. Fluoroscopic images were obtained demonstrating the articular facet margins. Radiographic measurements were performed and used to identify relative safe screw zones.

Results: All specimens demonstrated marked extension of the ulnar and radial facets dorsal to the central trochlear ridge. The ulnar facets extended further dorsally than the corresponding radial facets. The dorsal extent of the posterior and anterior ulnar facets from the central trochlear ridge averaged 9.7 mm (range, 7.9-13 mm; standard deviation [SD], 1.5 mm) and 6.2 mm (range, 3.4-9.4 mm; SD, 1.9 mm), respectively. The average footprint of the posterior ulnar facet occupied 44% (\pm 4.9%) of the total ulnar height from the dorsal cortex to the trochlear ridge.

Conclusion: The articular margins of the anterior and posterior facets of the proximal ulna are challenging to identify radiographically. Based on this study, a surgical "at-risk zone" exists within 9.7 mm from the radiographic margin of the central trochlear ridge. Implants placed within this zone have the potential to be intra- articular, particularly if placed about the radial or ulnar periphery. The "at-risk zone" is highlighted in red in the figure.



SCIENTIFIC POSTER #149 Upper Extremity

Homemade 3D Mirror Imaging Models' (HM3DMIM) Utility for Surgical Treatment of Complex Fractures of Scapula

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Purpose: Preoperative planning using HM3DMIM of the scapula allows more effective diagnosis, reduced improvisation, and simulates the surgical procedure. We describe a new methodology, through a Do It Yourself (DIY) process, from the initial diagnosis until the final plates premodeling, analyzing advantages and potential drawbacks.

Methods: We report the case of a 54-year-old male suffering from a floating shoulder. The CT study showed a double disruption of the shoulder's suspensory complex, sustaining a clavicle fracture (15.2C) associated with a complex fracture of the scapula (F1 B [lm]). Segmentation of the healthy scapula was performed and its mirror image was obtained, by inverting the x-axis, using image processing software (Osirix). The study was exported in STL format obtaining a 3-dimensional (3D) mesh that was repaired by software (MeshLab). HM3DMIM was printed with the Ultimaker 2+ Extended printer using polylactic acid (PLA) for fused deposition modeling, obtaining a tangible model that accurately reproduced the anatomy of the patient's scapula before suffering the fracture. We use the biomodel to select and premold the osteosynthesis implants. Model and plates were sterilized using ethylene oxide. After restoring the clavicular length by osteosynthesis with 1 plate, an extended Judet approach was performed exposing the scapula fracture. Once reducing and fixing the articular surface with 2 cannulated 4-mm screws through the glenoid neck was completed, an indirect reduction of the scapular body fracture was performed using the previously premolded osteosynthesis plates.

Results: The printing time was 8 hours and 22 minutes, and the plastic consumption was 230 g of PLA, so we printed our model for less than \$7 USD. The final plates, with the aid of standard plate-benders, were contoured over the plastic model during 25 minutes. No intraoperative modifications were required. The postoperative CT scan obtained 4 months after the surgery showed complete consolidation, good alignment of the scapula in all the planes, restoration of the native glenopolar angle, adequate joint congruence, and no gaps between plates and cortical bone. After 6 months of monitoring, the patient presented complete glenohumeral mobility, and has reincorporated his work and sports activity without restrictions, which gives him a score of 89 points on the Constant scale.

Conclusion: The use of preoperative planning, by HM3DMIM of the opposite scapula and precontouring plates over them leads to effective achievement of a predefined surgical objective and reduces the inherent risks. Its main advantages include indirect reduction and anatomical adaptation.

SCIENTIFIC POSTER #150 Wrist and Hand

Improvement in Postoperative Pain Control and Length of Stay with Peripheral Nerve **Block Prior to Distal Radius Repair**

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Purpose: Distal radius fractures are common injuries that frequently require surgical fixation. Improved postoperative pain control has the potential to not only improve patient satisfaction but also decrease length of stay (LOS) and thus lower health-care costs. Few studies have looked at the benefits of postoperative pain control with regional nerve blocks prior to distal radius repair. The purpose of this study is to investigate the differences in postoperative pain control and LOS in patients who receive peripheral nerve block versus those who do not prior to distal radius repair.

Methods: We performed a nonrandomized study in which 82 patients undergoing distal radius open reduction and internal fixation (ORIF) from March through August of 2016 were placed into 1 of 2 groups, peripheral nerve block versus general anesthesia only. Two patients were excluded from the study, 1 in each group. The first was excluded from the non-block group due to hospital transfer. The second patient was excluded from the nerve block group due to the patient's request to rest in phase 2. This left a total of 80 participating patients, 37 in the no-block group and 43 in the block group. The decision whether or not to place a nerve block was based solely on surgeon preference. Nerve blocks were performed using either a combination of 0.25% bupivacaine and 1% lidocaine or 0.25% bupivacaine only. We measured postoperative LOS in phase I, total LOS and patient- reported pain level at discharge. Pain levels were reported on a 0-10 numeric scale. The 2 groups were compared using standard t-test analysis.

Results: Patients in the nerve block group showed a statistically significant decrease in postoperative pain at discharge as well as decreased phase I and total LOS. Postoperative pain scores in the block group showed a mean of 0.932 ± 1.981 versus no-block group 3.93 \pm 2.780 (mean difference of 3.0024, P <0.00001). Phase I LOS showed a mean time of 37.27 \pm 12.79 minutes in the block group versus 71.21 ± 33.12 minutes in the no-block group (mean difference of 33.938, P < 0.0001). Total LOS differed between the 2 groups as well with a mean LOS of 72.12 ± 23.45 minutes in the nerve block group versus 109.18 ± 59.48 minutes in the no-block group (mean difference of 37.068, P < 0.0001).

Conclusion: The group of patients who received a peripheral nerve block prior to distal radius repair showed significantly lower pain scores at discharge as well as shorter length of stay. Based on these results we recommend the use of peripheral nerve block prior to distal radius repair for improved postoperative pain and decreased LOS.

Analysis of Radiological Accuracy Among Different Intraoperative Imaging Systems for Screw Fixation in Cervicothoracic Region

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Purpose: The aim of this study was to compare the accuracy of posterior subaxial cervicothoracic fixation using 3 different techniques: intraoperative CT (iCT-AIRO) scanner-guided navigation, 3-dimensional (3D) (O- arm) based spinal navigation, and fluoroscopy based posterior stabilization.

Methods: In the period between August 2007 and October 2018, a total of 495 screws were implanted in 67 patients with cervicothoracic instability who underwent posterior fixation. 163 screws were inserted with the use of the iCT-based spinal navigation (group A), 310 screws were implanted using the O-arm navigation system (group B), while 22 screws were inserted under the guidance of fluoroscopy (group C). Screw positions were evaluated using postoperative CT scans according to the Neo et al. (cervical pedicles) and Gertzbein and Robbins (thoracic) classifications. The screws in the cervical lateral mass were evaluated according to a new classification created by the authors. The assessment of the screw placement was retrospectively done and graded by an independent observer. Accurate positioning was defined then as screws that were correctly placed completely within the pedicle as well as screws with a breach of less than 2 mm or screws that were correctly placed within the lateral mass as well as screws with incomplete perforation of the cortex.

Results: Intraoperative CT-based navigation has permitted a more accurate intraoperative evaluation of the implanted screws and has allowed the immediate correction of misplaced screws. With the use of the iCT, the accuracy rate has reached 97.55% with a much better resolution of the images acquired, while with the O-arm navigation, the accuracy rate has reached 90%. In cervicothoracic posterior stabilizations done with the aid of fluoroscopy, the intraoperative accuracy was not determined and only a final accuracy rate was measured, which reached 90%. The most significant difference in accuracy was in the positioning of cervical pedicle screws. Our results have demonstrated an accuracy of 96% with iCT compared to an accuracy of 64% with the O-arm. The accuracy rates in positioning the cervical lateral mass screws and the thoracic pedicle screws with both the iCT or the O-arm were almost the same.

Conclusion: In subaxial cervicothoracic posterior fixation, especially of pedicle screws, the use of iCT-based spinal navigation has demonstrated higher accuracy rates as well as higher quality images allowing more accurate evaluation than with the O-arm-based spinal navigation or fluoroscopy based systems.

Salvage Procedure for Cut-Through After Surgical Fixation of Trochanteric Fractures with Trochanteric Fixation Nail

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Purpose: Closed reduction and fixation using cephalomedullary nailing (CMN) represents the accepted management of unstable intertrochanteric fractures. Cut-through has been described as a complication associated with the treatment. Although a hip arthroplasty may be the most predictable revision method, a non-prosthetic option can lead to similar results. The objective is to describe a non-prosthetic revision procedure in cases of cut-through.

Methods: We performed a retrospective analysis of our Institutional Registry for Hip Fractures in elderly patients (RIAFC) from January 2000 to June 2017 searching for cutthrough as a failure after unstable intertrochanteric fracture treatment. Age, gender, fractures pattern, fracture reduction (tip to apex score/Garden angle/Cleveland classification), surgical blood loss, and fracture healing during the last follow-up visit were analyzed. The revision procedure was (A) helical blade removal, introduction of structural bone graft (autologous or allograft) as a plug to obliterate the communication to the joint, and a new blade insertion or (B) same as in A but augmenting the blade/head purchase with Polymethylmethacrylate (PMMA). Before the cement insertion, a radiopaque solution was instilled to ensure lack of joint leakage.

Results: We evaluated 1616 patients. 16 of them presented a cut-through complication (1%). 10 of them were females with an average age for all of 84 years. In 14 cases the fracture was 31A2 and in 2, 31A3. Six patients had a Garden angle associated with a bad reduction. Four patients had their blades inserted in a dangerous zone according to Cleveland's. Blood loss had an average of 3.6 points of hematocrit declination. One patient denied an implant revision and opted for a total joint replacement. In 4 of the patients, the procedure A was done; 2 of them had a new failure and a joint arthroplasty was performed. In the B group, only 1 patient needed a revision to a total hip. The other 10 patients healed uneventfully and did not need any further intervention.

Conclusion: Cut-through revision after fixation of unstable intertrochanteric fractures treated with CMN by blocking of the joint communication and augmenting the head blade purchase with PMMA is a safe and minimally invasive procedure, generates low blood loss and rate of complications, and allows bone healing preserving the native joint.

Trabecular Metal Cup-Cage Construct in Immediate Total Hip Arthroplasty for Osteoporotic Acetabular Fractures: A Radiostereometric Analysis Study

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Purpose: The management of comminuted, displaced acetabular fractures in the elderly osteoporotic population remains a significant treatment challenge. Advocates of immediate total hip arthroplasty have presented a number of differing technical solutions. Achieving primary stability of the acetabular cup without early migration is challenging and there is no current consensus on the optimum method of acetabular reconstruction. We present clinical results and radiostereometric analysis (RSA) of trabecular metal (TM) cup-cage construct reconstruction in osteoporotic acetabular fractures treated with immediate total hip arthroplasty without acetabular fracture fixation.

Methods: Between 2011 and 2016, 21 acetabular fractures underwent acute total hip arthroplasty with a trabecular metal cup-cage construct. Patient, fracture, and surgical demographics were collected. Patients were followed for a minimum of 24 months. Clinical and patient-reported outcome measures were collected at regular postoperative intervals. RSA was used to measure superior migration and sagittal rotation of the acetabular component.

Results: 13 fractures were classified as anterior column posterior hemitransverse, 2 anterior column, 2 transverse, and 4 associated both-column acetabular fractures. Complications included 1 case of trochanteric fracture, a transient foot drop, and a deep infection. Mean Harris hip scores at 24 months was 79 (range, 33-98). The mean proximal migration of the acetabular components at 24 months was 0.91 mm (range, 0.09-5.12) and mean sagittal rotation was 0.52 mm (range, 0.03–7.35).

Conclusion: TM cup-cage reconstruction of acetabular fractures requires a single approach and provides cup stability allowing immediate full weight bearing. To our knowledge this is the first study to accurately measure cup stability following total hip arthroplasty for acetabular fractures. Our promising early clinical and radiological outcomes, assessed by RSA, suggests that this technique may be an alternative to a fix-and-replace construct and other immediate arthroplasty options for acetabular fractures in osteoporotic bone.

Fragment-Specific Fixation Technique Using 2.7-mm Variable-Angle Locking Compression Plates for Comminuted Posterior Wall Acetabular Fractures: A Novel Surgical Technique

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Purpose: The purposes of the study were to introduce a fragment-specific surgical fixation technique using multiple 2.7-mm variable-angle locking compression plates (VA LCPs) in comminuted posterior wall acetabular fractures and report its clinical results.

Methods: Among the 68 patients, 23 with comminuted posterior wall factures with \geq 3 fragments in the CT scan and no column involvement with a minimum follow-up duration of 12 months were enrolled in this study. We evaluated the clinical results after the treatment of comminuted posterior wall acetabular fractures via the fragment-specific fixation technique using 2.7-mm VA LCPs retrospectively.

Results: The average duration of follow-up was 26.8 months. Anatomical reduction was achieved in 18 patients. Imperfect reduction was achieved in 5 patients. 22 patients achieved fracture union and 1 patient underwent revision surgery due to acute postoperative infection. There were no complications, including loss of reduction, fixative failures, sciatic nerve palsy, heterotopic ossification, and early posttraumatic arthritis among 22 patients. The average functional outcome was measured as "very good".

Conclusion: Fragment-specific fixation technique using 2.7-mm VA LCPs for comminuted posterior wall acetabular fractures could be an acceptable alternative means of surgical fixation.



The GERtality Score: A Feasible and Adequate Tool to Predict Mortality in Geriatric Trauma Patients

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Purpose: A large number of prediction models and subsequent outcome scores for trauma mortality have been developed over the last decades. However, feasible scoring systems for the severely injured geriatric patient are lacking. Therefore, the aim of this study was to develop and validate a scoring system for the prediction of mortality in severely injured geriatric trauma patients.

Methods: The German Trauma Registry (TR-DGU) was utilized and all geriatric individuals (\geq 65 years) admitted between 2008 and 2017 with an ISS \geq 9 were included. Patient and trauma characteristics as well as diagnostics, therapy, and outcome data were gathered. Initially, data were dichotomized and thereafter the specific odds of all variables for mortality were calculated. Relevant variables were added to the novel GERtality scoring system. Subsequently, this score as a sole predictor for mortality was validated by conducting a receiver operating characteristic (ROC) curve analysis and comparison with the Geriatric Trauma Outcome Score and the RISC-II (Revised Injury Severity Classification) Score.

Results: A total of 58.055 trauma patients with a mean age of 77 years were included. Based on the univariable analysis, the following 5 variables were included in the GERtality-score: age \geq 80 years, PRBC (packed red blood cells) transfusion requirements in the time from admission to ward, ASA (American Society of Anesthesiologists) score \geq 3, GCS (Glasgow Coma Scale) \leq 13, and AIS (Abbreviated Injury Scale) in any body region \geq 4. For every positive variable in an indexed patient, the score ads up 1 point. So, the maximum GERtality-score was 5. A mortality rate of 72.4% was calculated in patients with a maximum GERtality score. Mortality rates of 65.1% and 47.5%, respectively, were encountered in patients with a GERtality scores of 4 versus 3. The area under the curve (AUC) found by the ROC curve analysis of the novel GERtality score was 0.803, whereas the Geriatric Trauma Outcome Score had an AUC of 0.784 and the highly complex RISC-II score resulted in an AUC of 0.879.

Conclusion: The novel GERtality score is a simple and feasible scoring system that enables an adequate prediction of the probability of mortality in severely injured geriatric patients by using only 5 specific parameters. Additional studies on different data sets should be performed to further validate this new scoring system.

OTA 2019

Novel Techniques for Superior Fixation of Patella (34C) Fractures *Jonathan Lenihan, MBBS*; Sonia Ramos Pascual; Pavlos Silvestros; Philip Beak, BA, MBBS; *Anthony William Miles, PhD; Alex Trompeter University of Bath, Department of Mechanical Engineering, Bath, United Kingdom*

Purpose: Patella fractures account for 1% of all fractures. Traditional tension-band wiring (TBW) remains the standard treatment for most patella fractures. Complications from this surgery include prominence/failure of metalwork, infection, and wound dehiscence. It can be technically challenging to site the longitudinal Kirschner wires (K-wires) without further damage to the quadriceps and patellar tendons. Failure to respect the soft tissues coupled by malposition of the metalwork can lead to complications. We have designed 3 novel techniques for fixation of 34C fractures using the same materials as those for TBW. Principally we have moved the longitudinal K-wires to a crossed position to facilitate ease of insertion and minimize soft-tissue trauma. We also considered the implications of moving the TBW to the sides as opposed to the dorsal surface of the patella.

Methods: An initial proof of concept was undertaken on human cadaveric knees to ensure the configurations could be constructed in a manner representing safe and reproducible surgery. A biomechanical study was then undertaken on porcine patellae. The method was based on published techniques and a specially designed rig was constructed. After dissection 34C fractures were created. One author performed reduction and fixation. Load was applied from an Instron 5965 5Kn Universal Testing Machine. Displacement was measured by a Caldaro S8FLP-10A-10K linear variable displacement transducer (LVDT) fixed on either side of the fracture. Specimens were tested cyclically from 90°-45° at a rate of 6.7 seconds for 100 cycles. The load and displacements (incremental and overall) were measured using Bluehill software and the LVDT recordings. Data were blindly analyzed for all tests that reached 100 cycles. The Initial cycle was defined as the 5th cycle to allow for any slack within the system to be taken up. Incremental displacements/ cycle were derived from the data sets at 3 set points: 5, 50, and 100 cycles and were defined as the Initial, Mid, and Final cycles.

Results: 17 of 22 specimens achieved 100 cycles. Cross K-wire with side TBW performed best with average fracture displacement (AFD) of 0.43 mm under average load of 84.1 N. The cross K-wire with standard TBW achieved an AFD of 0.61 mm under average load of 69.2 N. Standard TBW construct achieved AFD of 1.72 mm under average load of 79.6 N. Longitudinal K-wires with side TBW performed worst with AFD of 1.93 mm under average load of 75.4 N. The final incremental displacement/cycle for both cross K-wire configurations was 0.27 mm compared to 0.41 and 0.60 mm for standard TBW and longitudinal wires with side TBW respectively. This is evidence of the cross K-wire configuration conferring greater stiffness to the fracture gap under loading.

Conclusion: This study shows biomechanical superiority for 2 novel constructs: cross K-wires with standard figure-of-8 or side TBW compared to gold-standard TBW. They require no increase in terms of resources and incur less soft-tissue trauma, which may reduce 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.

Customized Three-Dimensional Printing Bone Plates for Complex Acetabular Fractures: A Biomechanical Testing

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Purpose: The purpose of this study was to investigate the biomechanical properties of 3 internal fixation techniques for complex acetabular fractures. Three-dimensional printing acetabular wing plates is a new minimally invasive surgical technique for complex acetabular fractures; our primary objective was to gather evidence speaking to the biomechanical stability of three-dimensional printing acetabular wing plates methods relative to traditional fixation, with the expectation of biomechanical equivalence.

Methods: Nine pairs of freshly frozen cadaveric pelvises with column acetabular fractures were randomly divided into 3 fixation groups: (A) iliosciatic plates and 2 lag screws; (B) three-dimensional printing (3D- printing) acetabular wing plates and 2 lag screws; and (C) 2 parallel reconstruction plates and 2 lag screws. These constructions were loaded onto a biomechanical testing machine and a force of 10 N/s up to 700 N was applied to vertically transfer the load down the femur to the acetabular fossa. Fracture line displacement and stiffness values of the constructs were measured to estimate their stability.

Results: No plates were broken and no screws were pulled or broken at a force \leq 700 N. When the load force reached 700 N, point 1 showed significant differences in the longitudinal displacement of fractures compared to Groups B and A, and B and C in the same load (P <0.05). No significant differences between Group A and C occurred (P >0.05). The performance of Group B was superior to Groups A and C. The results of point 2 showed no significant differences in the longitudinal displacement of fractures in Groups A, B, and C. Point 3 showed no significant differences in the displacement of the fracture line between Groups A and B (P >0.05), both of which were superior to the 2 parallel reconstruction plates and 2 lag screws (P <0.05). The axial stiffness of Groups A, B, and C were 122.4800 ± 8.8480 N/mm, 168.4830 ± 14.8091 N/mm, and 83.1300 ± 3.8091N/mm. Group B was significantly stiffer than A and C (P <0.05). Loads at failure of internal fixation were 1378.83 ± 34.383 N, 1516.83 ± 30.896 N, and 1351.00 ± 26.046 N for Groups A, B, and C, respectively. Group B was significantly superior to Groups A and C (P <0.05). No significant differences were evident between Groups A and C (P >0.05).

Conclusion: Customized 3D-printing acetabular wing plates provide stability for acetabular fractures compared to intraspecific buttressing fixation. Acetabular wing plates effectively fix comminuted quadrilateral region fractures and prevent protrusion of the femoral head.

Evaluation of Functional Outcome of Failed or Neglected Intracapsular Neck Femur Fractures Treated with Valgus Intertrochanteric Osteotomy Using a Double-Angle Blade Plate

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Purpose: Failed surgery of intracapsular neck femur fracture or a neglected presentation in young adults presents a unique dilemma to trauma surgeons. Every effort points toward preserving the head but the modalities available are difficult and results not standard. We evaluated the role of valgus intertrochanteric osteotomy with a 120° double-angle blade plate in such cases and in cases with delayed presentation in young adults.

Methods: Data of all patients between the ages of 16 and 50 years with intracapsular neck femur fractures managed from June 2015 to June 2018 were retrospectively reviewed. All cases with revision surgery for neck femur fractures or delayed cases presenting after more than 3 weeks of injury and managed with 120° double- angle blade plates were included. We treated 21 cases with valgus intertrochanteric osteotomy over the period with an average follow-up of 19 months (range, 6-42 months). The mean age of patients was 29.6 years. There were 4 cases with ipsilateral neck femur and shaft femur, 4 cases of neglected fractures, 5 cases of failure with DHS (dynamic hip screw), and the rest of the cases were managed initially with 3 partially threaded cancellous screws. All patients were managed with 120° double-angle blade plates after removing an intertrochanteric wedge based on the varus angle and ensuring that valgus angle did not increase more than 140°. All cases were evaluated radiologically and clinically and their functional outcome evaluated.

Results: In all 21 cases the fracture went on to satisfactory union after an average of 13.5 weeks (range, 10-20.5 weeks). The average Harris hip score increased from 63.2 points (range, 51-73 points) before surgery to 90 points (range, 79–97 points). All the patients with united fractures were able to sit cross-legged, squat, and do one-legged stance. Pain and limitation of motion improved remarkably. One patient had united fracture of the neck femur but developed avascular necrosis with collapse of femoral head after a period of 18 months.

Conclusion: Valgus intertrochanteric osteotomy is an effective procedure to achieve union in neglected and ununited neck femur fractures in young patients. Double-angle blade plate, because of its morphology, offers the advantage of usage even in cases where previously DHS has been used and the procedure has failed. A mild flexion deformity can also be corrected easily with the help of angle blade plate. In order to avoid medial joint pain of the knee joint, the blade plate was kept 5 mm beyond the lateral border of the trochanter, which helped to lateralize the shaft to its original axis. Double-angle blade plates provide a useful method to salvage young patients with failed neck femur or neglected fractures with very few complications.

DIGITAL CASE PRESENTATION #1

Foot, Ankle, Pilon

OTA 2019

Syndesmotic Reduction Without a Clamp and Without Opening the Joint: Cadaveric and Clinical Studies of an Innovative Elastic Wrap Reduction Tool Daniel R. Schlatterer, DO; Chetan S. Deshpande, MD; Aaron Morgenstein, MD Wellstar at Atlanta Medical Center, Atlanta, GA, United States

Purpose: Syndesmosis malreduction rates approach 50% in patients treated surgically. Furthermore, malreductions have been linked to the medial periarticular clamp (PAC) time position. Tine positioning has numerous positioning points, which is probably part of the reduction dilemma. The purpose of this study was to determine if an elastic ankle wrap would solve the positioning limitations of the PAC by compressing the ankle uniformly. After cadaveric proof of concept testing, 4 acute fibular fractures with syndesmotic injuries were treated operatively with an elastic wrap for reduction, a quadcortical screw for fixation, and postoperative ankle CT.

Methods: A grossly unstable syndesmosis of a fresh frozen cadaveric ankle was prepared at the ankle by a direct 4-cm longitudinal incision over the anterior aspect of the syndesmosis. All ligaments were sectioned sharply with a knife including the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the interosseous ligament for a distance of 7 cm from the ankle joint. Prior to ligament sectioning, a surgical marking pen made marks on the fibula and tibia denoting the fibula's reduced position. This served as the reference point for checking reduction. An elastic bandage was wrapped from the mid-calf to the mid-foot. Then the reduction was checked using an O-arm image intensifier. Next, pressure film was placed circumferentially around the cadaver leg, ankle, and foot. The elastic bandage was wrapped over and around the pressure film in a manner consistent with intention to reduce the syndesmosis. Finally during surgical management of a syndesmosis injury, the elastic wrap was utilized to achieve syndesmosis reduction. A postoperative CT scan confirmed anatomic reduction of the syndesmosis. No clamp was required, including the periarticular clamp.

DIGITAL PRESENTATION

Results: The ankle wrap was 100% successful in reducing the syndesmosis. Postoperative CT in all clinical cases demonstrated syndesmosis reduction. Syndesmosis reduction consistently resulted with the elastic wrap. The wrapping device functions in ways similar to a pelvic sheet or binder donned for hemodynamically unstable open-book pelvis injuries.

Conclusion: An elastic wrap in place of the standard PAC achieves reproducible reductions. The wrapping device appears to function in ways similar to a pelvic sheet or binder donned for open book pelvis injuries in hemodynamically unstable patients . Not since 1939 has there been a study utilizing an elastic wrap as an adjunctive for orthopaedic care . Wrapping the ankle eliminates tine positioning issues and solves a common malreduction issue.

DIGITAL CASE PRESENTATION #2

Knee and Tibial Plateau

OTA 2019

Osteosynthesis of Comminuted Proximal Fibula Fractures Using a Tension-Slide Technique David Cinats, MD; Trevor Stone, MD Royal Columbian Hospital, New Westminster, BC, Canada

Purpose: Comminuted proximal fibula fractures (AO/OTA 4F1B) (Fig. 1A) can defunction the posterolateral corner (PLC) and result in posterolateral knee instability. We describe a tension-slide technique (TST) for osteosynthesis of these injuries with reconstitution of the PLC.

Methods: A retrospective review was performed of the senior author's (T.S.) practice to identify patients with a 4F1B injury and posterolateral instability who were treated with the TST. The technique was performed by using an lateral approach to the knee. The fracture was identified and a #5 FiberWire (Arthrex) was sutured through the fragments and weaved in a running-locked fashion proximal and distal through the PLC soft-tissue structures. A 3.2-mm drill pin from the Arthrex BicepsButton is used to drill the intact fibula cortex. The FiberWire is placed through the BicepsButton and deployed beyond the fibular cortex (Fig 1B). The fracture is reduced and PLC structures tensioned using the TST.

Results: Nine patients (6 males, 3 females) with a mean age of 40 years were treated with the TST. Mean follow-up was 12.4 months (range, 2-24 months) with fracture healing occurring in all patients. Seven patients returned to full activities as tolerated with no posterolateral instability. There were 2 failures (defined by ongoing instability and/or the need for further surgery). One patient required a total knee arthroplasty following a medial tibial plateau fracture malunion. The second patient had a multiligamentous knee injury requiring additional ligament reconstruction.

Conclusion: The TST is novel and effective for osteosynthesis of isolated 4F1B fractures. The restoration of fibular head bone stock with minimal hardware allows for future fibula-based reconstructions if necessary.





DIGITAL CASE PRESENTATION #3

Geriatric Fractures

OTA 2019

Ten Tips for Successful Treatment of Atypical Femoral Fractures *Nisha Crouser, BS; Ryan Blackwell, MD; Jane Han, MD; Carmen E. Quatman, MD, PhD; Laura Phieffer, MD The Ohio State University, Columbus, OH, United States*

Purpose: Atypical femur fractures (AFFs) associated with bisphosphonate use have become an increasingly common problem for the treating orthopaedic surgeon due to the increased worldwide awareness and treatment of osteoporosis. The average postoperative healing time for an AFF ranges from 6 to 12 months, compared with 3 to 6 months for typical femoral fractures. Patients who sustain an AFF often have more medical comorbidities, prolonged hospital stays, and are at higher risk for reoperations and failed union than patients with typical femur fractures. These fractures require complex, specialized management in order to offer the best outcome possible. The aim of this study is to provide a comprehensive review of the 10 most important variables when managing AFFs and suggestions for how they can be incorporated into clinical practice.

Methods: A review of the literature was conducted in order to describe the diagnosis, medical and surgical management, operative pearls, postoperative care, and future directions for AFFs. The available literature was analyzed and 10 clear steps are provided to optimize patient outcomes and reduce treatment failures in this difficult population.

Results: Step 1 is recognizing and diagnosing an AFF. These fractures can be seen in patients with thigh pain alone, low-energy femur fractures, or as impending fractures. Step 2 is to always assess the contralateral femur, as the contralateral side is involved in 28% of cases of AFF within 4 years. Step 3 is optimizing medical management. This can include discontinuing or changing bisphosphonates as well as the early involvement of internal medicine and endocrinology colleagues. Steps 4 through 6 discuss the importance of and recommendations for preoperative planning, implant selection, surgical technique, and technical aspects in the surgical treatment of AFFs. Step 7 recommends treating the AFF as a nonunion on the first attempt as these fractures show prolonged healing times and higher nonunion rates with devastating functional consequences for patients. Step 8 reviews augmentation with biologics and bone graft. Techniques reviewed are reamer-irrigator- aspirator (RIA), bone marrow aspirate, platelet-rich plasma (PRP), and bone morphogenetic protein (BMP). Step 9 involves the postoperative management recommendations for AFFs, including weight bearing, therapy involvement, and frequent clinical and radiographic evaluations. Step 10 discusses future directions for research and management of AFFs.

Conclusion: Atypical femur fractures are difficult injuries to manage; however, outcomes can be optimized through an evidence-based approach to the surgical and medical management of these patients.
DIGITAL CASE PRESENTATION #4

Hip Arthroscopy Following Gunshot Wounds to the Hip Marcus Trotter; Brian Mullis, MD; Janos Paul Ertl, MD Indiana University, Indianapolis, IN, United States

Purpose: Hip arthroscopy is thought to limit soft-tissue dissection, operative time, and overall complications for patients who have a loose body in the hip that would not otherwise require an open approach. However, limited literature exists about hip arthroscopy in treating patients with a gunshot wound (GSW) to the hip. The purpose of this retrospective study is to review a limited series of these cases at a Level-I trauma center with over 30% penetrating trauma rate to determine the safety of this procedure.

Methods: All hip arthroscopies were performed by 2 experienced fellowship-trained trauma surgeons from 2006-2018 at a Level-I trauma center. A total of 50 hip arthroscopy cases were identified by CPT (Current Procedural Terminology) codes. Of the 50 cases identified, 7 patients suffered a GSW to the hip. A chart review was conducted of these 7 cases to determine the frequency and severity of complications for this indication.

Results: All 7 patients were male and African-American with a mean age of 31 years and mean follow-up of 8 weeks. Two patients were lost to follow-up. The most common complications reported for hip arthroscopy such as traction injuries, peripheral nerve injuries (ie, peroneal, sciatic, femoral nerve injuries, lateral femoral cutaneous nerve transection), and pressure wounds to the sacrum were not seen in these patients. However, 5 out of the 7 cases were noted to have poor visualization with arthroscopy. Common reasons for poor visualization were difficult access to the bullet fragments, morbid obesity, hematoma formation, and preexisting arthritis. Of these 5 cases, 2 were converted to open procedures to retrieve the remaining bullet fragments. Three patients developed postoperative hip pain, with 2 of these patients developing radiographic and clinical signs of posttraumatic arthritis. Most significantly, 1 patient developed abdominal compartment syndrome, most likely due to increased pulse pressure over a prolonged operative period. Emergent exploratory laparotomy and abdominal compartment fluid release were performed and the patient had an otherwise unremarkable hospital course.

Conclusion: Hip arthroscopy continues to become more popular for removal of loose bodies as a less invasive procedure with presumed little risk for a trauma patient. However, this limited series suggests there may be a much higher risk of complications with hip arthroscopy for loose bodies following GSW due to poor visualization and extravasation of fluid, with a life-threatening event from one of these cases. Also, 2 of the 7 cases (29%) were converted to an open approach, which suggests the surgeon should be accomplished in both arthroscopic and open approaches to the hip or have the appropriate backup in case a conversion to an open approach is needed.

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

DIGITAL CASE PRESENTATION #5

Upper Extremity

OTA 2019

Application of Loop-Plate Technique for the Fracture of Ulnar Coronoid Process in the Treatment for the Terrible Triad of the Elbow

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Purpose: The goal of reconstruction of terrible triad injuries is to restore sufficient elbow stability to allow early mobilization within a stable elbow arc of motion. This study was conducted to investigate the surgical strategies of loop-plate technique for the fracture of the ulnar coronoid process, and its application value and clinical curative effect in the terrible triad of the elbow joint.

Methods: A retrospective study was conducted on 33 patients who had been treated for terrible triad of the elbow joint from January 2013 to June 2016. There were 21 males and 12 females, 26 to 68 years of age (mean, 38.6 years). Injury causes were fall injury in 21 cases, high-falling injury in 7 cases, and traffic injury in 5 cases. All the patients underwent surgical treatments, which were performed to repair the fracture of ulnar coronoid process, the fracture of radial head, and the lateral collateral ligamentous complex from the deep layer to superficial layer in turn. All the fractures of the ulnar coronoid process were treated with loop-plate technique; the fracture of radial head was fixed with tiny plate, anatomical plate, and hollow screws or replaced with the prosthesis; and the lateral collateral ligamentous complex was reconstructed with suture anchor without the surgical repair of the medial collateral ligamentous complex. All the patients were equipped with an adjustable brace postoperatively and performed the early function rehabilitation of elbow joint.

Results: 33 patients were followed for 18 to 24 months (mean, 20.2 months). All patients got the healing of bony and ligamentous structures. Mayo Elbow Performance Score (MEPS) of the last follow-up was ~55-100 with the average 85.8: elbow function was excellent in 19 cases, good in 8, fair in 3, and poor in 3, giving an excellent to good rate of 81.8%. Elbow stiffness occurred in 2 cases, heterotopic ossification occurred in 3 cases, and superficial infection occurred in 1 case that was healed with the treatment of the anti-infection and wound care. No other severe complications like neurovascular injury, loosening or breakage of internal implants, dislocation of elbow joint, fracture nonunion, and deep infection occurred.

Conclusion: The restoration of the fracture of ulnar coronoid process is the key factor. The loop-plate technique for the fracture of ulnar coronoid process in the treatment for the terrible triad of the elbow can obtain an excellent fixation of the coronoid process, restore the elbow joint stability, early functional exercise, and obtain the satisfactory clinical effects.

DIGITAL CASE PRESENTATION #6

Foot, Ankle, Pilon

OTA 2019

Exposed Fracture Gustilo IIIC, Lower Member, Extremity Salvation, Case Report *José Luis Banuelos Rodriguez, OTR ISSSTE, Culiacan, Sinaloa, Mexico*

Purpose: The main objective of the clinical case treated in the ISSSTE Regional Hospital Dr. Manuel Cárdenas De la Vega is to demonstrate that salvage surgery is possible with a lesion classified as Gustilo IIIC with neurovascular lesion of artery and posterior tibial nerve and to count in its phase of recovery with irrigation of the anterior tibial artery, without complications. Fractures classified as Gustilo IIIC are the ones with the greatest demand since they require multidisciplinary management, prolonged hospital stay, high complication rate, and a poor prognosis for function.

Methods: We present the report of a case, a male patient 40 years of age who suffered highenergy trauma in a car accident by direct mechanism with partial traumatic amputation of the right foot, who was received and explored in the emergency area and upon finding capillary refill and mobility decided to move to surgery for salvage surgery.

Results: The lesion was an exposed Gustilo IIIC fracture with extensive soft-tissue injury, neurovascular lesion of the artery and posterior tibial nerve, rupture of the calcaneus tendon, fibula, debridement, profuse soft-tissue cleansing and external fixation of the fracture, wound closure, as well as cures with the support of a VAC (vacuum-assisted closure) system, taking and application of skin graft, evolving favorably until arthrodesis of tibioastragalina articulation with retrograde nail, achieving at the end of its recovery the bipedal march.

Conclusion: The decision-making to perform salvage surgeries precedes the support in various classifications; the good evolution is striking because the salvage prognosis in this patient was very poor due to posterior tibial neurovascular injury and complex soft-tissue injury. In his recovery, only the blood supply of the anterior tibial artery was counted,

which according to the literature has less relevance than the posterior tibial artery. We demonstrate with this case that it is viable not only as a rescue but also a recovery without complications in short, medium, and long term, being as a sequel to the trauma hindfoot anesthesia due to neurotmesis of the posterior tibial nerve. The patient's satisfaction in freely wandering with the results obtained is the best conclusion.



Posterior Tibial Artery Perforator Flap Series of Cases

Guido Sebastian Carabelli, MD; Franco De Cicco, MD; Jorge Daniel Barla, MD; Danilo Taype Zamboni, MD; Carlos F. Sancineto, MD Hospital Italiano de Buenos Aires, CABA, Argentina

Purpose: The coverage defects in the leg are a difficult problem to face due to the specific characteristics of the anatomic area. In the past different reconstruction alternatives were developed, with the fasciocutaneous perforators flaps being the most frequently used nowadays. The aim of this case series is to present a therapeutic alternative and to describe the results and complications of the posterior tibial artery perforator flap (PTAPF) for the treatment of coverage defects.

Methods: We performed a restrospective review of patients treated with a fasciocutaneous flap, including 12 patients with soft-tissue defects on the anterior face of the leg in whom the surgical reconstruction had been specifically performed with a PTAPF. The most important preoperative variables analyzed were type of defect and the indication for this flap and not another alternative. The intraoperative variables studied were the size of the skin paddle and the rotation degrees of the flap. Lastly the postoperative variables analyzed were the complications defined as venous congestion, partial or total necrosis, and the flap survival.

Results: 12s patient treated with PTAPF were included. The average age at the surgery time was 52 years (range, 29-77). The type of soft-tissue defects suffered by the patients were: 7 patients underwent wound necrosis, 3 patients underwent an active fistula, and 2 patients with soft-tissue defects. In the proximal and in the third half defects we choose to preserve the muscles, performing the PTAPF. Furthermore the aesthetic result was mostly satisfactory. In the distal area, the choice of this flap was due to therapeutic limitations regarding the vascular aspect. Two patients already had a previous sural flap, while the other patient had an injury in the peroneal artery. The remaining 3 patients did not show good perforators at the pulsed Doppler sonography. Summarizing, the flap influence area was of 2 flaps for the proximal third of the leg, 4 flaps for the middle third, and 6 for the distal third. The rotation degree was different according to each case being from 45° to 180°. The average size of the skin paddle was 12 x 5 cm (range, 16 cm x 4 cm). In the postoperative evaluation there were 2 flaps with distress due to congestion, but it resolved in a brief period, a partial failure, and a total failure. The maximum follow-up was 55 months and a minimum of 5 months (average, 18 months).

Conclusion: The posterior tibial artery perforator flap will be considered a relevant option to treat small to medium size defects from the proximal third to the distal third of the leg. It provides tissue similar to the recipient area in thickness, texture, and pigmentation, with little morbidity in the donor site resulting in good clinical and aesthetic outcomes. At the same time, it is used when it is not possible to use a reverse flow sural flap or as a rescue in case such a flap fails.

A Novel Technique for the Treatment of Scapular Body Fractures with Associated Glenohumeral Dislocation Treated with Contoured Oral Maxillofacial Reconstruction Plate

Shain Howard, DO; *Victor Hoang, DO*; *Erik Kubiak, MD University Medical Center, Las Vegas, NV, United States*

Purpose: Scapular body fractures with glenohumeral dislocations are rare injuries that only account for 3% to 5% of all fractures to the shoulder girdle. To date, there are no fragment-specific instrumentation systems that address irregular scapular body fracture patterns. We present a novel technique for the treatment of a scapula body fracture with glenohumeral dislocation utilizing an intraoperatively contoured oral maxillofacial reconstruction plate.

Methods: In this case presentation, a 64-year-old alcoholic male presented to our institution with a 2-week history of atraumatic left shoulder pain and swelling and imaging demonstrating a scapula body fracture with glenohumeral dislocation. The patient was placed in lateral decubitus position; a modified, extensile Judet approach was performed; and a window was utilized through a defect in the deltoid to further expose the fracture anteriorly. The patient was found to have a massive rotator cuff tear that was repaired with #2 FiberWire utilizing a marginal convergence technique. Bone tunnels were created across the clavicle and distal acromial arch and secured with FiberWire to approximate the acromial-clavicular joint. The scapular spine and body fracture were visualized, prepared, and a 2.7-mm oral maxillofacial reconstruction plate was contoured to the entire scapular spine extending out to the tip of the acromion. The plate was fixed with 2.7-mm cortical screws and

reinforced with locking screws. Postoperatively, the patient was non-weight-bearing in a sling for immobilization for 6 weeks. His incision healed well without wound complications or infection and he was sent to physical therapy for 6 weeks.

Results: At follow-up the patient shows maintenance of hardware position and anatomic reduction of the prior fracture.

Conclusion: There is no consensus on the ideal operative technique for scapula fractures and fragment-specific systems are scarce. Our novel technique allows for rigid internal fixation, early mobilization, and 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.

The Use of a Novel Moldable Calcium Phosphate Putty (Montage) for Periarticular **Fractures: Early Clinical Results**

Omar Hammad Atassi, MD; Gennadiy Busel, MD; Guadalupe De La Fuente, MD; David Donohue, MD; Benjamin Maxson, DO; Anjan Rajni Shah, MD; David Timothy Watson, MD; Anthony F. Infante, DO; Katheryne Downes, MPH, PhD; Roy W. Sanders, MD; Hassan Riaz Mir, MD, MBA, FACS *Florida Orthopaedic Institute, Tampa Bay, FL, United States*

Purpose: Metaphyseal voids are commonly encountered with periarticular fractures. Calcium phosphates have been used to provide structural support and promote bony union. Most commercially available calcium phosphates come in an injectable paste form, and their handling characteristics, setup time, and ability to be instrumented can make them challenging in clinical use. A novel moldable calcium phosphate putty (Montage, Abyrx Inc) provides these advantages in its clinical application. The goal of this study is to report on the early clinical results of Montage in managing metaphyseal voids associated with periarticular fractures.

Methods: A retrospective review was conducted on patients >18 years of age with periarticular fractures with an associated metaphyseal void filled with Montage in combination with open reduction and internal fixation. Patients with pathologic fractures or those in which Montage was used in combination with other bone grafts were excluded. Demographics and injury characteristics were collected. Fractures were classified using the OTA classification. Radiographs were reviewed for extravasation into the soft tissue or joint, articular subsidence, and incorporation and resorption of Montage. Charts were reviewed for clinical and radiographic union and wound complications. Descriptive statistics were utilized.

DIGITAL PRESENTATIONS

Results: 41 patients met the inclusion criteria. Fracture distribution was as follows: 23 plateau, 6 pilon, 5 acetabulum, 4 calcaneus, 1 midfoot, 1 olecranon, and 1 distal radius. 25 patients currently have >6-month follow-up. All fractures have united. There were no instances in which the Montage extravasated into the soft tissue or joint. 22 of 25 patients (88%) demonstrated articular subsidence <2 mm. 24 of 25 (96%) showed radiographic evidence of incorporation and partial resorption. There were 2 unplanned surgeries (8%). One patient had an open pilon fracture that underwent debridement and implant removal at 4 months for deep infection, and 1 patient with a tibial plateau fracture underwent debridement with implant retention at 4 weeks for deep infection. Both went on to clinical and radiographic union.

Conclusion: Montage shows excellent efficacy in preventing articular subsidence when used as a metaphyseal void filler with fixation of periarticular fractures. There is strong radiographic evidence of incorporation and partial resorption at early clinical follow-up. The handling characteristics during its application showed no soft tissue or intra-articular extravasation. Early clinical results are promising and further study is warranted.

DIGITAL CASE PRESENTATION #10 Hip and Femur

OTA 2019

Cement Leakage After Augmentation of Intramedullary Cervico-Diaphyseal Nail in a Revision Surgery of a Lateral Hip Fracture

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Purpose: The intra-articular migration of a spiral lamina or screw, of an intramedullary nail (cut-through), is one of the most catastrophic complications in the treatment of pertrochanteric fractures. We present a case of a cut- through, treated with replacement and augmentation of the screw, which was complicated by leakage of cement into the joint.

Methods: An 83-year-old man, who was in the third postoperative month of reduction and osteosynthesis of a lateral hip fracture, presented a cut-through as a complication. A new surgical time was planned, with head screw replacement and augmentation. The presence of intra-articular cement was found in the immediate postoperative period, so a new surgical time and removal of the migrated material was decided.

Results: The patient presented good clinical evolution in the first year of follow-up, without functional limitation or associated pain. In ambulatory radiological controls through this year, no new complications appeared, and the fracture evolved with further consolidation. The bibliographic reports of implant revision and cement augmentation are scarce, and according to our knowledge no complications associated with it are reported.

Conclusion: As far as we know, this is the first case in the literature where a case of cut-through treated with exchange of the screw and augmentation of it evolved into leakage of the cement into the joint.



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DIGITAL CASE PRESENTATION #11 Tibia

Carbon Fiber-Reinforced PEEK versus Titanium Tibial Intramedullary Nailing: A Preliminary Analysis and Results

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Purpose: This study compares a longitudinal cohort of patients with tibial fractures treated with intramedullary nailing, over 2 time periods, using a titanium nail followed by a carbon fiber-reinforced polyetheretherketone (PEEK) nail.

Methods: Tibial fractures treated with intramedullary nailing were reviewed over a 5-year period. In the initial period, titanium nails (TN) were used, while in the later period carbon fiber nails (CFN) were used. All patients were treated by a single surgeon with the same semi-extended, peri-articular technique of nail insertion and followed the same postoperative protocol. Follow-up intervals were 2, 8, and 12 weeks followed by 4-week intervals until fracture healing was verified radiographically. Outcome variables were interval healing rates, knee pain, infection, hardware removal, or barometric pain. Exclusion criteria were skeletal immaturity, neoplasm or an associated peri-articular fracture (pilon, plateau), prior surgery, infection, or nonunion. Cumulative healing rates at each interval were evaluated and analyzed using a Wilcoxon rank sum test while additional variables (ankle/knee pain, removal of hardware, barometric pain) were evaluated and analyzed with χ 2 test.

Results: All patients included were available for follow-up. Out of 56 patients, 26 received CFN and 30 received TN. Healing rates were reported at each time interval. At 8 weeks: TN was 0% and CFN 19%; 12 weeks, TN 17% and CFN 69%; 16 weeks, TN 57% and CFN 92%; 20 weeks, TN 87% and CFN 96%; and 24 weeks, TN 97% and CFN 96% (P < 0.0001 for every interval period except 24 weeks). Each group had 1 infected nonunion in an open fracture that went on to heal with subsequent treatment. There was a trend toward less barometric pain with CFN that did not reach statistical significance (P = 0.065). There were no significant differences with knee/ankle pain (P = 0.109), or removal of hardware (P = 0.269) potentially due to low power of the pilot study.

Conclusion: Tibial fractures treated with a carbon fiber-reinforced (CFR)-PEEK intramedullary nail had a higher rate of early healing compared with a titanium nail with statistically significant improvements between CFN and TN at time periods of 8, 12, 16, and 20 weeks. We believe that this effect is most likely due to the lower modulus of elasticity (which is closer to that of bone) while maintaining structure strength requirements and higher fatigue characteristics found in the CFR-PEEK implants. This unique material and structural technology provides an attractive alternative to current titanium nails. Furthermore, there was a trend toward less barometric pain with CFR-PEEK, which is a commonly noted anecdotal finding with metallic implants. Further study comparing the performance of CFR-PEEK would be beneficial.

OTA 2019

A New Surgical Technique for Fragility Fractures of the Pelvis, Rommens Classification Type?A: Femur Internal Rotation Reduction Method (FIRM) Shingo Okazaki; Masahiro Shirahama, MD, PhD; Ryuki Hashida; Yuka Sugiura; Matsuura Mitsuhiro, MD; Kenjiro Nakama; Hiroo Matsuse, MD; Naoto Shiba, MD, PhD Department of Orthopaedic Surgery, Kurume University School of Medicine, Kurume, Fukuoka, Japan

Purpose: The number of patients with fragility fractures of the pelvis (FFPs) is increasing. Recently, open reduction and internal fixation is performed in the case with large dislocation of Rommens classification Type? A, although percutaneous fixation is performed in the case with a little dislocation. It is the surgery for elderly patients, and the less invasive surgery is preferred for FFPs. We present a surgical technique of femur internal rotation reduction method (FIRM) for fragility fractures of the pelvis, Rommens classification Type?A.

Methods: FIRM is a reduction method to perform repositioning of the fragment with the lateral rotators by internally rotating the femur. In the procedure, the patient is in a prone position and the femur internally rotated. The obturator foramen and teepee view on the fractured side will be reduced in the fluoroscope. In this way, the supra-acetabular bone canal is approximately straightened from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine (AIIS), which makes screw insertion possible. For internal fixation, two 9.0-mm Expedium SAI screws are inserted in both sides from the PSIS to AIIS and are connected with 2 transverse rods. Between October 2017 and July 2018, this treatment was performed in 7 patients with Rommens classification Type?A. We retrospectively analyzed 6 patients whom we could follow more than 6 months. All patients were women, and the average age was 84.3 years. All patients fell from the standing position. This treatment was performed in a mean time of 4 days after the injury and 2 days after admission to our hospital.

Results: The mean operative time was 144 minutes and the mean blood loss was 198 g. All 6 patients achieved bone union and regained their preinjury walking ability. A pressure ulcer occurred in 1 patient and was treated with bedside lavage and negative pressure wound therapy.

Conclusion: Internal fixation using FIRM is a minimum invasive internal fixation method for fragility fractures of the pelvis, Rommens classification Type?A. The patients who underwent this treatment could gain early ambulation and regained their preinjury walking ability.

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A New Orthogonal Plate Configuration in Treating Periprosthetic Proximal Femur Fractures

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Purpose: The increasing number of total hip arthroplasties performed each year, combined with the increased life expectancy of patients, has resulted in a higher incidence of periprosthetic proximal femoral fractures (PPFFs). We present a series of patients with PPFFs who underwent fixation using a distal femur locking plate, spanning the entire femur, combined with an orthogonally positioned, posterior large fragment locking plate. Patients were allowed to fully bear weight immediately postoperatively.

Methods: Following IRB approval, patients who sustained PPFFs and had fixation with a laterally based, distal femur locking plate and a posterolateral plate were included for analysis. Serial radiographs were used to assess fracture healing and implant status. Fracture union was defined as bone bridging at 2 or more cortices on standard radiographs of the femur. Loss of reduction and failure of hardware were documented as well as the need for subsequent procedures and complications.

Results: 11 patients (9 female, 2 male) met inclusion criteria. The mean age was 79.1 years (range, 58-94). All fractures presented as isolated injuries and occurred around total hip prostheses. Eight patients had sustained acute fractures, and 2 patients had nonunions of a previous fracture treated by an outside surgeon. None of the patients were deceased at our follow-up intervals. Seven patients had extended followup with a mean follow-up time of 15.1 months postoperatively. No revisions were required for implant failure. Two patients had postoperative infections requiring irrigation and debridement. All patients with extended follow-up had fracture union and were fully ambulatory without pain at final follow-up.

Conclusion: PPFFs treated with orthogonal plating allow patients to fully weight-bear with minimal concern for fixation failure. Early mobilization in the elderly population may lead to an overall decrease in morbidity and mortality.



Intraoperative clinical photographs and postoperative radiographs

Figure A: Clinical photograph demonstrating the patient in the lateral position.

Figure C: Clinical photograph demonstrating final plate positioning.

Figures D-G: Postoperative radiographs of final construct

Figure B: Clinical photograph demonstrating atraumatic elevation of the vastus lateralis after the iliotibial band has been incised.

Treatment of Tibial Plateau Fractures with a Novel Fenestrated Screw System for Delivery of Bone Graft Substitute

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Purpose: Our objective was to describe the rate of articular subsidence, complications, reoperation, and patient- reported outcomes following surgical fixation of tibial plateau fractures using a novel fenestrated screw for the delivery of calcium phosphate bone graft substitute.

Methods: 34 patients with unicondylar and bicondylar tibial plateau fractures were treated according to the usual technique of 2 surgeons. After fixation, the N-Force Fixation System was placed and used for injection of the proprietary calcium phosphate bone graft substitute into the subchondral void. For all included patients, demographic information, operative data, radiographs, and clinic notes were reviewed. Patients were considered to have articular subsidence if 1 or more of 3 observations were made when comparing postoperative to their most recent clinic radiographs: >2 mm change in the distance between the screw and the lowest point of the tibial plateau, >2 mm change in the distance between the screw and the most superior aspect of the plate, or a decrease in the quality of reduction (excellent, adequate, poor) as determined by an orthopaedic trauma surgeon who was not involved in the surgical care of the patient. Patients were contacted by telephone to complete a 10 question PROMIS (Patient-Reported Outcomes Measurement Information System) Physical Function Assessment. Data were analyzed to determine if there were any identifiable risk factors for complication or subsidence using a Fisher exact test, Mann-Whitney U test, and binary logistic regression.

Statistical significance was set at P < 0.05.

Results: The fractures were classified according to the OTA/AO system as follows: 1 41B1, 1 41B2, 15 41B3, 7 41C1, 4 41C2, and 6 41C3. The mean time from injury to surgery was 15.4 days. One screw was used in 19 cases (55.9%) while 2 screws were used in 15 cases (42.9%). The screws were placed above the raft screws in 5 (14.7%) of cases and below the raft screws in 29 (85.3%) of cases. Patients followed up for a mean of 32.0 weeks (range, 2.1-103.9) and were allowed to weight-bear at 11.8 ± 2.7 weeks. There were a total of 6 complications (17.6%; 5 infections requiring reoperation, 1 other unplanned reoperation) and 4 (11.8%) cases of subsidence. The average PROMIS Physical Function T-Score was 43.67 ± 11.8 among 5 patients. On univariate analysis, concomitant soft-tissue injury was associated with a decreased risk of subsidence (P = 0.039). There were no significant findings on multivariate analysis.

Conclusion: The rate of articular subsidence after fixation of tibial plateau fractures with a novel fenestrated screw for delivery of calcium phosphate bone graft substitute is within the range of subsidence reported in the current literature. An appropriately powered prospective study is warranted to better identify the true rate of subsidence as well as identify risk factors for complication and reoperation.

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DIGITAL CASE PRESENTATION #15 Tibia

Tibial Shaft Fractures Treated with Reduction and Fixation with Carbon Fiber-Reinforced Polymer Nail *Gilbert Ralph Ortega, MD HonorHealth Osborn Trauma Center, Scottsdale, AZ, United States*

Purpose: We reviewed outcomes and complications of tibial shaft fractures treated with reduction and fixation using a carbon fiber-reinforced polyetheretherketone (CFR-PEEK) tibial nail.

Methods: This was a retrospective review of tibial shaft fractures treated with reduction and CFR-PEEK tibial nail from 2016-2018 by a single surgeon at a Level-I trauma center. Patients were identified by CPT code 27759, and fractures were classified according to the OTA Compendium. Imaging was reviewed by a fellowship-trained orthopaedic traumatologist. Patients were treated by a single surgeon using a semi-extended technique while using the same standardized postoperative protocol including allowing patients to be weight-bearing as tolerated and range of motion as tolerated.

Results: 37 patients with 38 tibial shaft fractures treated with reduction and fixation using a CFR-PEEK tibial nail were included. One patient had bilateral tibial fractures. 4/38 (11%) fractures were located at the tibia proximal third, 27/38 (71%) were located at the tibia middle third, and 7/38 (18%) were located at the tibia distal third. 8/38 (21%) were open fractures, and 30/38 (79%) were closed fractures. The patients treated were of an average age of 42 years (range, 17 to 81 years). 10/37 (27%) were female and 27/37 were male (73%). Patients were observed for an average of 28 weeks postoperatively (range, 4 weeks to 18 months). Six patients were lost to follow-up secondary to moving back to their original state. Two patients had an open fracture with a known bony defect that required a planned delayed bone grafting between 3 and 4 months. Of the 31 patients who have had followup, union was observed in 28/28 (100%) of the fractures. The average time to union was 10 weeks (range, 6 to 18 weeks) when including both closed and open fractures. Three of 38 tibia fractures are still in early phase of healing, under 6 weeks, and are not included in calculation of union rate. There were no intraoperative complications in any patients. Early postoperative complications included an infection of a free- flap tissue surgery that was not directly related to a bone infection. This soft-tissue infection occurred in 1 patient and was treated by his plastic surgeon with resolve. Late postoperative complications included 3 patients with hardware impingement from a prominent proximal screw. Two of these 3 patients required a secondary surgery to have 1 screw removed (2/31, 6%), which allowed resolution of their pain. In 1 of the 3 patients, pain resolved between 6 to 12 months and did not require further treatment.

Conclusion: CFR-PEEK tibial nails are an effective treatment in both open and closed tibia fractures with evidence of very low complication rates, high union rates, and early healing. Our data suggest that a CFR-PEEK tibial nail may be a working alternative to other methods of fixation with a low complication rate, high union rate, and earlier healing when compared to other methods of metal fixation.

Pelvis and Acetabulum

OTA 2019

Multidimensional Pelvic Fluoroscopy: A New and Novel Technique for Assessing Safety and Accuracy of Percutaneous Iliosacral Screw Fixation James Chung-Jade Shaw, MD; Joshua Layne Gary, MD; Catherine G. Ambrose, PhD; Milton L. Routt, MD University of Texas at Houston, Houston, TX, United States

Purpose: Assessing iliosacral screw safety using traditional fluoroscopy can be difficult. Postoperative evaluation using CT, although controversial, is an accurate way to assess iliosacral screw placement. Multidimensional fluoroscopy is new technology that generates intraoperative CT-like imaging in axial, sagittal, and coronal planes. This technology is currently used intraoperatively to assess safety and accuracy of percutaneous iliosacral screws. We hypothesize multidimensional intraoperative imaging provides sufficient resolution to ensure safety of screw placement comparable to postoperative CT scan.

Methods: 52 consecutive patients at a Level-I trauma center with posterior pelvic ring disruptions were selected. These patients were treated with percutaneous iliosacral and transsacral screw fixation by a single surgeon using traditional inlet, outlet, and lateral sacral fluoroscopic imaging. Intraoperative multidimensional imaging was then used for all patients after iliosacral screw fixation. All patients received a postoperative CT scan per protocol. The intraoperative multidimensional imaging and postoperative CT scan for each patient were retrospectively reviewed by the treating surgeon and another trauma surgeon. Screws were graded in relation to the sacral neuroforamen using both imaging modalities. Screws that were intraoseous without abutting the neuroforamen were classified as juxtaforaminal. Lastly, screws that intruded into the neuroforamen were classified as intraforaminal.

Results: No iliosacral or transsacral screws were graded intraforaminal seen on intraoperative multidimensional fluoroscopy or postoperative CT scan by either reviewer. All iliosacral and transsacral screw fixation was found to be safe. Intraobserver and interobserver variability existed between reviewers when grading screws to be extraforaminal versus juxtaforaminal. This was not clinically significant as both reviewers agreed that extraforaminal and juxtaforaminal screw position is safe. Multidimensional fluoroscopy was utilized in 3 patients to assess guide pin placement prior to definitive iliosacral screw fixation. Three patients underwent a change in fixation after reviewing intraoperative multidimensional imaging including: reposition of a guide pin that was found to be intraforaminal in bilateral sacral neuroforamen, reposition of an iliosacral screw, and removal of a transsacral screw. There were no immediate postoperative neurological examination changes.

Conclusion: Intraoperative multidimensional fluoroscopy is a new technology not previously studied. By generating intraoperative CT-like imaging, iliosacral screw position and accuracy can be assessed in real time with minimal risk to the patient. This novel technology carries much potential in aiding the treatment of orthopaedic injuries.

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Development of the New Short Femoral Nail for Trochanteric Fractures *Masahiro Shirahama, MD, PhD*; *Shingo Okazaki Kurume University School of Medicine, Kurume, Japan*

Purpose: The role of a short femoral nail for trochanteric fractures is to get the stability of proximal segment and the nail itself. Although there are various implants used for trochanteric fractures, the serious problem of cutout still occurs. Therefore, we developed a new short femoral nail for trochanteric fractures.

Methods: A new short femoral nail for trochanteric fractures can insert 1 lag screw, 1 antirotation screw, and 2 anti-rotation pins into the femoral head. According to the biomechanical test that measures the rotation torque and load resistance by increasing the number of screws and pins, the rotation torque and load resistance increased as the number of screws and pins increase. Inserting 4 screws and pins compared with 1 lag screw, the rotation torque increased up to 468.8%-616.1% and load resistance increased up to 425%. In literature, the femoral neck's most narrow part is 23.8 mm in Japanese, a part becoming largest is set to 23 mm in a new short femoral nail for trochanteric fractures. Therefore, we can use this nail even in Japanese small-sized elderly persons. A new short femoral nail for trochanteric fractures also can insert distal locking screws in cross to stabilize the nail itself. We used this new nail for 24 fractures of 23 cases from 2017 January to 2018 December. Patients included 6 male and 16 female, with the mean age of 81.9 years (range, 27-99). According to the AO classification, 4 patients had a stable type, and 19 had an unstable type.

Results: The average of surgical time was 80 minutes and intraoperative blood loss was 50 mL. All patients can be permitted full weight-bearing walking immediately after operation. The duration of hospitalization was mean of 20.1 days. During the follow-up period of 3 months, there were no complications or cutout. All patients recovered pre-injury function and achieved bone union.

Conclusion: A new short femoral nail for trochanteric fractures can insert 4 screws and pins into the femoral head in the 3 dimensions, have rotational resistance, and non-sliding system. This new short femoral nail can achieve rigid fixation, and it will prevent cutout after fixation of trochanteric fractures.

Use of Acellular Dermal Matrix for Reconstructing Fascial Defects from Both Bone Fractures in the Upper Extremity

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Purpose: Acellular dermal matrices (ADMs) fulfill the niche for a synthetic, integrative biologic substitute that avoids the morbidity, quantity, and quality limitation associated with autologous tissue grafting. We report here a novel surgical technique and 2 case reports for the use of ADM for fascial defects in the extremities. Without repair, these defects can lead to painful muscle herniation. To date we have found no literature reported on this technique.

Methods: We identified 2 patients who underwent removal of hardware after both bone forearm fracture open reduction and internal fixation that necessitated ADM placement for fascial defects identified at the time of surgery. A standard surgical approach was taken for removal of their diaphyseal radius and ulna hardware utilizing the original incisions. After plate and screw removal, fascial defects with resultant muscle bulge were noted. The fascial edges were undermined, and an ADM measured to the defect size was sutured using a 4-0 absorbable monofilament suture in a running simple inlay technique.

Results: Postoperatively patients were placed in a forearm-based short arm splint and maintained non-weight- bearing for 3 weeks postoperatively. At 3 weeks they were transitioned to a custom thermoplastic splint and started on occupational therapy for active range of motion exercises of the wrist and hand until 6 weeks postoperatively, at which time they were weaned out of the splint and allowed to advance weight-bearing as tolerated. At final follow-up both patients were pain-free with no recurrent hernia.

Conclusion: We believe that our technique utilizing ADM provides an innovative and effective solution to this previously unreported problem.



A, B: Ulnar and radial fascial defects after hardware removal C, D: coverage after placement of ADM

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

DIGITAL CASE PRESENTATION #19 Geriatric Fractures

Triangular Titanium Implants for Sacral Insufficiency Fracture John-David Black, MD Kadlec Northwest Orthopaedic and Sports Medicine, Richland, WA, United States

Purpose: Sacral insufficiency fractures are commonly thought to be stable fractures. In some patients, however, the pain of the fracture prevents participation in physical therapy (PT), thus leading to being bedbound, with the potential for increasing morbidity. The purpose of this study is to review the use and utility of unique triangular titanium implants to facilitate early unrestricted weight-bearing in sacral insufficiency fractures (SIFs) that fail conservative management.

Methods: Chart review was performed for 11 patients with OTA 61B1.1 and 61B3.2 fractures treated with surgical fixation using a single cannulated screw supplemented with 1-2 titanium triangular implants after failing conservative measures for at least 24 hours. Patients were allowed immediate weight-bearing postoperatively. Primary outcome measured was time to mobilization out of bed with PT compared to preoperative functional levels. Likewise, patient-reported pain scales 24 hours preoperatively compared to 24 hours postoperatively, and increase in distance traveled with PT prior to discharge were also evaluated.

Results: These 11 patients each were able to stand and work with therapy no later than postoperative day (POD) 1, whereas preoperatively all patients had been bedbound at least 24 hours. All had taken a minimum of 10 steps prior to discharge. Barring 1 outlier, the average increase in steps taken prior to discharge was 17.7 \pm 10.99 feet. Pain scales demonstrated an average pain score decrease of 4.9 ± 0.94 points compared to preoperative evaluation. Average time to discharge was 2.6 ± 1.6 days postoperatively.

Conclusion: Triangular titanium implants used in conjunction with a cannulated screw for sacral insufficiency fractures allow for immediate weigh- bearing. The increased stability of these implants, even in poor quality bone where screws not infrequently back out, facilitates mobility, thus leading to decreased morbidity for patients whose pain prevents active participation in PT. These implants should be considered for supplemental fixation in SIF patients who are unable to actively participate in therapy.

Reconstruction of Complex Scapula Body and Process Fractures with a Locking Mesh Plate Technique

Anthony Jospeh Dugarte, MD; **Peter A. Cole, MD** Regions Hospital, St. Paul, MN, United States

Purpose: Operative fixation in certain scapula variants can be challenging due to factors such as bone loss, comminution, and deforming forces commonly associated with acromion nonunion. We present a novel surgical technique utilizing a variable angle, locking mesh plate (Fig. 1) for complex variants in which the mesh plate is applied to a flat, bony surface. Secondarily, we report functional outcomes, complications, and union rate.

Methods: We retrospectively reviewed consecutive patients from a prospectively collected scapula registry at a Level-I trauma center between 2011 and 2017. 14 of 248 (6.0%) operatively managed patients received mesh plate fixation in which other fixation strategies were thought to have a high risk for failure. Shoulder strength, range of motion (ROM), and Disabilities of the Arm, Shoulder and Hand (DASH) scores were analyzed through descriptive measures.

Results: Nine of 14 patients (64%) patients achieved 1-year follow-up (mean = 13). Two geriatric patients were included in this series. There was a 100% union rate, although 1 patient achieved union after revision of failed fixation. There were no perioperative complications. At final follow-up, mean DASH was 34, mean ROM measures for the injured shoulder versus noninjured shoulder were 77% for forward flexion (FF), 82% for abduction (ABD), and 69% for external rotation (ER). Mean strength measures for the injured shoulder versus noninjured shoulder were 70% for FF, 68% for ABD, and 56% for ER.

Conclusion: Mesh plate fixation can be used safely and effectively to achieve union in complex scapula fractures, even in a geriatric population. In this series, union rate and perioperative complications were acceptable in extreme variants in which other methods of fixation may have been associated with high failure rates.



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

DIGITAL CASE PRESENTATION #21 Pelvis and Acetabulum

Do-It-Yourself (DIY) Workflow to Utilize 3D Printing for Acetabular Fracture Surgery *Bhavin Jadav, MBBS, MS; Mariana Rego, MD; Batur Hayat Flinders Medical Centre, Adelaide, Australia*

Purpose: The use of 3-dimensional (3D) printing in the medical domain has increased exponentially in recent times, with many applications published in the literature such as anatomical models, custom prostheses, and operative guides. However, few studies have characterized the clinical application of these tools and commercial services are expensive and often delayed. Acetabular fractures are complex and difficult to access surgically, creating a niche capacity for the use of 3D printing. We present our experience and subsequently developed workflow template using anatomical 3D-printed models of acetabular fractures to precontour surgical plates, with the aim of reducing operative time and improving surgical planning.

Methods: Our workflow template has been used in the management of 3 cases with acetabular fractures at our institution, including 1 multitrauma patient who was 23 weeks pregnant. We used an Aldi printer and freeware software for creating 3D-printed models for preoperative planning and precontouring fixation plates. We report our system used to surgically manage these fractures, and the potential benefits of the tool.

Results: This short case series demonstrates a clinical use for 3D printing in what is often a challenging and time-consuming operation, which may be replicated in other centers at a low cost to the institution.

Conclusion: 3D printing is evolving as a popular adjunct to understanding fractures, but the true clinical potential of the technique has not been realized. Precontouring plates using a 3D replica of a patient's acetabulum may be a useful tool in the management of these complex fractures.



Abrahams, John Matthew Adelaide, Australia	Poster 153
Abril Larrainzar, Jose Manuel Madrid, Spain	Poster 149
Acharya, Mehool R Bristol, United Kingdom	Poster 109
Achor, Timothy S McGovern Medical School At UTHealth Bellaire, TX USA	Paper 99; Posters 80, 91; Digital Case Presen- tation 13; Breakout Sessions
Adair, Christopher Carolinas Medical Center Charlotte, NC USA	Poster 70
Adler, Adam Dept of Orthopaedic Surgery El Paso, TX USA	Paper 71
Agel, Julie Harborview Med Ctr Seattle, WA USA	Paper 81; Posters 3, 6, 130
Agrawal, Yuvraj Nottingham University Hospitals NHS Trust Nottingham, United Kingdom	Poster 78
Ahmed, Irfan H Rutgers New Jersey Medical School Newark, NJ USA	Poster 118
Ahn, Jaimo Penn Musculoskeletal Center Philadelphia, PA USA	Breakout Session
Ahn, Junho University of Texas Southwestern Medical Center Dallas, TX USA	Poster 92
Al-Hourani, Khalid National Health Service Bristol, United Kingdom	International Paper 60; Paper 82; Poster 134
Al-Maazmi, Khalid University of Alberta Hospital Edmonton, AB Canada	Paper 114
Albert, Graham UThealth Dallas, TX USA	Poster 80
Albright, Patrick University of California, San Francisco San Francisco, CA USA	Paper 98
Alford, Andrea Ann Arbor, MI USA	Basic Science Paper 11
Ali, Syed H Shrewsbury, MA USA	Paper 98
Ali, Syed Z Lexington, KY USA	Poster 23
Allen, Elizabeth Brigham and Women's Hospital Boston, MA USA	Poster 48
Allende, Christian Córdoba, Argentina	International Symposium
Allison, Annabel Cambridge, United Kingdom	Poster 98

Almubarak, Sarah Toronto, ON Canada	Basic Science Paper 24
Alqudhaya, Rashed S Dalhousie University Halifax, NS Canada	Paper 73
Althausen, Peter L Reno, NV USA	Breakout Session
Altman, Gregory T Allegheny General Hospital Pittsburgh, PA USA	Posters 84, 88
Ambrose, Catherine G Uthsc-Houston Houston, TX USA	Basic Science Paper 16; Digital Case Presen- tation 16
Ambrosi, Thomas Han Stanford University Palo Alto, CA USA	Basic Science Papers 20, 23
Amin, Adeet Houston, TX USA	Poster 80
Amin, Nirav Hasmukh Loma Linda, CA USA	Poster 87
Andersen, Mette Renate Sandvika, Norway	Paper 123
Anderson, Donald D The University of Iowa Iowa City, IA USA	Poster 3
Anderson, Joshua T University of Utah - Dept of Ortho Salt Lake City, UT USA	Poster 90
Andres, Brendan MetroHealth System Cleveland, OH USA	Paper 111
Aneja, Arun University of Kentucky Lexington, KY USA	Paper 113; Posters 23, 113, 114
Anglen, Jeffrey Ocala, FL USA	Basic Science Paper 19
Anglen, Jeffrey Ocala, FL USA	Basic Science Paper 26
Ansu, Velarie Yaa Ankrah Bloomington, IN USA	International Paper 42
Appleton, Paul T BIDMC Dept of Orthopaedics Boston, MA USA	Posters 32, 66, 76
Archdeacon, Michael T UC Dept of Orthopaedics Cincinnati, OH USA	Breakout Sessions
Archer, Kristin Vanderbilt University Medical Center Nashville, TN USA	Posters 29, 47, 113
Arnez, Zoran trieste, Italy	Poster 121
Arora, Raghav Dayanand Medical College and Hospital Ludhiana, India	International Paper 41

Arora, Sona Atlanta, GA USA	Poster 108
Arvesen, John Saint Louis University Saint Louis, MO USA	Poster 9
Askam, Brad Michael Charlotte, NC USA	Poster 135
Atassi, Omar Hammad Florida Orthopaedic Institute Tampa, FL USA	Posters 14, 127; Digital Case Presentation 9
Atchison, Jared Maryland Shock Trauma Westbury, NY USA	Papers 84, 88, 89; Poster 110
Atrey, Amit West Suffolk Hospital Toronto, ON Canada	Poster 107
Atwan, Yousif Western University (LHSC) London, ON Canada	Paper 70
Au, Brigham K TMI Sports Medicine and Orthopedics Coppell, TX USA	Basic Science Paper 1
Audet, Megan MetroHealth System Cleveland, OH USA	Posters 8, 17
Augat, Peter Murnau, Germany	Basic Science Symposium; Basic Science Paper 4
Axelrod, Daniel McMaster University Hamilton, ON Canada	Paper 92
Aynardi, Michael C Penn State Milton S. Hershey Medical Center Hershey, PA USA	Basic Science Paper 6
Babhulkar, Sushrut S Sushrut Orthopedic & Research Centre Nagpur, India	International Symposium
Backer, Henrik Constatin New York, NY USA	Poster 143
Bae, Donald S Boston Children's Hospital Boston, MA USA	Papers 95, 131
Bagley, Joshua J Hershey, PA USA	Poster 44
Bahney, Chelsea S Steadman Philippon Research Institute Vail, CO USA	Basic Science Paper 24
Baidoo, Paa Kwesi Korle Bu Teaching Hospital Tampa, FL USA	International Paper 42
Baigent, Thomas Cambridge, United Kingdom	Paper 85
Baker, Andrea Houston, TX USA	Basic Science Paper 16

Baker, Mitchell R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine Baltimore, MD USA	Posters 28, 37, 39
Balg, Frederic CHUS Sherbrooke, QC Canada	Paper 65
Balogh, Zsolt Janos John Hunter Hospital New Lambton Heights, Australia	International Symposium
Banuelos Rodriguez, José Luis Culiacan, Mexico	Digital Case Presentation 6
Barei, David Harborview Med Ctr Seattle, WA USA	Breakout Session
Barksdale, Edward Metz Cleveland, OH USA	Poster 131
Barla, Jorge Daniel Hospital Italiano De Buenos Aires Buenos Aires, Argentina	Poster 68; International Poster 152; Digital Case Presentations 7, 10; Breakout Session
Barlow, Erin M Penn State College of Medicine Hershey, PA USA	Basic Science Paper 6
Barlow, Jonathan D Mayo Clinic Rochester, MN USA	Poster 123
Barousse, Patrick Stahel University of South Alabama Mobile, AL USA	Paper 77
Barron, John Saint Louis University Saint Louis, MO USA	Poster 57
Bartlett, Craig Scott Burlington, VT USA	Paper 127
Barton, Garry Cambridge, United Kingdom	Poster 98
Basmajian, Hrayr G Pomona Valley Hospital Medical Center Pomona, CA USA	Poster 87
Beak, Philip London, United Kingdom	International Poster 156
Beaupre, Lauren Alison Edmonton, AB Canada	Paper 114
Beeker, Ryan Indianapolis, IN USA	Paper 96
Behery, Omar A NYU Langone Orthopedic Hospital New York, NY USA	Poster 45
Behlmer, Richard Joseph University of Wisconsin Madison, WI USA	Poster 18
Bellino, Michael Stanford, Orthopaedic Surgery Redwood City, CA USA	Basic Science Paper 20

Bellino, Michael Stanford, Orthopaedic Surgery Stanford, CA USA	Basic Science Paper 23; Poster 140
Benchimol, Javier Buenos Aires, Argentina	Poster 68
Benedick, Alex MetroHealth System Cleveland, OH USA	Paper 125; Posters 8, 17, 26, 117
Benirschke, Stephen K Harborview Hospital Seattle, WA USA	Breakout Session
Benoit, Benoit Montreal, QC Canada	Paper 65
Bergin, Patrick F University of Mississippi Medical Center Madison, MS USA	Poster 21
Berkes, Marschall B Washington University in St. Louis St Louis, MO USA	Paper 90; Poster 91
Bernatz, James T University of Wisconsin Madison, WI USA	Poster 69
Bernstein, Mitchell Shriners Hospital For Children Montreal, QC Canada	Breakout Sessions
Bhandari, Mohit McMaster University Hamilton, ON Canada	Papers 70, 92, 102, 120; Poster 58
Bible, Jesse E. Penn State Milton S. Hershey Medical Center Hershey, PA USA	Basic Science Paper 6
Bidolegui, Fernando M Medico - Ortopedia y Traumatologia Buenos Aires, Argentina	Breakout Session
Biert, Jan Nijmegen, Netherlands	International Paper 35
Billiar, Timothy R Univ of Pittsburgh Medical Center Pittsburgh, PA USA	Basic Science Paper 7
Birch, Craig Munro Childrens Hospital Boston Boston, MA USA	Basic Science Paper 1
Bishop, Julius A Stanford University Hospital Palo Alto, CA USA	Basic Science Papers 20, 23; Paper 94; Posters 12, 140, 148
Black, John-David Proliance Northwest Orthopaedics & Sports Medicine Richland, WA USA	Digital Case Presentation 19
Blackwell, Ryan Columbus, OH USA	Digital Case Presentation 3
Blankenburg, Notker Leipzig, Germany	International Paper 32
Blankstein, Michael Univ. of Vermont Medical Center Orthopedics & Rehabilitation Center South Burlington, VT USA	Paper 102

Blazar, Philip E Brigham and Women's Hospital Boston, MA USA	Poster 136
Blessing, William Boston, MA USA	Basic Science Paper 5
Bliven, Emily Murnau am Staffelsee, Germany	Basic Science Paper 4
Bloom, Lee SUNY Downstate Medical Center Brooklyn, NY USA	Posters 142, 144
Boietti, Bruno Rafael Buenos Aires, Argentina	Poster 68
Boissonneault, Adam Emory Univ School of Medicine Atlanta, GA USA	Poster 108
Bolz, Nicholas Detroit, MI USA	Paper 126
Boomsma, Shawn Eugene Watertown, MA USA	Poster 101
Bosse, Michael J Carolinas Medical Center Charlotte, NC USA	Papers 83, 105; Poster 29
Bostrom, Mathias P G Hosp for Special Surgery New York, NY USA	Basic Science Paper 12
Botros, Mina A Boston, MA USA	Paper 101
Bott, Alasdair Richard Bristol, United Kingdom	Poster 109
Bottlang, Michael Happy Valley, OR USA	Basic Science Symposium
Bouillon, Bertil University of Witten Herdecke Cologne, Germany	International Symposium
Box, Hayden N Dallas, TX USA	Paper 93
Bragdon, Charles R Mass General Hospital Boston, MA USA	Paper 101
Bramer, Michelle Morgantown, WV USA	Paper 75
Brandariz, Rodrigo Buenos Aires, Argentina	International Poster 152
Bravin, Daniel A West Virginia University Morgantown, WV USA	Paper 75
Brealey, Stephen University of York York, United Kingdom	Paper 138
Breslin, Mary Alice MetroHealth System Bay Village, OH USA	Paper 111; Poster 26

Breslin, Mary Alice The Metrohealth System Bay Village, OH USA	Poster 117
Brewer, Jeffrey Mobile, AL USA	Papers 77, 100
Briceno, Jorge Santiago, Chile	Paper 128
Brinker, Mark R Texas Orthopedic Hospital Houston, TX USA	Breakout Session
Britt, Elise San Diego, CA USA	Poster 116
Brodke, Dane Jensen Los Angeles, CA USA	Poster 100
Brodkin, Michael Tempe, AZ USA	Breakout Session
Broekhuyse, Henry M Vancouver, BC Canada	International Symposium
Brooks, Andrew E University of Wisconsin Madison, WI USA	Poster 69
Brouwers, Lars Nijmegen, Netherlands	International Paper 35
Brown, Corina C Case Western Reserve University Cleveland, OH USA	Poster 131
Brown, Krista M Indiana University Indianapolis, IN USA	Papers 69, 108
Bruggers, Jennifer L Resurgeons Smyrna, GA USA	Paper 121
Buckley, Richard E Foothills Medical Centre Calgary, AB Canada	Paper 118; Breakout Session
Bui, Gabrielle Anne Iowa City, IA USA	Poster 3
Burekhovich, Steven Alexander SUNY Downstate Medical Center Brooklyn, NY USA	Poster 142
Burgess, Andrew R McGovern Medical School at UTHealth Houston, TX USA	Basic Science Paper 16
Burnett, Zachary Ryan Charlottesville, MO USA	Poster 9
Busch, Michael T Children's Healthcare of Atlanta Atlanta, GA USA	Paper 131
Busel, Gennadiy Tampa, FL USA	Poster 14; Digital Case Presentation 9
Bush, Ashleigh Nicole Indiana University Indianapolis, IN USA	Poster 9

	1
Bustamante, Sebastian New York, NY USA	Poster 142
Byun, Seong-Eun Bundang-Gu, Seongnam-Si, Gyeonggi-Do, Korea, Republic of	International Paper 51
Bzovsky, Sofia Hamilton, ON Canada	Papers 70, 92, 102
Cain, Megan Flinders Medical Centre Bedford Park, Australia	Poster 133
Callaghan, John Joseph Wayne, NJ USA	Poster 81
Callan, Alexandra Kathleen UT Southwestern Medical Center Dallas, TX USA	Poster 92
Callary, Stuart Adam Royal Adelaide Hospital Adelaide, Australia	International Poster 153
Campbell, Sean T Menlo Park, CA USA	Poster 12
Campbell, Sean T Stanford University Department of Orthopaedic Surgery Stanford, CA USA	Posters 140, 148
Canadian Orthopaedic Trauma Society (COTS) ON, Canada	Paper 63
Candrian, Christian Porza, Switzerland	International Poster 151
Cannada, Lisa K Jacksonville, FL USA	Paper 121, Posters 9, 57, 137
Carabelli, Guido Sebastian Hospital Italiano De Buenos Aires Buenos Aires, Argentina	Poster 68; International Poster 152; Digital Case Presentations 7, 10; International Symposium
Carlini, Anthony R Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Papers 76, 105; Poster 33
Carlock, Kurtis D NYU Langone Orthopedic Hospital New York, NY USA	Poster 38
Carney, John University of Southern California Los Angeles, CA USA	Digital Case Presentation 14
Carroll, Eben A Wake Forest Univ School of Medicine Winston Salem, NC USA	Paper 83; Poster 137; Breakout Session
Carrothers, Andrew Douglas Addenbrookes, Cambridge University Hospitals NHS Foundation Trust Cambridge, United Kingdom	Paper 85; Poster 98
Carter, Thomas Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 135; Poster 141
Castaneda, Paulo Phoenix, AZ USA	Basic Science Paper 3

See the meeting app for complete listing of authors' disclosure information.

386

INDEX - ALPHABETICAL BY AUTHOR

Castillo, Isaac University of Texas Health Science Center at Houston Houston, TX USA	Poster 126
Castillo, Renan C John Hopkins Bloomberg School of Public Health Baltimore, MD USA	Papers 76, 105; Poster 33
Cesarovic, Nikola University Hospital Zürich Zürich, Switzerland	Basic Science Paper 27
Chaichompoo, Thippatai Faculty of Medicine Siriraj Hospital, Mahidol University Bangkok , Thailand, Thailand	Paper 117
Chan, Charles KF Stanford Palo Alto, CA USA	Basic Science Papers 20, 23
Chana Rodríguez, Francisco Madrid, Spain	International Symposium; Poster 149
Chandhoke, Gurrattan Toronto, ON Canada	Paper 136
Chang, Gerard Rothman Institute of Orthopaedics, Thomas Jefferson University Philadelphia, PA USA	Basic Science Paper 14
Chang, Jiun Chiun San Francisco, CA USA	Basic Science Paper 24
Chaudhry, Hasaan Toronto, ON Canada	Poster 107
Chen, Jiahui Guangzhou, China, People's Republic of	International Paper 29
Chen, Neal C Massachusetts General Hospital Boston, MA USA	Poster 136
Chen, Yuhui Guangzhou, China, People's Republic of	Paper 86
Chesser, Tim North Bristol NHS Trust Bristol, United Kingdom	International Symposium; Paper 138; International Paper 60; Posters 59, 109, 146;
Childress, Paul J Indianapolis, IN USA	Basic Science Paper 19
Childs, Benjamin Randolph MetroHealth System El Paso, TX USA	Paper 111
Cho, Jae-Woo Guro Hospital, Korea University Medical Center Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53; International Poster 154
Cho, Wontae Orthopedic Surgery Department, Guro Hospital Seoul, Korea, Republic of	Basic Science Paper 13
Cho, Wontae Korean Armed Forces Capital Hospital Seongnam, Korea, Republic of	International Poster 154
Choi, Won Chul CHA University, CHA Bundang Medical Center Seongnam-si, Korea, Republic of	International Paper 51

Chokotho, Linda Africa, Malawi	Paper 98
Choo, Andrew Moon University of Texas Health Science Center at Houston Houston, TX USA	Paper 99; Poster 80
Chopra, Aman UC San Francisco CUPERTINO, CA USA	Basic Science Paper 24
Chou, Daud Cambridge, United Kingdom	Paper 85; Poster 98; International Poster 153
Chu, Tien Gabriel Indiana Univ Schl of Dentistry Indianapolis, IN USA	Basic Science Papers 19, 26
Chung, Hoejeong Wonju, Korea, Republic of	International Poster 154
Chung, Kaman Los Angeles, CA USA	Poster 31
Cinats, David Univ of Calgary/Health Sciences Ctr Vancouver, BC Canada	Paper 80; Digital Case Presentation 2
Cinelli, Paolo University Hospital Zurich Zurich, Switzerland	Basic Science Papers 9, 27
Ciufo, David University of Rochester Rochester, NY USA	Poster 64
Clement, Nicholas D Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 134
Coale, Max Baltimore, MD USA	Paper 91; Poster 19
Coghlan, Ryan Shriners Hospital - Portland Portland, OR USA	Basic Science Paper 24
Cohen, Joseph Bowman Loyola University Maywood, IL USA	Paper 79; Poster 51
Cole, Peter A Regions Hospital Dept of Ortho Surgery Saint Paul, MN USA	Digital Case Presentation 20
Coleman, Julia R University of Colorado Denver, CO USA	Poster 112
Coll, Daniel John Daniel John Coll Truckee, CA USA	Breakout Session
Collinge, Cory Alan Nashville, TN USA	Breakout Sessions
Collins, Susan Catherine Jane JHU-METRC Baltimore, MD USA	Papers 76, 83
Comadoll, Shea University of Kentucky, Wake Forest School of Medicine Lexington, KY USA	Posters 23, 27, 113

INDEX - ALPHABETICAL BY AUTHOR

Comeau-Gauthier, Marianne McGill University Montreal, QC Canada	Basic Science Papers 18, 22
Como, John J MetroHealth System Cleveland, OH USA	Paper 106; Poster 53
Compton, Edward University of Southern California Pasadena, CA USA	Digital Case Presentation 14
Compton, Jocelyn T University of Iowa Hospitals Iowa City, IA USA	Poster 3
Congiusta, Dominick Vincent Rutgers New Jersey Medical School Newark, NJ USA	Poster 118
Connelly, Daniel Maryland Shock Trauma, University of Maryland School of Medicine Baltimore, MD USA	Papers 88, 89; Poster 39
Conti, Bianca Baltimore, MD USA	Poster 39
Contini, Achille Napoli, Italy	International Symposium
Conway, Charles SUNY Downstate Medical Center Brooklyn, NY USA	Poster 144
Conway, Janet Donohue Baltimore, MD USA	Basic Science Symposium
Cook, James L Univ of Missouri Ortho Surg Columbia, MO USA	Basic Science Paper 15; Poster 79
Cook, Liz York, United Kingdom	Paper 138
Coomber, Ross Cambridge, United Kingdom	Paper 85
Corrigan, Chad Matthew University of Kansas-Wichita Wichita, KS USA	Breakout Session
Cosgrove, Christopher Thomas Washington University in St. Louis St. Louis, MO USA	Paper 90
Costa, Matthew L Coventry, United Kingdom	Paper 138; Posters 59, 98
Coste, Marine SUNY Downstate Medical Center Brooklyn, NY USA	Poster 144
Costi, Kerry Royal Adelaide Hospital Adelaide, Australia	International Poster 153
Coughlin, Tim Nottingham, United Kingdom	Paper 67
Cox, Kyle University of South Alabama Mobile, AL USA	Paper 100

Cox, William Tanner University of South Alabama Mobile, AL USA	Paper 100
Crawford, Maggie Delray Beach, FL USA	Paper 68
Craxford, Simon John The University of Nottingham Nottingham, United Kingdom	Poster 78
Cripps, Michael UTSW Dallas, TX USA	Paper 93
Crist, Brett D Univ of Missouri School of Med Columbia, MO USA	Basic Science Symposium; International Symposium; Posters 5, 30, 79; Breakout Session
Cristofaro, Caroline D Edinburgh Orthopaedic Trauma Edinburgh, United Kingdom	Paper 135; Poster 141
Crouser, Nisha COLUMBUS, OH USA	Digital Case Presentation 3
Crowther, Mark AA North Bristol NHS Trust Bristol, United Kingdom	Poster 146
Cubria, Maria Belen Beth Israel Deaconess Medical Center Boston, MA USA	Basic Science Paper 5
Cunningham, Brian Regions Hospital, University of Minnesota & HealthPartners Saint Paul, MN USA	Papers 74, 88, 89; Posters 22, 43, 99
Cunningham, Daniel Joseph Durham, NC USA	Poster 132
Cushnie, Duncan St. Joseph's Health Care London Hamilton, ON Canada	Paper 122
Cusick, Laurence A Belfast, United Kingdom	International Paper 45
Cutchen, William Mobile, AL USA	Paper 77
D'Achille, Roberta Smaligo Morristown, NJ USA	Poster 81
Dallacker-Losensky, Kevin Ulm, Germany	International Paper 32
Davenport, Daniel University of Kentucky Lexington, KY USA	Poster 23
Davis, Max Ann Arbor, MI USA	Basic Science Paper 11
Davis, Patrick Taylor University of South Florida Tampa, FL USA	Paper 88
Davis, Patrick Taylor University of South Florida Tampa, FL USA	Paper 89

INDEX - ALPHABETICAL BY AUTHOR

Davis, William J Loyola University Medical Center Maywood, IL USA	Poster 51
Dawson, Sarah Saint Louis University St. Louis, MO USA	Paper 121
De Boer, Siebe Erasmus MC Rotterdam, Netherlands	International Paper 37
De Cicco, Franco Hospital Italiano de Buenos Aires Buenos Aires, Argentina	Poster 68; Digital Case Presentation 7
De Jongh, Mariska Adriana ETZ Tilburg, Netherlands	International Paper 35; Poster 119
De La Fuente, Guadalupe Tampa Bay, FL USA	Poster 14; Digital Case Presentation 9
De La Huerta, Fernando Unidad de Ortopedia y Traumatologia Guadalajara, Mexico	International Symposium
De Latin, Laura LSUHSC - New Orleans Brusly, LA USA	Poster 24
De Lissovoy, Gregory Baltimore, MD USA	Poster 29
Dean, Chase S University of Colorado Aurora, CO USA	Poster 112
Dean, Christina Baltimore, MD USA	Poster 19
DeBaun, Malcolm Stanford, CA USAA	Basic Science Paper 17; Posters 140, 148
Degani, Yasmin R Adams Cowley Shock Trauma Center Baltimore, MD USA	Paper 76
Dehghan, Niloofar University of Arizona; The CORE Institute Banner - University Medical Center Phoenix Paradise Valley, AZ USA	Papers 63, 132, 136
Del Balso, Christopher London, ON Canada	Paper 122
Del Core, Michael UTSW Dallas, TX USA	Poster 137
Delgado, Gregg University of South Alabama Mobile, AL USA	Paper 100
Della Rocca, Gregory J. University of Missouri Columbia, MO USA	Breakout Sessions
Dello Russo, Bibiana Ciudad Autonoma De Buesnos Aires, Argentina	International Symposium
Demyanovich, Haley Baltimore, MD USA	Poster 28

Desanto, Donald University of California, Irvine - Orthopaedics Dana Point, CA USA	Basic Science Paper 2; Digital Case Presentation 14
Deshpande, Chetan S Chatham Orthopaedic Associates Savannah, GA USA	Digital Case Presentation 1
Devlin, Vincent J Fulton, MD USA	Basic Science Symposium
Dhawan, Aman Penn State Milton S. Hershey Medical Center Hershey, PA USA	Basic Science Paper 6
Di, Junrui Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Paper 83
Diamond, Owen J Belfast, County Antrim, United Kingdom	International Paper 45
Dias, Joe Div of Orthopaedic Surgeons Leicester, United Kingdom	Paper 138
Diaz Dilernia, Fernando Hospital Italiano de Buenos Aires CDAD de Buenos Aires, Argentina	Digital Case Presentation 10
Diebo, Bassel SUNY Downstate Medical Center Brooklyn, NY USA	Posters 142, 144
Dietrich, Michael Zurich, Switzerland	Poster 60
Dimachkieh, Omar Saad Baylor College of Medicine Houston, TX USA	Poster 127
Ding, Anthony Long Beach, CA USA	Poster 110
Diwan, Amna University of Massachusetts Medical Center Worcester, MA USA	Paper 113; Poster 36
Dixon, Paul Sunderland, United Kingdom	Poster 59
Doan, Jessica Seattle, WA USA	Poster 44
Donegan, Derek James Pennsylvania Medicine University City Philadelphia, PA USA	Breakout Session
Dong, Jingming Tianjin, China, People's Republic of	International Paper 56
Donohue, David Florida Orthopaedic Institute Tampa, FL USA	Poster 14; Digital Case Presentation 9; Breakout Session
Doornberg, Job N Flinders University Medical Centre Adelaide, Australia	International Paper 33; Posters 4, 133
Doro, Christopher University of Wisconsin Madison, WI USA	Poster 69

INDEX - ALPHABETICAL BY AUTHOR

Douglas, Lonnie R. Louisville, KY USA	International Symposium
Downes, Katheryne Tampa, FL USA	Poster 14; Digital Case Presentation 9
Dragonetti, Brittany Boston Children's Hospital Boston, MA USA	Paper 131
Duckworth, Andrew David Royal Infirmary of Edinburgh, Edinburgh Orthopaedic Trauma Edinburgh, United Kingdom	Papers 134, 135; International Paper 40; Poster 141
Duffy, Paul James Foothills Medical Centre Calgary, AB Canada	Paper 118
Dugarte, Anthony Jospeh Regions Hospital, Department of Orthopaedic Surgery Saint Paul, MN USA	Digital Case Presentation 20
Dunbar, Robert Paul Harborview Medical Center Mercer Island, WA USA	Paper 66
Dybvik, Eva Norwegian Hip Fracture Register Bergen, Norway	Paper 137
Earp, Brandon Elizabeth Brigham and Women's Hospital Boston, MA USA	Poster 136
Edmonds, Eric William Rady Children's Hospital San Diego, CA USA	Paper 131
Edwards, Michael Nijmegen, Netherlands	International Paper 35
Eglseder, W Andrew Shock Trauma Orthopaedics Baltimore, MD USA	Paper 139; Poster 147
Egol, Kenneth A NYU Langone Medical Center New York, NY USA	Symposium; Papers 66, 107, 109, 116; Posters 25, 38, 40, 45, 46, 50, 52, 86, 93, 103, 139; Breakout Session
Ehrnthaller, Christian Matthias Munich, Germany	International Paper 49
Eickhoff, Alexander Blaustein, Germany	International Paper 49; Posters 61, 111
El Moumni, Mostafa UMC Groningen Groningen, Netherlands	Paper 130
El Naga, Ashraf N Houston, TX USA	Poster 127
Elizondo, Cristina Maria Buenos Aires, Argentina	Poster 68
Elliott, Marilyn Texas Scottish Rite Hospital For Children Dallas, TX USA	Paper 95
Ellis, Henry Bone Texas Scottish Rite Hospital Dallas, TX USA	Paper 131

Elrick, Bryant University of Colorado Denver, CO USA	Poster 112
Emanuel, Noam PolyPid Ltd Petach Tikva, Israel	Paper 78
Endo, Atsushi Redwood City, CA USA	Poster 48
Engel, Jamie Cleveland Clinic Akron General Akron, OH USA	Paper 115
Enobun, Blessing Baltimore, MD USA	Paper 69; Poster 110
Ernst, Alexandra Atlanta, GA USA	Posters 34, 56
Ertl, Janos Paul Indianapolis, IN USA	Digital Case Presentation 4
Esposito, John Mississauga, ON Canada	Posters 13, 101
Evans, Andrew R University Orthopedics Providence, RI USA	Basic Science Symposium
Fairchild, Ryan W Dallas, TX	Paper 93
Fairhurst, Caroline York, United Kingdom	Paper 138
Fan, Shicai The Third Affiliated Hospital of SMU Guangzhou, China, People's Republic of	Paper 86; International Paper 29; International Poster 157
Fan, Wei Xi'an, China, People's Republic of	International Paper 59
Farley, Kevin Xavier Emory University Atlanta, GA USA	Poster 34
Farmer, Travis Dalton Loma Linda University, East Campus Loma Linda, CA USA	Poster 87
Feng, Weilou Xian Honghui Xi'An., China, People's Republic of	International Papers 36, 43, 55
Fernandez, Isaac El Paso, TX USA	Papers 71, 110
Fevang, Jonas Bergen, Norway	Paper 137
Ficke, James R Johns Hopkins, Ortho Baltimore, MD USA	Breakout Sessions
Figved, Wender Baerum Hospital, Vestre Viken Hospital Trust Drammen, Norway	Paper 123
Finik, Jackie New York, NY USA	Poster 62

INDEX - ALPHABETICAL BY AUTHOR

Finney, Fred University of Michigan Ann Arbor, MI USA	Paper 129
Fiorentini, Fernando Buenos Aires, Argentina	Poster 68
Firoozabadi, Reza University of Washington, Harborview Medical Center Seattle, WA USA	Posters 6, 7, 29, 44
Fischer, James Patrick Indianapolis, IN USA	Basic Science Paper 26
Fisher, Brian M Dartmouth-Hitchcock Medical Center Lebanon, NH USA	Poster 63
Fisher, Kalin University of Maryland Baltimore, MD USA	Poster 19
Fishler, Thomas Christopher Sonoran Orthopaedic Trauma Surgeons Scottsdale, AZ USA	Breakout Session
Flagstad, Ilexa Rae University of Minnesota Andover, MN USA	Papers 74, 88, 89; Poster 43
Flanagan, Christopher Case Western Reserve University, MetroHealth System Cleveland, OH USA	Posters 26, 117
Flint, Kathy J. Indianapolis, IN USA	Paper 96
Flynt, Amy Durham, NC USA	Paper 68
Fokin, Alexander Delray Medical Center Delray Beach, FL USA	Paper 68
Ford, Amy Loyola University Medical Center Department of Orthopaedic Surgery and Rehabilitation Maywood, IL USA	Paper 79
Ford, Amy Loyola University Medical Center Maywood, IL USA	Poster 35
Ford, Brian SUNY Downstate Medical Center BROOKLYN, NY USA	Poster 144
Forsberg, Jonathan A Walter Reed National Military Medical Center Bethesda, MD USA	Poster 124
Forsythe, Michael Edgar Moncton, NB Canada	Paper 72
Fournier, Matthew Newland Univ of TN-Campbell Clinic Memphis, TN USA	Paper 95
Fox, Rabun Samuel Rothman Institute Philadelphia, PA USA	Poster 24

Fram, Brianna Rothman Institute of Orthopaedics, Thomas Jefferson University Philadelphia, PA USA	Basic Science Paper 14
Freibott, Christina Columbia Univeristy Medical Center New York, NY USA	Poster 143
Frey, Katherine Johns Hopkins University Baltimore, MD USA	Paper 83
Frey, Marianna Bailey New York, NY USA	Poster 62
Friess, Darin M Oregon Hlth & Sci Univ Portland, OR USA	Paper 73
Frihagen, Frede Oslo, Norway	Paper 123
Fujita, Kenji Toyama Municipal Hospital Toyama, Japan	Poster 71
Fukui, Tomoaki Kobe, Japan	International Paper 52
Furey, Andrew Mem Univ of Newfoundland St. John's, NL Canada	Paper 72
Gabra, Joseph N Cleveland Clinic Akron General Akron, OH USA	Paper 115
Gage, Mark Duke University Dept of Ortho Surg Durham, NC USA	Poster 132; Breakout Sessions
Galea, Vincent Boston, MA USA	Paper 101
Galle, Samuel New York, NY USA	Poster 143
Ganta, Abhishek NYU Langone Orthopedic Hospital New York, NY USA	Poster 45
Garay Claudio, Mariano Allegheny General Hospital Pittsburgh, PA USA	Posters 84, 88
Gardner, Michael J Stanford University Surgery Stanford, CA USA	Symposium; Basic Science Papers 17, 20, 23; Posters 12, 140, 148; Breakout Sessions
Garg, Rajnish Dayanand Medical College and Hospital Ludhiana, India	International Paper 41
Garlich, John Los Angeles, CA USA	Poster 2
Garner, Matthew Robert Penn State Milton S. Hershey Medical Center Hershey, PA USA	Basic Science Paper 6; Paper 81; Poster 130
Gary, Joshua Layne UT Health Dept. of Orthopaedic Surgery Houston, TX USA	Basic Science Symposium; Basic Science Paper 16; Papers 73, 76, 99; Posters 29, 80; Digital Case Presentation 16; Breakout Session
INDEX - ALPHABETICAL BY AUTHOR

Gaski, Greg E Indiana University School of Medicine Carmel, IN USA	Basic Science Paper 7; Papers 69, 76, 108
Gausden, Elizabeth McGovern Medical School At UTHealth Houston, TX USA	Poster 80; Digital Case Presentation 13
Ge, Susan Mengxiao McGill University Montreal, QC Canada	Basic Science Paper 18
Ge, Wei Beijing, China, People's Republic of	Poster 1
Gebhard, Florian T Ulm University Ulm, Germany	International Symposium; International Paper 49; Posters 61, 111
Gent, Thijs Van Nijmegen, Netherlands	International Paper 35
Gessmann, Jan Bochum, Germany	Basic Science Paper 10
Giannoudis, Peter Leeds Gen.L Infirm/Dept of Trauma & Ortho Leeds, United Kingdom	International Symposia; Paper 97; Posters 73, 94
Gililland, Jeremy University of Utah Salt Lake City, UT USA	Poster 90
Gill, Bridget A. MetroHealth System Cleveland, OH USA	Poster 117
Gill, Jeff American University Washington, DC USA	Paper 69
Gitajn, Ida Leah Dartmouth Hitchcock Medical Center Lebanon, NH USA	Posters 41, 63
Githens, Michael Harborview Medical Center Seattle, WA USA	Poster 6
Githens, Thomas TX Tech Univ Health Science Center Redwood City, CA USA	Poster 148
Glatt, Vaida UT Health Science Center San Antonio, TX USA	Basic Science Paper 21
Glick, Wesley Adam Atlanta, GA USA	Poster 56
Godbout, Charles St. Michael's Hospital (keenan Research Centre) Toronto, ON Canada	Basic Science Paper 25
Goel, Rahul Kant Emory University Atlanta, GA USA	Poster 108
Goel, Ritu Baltimore, MD USA	Paper 139

Golob, Joseph F MetroHealth System Cleveland, OH USA	Paper 106; Poster 53
Gonzalez, Leah NYU Langone Orthopedic Hospital New York, NY USA	Paper 107; Posters 52, 103, 139
Goodnough, Lawrence Henry Stanford Medicine Outpatient Center Stanford, CA USA	Basic Science Paper 20
Goodnough, Lawrence Henry Stanford University Stanford, CA USA	Basic Science Paper 23; Posters 12, 148
Goodspeed, David University of Wisconsin Madison, WI USA	Posters 69, 122; Breakout Session
Goodwin, Jill Anne Banner Good Samaritan Ortho Residency Phoenix, AZ USA	Basic Science Paper 3
Gorbulev, Stanislav Mainz, Germany	Paper 64
Gorczyca, John T University of Rochester Rochester, NY USA	Paper 124; Breakout Session
Gorman, Catlea HealthPartners Saint Paul, MN USA	Poster 22
Gorman, Tiffany University of Minnesota Minneapolis, MN USA	Poster 43
Goshima, Kenichi Toyama Municipal Hospital Toyama, Japan	Poster 71
Goswami, Karan Philadelphia, PA USA	Basic Science Paper 14
Graafen, Marcus Erich Mainz, Germany	Paper 87
Graf, Ryan M University of Wisconsin Madison, WI USA	Posters 18, 69, 95, 122
Gras, Florian Jena, Germany	International Paper 32
Graves, Matthew L Univ of Mississippi Med Ctr Jackson, MS USA	Breakout Sessions; Poster 21
Greven, Johannes Aachen, Germany	Basic Science Paper 8
Grinstaff, Mark Boston, MA USA	Basic Science Paper 5
Grob, Patricio Whippany, NJ USA	Poster 81
Grossman, Leonid Univ of Nebraska Medical Center Pittsburgh, PA USA	Poster 10

	· · · · · · · · · · · · · · · · · · ·
Gruenwald, Konstantin Indiana University Little Rock, AR USA	Paper 73
Grueter, Kirsten Hospital For Special Surgery New York, NY USA	Poster 62
Grützner, Paul Alfred Ludwigshafen, Germany	Paper 64
Gudmundsdottir, Rakel Sif Bergen, Norway	Paper 137
Gulbrandsen, Trevor U of IA Iowa City, IA USA	Poster 5
Gulli, Stefano trieste, Italy	Poster 121
Gupta, Anupam N DELHI, India	International Paper 46
Habib, Nermine Fribourg, Switzerland	International Poster 151
Hackl, Simon BG Unfallklinik Murnau Murnau, Germany	Basic Science Paper 4
Hadidi, Lina McGill University Montreal, QC Canada	Basic Science Paper 18
Haggerty, Christopher Boston, MA USA	Poster 66
Haglin, Jack Hospital for Joint Diseases Scottsdale, AZ USA	Paper 109
Haglin, Jack NYU Langone Orthopedic Hospital New York, NY USA	Posters 45, 46
Hahn, Alexander University of Maryland School of Medicine Baltimore, MD USA	Poster 147
Hahn, Jesse Chapel Hill, NC USA	Paper 88
Haidukewych, George John Orlando Health Orlando, FL USA	Posters 77, 105; Breakout Session
Haidukewych, George John Orlando, FL USA	Poster 105
Hairuo, Wang Chongqing, China, People's Republic of	Poster 75
Hak, David J Denver, CO USA	Symposium; International Symposium Papers 83, 88, 89;
Hake, Mark Ann Arbor, MI USA	Basic Science Paper 11
Hall, Jeremy Toronto, ON Canada	Papers 132, 132, 136; Poster 107
Haller, Justin University of Utah Salt Lake City, UT USA	Basic Science Symposium; Posters 6, 55, 129

Halliday, Ruth Louise Southmead hospital Bristol, United Kingdom	Poster 109
Halvachizadeh, Sascha University Hospital Zurich Zurich, Switzerland	Basic Science Papers 9, 27
Hammad, Aws Detroit Medical Center Detroit, MI USA	Paper 126
Han, Jane Columbus, OH USA	Digital Case Presentation 3
Hanna, Philip Beth Israel Deaconess Medical Center Brookline, MA USA	Basic Science Paper 5
Hannan, Zachary Baltimore, MD USA	Paper 84, Posters 37, 110
Hansen, Denise H University of Texas Houston, TX USA	Poster 91
Harkin, Elizabeth Loyola University Maywood, IL USA	Paper 79
Harris, Mitchel B Massachusetts General Hospital Boston, MA USA	Basic Science Symposium; Poster 101
Harris, Robert M The Hughston Clinic Columbus, GA USA	Digital Case Presentation 11
Harrison, Tanja University of Calgary Calgary, AB Canada	Papers 118, 122
Hartline, Braden Edward University of Texas Health Science Center At Houston Houston, TX USA	Paper 99
Harvey, Edward J McGill University Westmount, QC Canada	International Symposia; Symposium; Basic Science Papers 18, 22
Harwood, Paul Leeds, United Kingdom	Posters 73, 94
Hashida, Ryuki Kurume, Fukuoka, Japan	Digital Case Presentation 12
Hashmi, Sohaib Zafar Northwestern Univ Med School Chicago, IL USA	Poster 97
Hast, Michael University of Pennsylvania Philadelphia, PA USA	Basic Science Symposium
Havermans, Roos JM ETZ Tilburg, Netherlands	Posters 104, 119
Hayat, Batur Alkmaar, Netherlands	Poster 4; Digital Case Presentation 21
Hayda, COL (ret) Roman A Providence, RI USA	Paper 83

See the meeting app for complete listing of authors' disclosure information.

400

INDEX - ALPHABETICAL BY AUTHOR

Hayek, Kevin R University of Minnesota Minneapolis, MN USA	Poster 99
Heare, Austin University of Colorado SOM Miami, FL USA	Papers 88, 89
Hecht, Garin Loyola University Medical Center Department of Orthopaedic Sur- gery and Rehabilitation Maywood, IL USA	Paper 79
Heiner, Jacob Anthony McGovern Medical School at University of Texas Health Science Center at Houston Houston, TX USA	Paper 81; Posters 126, 130
Held, Ulrike Zurich, Switzerland	Poster 60
Hendrickson, Sarah The Metrohealth System Cleveland, OH USA	Paper 111; Poster 117
Hendrickx, Hendrickx Alexander Marijn Somerton Park, Australia	Poster 133
Heng, Marilyn Massachusetts General Hospital Boston, MA USA	Paper 101
Henry, Patrick Toronto, ON Canada	Poster 107
Hensor, Elizabeth Mary Anne Leeds, United Kingdom	Poster 73
Heo, Jeong Jung-Gu, Daegu, Korea, Republic of	International Papers 30, 44
Heo, Jeong Kyungpook National University Hospital Daegu, Korea, Republic of	International Paper 39
Herath, Steven C. Homburg, Germany	International Paper 32
Hermans, Erik Nijmegen, Netherlands	International Paper 35
Herndon, Brooke Lexington, KY USA	Poster 114
Heyland, Mark Charité - University Medicine Berlin, Germany	Basic Science Symposium
Heyworth, Benton E Boston Children's Hospital Boston, MA USA	Paper 131
Higgins, Thomas F University Orthopaedic Center Salt Lake City, UT USA	Posters 55, 129
Hildebrand, Frank University Hospital Aachen Aachen, Germany	Basic Science Papers 8, 9, 27
Hildebrandt, Kyle NYU Langone Orthopedic Hospital Flint, MI USA	Poster 38

Hill, Brian W. Saint Louis University Saint Louis, MO USA	Poster 137
Hinde, Sebastian York, United Kingdom	Paper 138
Ho, Vanessa P MetroHealth System Cleveland, OH USA	Paper 111
Hoang, Victor Valley Hospital Medical Center Las Vegas, NV USA	Digital Case Presentation 8
Höch, Andreas Leipzig, Germany	International Paper 32
Hoekstra, Harm Leuven, Belgium	International Paper 37
Hofman, Martijn Aachen, Germany	Basic Science Paper 8
Hofmann, Alex Johannes Gutenberg University Medical Center Mainz, Department of Orthopedics and Traumatology Kaiserslautern, Germany	Papers 64, 87; Poster 65
Holdbrook-Smith, Henry Accra, Ghana	International Paper 42
Holmes, James R University of Michigan Ann Arbor, MI USA	Paper 129
Honeycutt, Michael Wesley University of South Alabama Mobile, AL USA	Paper 100
Hoover, Malachia Palo Alto, CA USA	Basic Science Paper 20
Horton, Steven Andrew University of Maryland, R Adams Cowley Shock Trauma Center Baltimore, MD USA	Paper 139; Poster 33
Horton, William Shriners Hospital - Portland Portland, OR USA	Basic Science Paper 24
Horwitz, Daniel Scott Geisinger Health System Danville, PA USA	Paper 73
Hoskins, Tyler Morristown, NJ USA	Poster 81
Howard, Roland San Diego, CA USA	Poster 116
Howard, Shain Valley Hospital Medical Center Henderson, NV USA	Digital Case Presentation 8
Howe, Andrea Lynn University of Maryland School of Medicine Baltimore, MD USA	Paper 69
Howie, Donald Royal Adelaide Hospital Adelaide, Australia	International Poster 153
Hoyt, Benjamin W Columbia, MD USA	Poster 33

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5

Hsu, Joseph R Charlotte, NC United States	Symposium
Huang, Hai Guangzhou, China, People's Republic of	International Poster 157
Huang, Yanjie Baltimore, MD USA	Paper 76
Huixu, Ma Chongqing, China, People's Republic of	Poster 75
Hulick, Robert Miles U of MS Jackson, MS USA	Poster 5
Hull, Peter Cambridge, United Kingdom	Paper 85; Poster 98
Humphrey, Catherine A Rochester, NY USA	Papers 66, 124; Poster 64; Breakout Session
Hustedt, Joshua Durham, NC USA	Poster 150
Hutzler, Lorraine NYU Langone Orthopedic Hospital New York, NY USA	Paper 107
Hyder, Mary Baltimore, MD USA	Poster 39
Hymes, Robert Inova Fairfax Falls Church, VA USA	Poster 137
Ibrahim, Ishaq Boston, MA USA	Poster 76
Ihle, Christoph Tuebingen, Germany	International Paper 32
Illical, Emmanuel SUNY Downstate Medical Center Philadelphia, PA USA	Posters 142, 144
Infante, Anthony F Tampa Bay, FL USA	Poster 14; Digital Case Presentation 9
Inui, Takahiro Teikyo University Hospital Tokyo, Japan	Poster 82
Investigators, FAITH McMaster University Hamilton, ON Canada	Papers 102, 120
Investigators, FLOW Hamilton, ON Canada	Paper 70; Poster 58
Investigators, HEALTH Hamilton, ON Canada	Paper 62
Investigators, METRC Bioburden Baltimore, MD USA	Paper 105
Isaac, Marckenley Tallahassee, FL USA	Paper 120
Ishii, Keisuke Tokyo, USA	Poster 82
Israel, Heidi Saint Louis University St Louis, MO USA	Paper 121; Posters 9, 57, 137

INDEX - ALPHABETICAL BY AUTHOR

Ivanov, David Rochester, MN USA	Poster 123
Iwai, Shintaro Graduate School of Medical Science, Kanazawa University Toyama, Japan	Poster 71
Jaarsma, Ruurd Flinders University and Flinders Medical Centre Bedford Park, Australia	Posters 4, 133
Jacobs, Cale Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky School of Medicine Lexington, KY USA	Posters 27, 47, 113, 114
Jacobsen, Kimberly Harborview Medical Center Seattle, WA USA	Poster 6
Jacobsen, Silje Berild Oslo, Norway	Paper 123
Jacobson, Lance Glen Idaho Falls, ID USA	Paper 96
Jacobson, Lance Glen Midvale, UT USA	Poster 129
Jadav, Bhavin Oaklands Park, Australia	Poster 133; Digital Case Presentation 21
Jain, Deepak Dayanand Medical College and Hospital Ludhiana, India	International Paper 41
Janssen, Stein Jasper Amphia Hospital Breda, Netherlands	Poster 136
Jarayabhand, Rahat Bangkok, Thailand	International Paper 57
Jenkins, David Oregon Hlth & Sci Univ Portland, OR USA	Paper 73
Jenkinson, Richard Sunnybrook Health Sciences Toronto, ON Canada	Paper 63
Jenkinson, Richard Toronto, ON Canada	Poster 107
Jensen, Kai Oliver University Hospital Zurich, Department of Trauma Zürich, Switzerland	Basic Science Paper 8; International Poster 155
Jeong, Imju Seoul, Korea, Republic of	Basic Science Paper 13
Jeray, Kyle James Greenville Health System Greenville, SC USA	Papers 70, 121; Poster 58; Breakout Session
Jevsevar, David S Dartmouth Hitchcock Medical Center Lebanon, NH USA	Poster 41
Ji, Wang Chongqing, China, People's Republic of	Poster 75
Jiamton, Chittawee Bangkok, Thailand	International Paper 57

INDEX - ALPHABETICAL BY AUTHOR

Jo, Jacob University of Massachusetts Worcester, MA USA	Paper 119; Poster 36
Johal, Herman Hamilton, ON Canada	Paper 92; Poster 43
Johnson, Anna USA Orthopaedics Mobile, AL USA	Paper 95
Johnson, Christopher Rolf Los Angeles, CA USA	Poster 49
Johnson, Joseph Robert NYU Langone Orthopedic Hospital New York, NY USA	Paper 116; Posters 40, 86, 93
Johnson, Pierce University of Arizona Phoenix Phoenix, AZ USA	Poster 150
Johnson, Shannon Lexington, KY USA	Poster 114
Johnson, Toby Bristol, United Kingdom	Poster 146
Jones, Alan L Dallas, TX USA	Breakout Session
Jones, Clifford B The CORE Institute, University of Arizona - Phoenix Phoenix, AZ USA	Symposium; Paper 66; Posters 7, 29, 137; Breakout Session
Jones, Kelly Perth, Australia	International Paper 58
Joo, Yong Bum Daejeon, Korea, Republic of	International Paper 51
Joseph, Noah MetroHealth System Cleveland, OH USA	Posters 26, 117
Joshi, Manjari University of Maryland Baltimore, MD USA	Papers 76, 105; Poster 58
Josten, Christoph Leipzig, Germany	International Paper 32
Judd, Kyle T Univ of Rochester Dept of Orthopaedics Rochester, NY USA	Paper 124
Julka, Manjula Dallas, TX USA	Paper 93
Kacena, Melissa Indiana University School of Medicine Indianapolis, IN USA	Basic Science Papers 19, 26
Kain, Michael S Boston Medical Center Boston, MA USA	Breakout Session
Kaiser, Philip Harvard Combined Orthopaedic Residency Program Boston, MA USA	Poster 66
Kalbas, Yannik University Hospital Zurich, Department of Trauma Zürich, Germany	Basic Science Papers 9, 27; International Poster 155

Kalina, Mark Anthony MetroHealth System Cleveland, OH USA	Poster 117
Kamal, Robin Neil Stanford University Department of Orthopaedic Surgery Stanford, CA USA	Poster 140
Kanakaris, Nikolaos K Academic Dept of Trauma and Orthopaedics Leeds, United Kingdom	International Symposium; Posters 73, 94
Kandemir, Utku Univ of Cal San Francisco San Francisco, CA USA	Posters 102, 125
Kane, Christina Sudbury, MA USA	Paper 119
Kane, Patrick Akron, OH USA	Paper 115
Kanellakos, James Morristown, NJ USA	Poster 81
Kang, Chan Chungnam National University Hospital Daejeon, Korea, Republic of	International Paper 31
Kang, Dong-Wan Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53
Kang, Jean Allston, MA USA	Paper 112
Kaplan, Heidi B. University of Texas Medical School At Houston Houston, TX USA	Basic Science Paper 16
Karunakar, Madhav A Carolinas Medical Center Charlotte, NC USA	Papers 73, 83; Posters 70, 135
Kates, Stephen L VCU Orthopaedics Richmond, VA United States	Symposium
Kaur, Japsimran Palo Alto, CA USA	Paper 94
Kavanagh, Michael MetroHealth System Cleveland Heights, OH USA	Poster 8
Kawano, Hirotaka Teikyo University School of Medicine Tokyo, Japan	Poster 82
Keita, Maningbe Baltimore, MD USA	Poster 29
Kellam, James F University of Texas Health Science Center at Houston Houston, TX USA	Poster 126
Kelly, Erin Arlene NYU Langone Orthopedic Hospital New York, NY USA	Papers 107, 116; Posters 40, 86, 93
Kelly, Michael North Bristol NHS Trust Bristol, United Kingdom	Paper 82; Poster 134
Kempton, Laurence Charlotte, NC USA	Paper 108

Kempton, Laurence Carolinas Medical Center Charlotte, NC USA	Posters 7, 29
Kennedy, Patrick Merrill Penn State Milton S. Hershey Medical Center Hershey, PA USA	Basic Science Paper 6
Kent, William T UC San Diego San Diego, CA USA	Poster 116
Kerkhoffs, Gino M Academic Medical Center Amsterdam, Netherlands	Posters 4, 133
Ketz, John P University of Rochester Department of Orthopaedics Pittsford, NY USA	Paper 124; Poster 64
Kfuri, Mauricio University Of Missouri Columbia, MO USA	Breakout Session
Khan, Safdar N The Ohio State University Wexner Medical Center Columbus, OH USA	Posters 11, 15, 16
Khan, Umraz Bristol, United Kingdom	Paper 82
Khoshbin, Amir St Michael's Hospital Toronto, ON Canada	Poster 107
Khosravani, Nima Orlando, FL USA	Poster 105
Kibble, Kendra University of Minnesota Minneapolis, MN USA	Poster 22, 99
Kim, Beom-Soo Korea University Guro Hospital Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53; International Poster 154
Kim, Ji Wan Haeundae Paik Hospital Seoul, Korea, Republic of	International Papers 50, 51, 54
Kim, Ji-Sup Catholic Kwandong University Incheon, Korea, Republic of	Poster 85
Kim, Jinkak Korea University Seoul, Korea, Republic of	International Paper 53; International Poster 154
Kim, Joon-Woo Kyungpook National University Hospital Daegu, Korea, Republic of	International Papers 30, 39, 44
Kim, Jun Young Seoul, Korea, Republic of	Poster 85
Kim, Yesul Tina McGovern Medical School At Uthealth Houston, TX USA	Basic Science Paper 16; Paper 81; Poster 130
King, John Dunseith Lexington, KY USA	Poster 27
Kisilak, Miha Ljubljana, Slovenia	Poster 65

Klahs, Kyle Jay El Paso, TX USA	Paper 110
Klatman, Samuel Harry LSUHSC - New Orleans New Orleans, LA USA	Poster 24
Kleftouris, George Leeds General Infirmary Leeds, United Kingdom	Poster 73
Kleweno, Conor P University of Washington Seattle, WA USA	Poster 3
Kliethermes, Stephanie University of Wisconsin Madison, WI USA	Poster 69
Kocher, Mininder S Boston Children's Hospital Boston, MA USA	Paper 131
Kocialkowski, Cezary Taunton, United Kingdom	Poster 138
Koeller, Manfred Bochum, Germany	Basic Science Paper 10
Koh, Justin J Boston, MA USA	Paper 112
Koh, Kyung University of Maryland School of Medicine Baltimore, MD USA	Poster 147
Kohring, Jessica M University of Rochester Department of Orthopaedics Rochester, NY USA	Paper 124
Kojima, Kodi Edson Sao Paulo, Brazil	International Symposia
Konda, Sanjit R Jamaica Hospital Medical Center, NYU Langone Orthopedic Hospital New York, NY USA	Papers 107, 109, 116; Posters 25, 38, 40, 45, 46, 86, 93, 103, 139
Korley, Robert Calgary, AB Canada	Paper 118
Kottmeier, Stephen Stony Brook University Stony Brook, NY USA	Paper 73; Breakout Sessions
Koval, Kenneth J Pass Christian, MS USA	Posters 77, 105
Kraus, Mark T UMass Memorial Worcester, MA USA	Paper 113
Krause, Peter C LSUHSC - New Orleans New Orleans, LA USA	Poster 24
Kreder, Hans J University of Toronto, Sunnybrook HSC Toronto, ON Canada	Paper 63; Poster 107
Kremen, Thomas J Department of Orthopaedic Surgery, David Geffen School of Medicine at UCLA Los Angeles, CA USA	Poster 2

Krieg, James C Rothman Institute of Orthopaedics, Thomas Jefferson University Philadelphia, PA USA	Basic Science Paper 14
Krijnen, Pieta Leiden University Medical Center Leiden, Netherlands	Paper 130
Kristoffersen, Per Martin Bergen, Norway	Paper 137
Krol, Oscar Brooklyn, NY USA	Poster 142
Krukhaug, Yngvar Bergen, Norway	Paper 137
Krum, L Nicole Baltimore, MD USA	Paper 139
Kubiak, Erik University Medical Center Las Vegas, NV USA	Digital Case Presentation 8
Kugelman, David Neil Manhattan, NY USA	Paper 109; Poster 46
Kulber, David Alan Cedars-Sinai Medical Center Los Angeles, CA USA	Digital Case Presentation 18
Kumaravel, Manickam Houston, TX USA	Paper 99
Kurata, Yoshiaki Hokkaido, Japan	Poster 82
Kuroda, Ryosuke Kobe, Japan	International Paper 52
Kurozumi, Taketo Teikyo University School of Medicine Tokyo, Japan	Poster 82
Kurtz, William Jason Cleveland Clinic Akron General Akron, OH USA	Paper 115
Kwek, Ernest Singapore, Singapore	Paper 104
Kwon, John Y Beth Israel Deaconess Medical Center Boston, MA USA	Paper 128; Poster 32
Labrum IV, Joseph T. Nashville, TN USA	Papers 88, 89
Lack, William Dean Seattle, WA USA	Paper 79; Poster 51
Laflamme, George Yves Hopital du Sacre-Coeur de Montreal Montreal, QC Canada	Papers 65, 72
Landrum, Matthew Dallas, TX USA	Basic Science Paper 1
Lane, Joseph M Hosp for Special Surgery New York, NY USA	Breakout Session

Lane, Joseph M Hosp for Special Surgery New York, NY USA	Poster 62
Lang, Gerald J University of Wisconsin Madison, WI USA	Posters 18, 69; Breakout Session
Langerhuizen, D.W.G. Adelaide, Netherlands	Poster 4
Langford, Joshua Orlando Health Orlando, FL USA	Posters 77, 105; Breakout Session
Lansink, Koen Oisterwijk, Netherlands	International Paper 35; Posters 104, 119
Lapite, Isaac Cleveland, OH USA	Poster 128
Larrainzar, Ricardo Madrid, Spain	Poster 149
Lau, Brian University of California, San Francisco San Francisco, CA USA	Paper 98
Lawendy, Abdel-Rahman London Health Sciences Centre London, ON Canada	Breakout Session
LeBrun, Christopher T University of Maryland School of Medicine Ellicott City, MD USA	Paper 69
Lechtig, Aron Beth Israel Deaconess Medical Center Boston, MA USA	Basic Science Paper 5; Poster 32
Lederman, Evan Scott The Orthopedic Clinic Assn Phoenix, AZ USA	Poster 150
Leduc, Stephane CIUSSS NIM Laval, QC Canada	Paper 65
Lee, Adam K University of Southern California Los Angeles, CA USA	Digital Case Presentation 14
Lee, Christopher R Adams Cowley Shock Trauma Medical Center Richmond, VA USA	Poster 39
Lee, Gisoo Chungnam National University Daejeon, Korea, Republic of	International Paper 31
Lee, Mark A Sacramento, CA USA	Basic Science Symposium; Breakout Sessions
Lee, Thay Q VA Healthcare Syst(09/151) Pasadena, CA USA	Basic Science Paper 2
Lee, Wu Chean Tan Tock Seng Hospital Singapore, Singapore	Paper 104
Leekha, Surbhi Baltimore, MD USA	Poster 58

Lefering, Rolf University of Witten/Herdecke Cologne, Germany	International Poster 155
Leighton, Ross K Nova Scotia Health Authority, Dalhousie University Halifax, NS Canada	Papers 72, 73
Lenihan, Jonathan Peterborough, United Kingdom	International Poster 156
Leonard, Dana Angell Stanford Medical School Stanford, CA USA	Paper 94
Leonardi, Claudia LSUHSC - New Orleans New Orleans, LA USA	Poster 24
Leucht, Philipp NYU Langone Orthopedic Hospital New York City, NY USA	Paper 107; Posters 50, 103, 139
Levack, Ashley New York, NY USA	Basic Science Paper 12
Levy, Joseph Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Poster 29
Lewis, Gregory S Penn State College of Medicine Hershey, PA USA	Basic Science Paper 6
Lewis, Sophie Cambridge, United Kingdom	Poster 98
Ley, Erica F Earls Colne, United Kingdom	International Paper 58
Li, G. Ying University of Michigan Ann Arbor, MI USA	Paper 131
Li, Junzui China Nanning, China, People's Republic of	International Paper 47
Li, Katherine Charlotte, NC USA	Paper 73
Lian, Serena New York, NY USA	Poster 62
Lim, Eic Ju Seoul, Korea, Republic of	Basic Science Paper 13; International Papers 50, 53
Lin, Carol Cedars-Sinai Medical Center Los Angeles, CA USA	Posters 31, 46, 54
Liotta, Elizabeth Savika Boston Children's Hospital Boston, MA USA	Paper 131
Lipof, Jason University of Rochester Rochester, NY USA	Poster 64
Liporace, Frank A Englewd Clfs, NJ USA	Breakout Sessions
Lisong, Heng Xi'An, China, People's Republic of	Poster 145

Little, Milton Thomas M Cedars Sinai Medical Center Los Angeles, CA USA	Posters 2, 49; Breakout Session
Liu, Boshen University of Kentucky Lexington, KY USA	Poster 27
Liu, Han Guangzhou, China, People's Republic of	International Paper 29; Paper 86
Liu, Hongliang Xi'an Honghui Hospital Xi'An, China, People's Republic of	International Paper 38
Liu, Junyang Tianjin, China, People's Republic of	International Paper 56
Llano, Lionel Buenos Aires, Argentina	International Poster 152; Digital Case Presentation 10
Longaker, Michael T. Palo Alto, CA USA	Basic Science Paper 20
Longaker, Michael T. Stanford University Stanford, CA USA	Basic Science Paper 23
Lott, Ariana New York, NY USA	Paper 109
Lowe, Mallory LSUHSC - New Orleans New Orleans, LA USA	Poster 24
Lu, Joana Chan Pomona, CA USA	Poster 87
Lu, Keyin Saint Louis University Saint Louis, MO USA	Poster 57
Lucas, Justin Harborview Medical Center San Jose, CA USA	Poster 12
Ludvigsen, Trine Voss, Norway	Paper 137
Lufrano, Reuben C University of Wisconsin Madison, WI USA	Papers 88, 89, 122
Luly, Jason METRC Baltimore, MD USA	Poster 7
Lund, Erik A University of South Florida Minneapolis, MN USA	Papers 88, 89
Luo, Congfeng Shanghai, China, People's Republic of	Poster 96
Ly, Thuan V The Ohio State University Wexner Medical Center Columbus, OH USA	Posters 11, 15, 16
Lyons, Madeline Chicago, IL USA	Paper 79
Mabarak, Dimitri Joseph Maywood, IL USA	Poster 51

INDEX - ALPHABETICAL BY AUTHOR

MacCormick Tatman, Lauren University of Minnesota Minneapolis, MN USA	Papers 88, 89
Maceroli, Michael A. Grady Memorial Hospital/Emory University Atlanta, GA USA	Breakout Sessions
Macias-Perez, Ines Cumberland Pharmaceuticals Nashville, TN USA	Paper 68
MacKenzie, Ellen Johns Hopkins SHPH Baltimore, MD USA	Paper 83
MacKenzie, Ellen Johns Hopkins SHPH Baltimore, MD USA	Poster 29
Mackenzie, Samuel Edinburgh, United Kingdom	International Paper 40
Macknet, David Carolinas Medical Center Charlotte, NC USA	Poster 135
Madsen, Jan Erik Oslo University Hospital Ullevaal Oslo, Norway	International Paper 33; Paper 123
Magnusson, Erik Arthur University of Washington Seattle, WA USA	Poster 44
Maher, Michael Allegheny General Hospital Denver, CO USA	Poster 106
Malchau, Henrik Boston, MA Sweden	Paper 101
Malik, Azeem Tariq The Ohio State University Wexner Medical Center Columbus, OH USA	Posters 11, 15, 16
Mallee, Wouter Academic Medical Center of Amsterdam Meibergdreef 9, Netherlands	Poster 4
Malo, Michel Montréal, QC Canada	Paper 65
Mandel, Jessica Miami, FL USA	Poster 25
Mandell, Jacob Brigham and Women's Hospital Boston, MA USA	Poster 101
Mandl, Lisa A Hospital For Special Surgery New York, NY USA	Poster 62
Manson, Theodore Thomas Bel Air, MD USA	Papers 69, 84; Posters 19, 28; Breakout Session
Manzano, Givenchy W MetroHealth System Cleveland, OH USA	Paper 73
Marcantonio, Andrew J Lahey Hospital Wellesley, MA USA	Paper 73; Poster 137

Marchand, Lucas Scott R Adams Cowley Shock Trauma Center Salt Lake City, UT USA	Paper 139; Poster 129
Märdian, Sven Charité - University Medicine Berlin Berlin, Germany	International Paper 32
Marecek, Geoffrey USC Department of Orthopaedic Surgery Los Angeles, CA USA	Digital Case Presentation 14
Marsh, J Lawrence Dept Of Orthopaedics Iowa City, IA USA	Poster 3
Marson, Ben The University of Nottingham Nottingham, United Kingdom	Poster 78
Martin, Ryan Foothills Medical Centre Calgary, AB Canada	Paper 118
Martínez Gómiz, José María Madrid, Spain	Poster 149
Matiski, Thomas J Phoenix, AZ USA	Poster 150
Matre, Kjell Haukeland Hospital Bergen, Norway	Paper 137
Matsui, Kentaro Teikyo University Tokyo, Japan	Poster 82
Matsuse, Hiroo Kurume, Fukuoka, Japan	Digital Case Presentation 12
Matthews, Paul A University of Nottingham Nottingham, United Kingdom	Paper 67
Matuszewski, Paul Edward University of Kentucky Lexington, KY USA	Papers 113, 119; Posters 23, 27, 47, 113, 114
Mauffrey, Cyril Denver Health Medical Center, Orthopedic Department Denver, CO USA	International Symposium; Papers 88, 89; Poster 106, 112
Maxson, Benjamin Florida Orthopaedic Institute Tampa, FL USA	Poster 14; Digital Case Presentation 9
Mazzei, Christopher Morristown, NJ USA	Poster 81
McAndrew, Christopher Washington University in St. Louis Saint Louis, MO USA	Paper 90
McCreary, Dylan Lowe University of Minnesota Minneapolis, MN USA	Poster 99
McDonald, Amy Ann Louis Stokes Cleveland VA Medical Center Cleveland, OH USA	Paper 106; Poster 53

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5
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13
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Z

McGarry, Michelle H Congress Medical Foundation Pasadena, CA USA	Basic Science Paper 2
McKee, Michael D Banner - University Medical Center Phoenix Phoenix, AZ USA	Symposium; Basic Science Paper 3; Papers 63, 132, 133, 136; Poster 107; Breakout Sessions
McKinley, Todd Owen Indiana University Indianapolis, IN USA	Basic Science Papers 7, 19, 26; Papers 69, 108
McMahon, Samuel Edward Belfast, United Kingdom	International Paper 45
McMillan, Logan J University of Minnesota Anoka, MN USA	Poster 22
McMurry, Sam Denver, CO United States	Symposium
McQueen, Margaret M Royal Infirmaryof Edinburgh Edinburgh, United Kingdom	Paper 135; Poster 141
McTague, Michael Massachusetts General Hospital Boston, MA USA	Paper 101; Poster 48
Meehan, Robert E Dearborn Orthopaedics and Sports Medicine Dearborn, MI USA	Paper 126
Meijer, Diederik Tim AMC Amsterdam, Netherlands	Poster 4
Meinberg, Eric G UCSF/SFGH Orthopaedic Trauma Institute San Francisco, CA USA	Breakout Session
Melo, Luana Torres Toronto, ON Canada	Poster 107
Mendelson, Daniel Ari University of Rochester School of Medicine Rochester, NY USA	Breakout Session
Mener, Amanda Atlanta, GA USA	Poster 34
Menon, Matthew Ramesh Edmonton, AB Canada	Paper 114
Merchant, Aziz Rutgers New Jersey Medical School Newark, NJ USA	Poster 118
Merimee, Stephanie Florida Orthopaedic Institute Tampa, FL USA	Poster 14
Merle, Géraldine McGill University Montreal, QC Canada	Basic Science Papers 18, 22
Metcalf, Kathryn B Cleveland, OH USA	Posters 128, 131
METRC, Baltimore, MD USA	Poster 29
METRC, Vanco R Baltimore, MD USA	Paper 76

Metsemakers, Willem-Jan University Hospitals Leuven Leuven, Belgium	Symposium
Metzger, Melodie Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 2
Miclau, Theodore Orthopaedic Trauma Institute San Francisco, CA USA	Basic Science Paper 24
Midic, Uros Burlingame, CA USA	Basic Science Paper 17
Miles, Anthony William Univ of Bath/Dept of Mechanical Engineering Bath, United Kingdom	International Poster 156
Milhoan, Madison Houston, TX USA	Basic Science Paper 16
Miller, Adam Joseph Houston, TX USA	Paper 73
Miller, Andy New York, NY USA	Basic Science Paper 12
Miller, Anna Noel Washington University In St. Louis Saint Louis, MO USA	Papers 73, 90; Poster 24
Miller, Christopher Dover, MA USA	Paper 128
Miller, Christopher Beth Israel Deaconess Medical Center Boston, MA USA	Poster 32
Mir, Hassan Riaz Florida Orthopaedic Institute Tampa Bay, FL USA	Papers 88, 89; Poster 14; Digital Case Presentation 9; Breakout Sessions
Mitchell, Scott A Houston, TX USA	Poster 127
Mitsuhiro, Matsuura Department of Orthopaedic Surgery, Kurume University School of Medicine Kurume, Japan	Digital Case Presentation 12
Miyamoto, Takashi Nagasaki University Hospital Nagasaki, Japan	International Symposium
Moattari, Cameron Reza Brooklyn, NY USA	Poster 144
Moen, Matthew Todd SIGN Fracture Care International Olympia, WA USA	Poster 95
Moghadamian, Eric Scott Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky School of Medicine Lexington, KY USA	Paper 113; Poster 114
Mohamadi, Amin Beth Israel Deaconess Medical Center Boston, MA USA	Poster 101
Moloney, Gele University of Pittsburgh Medical Ctr Pittsburgh, PA USA	Poster 10

INDEX - ALPHABETICAL BY AUTHOR

Molyneux, Samuel G Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 134
Monfiston, Carl-Henri Washington D.C., DC USA	Poster 2
Monteerarat, Yuwarat Faculty of Medicine Siriraj Hospital, Mahidol University Bangkok, Thailand	Paper 117
Moore, Ernest E Denver, CO USA	Symposium; Poster 112
Moore, Thomas Joseph Emory Univ School of Medicine Atlanta, GA USA	Poster 56
Moore, Timothy A MetroHealth System Shaker Heights, OH USA	Paper 111
Morellato, John Baltimore, MD USA	Poster 37
Morgan, Steven J Mountain Orthopaedic Trauma Surgeons Englewood, CO USA	Breakout Session
Morgenstein, Aaron Atlanta, GA USA	Digital Case Presentation 1
Morin, Matthew University of Arizona Tucson, AZ USA	Poster 135
Morris, Elizabeth R Vail, CO USA	Basic Science Paper 24
Morshed, Saam UCSF/SFGH Ortho Trauma Inst San Francisco, CA USA	Symposium; Paper 66; Posters 7, 29, 100
Mulles, Shanen Rutgers New Jersey Medical School Newark, NJ USA	Poster 118
Mulliken, Alexandra Bryn Baltimore, MD USA	Papers 84, 139; Posters 37, 110
Mullis, Brian Indiana University Zionsville, IN USA	Basic Science Symposium; Paper 73; Posters 9, 24, 137; Digital Case Presentation 4
Munz, John Wesley McGovern Medical School At UTHealth Houston, TX USA	Paper 99; Poster 80; Digital Case Presentation 13; Breakout Session
Murena, Luigi Trieste, Italy	Poster 121
Murphy, Michael Loyola University Medical Center Downers Grove, IL USA	Poster 51
Murray, Clinton Kenneth Aber Prov Grd, MD USA	Papers 76, 105
Murray, Nicholas Bristol, United Kingdom	Poster 146
Mutawakkil, Muhammad Yazid Chicago, IL USA	Poster 97

Myeroff, Chad M Saint Paul, MN USA	International Symposium
Myint, Yulanda Queens Medical Centre Nottingham, United Kingdom	Paper 73
Na, Young Gon Gachon University Gil Medical Center Incheon, Korea, Republic of	International Paper 51
Nadeau, Jason Denver Health Medical Center Denver, CO USA	Papers 88, 89; Poster 112
Nakama, Kenjiro Kurume City, Japan	Digital Case Presentation 12
Namm, Joshua Saint Louis, MO USA	Paper 73
Narayanan, Rajkishen New York, NY USA	Poster 25
Nascone, Jason Warren University of Maryland School of Medicine Baltimore, MD USA	Papers 69, 84
Natoli, Roman Indiana University Indianapolis, IN USA	Paper 69
Natoli, Roman Indiana University School of Medicine Indianapolis, IN USA	Basic Science Papers 19, 26
Nauth, Aaron Toronto, ON Canada	Breakout Session
Nauth, Aaron Toronto, ON Canada	Basic Science Paper 25; Papers 63, 132, 133, 136; Poster 107
Nazarian, Ara Beth Israel Deaconess Medical Center Boston, MA USA	Basic Science Paper 5
Nelen, Stijn Tilburg, Netherlands	Poster 104
Nelson, Lauren Louisville Louisville, KY USA	Poster 137
Nelson, Trevor Cedars-Sinai Los Angeles, CA USA	Poster 2
Nepple, Jeffrey J Washington University of St. Louis Saint Louis, MO USA	Paper 131
Nesbit, Robert David Burlington, VT USA	Paper 127
Nethi, Arun Dallas, TX USA	Paper 93
Neuhaus, Valentin University Hospital Zurich, Department of Trauma Boston, MA USA	International Poster 155
Newman, Erik T Harvard Combined Orthopaedic Residency Program Boston, MA USA	Poster 66

Newman, Jared M SUNY Downstate Medical Center Brooklyn, NY USA	Posters 142, 144
Ng, Richard University of Calgary Calgary, AB Canada	International Paper 40
Nguyen, Mai P Texas Tech University Health Sciences Center El Paso, TX USA	Papers 71, 106, 110; Poster 53
Nicholson, Jamie A Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 134
Nicol, Graeme Marshall Bristol, United Kingdom	Poster 109
Nightingale, Jessica Nottingham University Hospitals Nottingham, United Kingdom	Paper 67; Poster 78
Niikura, Takahiro Kobe University Kobe, Japan	International Paper 52
Noehren, Brian College of Health Sciences, University of Kentucky Lexington, KY USA	Posters 47, 113
Noori, Naudereh Cedars Sinai Medical Center West Hollywood, CA USA	Digital Case Presentation 18
Noorzad, Ali Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 49
Norman, Doron Haifa, Israel	Paper 78
Norris, Brent L Ortho & Trauma Serv of OK Tulsa, OK USA	Basic Science Symposium
Noser, Jonas University Hospital Zurich Zurich, Switzerland	Poster 60
Nousiainen, Markku Toronto, ON Canada	Poster 107
Novak, Avrey Seattle, WA USA	Poster 44
Nowak, Lauren Toronto, ON Canada	Paper 133; Poster 107
O'Hara, Nathan N University of Maryland School of Medicine Baltimore, MD USA	Papers 69, 84, 91, 139; Posters 28, 37, 39, 58, 110, 147
O'Leary, Ronan Neurosciences and Trauma Critical Care Unit Cambridge, United Kingdom	Paper 85
O'Pry, Erin Kathleen Suwanee, GA USA	Digital Case Presentation 11
O'Toole, Robert V R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine Lutherville, MD USA	Papers 69, 76, 83, 84, 88, 89, 91, 139; Posters 19, 28, 29, 33, 37, 39, 58, 110, 115, 147

Obremskey, William T. Vanderbilt Ortho Inst Nashville, TN USA	Papers 76, 83, 88, 89; Poster 137; Breakout Sessions
Ochenjele, George University Hospitals Case Medical Center Cleveland Heights, OH USA	Paper 139; Posters 128, 131
Odei, James Beguah Columbus, OH USA	International Paper 42
Oderuth, Eshan Nottingham University Hospitals NHS Trust Nottingham, United Kingdom	Poster 78
Odutola, Adekoyejo Bristol, United Kingdom	Poster 109
Oe, Keisuke Kobe, Japan	International Paper 52
Oh, Chang-Wug Kyungpook National University Hospital Daegu, Korea, Republic of	International Papers 30, 39, 44
Oh, Jong-Keon Korea University Guro Hospital Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53; International Poster 154
Okajima, Stephen Princeton Junction, NJ USA	Basic Science Paper 5
Okazaki, Shingo Kurume, Fukuoka, Japan	Digital Case Presentations 12, 17
Okelana, Bandele University of Minnesota St Paul, MN USA	Posters 22, 43
Okike, Kanu M Honolulu, HI USA	Paper 120
Olasubulumi, Ore-Oluwa Montreal, QC Canada	Basic Science Paper 18
Oliver, William M Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 134
Ollivere, Benjamin Queens Medical Centre Nottingham, United Kingdom	Papers 67, 73; Poster 78; Breakout Session
Olson, Jeffrey Boston, MA USA	Poster 13
Olson, Steven A Duke Hospital South Durham, NC USA	International Symposium
Olszewski, Nathan P Boston University Boston, MA USA	Paper 73
Ordonio, Katherine University of Maryland School of Medicine Baltimore, MD USA	Poster 28
Ortega, Gilbert Ralph Scottsdale, AZ USA	Digital Case Presentation 15
Osterhoff, Georg University Hospital Zurich Leipzig, Switzerland	Poster 60

INDEX - ALPHABETICAL BY AUTHOR

Ostrum, Robert F UNC Department of Orthopaedics Chapel Hill, NC USA	Paper 66; Poster 137
Overmann, Archie Walter Reed National Military Medical Center Bethesda, MD USA	Poster 124
Oyer, Mark Allen Northwestern Univ Med School Chicago, IL USA	Poster 97
Packham, Iain Bristol, United Kingdom	Poster 146
Padela, Muhammad Chicago Medical School At Rosalind Franklin Uni North Chicago, IL USA	Poster 20
Paiement, Guy D Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 49
Palm, Hans-George Bundeswehrkrankenhaus Ulm Ulm, Germany	International Paper 32
Paltoo, Karen Merrick, NY USA	Poster 142
Pandya, Nirav Kiritkumar Oakland Children's Hospital Oakland, CA USA	Paper 131
Panteli, Michalis Leeds, United Kingdom	Paper 97; Poster 94
Pape, Hans-Christoph University of Zurich Zurich, Switzerland	Basic Science Symposium; Basic Science Papers 8, 9, 27; Paper 66; Poster 60; International Poster 155
Parikh, Harsh Rajesh University of Minnesota & HealthPartners St. Paul, MN USA	Papers 74, 88, 89; Posters 22, 43
Park, Ki Chul Hanyang University Guri Hospital Guri City, Korea, Republic of	International Papers 44, 50, 54
Park, Kyeong Hyeon Kyungpook National University Jung-gu, Daegu, Korea, Republic of	International Papers 30, 39, 44
Park, Young-Chang Catholic Kwandong University Incheon, Korea, Republic of	Poster 74
Park, Young-Chang Catholic Kwandong University Incheon, Korea, Republic of	Poster 85
Parker, Amber Roxbury, MA USA	Paper 128
Parker, Ruth Atlanta, GA USA	Poster 34
Parry, Joshua A Denver Health Medical Center Denver, CO USA	Symposium; Posters 77, 105, 106, 112
Parvizi, Javad Rothman Institute of Orthopaedics, Thomas Jefferson University Philadelphia, PA USA	Basic Science Paper 14

See the meeting app for complete listing of authors' disclosure information.

421

Parzych, Lydia University of Massachusetts Auburn, MA USA	Poster 36
Patel, Jay Morristown, NJ USA	Poster 81
Patel, Raahil Tampa, FL USA	Poster 14
Patterson, Joseph UCSF Orthopaedic Surgery San Francisco, CA USA	Poster 125
Pavliv, Leo Cumberland Pharmaceuticals Nashville, TN USA	Paper 68
Pawlak, Amanda Stony Brook University Stony Brook, NY USA	Paper 73
Peabody, Michael Chicago, IL USA	Poster 97
Peck, Sarah Catherine University of Minnesota Minneapolis, MN USA	Paper 74
Pedri, Tony University of Minnesota & HealthPartners St. Paul, MN USA	Paper 74
Pennock, Andrew Tennant Rady Children's Hospital San Diego, CA USA	Paper 131
Pensy, Raymond A Brinklow, MD USA	Paper 139
Perez, Edward Campbell Clinic Memphis, TN USA	Paper 66
Perez-España, Manuel Madrid, Spain	Poster 149
Pesciallo, César Hospital Britanico de Buenos Aires Caba, Argentina	Breakout Session
Peter, Elvira Bochum, Germany	Basic Science Paper 10
Petrisor, Brad Hamilton General Hosp Hamilton, ON Canada	Papers 70, 92; Poster 58
Pfeifer, Roman Zürich, Germany	Basic Science Papers 8, 9, 27
Pflug, Alexander Jena, Germany	International Paper 32
Phieffer, Laura The Ohio State University Wexner Medical Center Columbus, OH USA	Papers 66, 73; Posters 11, 15, 16; Digital Case Presentation 3
Phruetthiphat, Ong-Art Bangkok, Thailand	International Paper 61
Pieroh, Philipp University of Leipzig Leipzig, Germany	International Paper 32

422

Pieroh, Philipp University of Leipzig Leipzig, Germany	Poster 60
Pizzo, Richard A RWJBarnabas Health - Jersey City Medical Center Jersey City, NJ USA	Poster 81
Plumarom, Yanin Phramongkutklao hospital Bangkok, Thailand	International Paper 61
Poggie, Robert A Biovera, Inc. Notre-dame-de-l'ile-Perrot, QC Canada	Basic Science Symposium
Poletick, Eileen Morristown Medical Center Morristown, NJ USA	Poster 81
Polk, Andrew U of Missouri Columbia, MO USA	Poster 5
Pollak, Andrew N R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine Baltimore, MD USA	Paper 66; Posters 29, 37, 39
Ponsen, Kornelis Ouderkerk Aan De Amstel, Netherlands	International Symposium
Porcheron, Geoffrey Mainz, Germany	Poster 65
Potter, Benjamin Kyle Walter Reed Military Medical Center Bethesda, MD USA	Basic Science Symposium; Symposium; Poster 124
Pountos, Ippokrates Leeds General Infirmary Leeds, United Kingdom	Paper 97
Powell-Bowns, Matilda Edinburgh, United Kingdom	International Paper 40
Praston, Lincoln Chapel Hill, NC USA	Paper 73
Prevost, Mark Alan University of South Alabama Mobile, AL USA	Paper 77
Puente, Ivan Delray Beach, FL USA	Paper 68
Pujari, Amit El Segundo, CA USA	Poster 49
Pujari, Amit Los Angeles, CA USA	Poster 54
Purcell, Kevin Francis University of Mississippi Medical Center Jackson, MS USA	Poster 21
Purcell, Kevin Francis University of Mississippi Medical Center Jackson, MS USA	Poster 24
Putzeys, Guy AZ Groeninge, Kortrijk Bellegem, Belgium	International Symposium

Putzeys, Guy AZ Groeninge Kortrijk, Belgium	Poster 72
Qiao, Zhi Aachen, China, People's Republic of	Basic Science Papers 8, 27
Quatman, Carmen E The Ohio State University Wexner Medical Center Columbus, OH USA	Posters 11, 15, 16; Digital Case Presentation 3
Queally, Joseph Martin Royal College of Surgeons in Ireland Cambridge, Ireland	Paper 85; Poster 98
Quinnan, Stephen Matthew Miami, FL USA	Poster 29
Quintens, Liselore Leuven, Belgium	International Paper 37
Rackard, Forrest Dartmouth Hitchcock Medical Center Lebanon, NH USA	Poster 41
Raeder, Benedikte W Drammen, Norway	Paper 123
Ramirez Garcia Luna, Jose Luis McGill University Montreal, QC Canada	Basic Science Papers 18, 22
Ramos Pascual, Sonia Bath, United Kingdom	International Poster 156
Rane, Ajinkya Salt Lake City, UT USA	Posters 55, 129
Rangan, Amar The James Cook Univ Hosp Middlesbrough, United Kingdom	Paper 138
Raschke, Michael University of Muenster Muenster, Germany	Paper 64
Rasmussen, Todd Bethesda, MD USA	Basic Science Symposium
Ravi, Bheeshma Toronto, ON Canada	Poster 107
Redondo, Andres Maywood, IL USA	Poster 51
Rego, Mariana Parkside, Australia	Digital Case Presentation 21
Reich, Michael Texas Tech Univ Health Sciences Center El Paso El Paso, TX USA	Papers 71, 110; Poster 53
Reid, J Spence Hummelstown, PA USA	Paper 76; Breakout Session
Reider, Lisa Baltimore, MD USA	Poster 29
Reilly, Mark C Ambulatory Care Ctr Newark, NJ USA	International Symposium
Remmel, Melissa Burlingame, CA USA	Basic Science Paper 17

INDEX - ALPHABETICAL BY AUTHOR

Ren, Cheng Xi'an Honghui Hospital Xi'An, China, People's Republic of	International Paper 38
Reul, Maike Brussels, Belgium	International Paper 37
Riansuwan, Kongkhet Faculty of Medicine Siriraj Hospital, Mahidol University Bangkok, Thailand	Paper 117
Ricci, William M Hospital For Special Surgery New York, NY USA	International Symposium; Paper 66
Riccio, Anthony Ian Texas Scottish Rite Hospital For Children Dallas, TX USA	Paper 95
Richards, Justin Edward Baltimore, MD USA	Poster 115
Richter, Peter H Ulm, Germany	International Paper 49; Posters 61, 111
Rickman, Mark Dept of Trauma & Orthopaedics Adelaide, Australia	International Paper 33
Riddick, Andrew North Bristol NHS Trust Newport, United Kingdom	Paper 82
Riedel, Matthew D R Adams Cowley Shock Trauma Center Baltimore, MD USA	Paper 128
Rinehart, Dustin B Dallas, TX USA	Paper 93
Rio, Marcelo Buenos Aires, Argentina	International Symposium
Rivera, Trenton William MetroHealth System Cleveland Heights, OH USA	Paper 125
Roberts, Haydn Tucson, AZ USA	Poster 135
Robitsek, R Jonathan New York, NY USA	Poster 40
Rocha, Daniela Barreto Geisinger Health System Danville, PA USA	Paper 73
Roddy, Erika San Francisco, CA USA	Poster 125
Rodham, Paul Lambton Durham, United Kingdom	Poster 94
Rodriguez, Edward Beth Israel Deaconess Medical Center Medfield, MA USA	Basic Science Paper 5; Posters 32, 66, 76
Rodriguez-Buitrago, Andres F Nashville, TN USA	Papers 73, 88, 89
Rogers, Nathan Brian Houston, TX USA	Paper 99

Rojas, David Gonzalo Denver Health Medical Center Denver, CO USA	Poster 112
Roller, Brandon L Winston Salem, NC USA	Basic Science Paper 15
Rommens, Pol Maria Johannes Gutenberg Univ Mainz, Germany	Papers 64, 87; Poster 65
Rooney, Edward University of Michigan Canton, MI USA	Paper 129
Rosenwasser, Melvin Paul Columbia University Medical Center New York, NY USA	Poster 143
Ross, Hunter Metro Health Hospital Salt Lake City, UT USA	Poster 6
Rosteius, Thomas Bochum, Germany	Basic Science Paper 10
Rothberg, David Lynn University of Utah Orthopaedic Center Salt Lake Cty, UT USA	Posters 55, 90, 129
Rouleau, Dominique Montreal, QC Canada	Paper 65
Routt, Milton L University of Texas Health Science Center at Houston Houston, TX USA	Paper 99; Poster 80; Digital Case Presentation 16; Breakout Session
Rubinstein, Sidney VU University Amsterdam Amsterdam, Netherlands	Paper 130
Rudnicki, Joshua University of Maryland School of Medicine Baltimore, MD USA	Paper 69
Russell, George V University of Mississippi Medical Center Jackson, MS USA	Poster 21
Ryan, Weston University of Colorado Aurora, CO USA	Poster 112
S, Sy Jinan, China, People's Republic of	Breakout Session
Sabatini, Coleen S Oakland Children's Hospital Oakland, CA USA	Paper 131
Sabogal, Angie N Beth Israel Deaconess Medical Center Boston, MA USA	Basic Science Paper 5
Sagi, Henry Claude UC Health Cincinnati, OH USA	Paper 66; Breakout Session
Sakong, Seungyeob Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53
Salai, Moshe Tel Aviv Medical Center Tel-Aviv, Israel	Paper 78

Salazar, Brett Peter Palo Alto, CA USA	Posters 12, 148
Saloky, Kaitlin Lorraine Geisinger Commonwealth School of Medicine Hershey, PA USA	Basic Science Paper 6
Samuel, Katherine Grace Los Angeles, CA USA	Poster 2
Sancineto, Carlos F Buenos Aires, Argentina	Poster 68; International Poster 152; Digital Case Presentation 7
Sanders, David Victoria Hospital London, ON Canada	Symposium; Paper 122; Breakout Session
Sanders, Drew T Dallas, TX USA	Poster 92
Sanders, Roy W University of South Florida Florida Orthopaedic Institute Tampa, FL USA	Basic Science Symposium; Poster 14; Digital Case Presentation 9; Breakout Session
Sandriesser, Sabrina Institute of Biomechanics, BG Unfallklinik Murnau Murnau, Germany	Basic Science Paper 4
Sapp, Travis Orlando, FL USA	Poster 77
Sassoon, Adam Anton UCLA Health Santa Monica, CA USA	Breakout Session
Sathy, Ashoke Kasyap University of Texas Southwestern Medical Center Southlake, TX USA	Poster 92
Savaglio, Michael K Indianapolis, IN USA	Paper 96
Savakus, Jonathan Carr MetroHealth System Nashville, TN USA	Paper 106; Posters 24, 53
Sawaguchi, Takeshi Toyama Municipal Hospital Toyama, Japan	Poster 71
Sawyer, Jeffrey R Germantown, TN USA	Paper 95
Scamacca, Veronica Orthopaedics and Traumatology Clinic of Trieste Trieste, Italy	Poster 121
Scammell, Brigitte Queens Med Ctr, Orthopaedics Nottingham, United Kingdom	Paper 67
Scarone, Pietro Lugano, Switzerland	International Poster 151
Schaefbauer, Heather HealthPartners St Paul, MN USA	Poster 22
Scharfstein, Daniel Oscar Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Papers 76, 83; Poster 29

Schemitsch, Christine Toronto, ON Canada	Papers 132, 136
Schemitsch, Emil H London, ON Canada	Basic Science Symposium; Basic Science Paper 25; Papers 63, 70, 102, 132, 133, 136; Poster 107
Schenk, Richard S Whippany, NJ USA	Poster 81
Schenker, Mara Lynne Emory University Atlanta, GA USA	Posters 34, 56, 108
Scherer, Julian University Hospital Zurich, Department of Trauma Zürich, Switzerland	International Poster 155
Schildhauer, Thomas A Chirurgische Universitaetsklinik und Poliklinik Bochum, Germany	Basic Science Paper 10
Schipper, Inger Leiden University Medical Center Leiden, Netherlands	Paper 130
Schlatterer, Daniel R Atlanta, GA USA	Digital Case Presentation 1
Schloss, Michael Baltimore, MD USA	Paper 84; Posters 33, 110
Schmidt, Andrew H HCMC Dept of Orthopedic Surgery Minneapolis, MN USA	Breakout Session
Schmidt, Andrew H HCMC Dept of Orthopedic Surgery Minneapolis, MN USA	Paper 66
Schmidt, Andrew H Hennepin County Medical Center Minneapolis, MN USA	Papers 74, 83, 88, 89
Schmidt, Tegan Metrohealth Med Ctr Cleveland Heights, OH USA	Papers 88, 89
Schneider, Prism Foothills Medical Centre Calgary, AB Canada	Papers 72, 118, 122
Schottel, Patrick Christopher University of Vermont Medical Center Burlington, VT USA	Papers 102, 127; Poster 91
Schröder, Tanja Lieselotte Homburg, Germany	International Paper 32
Schroeder, Ian Los Angeles, CA USA	Poster 54
Schuetze, Konrad University Hospital of Ulm Ulm, Germany	Poster 111
Schulte, Spencer El Paso, TX USA	Paper 71
Schultz, Blake Joseph Stanford University Palo Alto, CA USA	Basic Science Paper 17

Schulz, Arndt Peter University Hospital Luebeck Luebeck, Germany	Paper 64
Schupfner, Rupert Bayreuth, Germany	Paper 64
Schütze, Konrad Ulm, Germany	International Paper 49; Poster 61
Schwartz, Andrew Michael Emory University Atlanta, GA USA	Posters 34, 108
Schweitzer, Ronen Portland, OR USA	Basic Science Paper 24
Schweser, Kyle University of Missouri Columbia, MO USA	Poster 79; Breakout Session
Sciadini, Marcus F Shock Trauma Orthopaedics Baltimore, MD USA	Paper 69; Poster 19; Breakout Session
Scolaro, John Alan University of California, Irvine - Orthopaedics Orange, CA USA	Basic Science Paper 2; Digital Case Presentation 14; Breakout Sessions
Scott, Chloe Edinburgh, United Kingdom	International Paper 40
Scott, Elizabeth University of Iowa Sports Medicine Iowa City, IA USA	Poster 3
Segbefia, Michael University of Ghana Medical School/Surgery Accra, Ghana	International Paper 42
Segovia, Nicole Alexandria Stanford University Redwood City, CA USA	Paper 94
Selhi, Harpal S Dayanand Medical College and Hospital Ludhiana, India	International Paper 41
Sems, Stephen A Mayo Clinic Rochester, MN USA	Paper 66; Poster 123
Seo, Il Jung-gu, Daegu, Korea, Republic of	International Papers 30, 39
Sepehri, Aresh University of Maryland School of Medicine Vancouver, BC Canada	Poster 39
Seybold, Dominik Bochum, Germany	Basic Science Paper 10
Seymour, Rachel Charlotte, NC USA	Poster 70
Shaath, Mohamad McGovern Medical School At UTHealth Houston, TX USA	Digital Case Presentation 13
Shah, Anjan Rajni Florida Orthopaedic Institute Tampa, FL USA	Poster 14; Digital Case Presentation 9

INDEX - ALPHABETICAL BY AUTHOR

Shah, Apurva Children's Hospital of Philadelphia Philadelphia, PA USA	Paper 95
Shah, Neil Vijay SUNY Downstate Medical Center New York, NY USA	Posters 142, 144
Shah, Sagar Amit Louisiana State Univ Hlth Sci Ctr New Orleans, LA USA	Paper 73
Shannon, Steven F Shock Trauma Orthopaedics Columbia, MD USA	Poster 19
Shapiro, Joshua UNC Health Chapel Hill, NC USA	Paper 73
Shaw, James Chung-Jade McGovern Medical School at UTHealth Houston, TX USA	Basic Science Paper 16; Digital Case Presentation 16
Shaw, Jordan T University of Wisconsin Madison, WI USA	Posters 95, 122
Shaw, Nichole Denver Health Medical Center Baltimore, MD USA	Papers 88, 89
Shearer, David University of California, San Francisco San Francisco, CA USA	Paper 98
Shehu, Alba Aachen, Germany	Basic Science Paper 8
Sheira, Dina New York, NY USA	Poster 62
Shelton, Trevor J Univ of California At Davis Med Ctr Sacramento, CA USA	Poster 116
Shelton, William L LSUHSC - New Orleans New Orleans, LA USA	Poster 24
Sheridan, Elizabeth Ohio State University Columbus, OH USA	Paper 73
Sherman, Alain Emil Northwestern University Chicago, IL USA	Poster 97
Shiba, Naoto Kurume Univ Sch of Medicine Fukuoka, Japan	Digital Case Presentation 12
Shields, Charlotte N NYU Langone Orthopedic Hospital New York, NY USA	Posters 52, 139
Shigemoto, Kenji Toyama, Japan	Poster 71
Shirahama, Masahiro Kurume University School of Medicine, Department of Orthopaedic Surgery Kurume, Japan	Digital Case Presentations 12, 17

INDEX - ALPHABETICAL BY AUTHOR

Shively, Karl D Indiana University School of Medicine Indianapolis, IN USA	Basic Science Papers 19, 26
Shoap, Seth Columbia Univeristy Medical Center New York, NY USA	Poster 143
Shon, Oog Jin Daegu, Korea, Republic of	International Paper 51
Shorten, Peter University of Vermont Burlington, VT USA	Paper 127
Siegel, Judith UMass Memorial Med Ctr Worcester, MA USA	Papers 113, 119
Sierevelt, Inger SCORE Amsterdam Amsterdam, Netherlands	Poster 133
Siljander, Breana University of Minnesota Minneapolis, MN USA	Poster 99
Silvestros, Pavlos Bath, United Kingdom	International Poster 156
Sim, Jaeang Gachon University Gil Med Center Incheon, Korea, Republic of	International Paper 51
Simpson, Megen Joann MetroHealth System Cleveland, OH USA	Posters 26, 117
Simske, Natasha University of Wisconsin, MetroHealth System Madison, WI USA	Papers 88, 89, 106; Posters 18, 69, 95, 122
Sinclair, Mark R University of Missouri - Kansas City Department of Orthopaedic Surgery Overland Park, KS USA	Paper 95
Singh, Keerat Tucker, GA USA	Poster 79
Sivalingam, Kavitha Bochum, Germany	Basic Science Paper 10
Siy, Alexander University of Wisconsin Brookfield, WI USA	Papers 88, 89; Poster 69
Slobogean, Gerard University of Maryland School of Medicine Baltimore, MD USA	Symposium; Papers 69, 120; Poster 58
Smith, Conor Alan University of Missouri School of Medicine Columbia, MO USA	Poster 30
Smith, Jeffrey Mark Orthopaedic Trauma & Fracture Specialist San Diego, CA USA	Breakout Sessions
Smith, Randi N Atlanta, GA USA	Poster 34

Smith, Raymond Malcolm Massachusetts General Hospital Boston, MA USA	Poster 13
Smith, Thomas J Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Paper 134
Snowden, Gordon Thomas Edinburgh, United Kingdom	International Paper 40
Sobol, Keenan Philadelphia, PA USA	Basic Science Paper 14
Soles, Gillian University of Rochester Department of Orthopaedics Rochester, NY USA	Paper 124; Breakout Session
Solomon, Lucian B Royal Adelaide Hospital Adelaide, Australia	International Poster 153
Song, Zhe Honghui Hospital,Xian Jiaotong University Xian, China, People's Republic of	International Papers 36, 43, 55; Digital Case Presentation 5
Sontich, John K Chagrin Falls, OH USA	Posters 128, 131
Soo, Andrea Calgary, AB Canada	Paper 118
Sorkin, Anthony T Indiana University Indianapolis, IN USA	Paper 69
Sparks, Michael Brent Dartmouth Hitchcock Med Ctr Lebanon, NH USA	Poster 41
Spence, David D Memphis, TN USA	Paper 131; Poster 109
Spiegel, David Andrew Philadelphia, PA USA	Paper 95
Spinnickie, Anthony O Atlantic Orthopedic Associates Whippany, NJ USA	Poster 81
Spitler, Clay A University of Alabama-Birmingham Birmingham, AL USA	Posters 5, 21, 24; Breakout Session
Sprague, Sheila McMaster University Hamilton, ON Canada	Papers 70, 92, 102, 120; Poster 58
Sprengel, Kai University Hospital Zurich, Department of Trauma Zurich, Switzerland	International Poster 155
Staffa, Steven Boston, MA USA	Paper 128
Staley, Christopher A Atlanta, GA USA	Poster 56
Stannard, James P Missouri Orthopaedic Institute Columbia, MO USA	Basic Science Symposium; Breakout Session
Starr, Adam Jennings University of Texas Southwestern Medical Center Dallas, TX USA	Paper 93; Poster 92
IDEX	AUTHOR
------	------------
	BETICAL BY
	X - ALPHAF
	INDE

Poster 129
Poster 58
Poster 107
Poster 54
Paper 83
International Paper 60; Paper 82; Poster 134
Basic Science Paper 15
Paper 80; Digital Case Presentation 2
Basic Science Paper 14
Poster 104
Posters 142, 144
International Paper 32
International Paper 46
Digital Case Presentation 12
Paper 79; Poster 51; Breakout Session
Basic Science Paper 25
Poster 89
International Paper 56
Poster 101
Paper 73
Poster 82

Svarzchtein, Santiago Javier CABA, Argentina	International Symposium
Swain, Brendan Gregory Dallas, TX USA	Basic Science Paper 1
Swart, Eric F University of Massachusetts Worcester, MA USA	Papers 113, 119; Posters 36, 70
Sweeney, Tim E Burlingame, CA USA	Basic Science Paper 17
Swenning, Todd Allen Desert Regional Medical Center Palm Springs, CA USA	Breakout Session
Swetz, Anna Marie MetroHealth System Orchard Park, NY USA	Paper 111
Swiontkowski, Marc F University of Minnesota Minneapolis, MN USA	Papers 102, 120
Tagliaferro, Matthew Pittsburgh, PA USA	Poster 10
Talusan, Paul University of Michigan Health System Ann Arbor, MI USA	Paper 129
Tan, Timothy Philadelphia, PA USA	Basic Science Paper 14
Tang, Pei Fu Beijing, China, People's Republic of	Poster 1
Tanner, Stephanie Lewis Greenville Health System Greenville, SC USA	Paper 121
Tantigate, Direk Faculty of Medicine Siriraj Hospital, Mahidol University Bangkok, Thailand	Paper 117
Tarabochia, Matthew Brookline, MA USA	Poster 136
Tarchala, Magdalena McGill University Montreal, QC Canada	Basic Science Paper 22
Tarkin, Ivan Seth Univ of Pittsburgh Med Ctr Pittsburgh, PA USA	Poster 10
Taylor, Tara J Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Paper 76
Taype Zamboni, Danilo Hospital Italiano Buenos Aires Ciudad De Buenos Aires, Argentina	International Poster 152; Digital Case Presentations 7, 10
Teague, David C Univ of OK Health Sciences Center Oklahoma City, OK USA	International Symposium; Paper 66; Poster 7, 137
Tejwani, Nirmal C NYU Hosp for Joint Diseases New York, NY USA	Breakout Session
Telis, Alexander Pasadena, CA USA	Digital Case Presentation 14

INDEX - ALPHABETICAL BY AUTHOR

Termaat, M. Frank Leiden University Medical Center Leiden, Netherlands	Paper 130
Tetsworth, Kevin Royal Brisbane Hospital Brisbane, Australia	Basic Science Paper 21
Teuben, Michel University Hospital Zurich, Department of Trauma Zurich, Switzerland	Basic Science Papers 8, 9, 27; International Poster 155
Tharmviboonsri, Theerawoot Faculty of Medicine Siriraj Hospital, Mahidol University Bangkok, Thailand	Paper 117
Thoren, Jacalyn London, ON Canada	Paper 122
Tian, Xu Tianjin, China, People's Republic of	International Symposium; International Paper 56
Tieszer, Christina London Health Science Centre London, ON Canada	Paper 122
Tilan, Justin U Washington University In St. Louis Panorama City, CA USA	Poster 24
Tiongson, Michael Denis New York, NY USA	Poster 62
Tjong, Vehniah K Chicago, IL USA	Poster 97
Tokash, Jeremy Allegheny General Hospital Scranton, PA USA	Poster 84
Tong, Yixuan NYU Langone Orthopedic Hospital New York, NY USA	Poster 52
Toppe, Monika Bergen, Norway	Paper 137
Torchia, Michael E Mayo Clinic Rochester, MN USA	Poster 123
Tornetta, Paul Boston University Boston, MA USA	Basic Science Symposium; International Symposium; Papers 66, 73, 112; Poster 137; Breakout Sessions
Tosounidis, Theodoros Crete, United Kingdom	Poster 73
Tougas, Caroline Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 54
Tran, Hai P Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 31
Trial Investigators, FAITH-2 Hamilton, ON Canada	Paper 103
Trikha, Vivek N Delhi, India	International Papers 28, 46; International Poster 158

Trompeter, Alex St George's Hospital Farnham, Surrey, United Kingdom	Poster 59; International Poster 156
Trotter, Marcus Indianapolis, IN USA	Digital Case Presentation 4
Tsui, Ban Stanford University Santa Clara, CA USA	Paper 114
Tucker, Michael Charles Palmetto Health USC Orthopedic Center Columbia, SC USA	Poster 137
Turajane, Kathleen New York, NY USA	Basic Science Paper 12
Udogwu, Ugo Mount Sinai New York, NY USA	Paper 120
Udogwu, Ugo University of Maryland School of Medicine Baltimore, MD USA	Poster 28
Um, Kyusub Yonsei University, Gangnam Severance Hospital Seooul, Korea, Republic of	Poster 74
Vaida, Justin Morgantown, WV USA	Paper 75
Vaidya, Rahul Ann Arbor, MI USA	Poster 20
Vallier, Heather A Metrohealth Med Ctr Cleveland, OH USA	Papers 88, 89, 106, 111, 125; Posters 8, 17, 24, 26, 53, 117; Breakout Session
Van Den Berg, Juriaan Leuven, Belgium	International Paper 37
Van Gerven, Pieter Leiden, Netherlands	Paper 130
Van Griensven, Martijn Munich, Germany	Paper 64
Van Lieshout, Esther MM Erasmus MC Rotterdam, Netherlands	International Paper 37
Van Tienderen, Richard El Paso, TX USA	Paper 71
Van Tulder, Maurits Dept. Health Sciences, Faculty of Science, VU Amsterdam, Netherlands	Paper 130
Van Wyngaarden, Josh Lexington, KY USA	Poster 47
Van Wyngaarden, Josh Lexington, KY USA	Poster 113
Vang, Sandy University of Minnesota & HealthPartners St Paul, MN USA	Poster 43
Vargas-Hernandez, Juan Sebastian Rochester, MN USA	Paper 73
Vasireddy, Aswinkumar London, United Kingdom	International Paper 58

Veera, Shreya Sanjay Indianapolis, IN USA	Paper 96
Vegt, Paul Alexander Dordrecht, Netherlands	Poster 67
Verhofstad, Michael Erasmus MC Rotterdam, Netherlands	International Paper 37
Vetti, Nils Bergen, Norway	Paper 137
Vezina, Francois Sherbrooke, QC Canada	Paper 65
Vicente, Milena St. Michael's Hospital Toronto, ON Canada	Papers 63, 132, 136
Villa Camacho, Juan Boston, MA USA	Basic Science Paper 5
Virkus, Walter W Indiana University Zionsville, IN USA	Paper 69
Virkus, Walter W Indiana University School of Medicine Zionsville, IN USA	Paper 108
Viskontas, Darius New Westminster, BC Canada	Paper 80
Vo, Kiet V University of Washington School of Medicine Seattle, WA USA	Poster 44
Vodovotz, Yoram University of Pittsburgh School of Medicine Pittsburgh, PA USA	Basic Science Paper 7
Von Keudell, Arvind Gabriel Harvard Affl Hosps Chestnut Hill, MA USA	Posters 13, 48, 101, 136
Vorhies, John Stanford Children's Stanford, CA USA	Paper 94
Vosbikian, Michael M Rutgers New Jersey Medical School Newark, NJ USA	Poster 118
Vrahas, Mark S Cedars-Sinai Medical Center Los Angeles, CA USA	Paper 101
Vun, James Leeds, United Kingdom	Paper 97
Wagner, Daniel University Medical Center Mainz, Centre of Orthopedics and Trauma Surgery Mainz, Germany	Paper 87; International Paper 32; Poster 65
Wagstrom, Emily Hennepin County Medical Center Minneapolis, MN USA	Papers 88, 89
Waki, Takahiro Akashi Medical Center Akashi Japan	Poster 83

Walden Timothy	Poster 103
NYU Langone Orthopedic Hospital	
New York, NY USA	
Walker, Matthew R Houston TX USA	Poster 127
Walker, Robert	Basic Science Paper 3
Phoenix, AZ USA	······································
Walton, David Matthew	Paper 129
Dexter, MI USA	
Walton, Sharon Lichelle	Poster 92
University of Texas Southwestern Medical Center	
Dallas, IX USA	Laterational Dense 20, Dense 96
Guangzhou, China, People's Republic of	International Paper 29; Paper 86; International Poster 157
Wang, Pengfei	International Paper 34; Poster 102
Xi'An, China, People's Republic of	
Wang, Yeming Tianiin Hospital	International Paper 56
Tianjin, China, People's Republic of	
Wang, Yukai	Poster 96
Shanghai, China, People's Republic of	D. (100
Bristol, United Kingdom	Poster 109
Warner, Stephen James	Papers 81, 99; Posters 80, 126, 130;
McGovern Medical School at University of Texas Health	Digital Case Presentation 13
Houston, TX USA	
Warren, Ann Marie	Breakout Session
Baylor University Medical Center	
Wasserstein David	Poster 107
Toronto, ON Canada	105(0110)
Watanbabe, Yoshinobu	Poster 82
Tokyo, Japan	D 00
Watkins, John David PCCI	Paper 93
Dallas, TX USA	
Watson, David Timothy Tampa Bay, FL USA	Poster 14; Digital Case Presentation 9
Watson, J Tracy	Basic Science Symposium; Symposium;
Banner University Medical Center Phoenix AZ USA	Breakout Sessions
Wawrose, Richard	Poster 10
Univ of Pittsburgh Medical Center	
Pittsburgh, PA USA	
Weaver, Michael John Brigham and Women's Hospital	Paper 101; Posters 13, 48, 101
Boston, MA USA	
Weber, Lee E	Poster 105
Orlando, FL USA	D 0(D + 120
OrthoIndy	Paper 96; Poster 129
Indianapolis, IN USA	

INDEX - ALPHABETICAL BY AUTHOR

Weil, Yoram A Hadassah Hebrew University Med Center Jerusalem, Israel	International Symposium
Weisz, Russell Delray Medical Center Boca Raton, FL USA	Paper 68
Weitlich, John Univ of Missouri Ortho Surg Columbia, MO USA	Poster 79
Welby, John Patrick Rochester, MN USA	Poster 123
Weldon, Matthew UT Houston Spring, TX USA	Poster 91
Wellman, David Hospital for Special Surgery New York, NY USA	Basic Science Paper 12
Wells, Joel E UT Southwestern Dept of Orthopaedic Surgery Dallas, TX USA	Poster 92
Wen, Xiangyuan Guangzhou, China, People's Republic of	International Poster 157
Werner, Clement University of Zurich Zurich, Switzerland	Poster 60
Werth, Paul Michael Lebanon, NH USA	Poster 41
West, Robert Michael University of Leeds Leeds, United Kingdom	Paper 97
Westberg, Jerald Hennepin County Medical Center Minneapolis, MN USA	Papers 74, 88, 89
Westrick, Edward Ryan Allegheny General Hospital Gibsonia, PA USA	Poster 84
Westrick, Edward Ryan Gibsonia, PA USA	Poster 88
Wetzel, Robert Joseph University Hospitals Case Medical Center Cleveland, OH USA	Posters 128, 131
Wheatley, Benjamin Matthew Washington, DC USA	Paper 91
White, Melissa University of Minnesota Minneapolis, MN USA	Papers 88, 89; Poster 43
White, Timothy O Royal Infirmary of Edinburgh Edinburgh, United Kingdom	Papers 134, 135; Poster 141
Whiting, Paul S University of Wisconsin Madison, WI USA	Papers 88, 89; Posters 18, 69, 95, 122
Wichern, Emily University of Indiana Indianapolis, IN USA	Poster 24

Wickramasinghe, Neil Ranjan Edinburgh, United Kingdom	Paper 135; Poster 141
Wild, Jason Randall Tucson, AZ USA	Poster 135
Will, Ryan Edward Olympia Orthopaedic Associates Olympia, WA USA	Breakout Session
Willey, Michael C University of Iowa Hospitals Iowa City, IA USA	Poster 3; Breakout Session
Williams, David Neil Boston Children's Hospital Boston, MA USA	Paper 131
Willier, Donald Paul Lahey Hospital Burlington, MA USA	Paper 73
Willimon, Samuel Clifton Children's Healthcare of Atlanta Atlanta, GA USA	Paper 131
Wilson, Eleanor MetroHealth System Cleveland, OH USA	Paper 73
Wilson, Nathaniel M University of Wisconsin Fitchburg, WI USA	Poster 95
Wilson, Philip L Texas Scottish Rite Hospital Dallas, TX USA	Paper 131
Wininger, Austin Indianapolis, IN USA	Basic Science Paper 19
Wise, Brent Thomas Emory Univ School of Medicine Atlanta, GA USA	Poster 56
Wittenberg, Silvan Berlin, Germany	International Paper 32
Wittig, James C James C Wittig MD Morristown, NJ USA	Poster 81
Wixted, John J Northborough, MA USA	Posters 32, 66, 76
Wojewnik, Bartosz Loyola University Affl Hosps Maywood, IL USA	Poster 35
Wolinsky, Philip R Univ of CA at (Davis) Med Ctr Sacramento, CA USA	Paper 90
Woloszyk, Anna San Antonio, TX USA	Basic Science Paper 21
Womble, Tanner University of Kentucky Lexington, KY USA	Poster 23
Won, Yougun College of Medicine, Konyang University Daejeon, Korea, Republic of	International Paper 31

INDEX - ALPHABETICAL BY AUTHOR

Working, Zachary Portland, OR USA	Basic Science Paper 24; Poster 129
Wright, Craig Bloomfield, NJ USA	Poster 81
Wright, David University of California, Irvine - Orthopaedics Orange, CA USA	Basic Science Paper 2
Wright, Raymond Dayne UK Dept of Orthopaedic Surgery Lexington, KY USA	Paper 113; Posters 23, 114
Wu, Edward J Stanford University Department of Orthopaedic Surgery Stanford, CA USA	Poster 140
Wu, Hao-Hua Irvine, CA USA	Paper 98
Wu, Jim Beth Israel Deaconess Boston, MA USA	Paper 128
Wukich, Dane K University of Texas Southwestern Medical Center Dallas, TX USA	Poster 92
Wun, Kelly Northwestern University Chicago, IL USA	Poster 97
Xi, Liu Chongqing City Hospital of Traditional Chinese Medicine Chongqing, China, People's Republic of	Poster 75
Xiaohua, Chen Chongqing, China, People's Republic of	Poster 75
Xiaotao, Long Chongqing, China, People's Republic of	Poster 75
Xie, Xuetao Shanghai, China, People's Republic of	Poster 96
Xie, Yong B Beijing, China, People's Republic of	Poster 1
Yadavalli, Aditya Penn State College of Medicine Hershey, PA USA	Basic Science Paper 6
Yang, Dawei China Harbin, China, People's Republic of	Poster 120
Yang, Jianhua Tianjin, China, People's Republic of	International Paper 56
Yang, Kyuhyun Yonsei University, Gangnam Severance Hospital Seoul, Korea, Republic of	Poster 74
Yang, Kyuhyun Gangnam Severance Hospital Seoul, Korea, Republic of	Poster 85
Yang, Liu Chengdu, China, People's Republic of	International Paper 48
Yang, Xu New York, NY USA	Basic Science Paper 12

Yao, Jeffrey Stanford University Department of Orthopaedic Surgery Stanford, CA USA	Poster 140
Yegorova, Katy San Diego, CA USA	Breakout Session
Yeo, Do-Hyun Seoul, Korea, Republic of	Basic Science Paper 13; International Paper 53; International Poster 154
Yeo, Ping Yen Singapore, Singapore	Paper 104
Yeung, Samantha Cedars-Sinai Medical Center Los Angeles, CA USA	Poster 31
Yim, Nury NYU Hospital for Joint Diseases new york, NY USA	Poster 50
Yimgang, Doris Baltimore, MD USA	Poster 58
Yoon, Richard S Jersey City Medical Center - RWJ Barnabas Health Jersey City, NJ USA	Breakout Sessions
You, Daniel University of Calgary Calgary, AB Canada	Paper 118
Young, Patrick Graham University of South Alabama Mobile, AL USA	Paper 77
Yousaf, Imran Baltimore, MD USA	Poster 28
Yousaf, Omer Baltimore, MD USA	Poster 28
Yuan, Brandon J Mayo Clinic Rochester, MN USA	Paper 73; Poster 123
Yun, Heather C San Antonio Military Medical Center JBSA FT Sam Houston, TX USA	Paper 105
Zaidi, Syed Muhammad Raza Baltimore, MD USA	Paper 84; Posters 33, 110
Zexiang, Xu Chongqing, China, People's Republic of	Poster 75
Zhan, Yu Shanghai, China, People's Republic of	Poster 96
Zhang, Bin-Fei Xi'An, China, People's Republic of	International Paper 34
Zhang, Dafang Brookline, MA USA	Poster 136
Zhang, Kun Xi'An, China, People's Republic of	International Papers 36, 55; Poster 145 Digital Case Presentation 5
Zhang, Li-Qun University of Maryland School of Medicine Baltimore, MD USA	Poster 147
Zhang, Licheng Beijing, China, People's Republic of	Poster 1

Zhang, Wei Shanghai, China, People's Republic of	Poster 89
Zheng, Evan Harvard School of Medicine Penfield, NY USA	Paper 95
Zhu, Yangjun XiAn, China, People's Republic of	International Papers 36, 55; Poster 145; Digital Case Presentation 5
Zhu, Yi Shanghai, China, People's Republic of	Poster 89
Zhuang, Yan Honghui Hospital, Xi'an Jiaotong University Xi'An, China, People's Republic of	International Paper 34
Ziegenhain, Franzisa University Hospital Zurich, Department of Trauma Zürich, Switzerland	International Poster 155
Zipunnikov, Vadim Johns Hopkins Bloomberg School of Public Health Baltimore, MD USA	Paper 83
Ziran, Bruce The Hughston Clinic Atlanta, GA USA	Digital Case Presentation 11; Breakout Sessions
Zirkle, Lewis G SIGN Fracture Care International Richland, WA USA	Poster 95
Zuidema, W.P. VU University Medical Center Amsterdam Amsterdam, Netherlands	Paper 130
Zura, Robert D LSU-NO New Orleans, LA USA	Paper 121
Zurakowski, David Children's Hospital Boston Boston, MA USA	Paper 128

See the meeting app for complete listing of authors' disclosure information.



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September 14 - 15, 1985 November 20 - 22, 1986 November 19 - 21, 1987 October 27 - 29, 1988 October 19 - 21, 1989 November 7 - 10, 1990 October 31 - November 2, 1991 October 1 - 3, 1992 September 23 - 25, 1993 September 22 - 24, 1994 September 29 - October 1, 1995 September 27 - 29, 1996 October 17 - 19, 1997 October 8 - 10, 1998 October 22 - 24, 1999 October 12 - 14, 2000 October 18 - 20, 2001 October 11 - 13, 2002 October 9 - 11, 2003 October 8 - 10, 2004 October 20 - 22, 2005 October 5 - 7, 2006 October 18 - 20, 2007 October 15 - 18, 2008 October 7 - 10, 2009 October 13 - 16, 2010 October 12 - 15, 2011 October 3 - 6, 2012 October 9 - 12, 2013 October 15 - 18, 2014 October 7 - 11, 2015 October 5 - 8, 2016 October 11 - 14, 2017 October 17 - 20, 2018 September 25 - 28, 2019

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Sara Putnam, MD:Resident Member Toney Russell, MD:Presidential Consultant Ted Miclau, MD:IOTA Steering Committee Chair

MEMBERSHIP (Elected Committee) Milan Sen, MD, Chair Peter Althausen, MD Emily Benson, MD Conor Kleweno, MD Gilbert Ortega, MD

Ex-Officio Members Dennis Gregory, PA-C

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Ex-Officio Members Lt. Michelle Gosselin, BS, MD: Resident Member

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ACS COT (American College of Surgeons

Committee on Trauma) Anna Miller, MD, Chair James R. Ficke, MD A. Alex Jahangir, MD Clifford B. Jones, MD James C. Krieg, MD Mark P. McAndrew, MD Hassan R. Mir, MD Bruce Ziran, MD

Other Orthopaedic Liaison Positions

Bruce Browner, MD; Member-at-Large USBJI Andy Schmidt, MD; Civilian Rep, EWI James Ficke, MD; Board Member, National Trauma Institute

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Ex-Officio Members

Douglas Lundy, MD: OTA CFO Michael Gardner, MD: Annual Program Chair Ed Harvey, MD: Basic Science Focus Forum Chair Vindra Dass: WK Representative JOT Brian Brown: WK Representative R&G

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Ad Hoc

Mike Githens, MD: OrthoInfo Project Team Co-Chair Jason Lowe, MD: OrthoInfo Project Team Co-Chair Josh Gary, MD: Newsletter Editor Arvin Von Keudell, MD: Newsletter Resident Member

RESEARCH

Michael Archdeacon, MD, Chair Donald Anderson, MD Patrick Bergin, MD Philipp Leucht, MD Victor De Ridder, MD Anna Miller, MD, FACS Reza Firoozabadi, MD Kelly Lefaivre, MD Mara Schenker, MD Frank Avilucea, MD Emil Schemitsch, MD Andrew Trenholm, MD

STRATEGIC RESEARCH INITIATIVE

Saam Morshed, MD, PhD, Chair Mohit Bhandari, MD, PhD, FRCSC Mitch Harris, MD Research Chair (*ex officio*): Michael Archdeacon, MD Governance Council Chair (*ex officio*): Ted Miclau, MD BSFF Chair (*ex officio*): Ed Harvey, MD Fund Development Chair (*ex officio*): Dan Horwitz, MD

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Barbara Shozda Managing Director 847-430-5137

Sharon Moore Senior Education Manager 847-430-5130

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Aimee Spellman Meetings and Programming Manager 847-430-5136

Headquarters Office Orthopaedic Trauma Association

9400 W Higgins Rd, Suite 305 Rosemont, IL 60018 USA Tel: 847.698.1631 Fax: 847.430.5140 E-mail: OTA@ota.org web: www.ota.org



CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2019 Academic Year Fellowship Program Awards:

Allegheny General Hospital – Pittsburgh, PA Gregory Altman, MD

Carolinas Medical Center Department of Orthopaedic Surgery – Charlotte, NC Madhav Karunakar, MD

> Cedars Sinai Orthopaedic Trauma Fellowship – Los Angeles, CA Milton T. Little, MD

Cooper University Hospital/Cooper Medical School of Rowan University – Camden, NJ Rakesh P. Mashru, MD

> Detroit Medical Center / Wayne State University – Detroit, MI Rahul Vaidya, MD

Duke University Orthopaedic Trauma Fellowship – Durham, NC Rachel Reilly, MD

> Georgia Orthopaedic Trauma Institute – Macon, GA Lawrence X. Webb, MD

> > Prisma Heatlh Upstate – Greenville, SC *Kyle Jeray, MD*

University of Washington Orthopaedics Trauma / Harborview – Seattle, WA David P. Barei, MD

Harvard Orthopedic Trauma Fellowship Program – Boston, MA Michael J. Weaver, MD

Hospital for Special Surgery Orthopaedic Trauma Fellowship – New York, NY David L. Helfet, MD

IU Health Methodist Hospital Orthopedic Trauma Fellowship – Indianapolis, IN *Greg Gaski*, MD

LAC / USC Medical Center Trauma Fellowship Program – Los Angeles, CA Jackson Lee, MD

> Orlando Health Trauma Fellowship – Orlando, FL George J. Haidukewych, MD



CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2019 Academic Year Fellowship Program Awards, continued:

OrthoIndy Trauma Fellowship – Indianapolis, IN *Tim Weber, MD*

University of Minnesota Orthopaedic Trauma Fellowship – St. Paul, MN Peter A. Cole, MD

> Reno Orthopaedic Clinic Trauma Fellowship – Reno, NV *Timothy J. Bray, MD*

Rutgers, NJMS Department of Orthopedics – Trauma Fellowship – Rutgers, NJ Mark Adams, MD

Saint Louis University, Orthopaedic Traumatology Fellowship – St. Louis, MO Daemeon Nicolaou, MD

> San Diego Orthopaedic Trauma Fellowship – San Diego, CA Jeffrey M. Smith, MD

University of Maryland / Shock Fellowship Program – Baltimore, MD Robert V. O'Toole, MD

> Sonoran Orthopaedic Trauma Program – Scottsdale, AZ Gilbert Ortega, MD, MPH

Stanford Orthopaedic Trauma Fellowship Program – Redwood City, CA Michael Bellino, MD

> Tampa General Hospital – Tampa, FL *Roy Sanders, MD*

The Hughston Foundation, Inc. – Columbus, GA John C. P. Floyd, MD, FACS

University of California / Davis – Sacramento, CA Mark A. Lee, MD

The University of Texas Health Science Center at Houston – Houston, TX *Timothy S. Achor, MD*

The University of Texas Health Science Center at San Antonio – San Antonio, TX Boris Alexander Zelle, MD



CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2019 Academic Year Fellowship Program Awards, continued:

University of California, San Diego, Orthopaedic Trauma Fellowship – San Diego, CA Alexandra Schwartz, MD

> UCSF SFGH Orthopaedic Trauma Institute – San Francisco, CA Theodore Miclau III, MD

University of Mississippi Orthopaedic Trauma Fellowship – Jackson, MS Matt Graves, MD

University of Missouri Department of Orthopaedic Trauma – Columbia, MO Brett D. Crist, MD

University of Oklahoma / St. John Health System Foundation – Tulsa, OK Paul Stafford, MD

Vanderbilt Orthopaedic Trauma Fellowship Program – Nashville, TN William Obremskey, MD

Wake Forest University School of Medicine Trauma Fellowship – Winston Salem, NC Eben A. Carroll, MD

Washington University Orthopaedic Surgery Trauma Fellowship – St. Louis, MO Christopher M. McAndrew, MD

Funded by the generous medical education contributions from: Smith & Nephew, Stryker, DePuy Synthes & Zimmer Biomet



CONGRATULATIONS 2018-2019 OTA Fellowship Graduating Class:

Chima Dike Nwankwo, MD and Brett Justin Pettett, MD Allegheny Health Network, Pittsburgh, PA *Gregory Altman, MD, Director*

Cody Lamar Evans, MD, Abhishek Ganta, MD, and Louis Lewandowski, MD Carolinas Medical Center, Charlotte, NC Madhav Karunakar, MD, Director

> Mikhail Bekarev, MD Cedars Sinai Orthopaedic Center, Los Angeles, CA Milton Little, MD, Director

Vince Lands, MD Cooper University Medical Center, Camden, NJ Rakesh P. Mashru, MD, Director

Michael Maher, MD Denver Health Medical Center, Denver, CO *Cyril Mauffrey, MD, Director*

Devon Mansour, DO Detroit Medical Center/ Wayne State U, Detroit, MI Rahul Vaidya, MD, Director

Travis J. Rump, DO Duke University Medical Center, Durham, NC Rachel Reilly, MD, Director

Matthew Martell, DO Georgia Orthopaedic Trauma Institute, Macon, GA Lawrence X. Webb, MD, Director

Frederick P. Korpi, DO, Philip Myers, DO, and Sergio Hernando Pulido, DO Grant Medical Center, Columbus, OH Ben Taylor, MD, Director

Jerad Allen, MD, Robert Conrad Jacobs, MD, Kimberly Jacobsen, MD, Jennifer Tangtiphaiboontana, MD, and Robert Wojahn, MD Harborview Medical Center, Seattle, WA David P. Barei, MD, Director



Shawn Eugene Boomsma, DO and Nishant Suneja, MD Harvard Orthopaedic Trauma, Boston, MA *Michael Weaver, MD, Director*

Michael Koerner, MD Hennepin County Medical Center, Minneapolis, MN David C Templeman, MD, Director

Mengyang Mike Li, MD, James Shaw, MD, and Pierre Philippe Zaharia, MDCM Hospital for Special Surgery, New York, NY David L. Helfet, MD, Director

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> Raveesh Richard, MD and Neil Sardesai, MD, MS IU Methodist Orthopaedic Trauma Fellowship, Indianapolis, IN *Greg Gaski, MD, Director*

Alexander Telis, MD Los Angeles County USC Medical Center, Los Angeles, CA Jackson Lee, MD, Director

> Nicholas Alfonso, MD MetroHealth Medical Center, Cleveland, OH John H. Wilber, MD, Director

Sandeep Paul Soin, MD Orlando Regional Medical Center, Orlando, FL George Haidukewych, MD, Director

Daryl Brian Dillman, MD, MPH and Ross Parker Smith, MD OrthoIndy, Indianapolis, IN *Timothy Weber, MD, Director*

Andrew Swentik, MD Orthopaedic Trauma Surgeons of Northern California, Carmichael, CA Paul Gregory Jr. MD, Director

> Shasta Elizabeth Henderson, MD Penn State University, College of Medicine, Hershey, PA J. Spence Reid, MD, Director



Lucas Marchand, MD, Ian McAlister, MD, Joshua Kyle Napora, MD, Matthew Daniel Riedel, MD, and Steven F. Shannon, MD R Adams Cowley Shock Trauma Center, Baltimore, MD *Robert V. O'Toole, MD, Director*

Adam Breceda, MD and Tony Pedri, MD

Regions Trauma Center/Univ. of Minnesota Orthopaedic, St. Paul, MN Peter A. Cole, MD, Director

> **Ryan Nielsen, DO** Reno Orthopaedic Trauma Fellowship, Reno, NV *Timothy Bray, MD, Director*

> > John Neal, MD

Rutgers New Jersey Medical School, Newark, NJ Mark R. Adams, MD, Director

> Christopher Rashidifard, DO St. Louis University, Saint Louis, MO Daemeon Nicolaou, MD, Director

Thomas Caudill Githens, DO

Stanford University, Redwood City, CA Michael J. Bellino, MD, Director

Robert Stewart, MD Swedish Medical Center Orthopedic Trauma Fellowship, Englewood, CO *Wade Smith, MD, Director*

Omar H. Atassi, MD, **Gennadiy Busel, MD**, and **Guadalupe De La Fuente, MD** Tampa General Hospital, Tampa, FL

Roy Sanders, MD, Director

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Jon R. Shereck, MD

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Elizabeth Gausden, MD, Philip Lim, MD, Phillip M. Mitchell, MD, and Mohamad Kareem Shaath, MD

University of Texas Health Science Center at Houston, Houston, TX *Timothy S. Achor, MD, Director*

> **Brock Foster, MD** and **Tyler R. Morris, MD** Vanderbilt University Medical Center, Nashville, TN *William Obremskey, MD, Director*

Jamie Lyn Engel, MD

Virginia Commonwealth University, Richmond, VA Varatharaj Mounasamy, MD, Director

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Joshua Namm, MD

Washington University School of Medicine/Barnes-Jewish Hospital, Saint Louis, MO Christopher McAndrew, MD, MSc, Director

Jason P. Welter, DO, MAJ, USAF, MC

Wright State University, Dayton, OH Michael J. Prayson, MD, Director

Assaf Kadar, MD Yale University, New Haven, CT Brad Yoo, MD, Director

Alex Stroh, MD York Hospital, York, PA Thomas DiPasquale, DO, FACOS, FAOAO, Director

AWARDS

OTA HUMANITARIAN SCHOLARS

The OTA has established a Humanitarian Scholarship designed to provide orthopaedic trauma education for young surgeons from low-middle income countries. Scholarship award covers the individuals travel, room and board for attending OTA Annual Meeting and the opportunity to participate in an observership at a U.S. Institution with an OTA member serving as a mentor during the visit.

Congratulations to the following 2019 scholarship recipient:

Linda Chokotho, MD - Malawai, Africa - (Paper #98) *Observation at Denver Health Medical Center*

OTA/AAOS INTERNATIONAL SCHOLAR AWARD

Through this program, a scholarship is awarded to eligible orthopaedic surgeons from countries with limited resources. Scholars attend the OTA Annual Meeting and participate in an observership at a U.S. Institution. The goal of the program is to improve the quality and outcomes of orthopaedic care worldwide through education and training. Through sharing newly acquired knowledge with peers and students, scholarship alumni have facilitated professional development to impact orthopaedic patient care in their country.

Congratulations to the 2019 scholarship recipient: *Ségla Pascal Éric Chigblo, MD - Benin, Africa Observation at Denver Health Medical Center*

2018 VIDEO VIEWER'S CHOICE AWARD

Uniplanar Osteotomy for Multiplanar Femoral Deformity Correction *Suman Medda, MD*, Jinnah Alexander, MD, Marquez-Lara Alejandro, MD, *Araiza Edgar, MD, Eben Carrol, MD*

EDWIN G. BOVILL, Jr., MD AWARD WINNER

Best paper* from the 2017 Annual Meeting. Dedicated to Edwin G. Bovill, Jr., MD, (1918 - 1986) Surgeon, traumatologist, educator, academician, and gentleman; co-founder of the Orthopaedic Trauma Association.

2018 – Short versus Long Cephalomedullary Nailing of Pertrochanteric Hip Fractures: A Randomized Prospective Study Steven Shannon, MD; Brandon Yuan, MD; William Cross, MD; Jonathan Barlow, MD; Michael Torchia, MD; Andrew Sems, MD *of papers that granted first right of refusal to the Journal of Orthopaedic Trauma

2019 OTA AFA COMMUNITY SURGEON ACHIEVEMENT AWARD* RECIPIENT

*Orthopaedic Trauma Association (OTA) and American Fracture Association (AFA) co-founded this annual award in 2017.

2019 - Raymond Robert White, MD

OTA MEMORIAL AWARD (Resident Research Award)

2019 – Short versus Long Cephalomedullary Nailing of Pertrochanteric Hip Fractures: A Randomized Prospective Study Steven Shannon, MD; Brandon Yuan, MD; William Cross, MD; Jonathan Barlow, MD; Michael Torchia, MD; Andrew Sems, MD



OTA 2019 MEMBER FULL AWARDED GRANTS

(January 1, 2019 - December 31, 2020 Grant Cycle)

Clinical Research Grant (up to	\$40,000/year, 2 year grant cycle)
A Prospective, Randomize to Non-Operative Manage	ed Controlled Trial Comparing Percutaneous Screw Fixation ement for the Treatment of Sacral Fragility Fractures
Principal Investigator: Clifford B.	Jones, MD, FACS
Co-Principal Investigators: Micha	iel McKee, MD, Niloofar Dehghan, MD
Awarded Funds: \$79,208	Grant Funded by: OTA/Zimmer
Title: The Development and Pre Outcome Measure for Pro	liminary Assessment of a Patient-Reported Functional ximal Humerus Fracture Patients
Principal Investigator: Emil H. Sc	hemitsch, MD
Co-Principal Investigator: Michae	el McKee, MD
Awarded Funds: \$79,917	Grant Funded by: OTA/Smith & Nephew
Title: Can Soft Tissue Perfusion Angiography Predict Post Principal Investigator: Gerard P. S Co-Principal Investigator: Raymo	Measured by Real-time Laser Assisted Indocyanine Green -Operative Wound Complications in High Slobogean, MD, MPH, FRCSC and Pensy, MD
Awarded Funds: \$79,579	Grant Funded by: OTA/TAF
Title: Introducing Wire Navigat Principal Investigator: Matthew I	ion Simulation to the OTA Resident Fracture Courses O Karam, MD 1 Anderson PhD
Awarded Funds: \$79 286	Grant Funded by: OTA
$\phi = \frac{1}{2} $	Grant i anaca by. OIA
Title: Biofilm Detection for Earl A Nested Cohort within th Principal Investigator: Aaron J Jo	y Diagnosis after Treatment of Open Fractures: 1e PREP-IT Trials. {Bio-PREP (B-PREP)} hnson, MD, MS
<u>, , , , , , , , , , , , , , , , , , , </u>	

Co-Principal Investigator: Robert O'Toole, MD Awarded Funds: \$100,000 Grant Funded by: OTA/AOTNA

Basic Research Grants (up to \$50,000 with \$25,000/year max up to 2-year grant cycle)

Title:Concurrent Administration of Kartogenin and Anakinra for the Prevention and
Treatment of Post-Traumatic Osteoarthritis in a Rat Model of Intraarticular FracturePrincipal Investigator:Stephen Goldman, PhDCo-Principal Investigator:Benjamin Potter, MDAwarded Funds:\$49,819Grant Funded by:OTA

International Grants (up to \$30,000 with \$15,000/year max up to 2-year grant cycle)

 Title: Diagnosing Acute Compartment Syndrome Using an Intramuscular pH Probe: What pH Level Equates to Impending Cell Death and Are Some Muscles more Susceptible than Others to Ischemia?
 Principal Investigator: Alan John Johnstone, FRCS
 Co-Principal Investigators: Andrew Schmidt, MD, Derek Ball, MD
 Awarded Funds: \$30,000 Grant Funded by: OTA

TOTAL OTA MEMBER GRANTS AWARDED: \$497,809

OTA 2019 RESIDENT AWARDED GRANTS

(January 1, 2019 - December 31, 2019 Grant Cycle)

Title: Local Multimodal Analgesia for Tibial Plateau Fractures Principal Investigator: Patrick Kellam, MD				
Amount Funded: \$12,348.84 Grant Funded by: OTA/DePuy Grant I	Number: 3187			
Title: Early Weightbearing vs Delayed Weightbearing After Surgical Fixation of Unstable Ankle Fractures with Syndesmosis Disruption: A Randomized Controlled Trial Principal Investigator: William K Roache, MD Co-Investigators: Michael McKee, MD, Niloofar Dehghan, MD				
Amount Funded: \$19,744Grant Funded by: OTA/DePuyGrant I	Number: 3190			
Title: Evaluation of Shoulder Ptosis after Middle Third Clavicle Fractures to Predict Patient Reported Outcomes Principal Investigator: Malcolm Rutledge DeBaun, MD				
Amount Funded: \$20,000 Grant Funded by: OTA/FOT Grant I	Number: 3169			
Title: Virtual Reality for Pain Management in Orthopaedic Trauma Patients: A Prospective Randomized Control Pilot Study Principal Investigator: Eitan Micah Ingall, MD Co-Investigator: Marilyn Heng, MD				
Amount Funded: \$17,066Grant Funded by: OTA/FOTGrant I	Number: 2758			
Title: Return to Driving after Orthopaedic Trauma and Correlation with Patient-Reported Outcomes Principal Investigator: Chang-Yeon Kim, MD Co-Investigator: Heather Vallier, MD				
Amount Funded: \$20,000 Grant Funded by: OTA/FOT Grant I	Number: 3189			

TOTAL RESIDENT GRANTS AWARDED: <u>\$89,158.84</u>

OTA 2019 RESIDENT AWARDED GRANTS

(June 1, 2019 - May 31, 2020 Grant Cycle)

Title: Prospective Isolation of Skeletal Stem Cells from Acute Fractures Principal Investigator: Lawrence Henry Goodnough , MD, PhD Co-Investigator: Charles Chan , MD, Michael Gardner, MD				
Awarded Funds: \$20,000	Grant Funded by: OTA	Grant Number: 3738		
Title: Dynamic CT Analysis of Normal Syndesmosis Motion and Syndesmosis Motion after Static and Dynamic Fixation Principal Investigator: Murray Wong				
Awarded Funds: \$20,000	Grant Funded by: OTA	Grant Number: 3673		
Title: Caspofungin Elution from Bone Cement: Biomechanics and Mean Biofilm Erradication Concentration Principal Investigator: Jessica Davis Burns, MD, MPH				
Co-Investigators: Michael McKee,	, MD, Alex McLaren, MD			
Awarded Funds: \$9,200	Grant Funded by: OTA	Grant Number: 3814		
Title: Malnourishment in Orthopaedic Trauma Patients and the Effect of Nutritional Supplementation on Surgical Outcomes Principal Investigator: Timothy R. Niedzielak, DO				
Awarded Funds: \$20,000	Grant Funded by: OTA	Grant Number: 3704		
Title: Utility of Serum Biomarkers in Diagnosing Fracture-related Infections: A Pilot Study				
Co-Investigator: Roman Natoli, M	D			
Awarded Funds: \$20,000	Grant Funded by: OTA	Grant Number: 3795		
Title: Patient Adherence to Venous Thromboembolism Prophylaxis in Orthopaedic Trauma Patients: A Randomized, Controlled Trial Comparing Subcutaneous Enoxaparin and Oral Rivaroxaban Principal Investigator: Benjamin D. Streufert, MD				
Awarded Funds: \$17,194	Grant Funded by: OTA	Grant Number: 3846		
Title: Crash Safety Analysis of Rear Facing Vehicular Restraint Systems for Hip Spica Casted Infants Utilizing Casted Pediatric Crash Test Dummies Principal Investigator: Angela Collins, MD, PhD				
Co-Investigator: James Ostrander Awarded Funds: \$20,000	Grant Funded by: OTA	Grant Number: 3681		

TOTAL RESIDENT GRANTS AWARDED: **<u>\$126,394</u>**

AWARDS

INFORMATION

IS WI-FI AVAILABLE?

Yes, in the Colorado Convention Center Wi-Fi Login: **OTA2019** Password: **OTAwifibyGlobus**

WHERE CAN I DOWNLOAD THE OTA ANNUAL MEETING APP?

iTunes and Google Play store Search: **Orthopaedic Trauma Association**



HOW DO I GET MY CME'S?

- Download the 2019 OTA Annual Meeting App or watch your email for the post meeting evaluation
- Complete the evaluation for CME credits earned
- Upon submittal of the evaluation; a CME certificate will appear
- Save and print later

MOTHERS ROOM

Wednesday, September 25- Saturday, September 28

6:00 am - 5:00 pm

Located in Lobby A of the Convention Center. Retrieve the key from the Guest Services desk in the Lobby.

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.

Annual Meeting 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 35th Anniversary Annual Meeting of the OTA will allow all registrants to:

- Discuss and highlight recently presented prospective clinical trials in orthopaedic trauma
- Summarize evidence-based recommendations for the treatment of common fractures
- Knowledge transfer to initiate practice change to include treatment strategies based on evidence-based medicine
- Identify consensus opinions on many current issues and controversies regarding the treatment of infected fractures.

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.

ACCREDITATION – CME INFORMATION

The Orthopaedic Trauma Association (OTA) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. OTA designates this live activity for a maximum of **21** *AMA PRA Category 1 Credits*TM. Physicians should claim only the credits commensurate with the extent of their participation in the activity.



The Orthopaedic Trauma Association designates the live activity of

the Basic Science Focus Forum for a maximum of **11.0** *AMA PRA Category 1 Credits*TM. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The Orthopaedic Trauma Association designates designates the live activity of the International Trauma Care Forum for a maximum of **11.5** *AMA PRA Category* **1** *Credits*[™]. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

FDA STATEMENT

All drugs and medical devices used in the United States are administered in accordance with the Food and Drug Administration (FDA) Regulations. These regulations vary depending on the risks associated with the drug or medical device, the similarity of the drug or medical device to products already on the market, and the quality and scope of clinical data available.

Some drugs or medical devices described or demonstrated in OTA educational materials or programs have not been cleared by the FDA or have been cleared by the FDA for specific uses only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or device s/he wishes to use in clinical practice.

DISCLAIMER

The material presented at the 35th 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 35th Annual Meeting are printed in **boldface**.

As an accredited provider of continuing medical education CME, OTA is 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. The ACCME defines "relevant' financial relationships" as financial relationships in any amount occurring within the past 12 months that create a conflict of interest.
- 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 OTA 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 OTA does 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 — Orthopaedic Trauma Association ANTITRUST POLICY

N (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.



Orthopaedic Trauma Association CODE OF ETHICS FOR BOARD MEMBERS (Adopted December 2008)

OTA Board Members agree to:

- 1. Faithfully abide by the Articles of Incorporation, by-laws and policies of the organization.
- 2. Exercise reasonable care, good faith and due diligence in organizational affairs.
- 3. Disclose information that may result in a perceived or actual conflict of interest.
- 4. Disclose information of fact that would have significance in Board decision-making.
- 5. Remain accountable for prudent fiscal management to association members, the Board, and nonprofit sector, and where applicable, to government and funding bodies.
- 6. Maintain a professional level of courtesy, respect, and objectivity in all organization activities.
- 7. Strive to uphold those practices and assist other members of the Board in upholding the highest standards of conduct.
- 8. Exercise the powers invested for the good of the organization rather than for his or her personal benefit, or that of the nonprofit they represent.
- 9. Respect the confidentiality of sensitive information known due to Board service.
- 10. Respect the diversity of opinions as expressed or acted upon by the Board, committees and membership, and formally register dissent as appropriate.
- 11. Promote collaboration and cooperation among association members.
- 12. Procedure to Distribute and Approve Form 990

The OTA Board of Directors retains the services of an independent CPA firm to audit the organization's form 990. Management reviews the completed form 990 and provides a full copy to all voting members of the OTA Finance Committee prior to filing. The Board of Directors is provided a reasonable period of time to review the form 990 and direct any questions to organization management or the independent CPA firm prior to filing. If necessary, conference call may be requested and scheduled for the CPA firm and organization management to discuss the form 990 with the OTA Finance Committee.



Orthopaedic Trauma Association CONFLICT OF INTEREST POLICY (Revised March 2013)

ARTICLE I

Purpose:

The purpose of this Board's conflict of interest policy is to protect the interests of the organization in all matters where a potential conflict may exist; especially when contemplating entering into a transaction or arrangement that might benefit the private interests of an officer or director by creating unfair personal advantages with regard to industrial, institutional or political relationships; or by the failure to disclose concurrent relationships that potentially conflict with the mission, values or governance of the OTA (referred to as 'conflict of commitment').

The OTA bylaws mandate that the Board's governance provides continued review and monitoring of potential conflicts with regard to intellectual information presented at national meetings, educational offerings and sponsored research. The policy recognizes the educational level of its members and their individual capability to determine what may represent a conflict. This policy also recognizes that all potential conflicts may not be clearly identifiable, and the Board will strive, at all times, to identify and protect the interests of the organization. Finally, this policy recognizes the Standard of Conduct and the Board agrees to abide by the provisions as outlined below.

This policy is intended to supplement but not replace any applicable state and federal laws governing conflict of interest applicable to nonprofit and charitable organizations.

ARTICLE II

Definitions:

1. Interested Person

Any director, board member, or committee chair with governing board delegated powers, who has a direct or indirect financial interest or commitment, as defined below, is an interested person.

2. Financial Interest

A person has a financial interest if the person has, directly or indirectly, through business, investment, or family:

- a. An ownership or investment interest in any entity with which the Organization has a transaction or arrangement,
- b. A compensation arrangement with any entity or individual with which the Organization has a transaction or arrangement, or
- c. A proposed ownership or investment interest in, or compensation arrangement with, any entity or individual with which the Organization is negotiating a transaction or arrangement. Compensation includes direct and indirect remuneration as well as gifts or favors that are not insubstantial.

3. Conflict of Commitment

During the tenure of the OTA leadership position, any member being considered for or in a leadership position must disclose concurrent board or committee chair appointments in any other professional organization deemed potentially competitive to the mission of the OTA.

A 'financial interest' or 'conflict of commitment' is not necessarily a conflict of interest. A person who has a financial interest or conflict of commitment may have a conflict of interest only if the appropriate governing board or committee decides that a conflict of interest exists.

ARTICLE III

Procedures:

As stipulated in the OTA Mandatory Disclosure Program, 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 at least semi-annually. A list of all participants in 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.

Based on the information provided in the Disclosure Program and / or upon a further review, the chair of the OTA governance group may determine that the participant shall:

- a) Disclose the conflict and continue to participate fully in the OTA governance group's deliberations
- b) Disclose the conflict, but abstain from discussing and voting on the matter; or
- c) Disclose the conflict and leave the room until the matter has been fully discussed and acted upon.

ARTICLE IV

Records of Proceedings:

The minutes of the Board and all committees with board delegated powers shall contain:

- a. The names of the persons who disclosed or otherwise were found to have a financial or commitment interest in connection with an actual or possible conflict of interest, the nature of the financial/commitment interest, any action taken to determine whether a conflict of interest was present, and the Board's or Executive Committee's decision as to whether a conflict of interest in fact existed.
- b. The names of the persons who were present for discussions and votes relating to the transaction or arrangement, the content of the discussion, including any alternatives to the proposed transaction or arrangement, and a record of any votes taken in connection with the proceedings.

ARTICLE V

Recusal from Voting:

A voting member of any committee whose jurisdiction includes allocating and/or distributing OTA resources is precluded from voting on matters pertaining to the distribution of awards, funding or compensation that could potentially benefit the voting member or his/ her interests or institutions.

ARTICLE VI

Affirmation of Understanding of OTA Policies:

- 1. Each director, principal officer and member of a committee with Board delegated powers shall annually sign a statement which affirms such person:
 - a. Has received a copy of the conflict of interest policy and code of conduct.
 - b. Has read and understands the policy and code.
 - c. Has agreed to comply with the policy by signing the compliance agreement. (Attachment)
- 2. If at any time during the year, the information in the annual statement changes materially, the director shall disclose such changes and revise the annual disclosure form.
- 3. The appropriate governance Committee shall regularly and consistently monitor and enforce compliance with this policy.







Prescription painkillers are America's most dangerous epidemic, with millions of citizens dependent or addicted. Onthopoedic surgeons recognize the lifethreatening danger of these opioids and call for patients and doctors alike to minimize their use.





PSA

INDUSTRY SESSIONS

Session	Title	Faculty
IS01 Stryker Wednesday, 6:00 - 9:00 PM (Buell Theatre Performing Arts Complex)	The Stryker Experience	
IS06 Zimmer Biomet Thursday, 11:15 AM - 12:45 PM (301)	Innovative Concepts in External Fixation and Periprosthetic Plating of the Femur	Philip R. Wolinsky, MD; Jason W. Nascone, MD
IS07 Stryker Thursday, 11:15 AM - 12:45 PM (302)	Nailing Redefined: ADAPT for Gamma3	Sanjit R. Konda, MD
IS08 Conventus Ortho Thursday, 11:15 AM - 12:45 PM (303)	An Innovative Approach to Proximal Humerus Fracture Repair Using the PH Cage	Michael Gardner, MD
IS09 Skeletal Dynamics Thursday, 11:15 AM - 12:45 PM (304)	Distal Elbow System: The Total Solution to Distal Elbow Trauma	Jorge L. Orbay, MD
IS10 DePuy Synthes Thursday, 11:15 AM - 12:45 PM (401)	Techniques for the Management of Large Segmental Defects	Brent Norris, MD; Peter Giannoudis, MD
IS11 DePuy Synthes Thursday, 11:15 AM - 12:45 PM (402)	Key Clinical Considerations in Treating Femoral Neck Fractures: Timing, Reduction and Implant Selection	Christopher Finkemeier, MD; Eben Carroll, MD
IS12 DePuy Synthes Thursday, 11:15 AM - 12:45 PM (403)	A Novel Approach to Maintaining Reduction and Achieving Compression in Transverse, Subtrochanteric and Pelvic Fractures Using Continuous Compression Implants	Paul Gladden, MD; Patrick Wiater, MD; Brian J. Cross, DO
IS13 Nuvasive Specialized Orthopedics Thursday, 11:15 AM - 12:45 PM (404)	The New Precice Bone Transport Nail - Early Clinical Results and Technology Review	

INDUSTRY SESSIONS, continued

Session	Title	Faculty
IS14 SI-BONE Thursday, 11:15 AM - 12:45 PM (405)	SI-BONE: Trauma in the SI Joint, Didactic and Hands-On Lab	
IS15 Arthrex Thursday, 11:15 AM - 12:45 PM (503)	Arthrex Innovations in Orthopedic Trauma	
IS16 Legally Mine Thursday, 11:15 AM - 12:45 PM (504)	Asset Protection, Tax Reduction, Lawsuit Prevention & License Protection	
IS17 Smith & Nephew Thursday, 11:15 AM - 12:45 PM (108/112)	Current Concepts in Small Fragment Fixation	

OTA GRATEFULLY ACKNOWLEDGES THE FOLLOWING EXHIBITORS FOR THEIR SUPPORT OF THE 35TH ANNUAL MEETING:

Booth #	Company Names	City, State
306	Abyrx, Inc.	Irvington, NY
722	ACell	Columbia, MD
201	Acumed, LLC	Hillsboro, OR
414	Advanced Orthopaedic Solutions	Torrance, CA
215	AMDT Holdings, Inc	Collierville, TN
410	American Geriatrics Society CoCare: Ortho	New York, NY
721	AOTrauma North America	Wayne, PA
823	Arbutus Medical	Vancouver, BC, Canada
811	Arthrex, Inc.	Naples, FL
316	Artoss, Inc.	Saint Cloud, MN
627	Austin Miller Trauma	Germantown, TN
922	Avitus Orthopaedics, Inc.	Farmington, CT
821	Biedermann Motech	Miami, FL
311	BioAccess Inc	Baltimore, MD
421	Biocomposites	Wilmington, NC
417	Bone Foam Inc.	Corcoran, MN
301	Bone Solutions Inc.	Colleyville, TX
521	BONESUPPORT	Cambridge, MA
724	C2Dx	Schoolcraft, MI
321	CarboFix Orthopedics, Inc	Ocean Isle Beach, NC
314	Cardinal Health	Dublin, OH
211	CAREstream America	Altamonte Springs, FL
221	CITIEFFE inc.	Miami, FL
725	Conventus Orthopaedics, Inc.	Westwood, MA
403	DePuy Synthes	West Chester, PA
Office B&C	DePuy Synthes	West Chester, PA
723	ECA Medical Instruments	Thousand Oaks, CA
420	Envision Physician Services	Dallas, TX
827	ExsoMed	Aliso Viejo, CA
422	Gauthier Biomedical Inc.	Grafton, WI
610	Globus Medical	Audubon, PA

Booth #	Company Names	City, State
Office A	Globus Medical	Audubon, PA
924	HRA Healthcare Research & Analytics	Cranbury, NJ
527	Innomed, Inc.	Savannah, GA
826	Integra Lifesciences	Plainsboro, NJ
622	Invibio Biomaterials Solutions	West Conshohocken, PA
423	ITS	Maitland, FL
317	Jeil Medical Corporation	Seoul, Korea
616	KCI, an Acelity company	San Antonio, TX
726	KLS Martin	Jacksonville, FL
825	Legally Mine	Orem, UT
824	McGinley Orthopedics	Casper, WY
223	McLeod Health	Florence, SC
325	Medartis, Inc.	Exton, PA
305	MedShape	Atlanta, GA
523	Medtronic	Minneapolis, MN
322	MY01 Inc.	Montreal, QC, Canada
720	NuVasive Specialized Orthopedics, Inc.	Aliso Viejo, CA
323	Nutek Orthopaedics	Fort Lauderdale, FL
300	OBERD	Columbia, MO
425	ODi (Orthopedic Designs Inc.)	Tampa, FL
217	Orthofix	Lewisville, TX
307	OrthoGrid Systems Inc.	Salt Lake City, UT
213	Orthomed inc.	Tigard, OR
626	OrthoPediatrics	Warsaw, IN
313	OrthoXel	Bishopstown, Cork, Ireland
412	OSF HealthCare	Peoria, IL
623	OsteoCentric Technologies	Austin, TX
310	Pacific Instruments	Honolulu, HI
303	Paragon 28	Engelwood, CO
520	PFS Med, Inc	Springfield, OR
312	PolyNovo North America	Carlsbad, CA
320	Puracyn Plus by Innovacyn	Rialto, CA

EXHIBITORS LISTING, continued

EXHIBITORS

Booth #	Company Names	City, State
522	Sectra North America, Inc.	Shelton, CT
822	Shukla Medical	St. Petersburg, FL
620	SI-BONE, Inc.	Santa Clara, CA
411	Skeletal Dynamics	Miami, FL
602	Smith and Nephew	Cordova, TN
920	Starr Frame LLC	Richardson, TX
710	Stryker	Mahwah, NJ
304	Synergy Surgicalists	Bozeman, MT
524	Synovis MCA	Birmingham, AL
400	The Orthopaedic Implant Company	Reno, NV
621	TriMed, Inc.	Santa Clarita, CA
926	Wright Medical	Bloomington, MN
404	Ziehm Imaging	Orlando, FL
802	Zimmer Biomet	Warsaw, IN
Office D	Zimmer Biomet	Warsaw, IN
315	ZipLine Medical, Inc.	Campbell, CA

EXHIBITORS LISTING, continued