ORTHOPAEDIC TRAUMA ASSOCIATION

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William M. Ricci, MD

It is my pleasure to provide the OTA Annual Meeting welcome for the second consecutive year. This anomaly is related to an organizational shift in the timing for transition of OTA held offices and positions from the Spring AAOS to the Fall OTA meeting. When the OTA was established, some 30 years ago, there was no OTA Annual Meeting. There was no OTA specific venue or opportunity for gathering, sharing, learning, educating, partnering, or doing OTA business. Since 1985, our Annual Meeting has grown from nonexistent to the premier orthopaedic trauma related meeting in the world.

The timing shift for transition affected all committees. The Program Committee was no exception. Last year Mike McKee did double duty as the Program Committee Chair and Second President- Elect positions and Mike Gardner entered as Co-Chair of the Program Committee. Rather than following the normal two-year cycle in their Program Committee leadership duties, Mike McKee rotated off after one year to assume Presidential Line responsibilities, and Mike Gardner assumed the helm of the Program Committee a year early. Stephen Kottmeier joined the Program Committee as co-Chair. Despite the disturbance in normal cadence, the 2018 OTA Annual Meeting in Orlando, FL, as you will see, represents an evolution toward a more robust, more comprehensive, and more modern Annual Meeting sure to be our best yet. A testament to the commitment and dedication of all our member volunteers and the hard work of our OTA staff. Thanks to all!!

Another exciting launch at this year's Annual Meeting is *OTA Online Trauma Access*. *OTA Online* is a one stop online portal for educational material related to orthopaedic trauma. It will house the largest, most comprehensive, peer reviewed library of technique videos available. *OTA Online* will also include access to three Rockwood & Green titles: *Rockwood & Green Textbook of Fractures in Adults/Children* including a new living textbook edition *Rockwood & Green Live* that will provide consistent up-to-date material and the in demand *Rockwood & Green On-Call* a quick reference, bullet point resource based on the Rockwood & Green text. *OTA Online* will also provide access to the *Journal of Orthopaedic Trauma, OTA International* (OTA's new open access journal), and forthcoming *OTA Orthopaedic Trauma Textbook Series* (targeted monographs to the most relevant clinical issues). This launch is the culmination of several years' effort and a partnership with our publisher Wolters Kluwer. Finally, *OTA Online* will include Industry Channels where our corporate partners will showcase educational and reference content specific to their products. Again, hearty thanks to all involved for their tireless efforts to make *OTA Online* a reality.

I hope you will agree with our OTA Board of Directors that there is no better place or time than the OTA Annual Meeting to gather, share, learn, educate, partner, do OTA business, and now transition our offices and positions. Enjoy the meeting and please visit *OTA Online* often and encourage colleagues and trainees to visit often as well.

Bill Ricci, MD
OTA President

Welcome

Find a Surgeon

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

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

SCIENTIFIC POSTERS and TECHNICAL EXHIBITS — *Exhibit Hall E & F*

(See Scientific Posters on pages 211 - 383; Exhibitor Listing on pages 487 - 488)

Open: Thursday 2:30 pm – 5:00 pm *(Unopposed time: 2:50 - 3:20 pm)*
5:07 pm – 6:07 pm
(Happy Hour Exhibitor Reception - Sponsored by **OsteoCentric Technologies** previously SMV Scientific)

Friday 9:00 am – 5:00 pm
(Unopposed times: 9:10 am - 9:55 am; 12:25 pm - 1:25 pm; 3:30 pm - 4:00 pm)

Saturday 9:00 am – 1:45 pm
(Unopposed time: 10:17 am - 11:02 am)

SPEAKER READY ROOM — *Gainesville 1 & 2*

Open: Tuesday 6:00 pm – 8:00 pm
Wed. thru Sat. 6:00 am – 6:30 pm

OTA VIDEO SHOWCASE — *Osceola ABCD Foyer (Outside the General Session Room)*

Open: Wednesday 12:00 pm – 5:00 pm
Thurs. thru Sat. 6:30 am – 5:00 pm

INTERNATIONAL RECEPTION — *Castillo Fort –Atrium Level*

Wednesday 4:45 pm – 6:00 pm

WELCOME RECEPTION — *Gaylord Palms Coquina Lawn*

Thursday 6:10 pm – 8:10 pm

INTERNATIONAL TOWN HALL LUNCH DISCUSSION — *Exhibit Hall D – Room 1*

Forum for open discussion about new ways the OTA can support the international community and hear of the many growing OTA global benefits.

Friday 12:45 pm – 1:25 pm

MILITARY RECEPTION — *Osceola Foyer*

Friday 5:30 pm – 6:30 pm

YOGA Sponsored by **SurgeonMasters**

Wednesday 7:00 pm – 8:00 pm — *Daytona 1 & 2*
Friday 6:00 am – 7:00 am — *Palm Beach Room*

MEDITATION Sponsored by **SurgeonMasters** — *Palm Beach Room*

Thursday 6:00 am – 6:45 am

BICYCLING (TOUR DE BONE) Sponsored by **SurgeonMasters** — *Offsite*

Thursday 7:00 am – 10:00 am

TAI CHI Sponsored by **SurgeonMasters** — *Osceola 3*

Saturday 6:00 am – 7:00 am

ACKNOWLEDGMENTS

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

2018 OTA RESEARCH & EDUCATION DONORS
(as of September 4, 2018)

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Thank You

OTA Legacy Society

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

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

William M. Ricci, MD
Marc F. Swiontkowski, MD
Bruce H. Ziran, MD, FACS

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

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Heather Vallier, MD
J. Tracy Watson, MD
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ACKNOWLEDGMENTS *(as of September 3, 2018)*

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Thanks

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

Center for
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Smith and Nephew	**$300,000**
DePuy Synthes	**$200,000**
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website: www.cotagrants.org

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 BASIC SCIENCE FOCUS FORUM

October 17-18, 2018

(Sun Ballroom B)

Basic Science Committee

Edward J. Harvey, MD, Chair
Michael T. Archdeacon, MD
Mohit Bhandari, MD, PhD, FRCSC
Joseph Borrelli Jr., MD
Todd O. McKinley, MD
Tyler Morris, MD
Aaron Nauth, MD
Emil H. Schemitsch, MD

Learning Objectives

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

- Understand how precision medicine principles will change how we look at research
- Outline internal fixation principles to guide treatment
- Discover new options for treatment of soft tissue injuries
- Comprehend the patient parameters that make fracture healing difficult
- Explore the basic science and clinical applications of bone grafting
- Understand current concepts in cell based therapies for fracture healing

The American Academy of Orthopaedic Surgeons designates this live activityfor a maximum of **10.5** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 BASIC SCIENCE FOCUS FORUM

Wednesday, October 17, 2018

(Sun Ballroom B)

6:00 am	**Speaker Ready Room** *(Gainesville 1 & 2)*
6:30 am	**Registration**
6:45 am	**Continental Breakfast** *(Sun Ballroom B)*
7:30 am	**Introduction** *Edward J. Harvey, MD, Program Chair*

7:35 – 8:35 am

SYMPOSIUM I: PRECISION MEDICINE APPLICATIONS TO MANAGE MULTIPLY INJURED PATIENTS WITH ORTHOPAEDIC TRAUMA

Moderators: *Todd O. McKinley, MD*
Samir Mehta, MD

7:35 am	**Introduction**
7:40 am	**Precision Methods for Wound Management** *Felipe A. Lisboa, MD*
7:53 am	**Precision Methods for Nonunions** *Annamarie Horan, PhD*
8:06 am	**Precision Methods to Stage Orthopaedic Interventions** *Greg Gaski, MD*
8:19 am	Discussion

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.

8:35 – 9:15 am PAPER SESSION I
NEW TECHNIQUES IN PATIENT CARE AND DIAGNOSIS

Moderators: *Todd O. McKinley, MD*
Samir Mehta, MD

8:35 am	**Overview** Todd O. McKinley, MD
8:40 am (p. 61) PAPER 1	**Quantifying Ionizing Radiation Dosage to Clinicians' Brains During Fluoroscopic-Guided Orthopaedic Surgery: Simulated Cadaver Experiment. QIRDOSC Study** ***Darryl Ramoutar, FRCS****; Yogesh Thakur, PhD; Vineet Batta, FRCS; Petar Seslija; Vivian Chung; Danmei Liu, PhD; Pierre Guy, MD*
8:46 am (p. 62) PAPER 2	**Infection and Biofilms After Washout In Braided Versus Barbed-Monofilament Sutures: A Murine Model** ***David Markel, MD****; Christopher Bergum, BS; Bin Wu, MD; Therese Bou-Akl, PhD; Weiping Ren, PhD*
8:52 am (p. 63) PAPER 3	**Can Dorsal Dermal Fascial Fenestrations Treat Acute Compartment Syndrome of the Foot?** ***Reuben Lufrano, MD****; Matthew Nies, MD; Benjamin Ebben, MD; Scott Hetzel, MS; Robert O'Toole, MD; Christopher Doro, MD*
8:58 am (p. 64) PAPER 4	**Detection of Elevated Compartment Pressure in a Cadaver Model Using Standard Musculoskeletal Ultrasound** ***Meir Marmor, MD****; Jonathan Charlu, BS; Riley Knox, BS; Safa Herfat, PhD*
9:04 am	Discussion
9:15 am	Refreshment Break

9:30 – 10:30 am SYMPOSIUM II:
OPTIMAL LOCKING PLATE CONFIGURATION

Moderator: *Emil H. Schemitsch, MD*

9:30 am	**Overview** Emil H. Schemitsch, MD
9:35 am	**How Stiff Should The Construct Be?** Michael Hast, PhD
9:43 am	**Role of Screw Location, Screw Type And Plate Working Length!** Mark Heyland, PhD.c
9:51 am	**Role of Lag Screws and Miniplates** Utku Kandemir, MD

Basic Science Focus Forum – WEDNESDAY, OCTOBER 17, 2018

9:59 am	**Are Active Plates Better than Conventional Locking Plates?** Michael Bottlang, PhD
10:07 am	**How to Reduce the Risk of Implant Failure and Nonunion** Brett D. Crist, MD
10:15 am	Discussion

10:30 – 11:30 am

PAPER SESSION II: BIOMECHANICS IN CLINICAL MODELS

Moderator: *Emil H. Schemitsch, MD*

10:30 am (p. 65) PAPER 5	**Fixation of Acetabular Fractures With Precontoured Plates Alone Causes Fracture Malreduction** ***Nicholas Alfonso, MD****; Weston Ryan, BS; Todd Baldini, MSc; Christopher Joyce, MD; Michael Reiter, MD; Cyril Mauffrey, MD*
10:36 am (p. 66) PAPER 6	**Hybrid Screw Fixation for Femoral Neck Fractures: Does It Prevent Mechanical Failure?** ***Derly Cuellar, MD****; J. Bledsoe, PhD; J. Tracy Watson, MD*
10:42 am (p. 67) PAPER 7	**Precontoured Quadrilateral Surface Acetabular Plate Fixation Demonstrates Increased Stability When Compared to Pelvic Reconstruction Plates: A Biomechanical Study** ***Weston Ryan, BS****; Nicholas Alfonso, MD; Todd Baldini, MSc; Michael Reiter, MD; Christopher Joyce, MD; Wei Chen, MD; Ying-Ze Zhang, MD; Cyril Mauffrey, MD*
10:48 am (p. 68) PAPER 8	**Δ Elevated Joint Contact Stress Is Associated With Radiographic Measures of Osteoarthritis in Operatively Treated Acetabular Fractures at 2 Years** ***Holly Thomas-Aitken, MS****; Kevin Dibbern, MS; Tyler Carllee, MD; J. Lawrence Marsh, MD; Michael Willey, MD; Jessica Goetz, PhD; Donald Anderson, PhD*
10:54 am	Discussion
11:04 am (p. 69) PAPER 9	**The Effect of a Dynamic Fixation Construct on Syndesmosis Reduction: A Cadaveric Study** ***M. Wesley Honeycutt, MD****; John Riehl, MD*
11:10 am (p. 70) PAPER 10	**Calcar Screw Position in Proximal Humerus Fracture Fixation: Don't Miss High** *Samir Mehta, MD; Matthew Chin, BS; Surena Namdari, MD;* ***Michael Hast, PhD***
11:16 am (p. 71) PAPER 11	**Δ Characterization of a Novel Murine Femur Fracture Model** ***Joseph Johnson, MD****; Jeremy Truntzer, MD; P. Mansuripur, MD; Nathan Thomas, BS; Justin Kleiner, BS; Sarath Koruprolu, MS; Christopher Born, MD*
11:22 am	Discussion
11:30 am	Move down to Exhibit Hall D / Room 2

Δ OTA Grant

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

11:40 am – 12:30 pm *Exhibit Hall D*

INTERNATIONAL INDUSTRY LUNCH SYMPOSIUM
Zimmer Biomet
(No CME credits offered)

Innovative Concepts in External Fixation

FastFrame™ External Fixation System Overview & Early Clinical Experience

Faculty: *Jason Nascone, MD*

Box Lunch Provided by OTA

12:30 pm — Break / Walk Back to BSFF Room *(Sun Ballroom B)*

12:40 – 1:40 pm — SYMPOSIUM III: SOFTER TISSUE ISSUES

Moderators: *Aaron Nauth, MD*
Henry Broekhusye, MD

12:40 pm — **Introduction**
Aaron Nauth, MD

12:45 pm — **Joint Contractures following Intra-articular Fracture Surgery: Where are We Now?**
Ken Egol, MD

12:55 pm — **Staged versus Early Definitive Fixation of High Energy Tibial Plateau and Plafond Fractures: What is Best for the Soft Tissues and the Patient?**
Henry Broekhuyse, MD

1:05 pm — **Soft Tissue Coverage Following Open Tibia Fractures: Timing and Flap Selection**
Martin I. Boyer, MD

1:15 pm — **Heterotopic Ossification in Orthopaedic Trauma: State of the Art**
Jeffrey Anglen, MD

1:25 pm — Discussion

1:40 – 2:14 pm — PAPER SESSION III: NON-BONE ISSUES

Moderators: *Aaron Nauth, MD*
Henry Broekhusye, MD

1:40 pm (p. 72) PAPER 12

Delayed Fixation of Intra-Articular Fractures Increased Cartilage Degeneration in a Large Animal Model
Jessica Goetz, PhD; *Christopher Heck, BS; Emily Petersen, DVM; Douglas Fredericks, BS; Michael Willey, 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.

1:46 pm (p. 73) PAPER 13	**Δ Progression of Inflammation in Muscle and Callus in a Rat Model of a High-Energy Open Tibia Fracture** ***Kayla Delaney, BS***; *Kayla Delaney, BS; Natalie Taylor, BS; Hans-Christoph Pape, MD; Fletcher White, PhD; Todd McKinley, MD*
1:52 pm (p. 74) PAPER 14	**Mitigating Pathologic Fibrosis Following Volumetric Muscle Loss Injury** ***Benjamin Corona, PhD***; *Jessica Rivera, MD; Sarah Greising, PhD*
1:58 pm (p. 75) PAPER 15	**Inflammatory Cytokines Provide Unique Predictive Value Beyond Injury Severity: A Prospective Cohort Study of Orthopaedic Trauma Patients** *Arun Aneja, MD, PhD; Alejandro Marquez-Lara, MD; David Landy, PhD;* ***Boshen Liu, MD***; *Peter Mittwede, MD; Seth Phillips, DO; Lusha Xiang, MD; George Russell, MD*
2:04 pm	Discussion
2:14 pm	Refreshment Break

2:30 – 3:30 pm SYMPOSIUM IV: MAKING NONUNIONS INTO UNIONS

Moderators: *Michael T. Archdeacon, MD*
Joseph Hsu, MD

2:30 pm	**Overview** *Michael T. Archdeacon, MD*
2:35 pm	**What Is the Role of Nutritional Optimization in the Treatment of Nonunions?** *Ivan Tarkin, MD*
2:45 pm	**Does Vitamin D Supplementation Impact Fracture Healing / Nonunion Surgery?** *Laurence B. Kempton, MD*
2:55 pm	**Is the Endocrinologist an Integral Member of the Team for Improving Outcomes in Nonunion Surgery?** *Patrick Bergin, MD*
3:05 pm	**Do Perioperative NSAIDS Adversely Affect Fracture Healing and Are They Contraindicated in Nonunion Surgery?** *H. Claude Sagi, MD*
3:15 pm	Discussion

Δ OTA Grant

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

3:30 – 4:30 pm PAPER SESSION IV: CHEMICALS AND COMPOUNDS IN FRACTURE OPTIMIZATION

Moderators: *Michael T. Archdeacon, MD*
Joseph Hsu, MD

3:30 pm
Overview
Michael Archdeacon, MD

3:35 pm (p. 76) PAPER 16
Δ **Beta-Blocker Treatment Prevents Delayed Fracture Healing Observed With Selective Serotonin Reuptake Inhibitors Treatment**
Sooyeon Lee, PhD; Vivian Bradaschia Correa, PhD; Nury Yim, MD; Madeleine Wong, BS; ***Philipp Leucht, MD***

3:41 pm (p. 77) PAPER 17
Enhanced Healing of Rat Calvarial Bone Defect With Stem Cell-Seeded Collagen Nanofibers
Therese Bou-Akl, PhD*; Bin Wu, MD; Conor Daly-Seiler, MS; Mario Rossi, BS; Weiping Ren, PhD; David Markel, MD*

3:47 pm (p. 78) PAPER 18
Effects of Powdered Rifampin and Vancomycin on Biofilm Production of *Staphylococcus aureus* on Orthopaedic Implants
Christian Douthit, MD*; Brent Gudenkauf, BS; Abdul Hamood, PhD; Nithya Mudaliar, MS; Mark Jenkins, MD; Cyrus Caroom, MD*

3:53 pm
Discussion

4:03 pm (p. 79) PAPER 19
Serum 25(OH)D Alters Bone Turnover Marker Response After Hip Fracture: A Multihospital Prospective Cohort of 296 Elderly Patients
Christopher Stewart, BA*; Nathan O'Hara, MPH; Denise Orwig, PhD; Marc Hochberg, MD, MPH; Sheila Sprague, PhD; Jay Magaziner, PhD; Gerard Slobogean, MD, MPH*

4:09 pm (p. 80) PAPER 20
Diagnosing Orthopaedic Infections: A Novel Serum Screening Tool
Aaron Johnson, MD*; D. Marinos, BS; Robert O'Toole, MD; Roman Natoli, MD; R. Montalvo, BS; Timothy Zerhusen, BS; Janette Harro, PhD; Manjari Joshi, MD; Ted Manson, MD; Mark Shirtliff, PhD*

4:15 pm (p. 81) PAPER 21
Differences in Local O_2 Supply and Consumption After Intramedullary Nailing Depends on the Degree of Injury: A Study in Hemodynamically Stable Pigs
Yannik Kalbas*; Klemens Horst, MD; Zhi Qiao, MD; Michel Teuben, MD; Frank Hildebrand, MD; Hans-Christoph Pape, MD; Roman Pfeifer, MD*

4:21 pm
Discussion

4:30 pm
Adjourn for the Day

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.

2018 BASIC SCIENCE FOCUS FORUM

Thursday, October 18, 2018

(Exhibit Hall D - Room 2)

6:00 am	**Speaker Ready Room** *(Gainesville 1 & 2)*
6:30 am	**Registration**
6:45 am	**Continental Breakfast** *(Exhibit Hall D - Room 2)*
7:30 am	**Introduction** *(Exhibit Hall D - Room 2)* *Edward J. Harvey, MD, Program Chair*

7:35 – 8:35 am

JOINT SESSION: THE SCIENCE OF BONE GRAFTING

(Exhibit Hall D - Room 2)

Moderators: *Peter V. Giannoudis, MD, FACS, FRCS*
Edward J. Harvey, MD

7:35 am	**Limitations of Autologous Bone Graft** *Joseph Borrelli Jr., MD*
7:45 am	**Ant/Post Iliac Crest Graft Harvesting: Tips / Tricks** *Steven A. Olson, MD*
7:55 am	**Distal Femur: How I Do It** *Paul Tornetta III, MD*
8:05 am	**RIA Grafting: Technique–Issues–Solutions** *Brent L. Norris, MD*
8:15 am	**Composite Grafting: What I Do and Why?** *Peter V. Giannoudis, MD, FACS, FRCS*
8:25 am	Discussion *All Faculty*
8:35 am	Break *(BSFF Attendees remain in Exhibit Hall D)*

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

8:40 – 9:20 am

PAPER SESSION V: MAKING BONE HEAL

Moderators: *Paul Tornetta III, MD*
Steven A. Olson, MD

8:40 am	**Overview** Joseph Borrelli Jr., MD
8:45 am (p. 82) PAPER 22	**Noninvasive Localized Cold Therapy Enhances Angiogenesis in Bone Defect Model** ***Marianne Comeau-Gauthier, MD***; *Daniel Castano, MD; Geraldine Merle, PhD; Justin Drager, MD, MsC; Edward Harvey, MD, MsC*
8:51 am (p. 83) PAPER 23	**Biological Activity of Human-Induced Membranes: Differences Between Femoral and Tibial Sites** ***Vaida Glatt, PhD***; *Anna Woloszyk, PhD; Kevin Tetsworth, MD*
8:57 am (p. 84) PAPER 24	**hPTH(1-34) Promotes Bone Fracture Healing in Multiple Diabetic Murine Models** ***Shasta Henderson, MD***; *Francis Lee, MD, PhD*
9:03 am (p. 85) PAPER 25	**Inflammatory Profile and Osteogenic Potential of Fracture Hematoma in Humans** *Gavin Walters;* ***Ippokratis Pountos, MD***; *Peter Giannoudis, MD*
9:09 am	Discussion
9:20 am	Refreshment Break

9:35 – 10:25 am

SYMPOSIUM VI: CELL BASED THERAPIES FOR FRACTURES

Moderators: *Joseph Borrelli Jr., MD*
Gregory J. Della Rocca, MD, PhD, FACS

9:35 am	**Introduction** *Joseph Borrelli Jr., MD*
9:40 am	**Osteoimmunology and Fracture Healing** *Prism Schneider, MD, PhD, FRCSC*
9:48 am	**The Importance of Cell to Cell Communication and the Role of Extracellular Vesicles** *Hans-Christoph Pape, MD*
9:56 am	**Stem Cell Based Therapy for Prevention of Delayed Fracture Union** *Yoram Weil, MD*

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Basic Science Focus Forum – THURSDAY, OCTOBER 18, 2018

10:04 am **Bone Marrow Aspirate Concentration In the Treatment of Fractures**
J. Tracy Watson, MD

10:12 am Discussion
All Faculty

10:25 – 11:05 am

PAPER SESSION VI: BONE HEALING BY TREATMENT WITH CELLS AND ADJUNCTS

Moderators: *Joseph Borrelli Jr., MD*
Gregory J. Della Rocca, MD, PhD, FACS

10:25 am **Overview**
Joseph Borrelli Jr., MD

10:30 am (p. 86) PAPER 26
Δ Mesenchymal Stem Cell Spheroids Augment Myoblast Secretome to Increase Osteoblast Activity
Augustine Saiz, MD*; Marissa Gionet-Gonzales, BS; Jonathan Leach, PhD; Mark Lee, MD*

10:36 am (p. 87) PAPER 27
Biomarkers of Neutrophil Extracellular Trap Formation (NETosis) and Their Relationship to Wound Healing in Ankle Fracture Surgery
William Kent, MD*; Mathew Whittaker, BS; Vitor Martins, BS; Simon Schenk, PhD; Paul Girard, MD; Alexandra Schwartz, MD*

10:42 am (p. 88) PAPER 28
Are RIA-MSCs More Stressed and Proapoptotic Than Bone Marrow-MSCs?
Jehan El-Jawhari, PhD*; Payal Ganguly, MSc; Elena Jones, PhD; Peter Giannoudis, MD*

10:48 am (p. 89) PAPER 29
The Effect of Different Washing Solutions on the Growth and Function of Primary Human Osteoblasts In Vitro
Therese Bou-Akl, PhD; Jacob Markel, BA; ***Alan Afsari, MD***

10:54 am Discussion

11:05 am **Adjourn to**
INDUSTRY LUNCH SYMPOSIA *(On-site Registration Available)*
Boxed lunch provided by OTA.

Δ OTA Grant

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

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 INTERNATIONAL TRAUMA CARE FORUM

October 17-18, 2018
(Sun Ballroom C)

International Committee

Peter V. Giannoudis, MD, FACS, FRCS, Chair
Ney Amaral, MD
Fernando de la Huerta, MD
Theodore Toan Le, MD
Amir M. Matityahu, MD
Cyril Mauffrey, MD, FACS, FRCS
Hans-Christoph Pape, MD, FACS
Sara M. Putnam, MD
Thomas A. (Toney) Russell, MD

Learning Objectives

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

- Discuss surgical techniques of elbow injuries
- Understand surgical management of pediatric hip and pelvic fractures
- Become familiar with the issues surrounding the treatment of atypical femoral fractures
- Appreciate differences in the treatment of distal tibial fractures reconstructed either with ORIF or fine wire fixators (Ilizarov)
- Become aware of the latest techniques in the management of femoral head fractures
- Gain knowledge on the differences of treatment of intertrochanteric fractures from a global perspective.

The American Academy of Orthopaedic Surgeons designates this live activityfor a maximum of **10.25** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 INTERNATIONAL TRAUMA CARE FORUM

Wednesday, October 17, 2018

(Sun Ballroom C)

6:00 am **Speaker Ready Room**
(Gainesville 1 & 2)

6:30 am **Registration**

6:45 am **Continental Breakfast**
(Sun Ballroom C)

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: ELBOW INJURIES

Moderators: *Thomas Higgins, MD*
Peter V. Giannoudis, MD, FACS, FRCS

7:35 am **Overview**
Thomas Higgins, MD

7:37 am **Radial Head Replacement: When and How?**
Michael D. McKee, MD

7:47 am **Coronoid Displaced Fractures: My Preferred Method of Reconstruction**
Craig Roberts, MD

7:57 am **Comminuted Distal Humeral Fractures in the Elderly: Total Elbow Replacement**
Chad Myeroff, MD

8:07 am Discussion
All Faculty

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.

8:15 – 8:47 am

PAPER SESSION 1: UPPER EXTREMITY

Moderators: *Florian T. Gebhard, MD*
Henry Broekhuyse, MD

8:15 am
(p. 90)
PAPER 30

Functional and Radiological Outcome in 4-Part Proximal Humeral Fractures Treated With the Affinis Fracture Hemi-Arthroplasty Using the Ca Technique
Sigurd Uyttebroek, MD; *Guy Putzeys, MD*

8:21 am
(p. 91)
PAPER 31

Comparison of the Clinical Effect of Internal Fixation Combined With Bone Graft and Replacement of the Humeral Head With the Semi-Shoulder Arthroplasty for the Treatment of Proximal Humerus Fracture
Bin-Fei Zhang, MD; *Shuang Han, MD; Shiming Wen, MD; Yan Zhuang, MD*

8:27 am
(p. 92)
PAPER 32

Hinge External Fixator Combined With Internal Fixation in the Treatment of Complex Elbow Fractures
Lisong Heng, MD

8:33 am
(p. 93)
PAPER 33

Infected Nonunion of the Forearm: The Masquelet Technique
Naseer Mir, MD

8:39 am

Discussion

8:47 – 8:57 am

HUMANITARIAN SCHOLAR PRESENTATION

8:47 am

Humanitarian Scholar
Kisitu Kyengera, MBBS - Uganda

(p. 94)
PAPER 34

The Feasibility of a Randomized Controlled Trial Comparing External Fixation Versus Intramedullary Nailing for Open Tibia Fractures at a Regional Hospital in Uganda
Kisitu Kyengera, MBBS; *David Stockton, MD; Nathan O'Hara, MPH; Gerard Slobogean, MD, MPH; Andrea Howe, BS; D. Marinos, BS; Piotr Blachut, MD; Peter O'Brien, MD, FRCPC*

8:57 – 9:37 am

PAPER SESSION II: BEST OF THE BEST

Moderators: *David C. Teague, MD*
Kees Jan Ponsen, MD, PhD
Thomas A. (Toney) Russell, MD

8:57 am
(p. 95)
PAPER 35

The Role of Video-Assisted Thoracoscopic Surgery in the Treatment of Flail Chest Injuries
Nicolaas Roozendaal, Doctoral Student; Lori van Roozendaal, MD; Matthijs van Gool, MD; Antoinette Pijnenburg, MD; Paul Hustinx, MD, PhD; ***Raoul Van Vugt, MD, PhD****; Berry Meesters, MD; Karel Hulsewe, MD, PhD; Yvonne Vissers, MD; Erik de Loos, MD*

9:03 am
(p. 96)
PAPER 36

Treatment of Open Distal Tibia Intra-Articular Fractures (OTA/AO 43) With Circular External Fixators: Multicenter Report of 57 Cases
Ahmed Thabet Hagag, MD*; Francesco Sala, MD; Giovanni Lovisetti, MD; Christopher Gerzina, BS; Gautham Prabhakar, BS; Thomas DeCoster, MD; Amr Abdelgawad, MD, MBA*

9:09 am
(p. 97)
PAPER 37

Assessment of Polytraumatized Patients According to the Berlin Definition: Does the Addition of Physiological Data Really Improve Interobserver Reliability?
C. E. M. Pothmann, MD*; Kai Jensen, MD; Ladislav Mica, MD; Georg Osterhoff, MD; H.-P. Simmen, MD; Kai Sprengel, MD*

9:15 am
(p. 98)
PAPER 38

Does the Use of Augmented Compression in Exchange Nailing for Femoral and Tibial Nonunion Accelerate Time to Radiographic Union?
Simon Weil, MRCS; Mark Middleton, FRCS; Myriam Guessoum, MRCS; ***Alex Trompeter, FRCS***

9:21 am
(p. 99)
PAPER 39

Dissecting the Mesenchymal Stem Cells Heterogeneity for Clinical Applications
Daisy Canepa, MSc*; Elisa Casanova, PhD; Vinko Tosevski, PhD; Benjamin Eggerschwiler, MSc; Eirini Arvaniti, MSc; Manfred Claassen, PhD; Hans-Christoph Pape, MD; Paolo Cinelli, PhD*

9:27 am

Discussion
All Faculty

9:37 am

Refreshment Break

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

9:52 – 10:42 am

SYMPOSIUM II: GUEST NATION (THE NETHERLANDS) Pediatric Fractures: Current Insights

Moderators: *William M. Ricci, MD*
Inger B. Schipper, MD, PhD

9:52 am **Operative Treatment of Paediatric Pelvic Fractures: Indications and Clinical Results**
Victor A. de Ridder, MD

10:02 am **Operative Treatment of Acetabular Fractures: Indications and What Outcomes Should be Expected?**
Steven A. Olson, MD

10:12 am **Femoral Shaft Fractures in the Age Group of 8-14 Years? My Preferred Method of Treatment**
Jan Bernard Sintenie, MD

10:22 am **Femoral Neck Fractures in Children: Issues Challenges and Solutions**
Daniel S. Horwitz, MD

10:32 am Discussion
All Faculty

10:42 – 11:02 am

KEY NOTE LECTURE

10:42 am **Double Dutch: Can Fracture Surgery in a General Trauma Surgery Curriculum?**
Kees Jan Ponsen, MD, PhD*, President NVT*

11:02 – 11:32 am

SYMPOSIUM III: ATYPICAL FRACTURES

Moderators: *Kees Jan Ponsen, MD, PhD*
Douglas W. Lundy, MD

11:02 am **Is the Healing Response Disturbed? What is the Evidence?**
Peter Giannoudis, MD, FACS, FRCS

11:12 am **Treatment of Atypical Femoral Fracture Non-union**
Ross K. Leighton, MD

11:22 am Discussion
All Faculty

11:32 am	Move down to Exhibit Hall D
11:40 am – 12:30 pm *Exhibit Hall D*	**INTERNATIONAL INDUSTRY LUNCH SYMPOSIUM** **Zimmer Biomet** (No CME credits offered)
	Innovative Concepts in External Fixation FastFrame™ External Fixation System Overview & Early Clinical Experience Faculty: *Jason Nascone, MD* Box Lunch Provided by OTA
12:30 pm	Break / Return to ITCF Room *(Sun Ballroom C)*

12:40 – 1:12 pm

PAPER SESSION III: BASIC SCIENCE RESEARCH

Moderators: *Hans-Christoph Pape, MD*
Enrique Guerado, MD, PhD

12:40 pm (p. 100) PAPER 40	**A Masquelet Animal Model to Evaluate Engineered Induced Membranes for Single-Stage Segmental Bone Healing** ***Malcolm DeBaun, MD****; Alex Stahl, BS; Yunzhi Yang, PhD; Michael Gardner, MD*
12:46 pm (p. 101) PAPER 41	**Comparative Evaluation of Concentrates of Adult Stem Cell Resources Derived by an Innovative Indigenized Algorithm Based on Differential Centrifugation and Ficoll-Hypaque Method** ***Rajeshwar Srivastava, MS****; Ashok Agrahari, Doctoral Student; Alka Singh, MSc; Saloni Raj, MBBS*
12:52 pm (p. 102) PAPER 42	**A New Ex Vivo Murine Model for Evaluation of Adhesiveness of a Novel Biomimetic Bone Glue** ***Philip Procter, PhD****; Sune Larsson, MD, PhD; Gry Hulsart-Bilström, PhD; Gerard Insley, PhD; Håkan Engqvist, PhD; Michael Palmer, PhD*
12:58 pm (p. 103) PAPER 43	**The Potential of Scaffolds Loaded With iPSC Extracellular Matrix in Treating Critical Size Bone Defects** ***Simon Tiziani, MD****; Elisa Casanova, PhD; Daisy Canepa, MSc; Benjamin Eggerschwiler, MSc; Hans-Christoph Pape, MD; Paolo Cinelli, PhD*
1:04 pm	Discussion *All Faculty*

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

1:12 – 1:27 pm SPECIAL INTEREST LECTURE

1:12 pm **"Scientific Output from a Small Country: The Secret of Success in RCT's"**
Dennis den Hartog, MD, PhD

1:27 – 2:15 pm PAPER SESSION IV: GENERAL TRAUMA

Moderators: *David J. Hak, MD*
Nirmal C. Tejwani, MD

1:27 pm (p. 104) PAPER 44
Does Immunosuppressive Therapy Influence Postoperative Fracture Healing After Organ Transplantation?
C. E. M. Pothmann, MD*; Hans-Christoph Pape, MD; H.-P. Simmen, MD; V. Neuhaus, PD, MD*

1:33 pm (p. 105) PAPER 45
Incidence and Complications of Fractures Managed by Traditional Bone Setters
Riaz Ahmed, MS*; Muhammad Sohail, MS; Junaid Khan, MBBS*

1:39 pm (p. 106) PAPER 46
The Incidence of Deep Venous Thrombosis and the Epidemiological Analysis of Patients With Lower Extremity Fracture in Different Age Groups in Northwest China
Shuang Han, MD*; Shiming Wen, MD; Yan Zhuang, MD*

1:45 pm Discussion

1:51 pm (p. 107) PAPER 47
Factors Associated With Deep Surgical Site Infection Following Fracture Treatment Using the SIGN Nail
Mamer Rosario, MD*; Romer Ariel Santos, MD; Misael Jonathan Ticman, MD; Geoffrey Battad, MD; Lendell John Gatchalian, MD; Paul Christian Bejosa, MD*

1:57 pm (p. 108) PAPER 48
The Effect on the Stability of the Knee Joint for Patients With Type IV, V, and VI Tibial Plateau Fracture Through Posteromedial Approaches After the Separation of the Medial Collateral Ligament
Han Zhong Xue, MD*; Cheng Ren, MD; Zhong Li, MD*

2:03 pm (p. 109) PAPER 49
Varus Mechanism Is Associated With High Incidence of Popliteal Artery Lesions in Multiligament Knee Injuries
Maximiliano Scheu, MD, MS*; Alan Garin, MD; Pedro Díaz, MD; Luis O'Connell, MD; Carolina Mellado, MD; Gonzalo Espinoza, MD*

2:09 pm Discussion

2:15 –
2:55 pm

SYMPOSIUM IV:
FEMORAL HEAD FRACTURES: AN UPDATE

Moderators: *Amir M. Matityahu, MD*
Joey Johnson, MD

2:15 pm **Non-operative Management: Which Lesion - Evidence?**
Hans-Christoph Pape, MD

2:25 pm **Which Lesions I Fix and How?**
David Hak, MD

2:35 pm **When I Do THR and Why?**
Timothy Chesser, MB, BS, FRCS

2:45 pm Discussion

2:55 pm Refreshment Break

3:10 –
3:40 pm

SYMPOSIUM V:
DEBATE
Distal Tibia Fractures With or Without Articular Extension?

Moderators: *Paul Duffy, MD*
Takashi Matsushita, MD

3:10 pm **Fine Wire Fixators**
David W. Lowenberg, MD

3:20 pm **ORIF/Plating**
R. Malcolm Smith, MD

3:30 pm Discussion

3:40 –
4:30 pm

PAPER SESSION V:
PELVIS and HIP FRACTURES

Moderators: *Gregory J. Della Rocca, MD, PhD, FACS*
Fernando de la Huerta, MD

3:40 pm **Robotic-Assisted Fixation of Sacral Fractures: Initial Experience**
(p. 110) ***Yoram Weil, MD***; *Meir Liebergall, MD; Rami Mosheiff, MD;*
PAPER 50 *Joshua Shroeder, MD; Amal Khoury, MD*

3:46 pm **The Clinical Application of Modified Stoppa Approach With Spring Plate**
(p. 111) **for Posterior Column Acetabular Fractures**
PAPER 51 ***Cheng Ren, MD***; *Han Zhong Xue, MD; Zhong Li, MD*

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

3:52 pm (p. 112) PAPER 52	**Minimally Invasive Stabilization of Posterior Pelvic Ring Instabilities With Pedicle Screw Connected to a Transverse Rod** ***Hu Wang, MD***
3:58 pm	Discussion
4:04 pm (p. 113) PAPER 53	**Operative Treatment of Intertrochanteric Femoral Fractures: Blade Versus Screw** *Joost van Leur, MSc; Tijs Jakma, MD; Sten Willemsen, PhD;* ***Bastiaan Punt, MD***
4:10 pm (p. 114) PAPER 54	**Cemented Versus Cementless Femoral Stem Design and the Risk of Revision for Periprosthetic Femoral Fracture in Total Hip Arthroplasty** ***Tanvir Khan, MBBS****; Brigitte Scammell, PhD; Andrew Manktelow, FRCS; Benjamin Ollivere, MD*
4:16 pm (p. 115) PAPER 55	**Pattern of Hip Fractures Over a 10-Year Period in a Major Referral Center** ***Paa Baidoo, MD****; Agbeko Ocloo, MD; Velarie Ansu, PhD Candidate*
4:22 pm	Discussion
4:30 pm	Adjourn for the Day
4:45 – 6:00 pm	**INTERNATIONAL RECEPTION** Castillo Fort–St. Augustine Area *Atrium Level*

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ORTHOPAEDIC TRAUMA ASSOCIATION

2018 INTERNATIONAL TRAUMA CARE FORUM

Thursday, October 18, 2018

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7:35 – 8:35 am

JOINT SESSION: THE SCIENCE OF BONE GRAFTING

(Exhibit Hall D - Room 2)

Moderators: *Peter V. Giannoudis, MD, FACS, FRCS*
Edward J. Harvey, MD

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8:25 am	Discussion *All Faculty*
8:35 am	Break *(International Forum Attendees move to Sun Ballroom C)*

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Sun Ballroom C

8:45 – 9:40 am

SYMPOSIUM VI: IOTA SYMPOSIUM INTERTROCHANTERIC FRACTURES: GLOBAL PERSPECTIVES ON AN EXPANDING PROBLEM

Moderators: *Theodore Miclau III, MD (USA)*
Peter V. Giannoudis, MD, FACS, FRCS

8:45 am **Introduction**
Peter V. Giannoudis, MD, FACS, FRCS

8:50 am **Intertrochanteric Fracture Reductions: Tips and Tricks**
Etsuo Shoda, MD, Japanese Society for Fracture Repair

9:00 am **Hip Fracture Mortality: What is Preventable?**
Yun Tian, MD, Chinese Academic Orthopaedic Society

9:08 am **Intertrochanteric Fracture Fixation: Are the Indications for a DHS Changing Worldwide?**
Fernando de la Huerta, MD,
Mexican Federation of Colleges of Orthopaedics and Traumatolog

9:16 am **Osteoporotic Bone: When and How to Use Augmentation**
Florian Gebhard, MD, German Trauma Society

9:24 am **Hip Fracture Registries: What Are the Benefits?**
Roger Bingham, MD, Australian Orthopaedic Association

9:32 am Discussion
All Faculty

9:40 am Refreshment Break

9:50 – 10:14 am

PAPER SESSION VI: FEMORAL FRACTURES

Moderators: *Victor A. de Ridder, MD*
Raymond Malcolm Smith, MD

9:50 am
(p. 116)
PAPER 56

A Biomechanical Analysis About Fixing the Locking Compression Plate of Distal Femur Fractures
Joon-Woo Kim, MD, PhD*; Chang-Wug Oh, MD, PhD; Jin-Han Lee, PhD; Il-Hyung Park, MD, PhD; Kyeong-Hyeon Park, MD; Tae-Seong Kim, MD; Il Seo, MD; Seong-Min Kim, MD*

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9:56 am (p. 117) PAPER 57	**Satisfactory Postoperative Alignment Following Retrograde SIGN Fin Nailing for Femoral Shaft Fractures: A Case-Control Study** ***Nathaniel Wilson, MD***; *Jordan Shaw, MD; Mbonisi Malaba, MD; Fasto Yugusuk, MD; Philemon Nyambati, MD; Alexander Siy, BS; Daniel Galat, MD; Kiprono Koech, MD; Dylan Nugent, MD; Paul Whiting, MD*	
10:02 am (p. 118) PAPER 58	**Open Diaphyseal Femoral Fractures Treated With Intramedullary Nailing: Incidence of Complications and Health-Related Quality of Life Outcomes** ***Hany Saleeb, MRCS***; *Theodoros Tosounidis, MD, PhD; Paul Harwood, FRCS; Nikolaos Kanakaris, PhD, MD; Peter Giannoudis, MD*	
10:08 am	Discussion	

10:14 – 10:38 am

PAPER SESSION VII:
FOOT and ANKLE

Moderators: *Roy Sanders, MD*
J.B. Sintenie, MD

10:14 am (p. 119) PAPER 60	**Outcomes of Neglected Bosworth Fracture-Dislocation** *Gisoo Lee, PhD, MD; Chan Kang, MD;* ***Yougun Won, MD***
10:20 am (p. 120) PAPER 61	**Soft-Tissue Complications and Timing of Surgery in Patients With a Tongue-Type Displaced Intra-Articular Calcaneal Fracture: An International Retrospective Cohort Study** ***Siebe De Boer, MD***; *Esther M.M. Van Lieshout, PhD, MSc; Freek Van't Land, BSc; Dominique Misselyn, MD; Tim Schepers, MD, PhD; Dennis den Hartog, MD, PhD; Michael H.J. Verhofstad, MD, PhD*
10:26 am	Discussion

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

10:32 – 10:56 am

PAPER SESSION VIII: GENERAL TRAUMA II

Moderator: *Emil Schemitsch, MD*

10:32 am (p. 121) PAPER 62	**Treatment of Infection Following Intramedullary Nailing of Tibial Shaft Fractures: Results of the ORS/ISFR Expert Group Survey** *Cyril Mauffrey, MD; David Hak, MD; Peter Giannoudis, MD; Volker Alt, MD; Christoph Nau, MD; Ingo Marzi, MD; Peter Augat, PhD; Jong-Keon Oh, MD, PhD; Johannes Frank, MD; Andreas Mavrogenis, MD; Xavier Flecher, MD; Jean Argenson, MD;* ***Ashok Gavaskar, MD****; David Rojas, MD; Yehia Bedeir, MD; Raymond Wright, MD; Arun Aneja, MD, PhD*
10:38 am (p. 122) PAPER 63	**A Comparison of Knee Pain and Kneeling Pain in Suprapatellar Versus Infrapatellar Tibial Nailing** *Mark Middleton, FRCS; Simon Weil, MRCS; Tamer Ads, MScOT; Thomas Anderson, MBBS; Andreas Fontalis, MD;* ***Alex Trompeter, FRCS***
10:44 am (p. 123) PAPER 64	**Distal Radius Volar Plate Design Predicts Volar Prominence to Watershed Line in Clinical Practice: Comparison of Soong Grading of 2 Common Low-Profile Plates in 400 Patients** ***Minke Bergsma, MD****; Kimberly Brown, MD; Job Doornberg, MD, PhD; Inger Sierevelt, MSc; Ruurd Jaarsma, MD, PhD; Bhavin Jadav, FRCS*
10:50 am	Discussion
10:56 am	**Introduction to *OTA International*** *Emil Schemitsch, MD*
11:05 am	**Adjourn to** **INDUSTRY LUNCH SYMPOSIA** *(On-site Registration Available)* Boxed lunch provided by OTA.

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

2018 ANNUAL MEETING

October 18-20, 2018
(Osceola ABCD)

Program Committee

Michael J. Gardner, MD, Chair
Stephen A. Kottmeier, MD, 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

Upon successful completion of this course, 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 American Academy of Orthopaedic Surgeons designates this live activityfor a maximum of **20** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 ANNUAL MEETING

Thursday, October 18, 2018

(Osceola ABCD)

6:00 am — **Speaker Ready Room**
(Gainesville 1 & 2)

6:30 am — **Registration**

11:15 am — **INDUSTRY LUNCH SYMPOSIA** *(On-site Registration Available)*
Boxed lunch provided by OTA.

1:00
1:20 pm — **Welcome and Donor Awards**
William M. Ricci, MD, *President*
Michael J. Gardner, MD, *Program Chair*

Osceola ABCD
1:20 –
2:50 pm

SYMPOSIUM I:
THE TREATMENT OF HIP FRACTURES IN 2018: CAN WE REACH A CONSENSUS?

Moderator: *Emil H. Schemitsch, MD*

Introduction
Emil H. Schemitsch, MD

The Young Femoral Neck Fracture:
When Should An Open Reduction Be Performed?
Gerard P. Slobogean, MD, MPH

Timing of Surgery: Should Care Be Accelerated even Further?
Abdel-Rahman Lawendy, MD, PhD

IM Nail versus Plate for Intertrochanteric Fractures:
Can We Finally Reach Consensus?
David Sanders, MD

Ipsilateral Hip and Femoral Shaft Fractures: Evidence Based Approach
Robert V. O'Toole, MD

Adjuncts to Improve Outcomes: Is Anything Ready for Prime Time?
Michael D. McKee, MD

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

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

Managing Complications: Strategies Before Arthroplasty!
Steven A. Olson, MD

What Is the Role of Arthroplasty In 2018?
Emil H. Schemitsch, MD

2:50 pm	Refreshment Break (Exhibit Hall opens at 2:30) Visit Scientific Posters & Technical Exhibits *(Exhibit Hall E & F)*

Osceola ABCD

3:20 – 4:37 pm

SCIENTIFIC PAPER SESSION I: PROGRAM HIGHLIGHTS

Moderators - Michael J. Gardner, MD & Stephen A. Kottmeier, MD

3:20 pm (p. 127) PAPER 65	**Δ A Randomized Controlled Trial Comparing rhBMP-2 Versus Autograft for the Treatment of Tibia Fractures With Critical Size Defects** ***Lisa Cannada, MD***; *Paul Tornetta III, MD; William Obremskey, MD, MPH; Lisa Reider, PhD; Jason Luly, MS; University of Maryland at Baltimore School Medicine, PhD; Ellen MacKenzie, PhD; The METRC*
3:26 pm (p. 128) PAPER 66	**A Different Approach to Preventing Thrombosis (ADAPT): A Randomized Controlled Trial Comparing Bleeding Events After Orthopaedic Trauma With Aspirin to Low Molecular Weight Heparin Venous Thromboembolism Prophylaxis** ***Bryce Haac, MD***; *Nathan O'Hara, MPH; Ted Manson, MD; Gerard Slobogean, MD, MPH; Richard Van Besien, BA; Renan Castillo, PhD; Herman Johal, MD, MPH; Peter Berger, BS; Bradley Reahl, BS; D. Marinos, BS; Yasmin Degain, MPH; Daniel Mascarenhas, BS; Daniel Connelly, BS; Thomas Scalea, MD; Deborah Stein, MD, MPH; Robert O'Toole, MD*
3:32 pm (p. 129) PAPER 67	**Tibia Fractures and NSAIDs: Does It Make a Difference? A Multicenter Retrospective Study** ***Lauren Fader, MD***; *Rodolfo Zamora, MD; John Whitaker, BS*
3:38 pm	Discussion
3:43 pm (p. 130) PAPER 68	**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*

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

3:49 pm (p. 131) PAPER 69	**Results of Operative Fixation for Femoral Neck Fractures in Patients Aged 18 to 59 Years: A Study of 16 Centers and 596 Cases** ***Cory Collinge, MD****; Andres Rodriguez-Buitrago, MD; H. Mir, MD; Andrew Sems, MD; John Scolaro, MD; Brett Crist, MD; Patrick Bergin, MD; Jaimo Ahn, MD, PhD; Joseph Hsu, MD; Andrew Schmidt, MD; Nirmal Tejwani, MD; Walter Virkus, MD; Timothy Weber, MD; Brian Mullis, MD; Michael Gardner, MD; Frank Liporace, MD; Frank Avilucea, MD; Daniel Horwitz, MD; Robert Hymes, MD; Chad Coles, MD*
3:55 pm (p. 132) PAPER 70	**Effectiveness of Various Vitamin D Protocols on Raising and Maintaining Blood Serum 25(OH)D3 Levels Over a 3-Month Period: A Randomized, Prospective Study** ***Cesar Cereijo, DO****; Perry Hooper, DO; Rikesh Patel, DO; Timothy Wagner, MD; Damien Billow, MD*
4:01 pm	Discussion
4:06 pm (p. 133) PAPER 71	**A Multicenter Randomized Trial Evaluating Intrawound Vancomycin Powder for Reducing Surgical Site Infection After Fracture Surgery** ***Robert O'Toole, MD****; Manjari Joshi, MD; Anthony Carlini, MS; Joshua Gary, MD; William Obremskey, MD, MPH; Clint Murray, MD; Greg Gaski, MD; J Reid, MD; Yasmin Degani, MPH; Tara Taylor, MPH; Susan Collins, MSc; Yanjie Huang, MS; University of Maryland at Baltimore School Medicine; The METRC; Renan Castillo, PhD*
4:12 pm (p. 134) PAPER 72	**Effectiveness of Bone Marrow-Derived Mononuclear Stem Cells for Neurological Recovery in Participants With Spinal Cord Injury: A Randomized Controlled Trial** ***Rajeshwar Srivastava, MS****; Alka Singh, MSc; Ashok Agrahari, Doctoral Student; Tulika Chandra, MD; Saloni Raj, MBBS*
4:18 pm (p. 135) PAPER 73	**Prospective Randomized Controlled Trial Comparing the Functional Outcome of Olecranon Osteotomy Versus Triceps Tongue Elevation for Surgical Exposure of Distal Humerus in Adults** ***Rajiv Maharjan, MD****; Asish Rajak, MD; Bikram Shrestha, MD; Pashupati Chaudhary, MD; Rosan Shah Kalawar, MD*
4:24 pm (p. 136) PAPER 74	**Operative Versus Nonoperative Treatment of Isolated Humeral Shaft Fractures: A Prospective Cohort Study** ***Lisa Cannada, MD****; Lauren Germany, BS; Paul Tornetta III, MD; Robert Hymes, MD; Clifford B. Jones, MD; William Obremskey, MD, MPH; Eben Carroll, MD; Brian Mullis, MD; Michael Tucker, MD; David Teague, MD; Andrew Marcantonio, DO; Robert Ostrum, MD; Michael Del Core, MD; Sarah Dawson, BS; Heidi Israel, PhD*
4:30 pm	Discussion

4:37 –
5:07 pm

President's Message

(Osceola ABCD)

"Leadership, Mentorship and Transitions in our Changing Practice Landscape"

William M. Ricci, MD
OTA President

5:07 –
6:07 pm

Business Meeting
(Members Only)

5:07 –
6:07 pm

Happy Hour – Exhibitor Reception *(Sponsored by* ***OsteoCentric Technologies****)*
(Exhibit Hall E & F)
previously SMV Scientific

6:10 –
8:10 pm

WELCOME RECEPTION
Join your colleagues for cocktails and hors d'oeuvres on the Gaylord Palms Coquina Lawn.

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

ORTHOPAEDIC TRAUMA ASSOCIATION

2018 ANNUAL MEETING

Friday, October 19, 2018

(Osceola ABCD)

6:00 am	**Speaker Ready Room** *(Gainesville 1 & 2)*
6:30 am	**Registration**
6:30 – 7:30 am	**Concurrent Breakout Sessions –** Seating available first come, first-served. Hands-on Skills Sessions and Concurrent Breakout Sessions
6:30 am	**Continental Breakfast** *(Outside Breakout Session Rooms)*

6:30 – 7:30 am

CONCURRENT HANDS-ON SKILLS SESSIONS

Pelvis Fractures: Contemporary Reduction and Fixation *(Sun 1-3)*
Moderator: *Chip Routt, MD*
Faculty: *Timothy Achor, MD; Joshua Gary, MD; Stephen Warner, MD; James Kellam, MD, FRCSC, FACS, FRCS*

Proximal Humerus Plating Tips and Tricks *(Sun 4-5)*
Moderator: *Clifford B. Jones, MD*
Faculty: *David Hak, MD; Daniel Horwitz, MD; Brett Crist, MD; Andrew Choo, MD*

Ankle Fractures Fixation: Pearls and Pitfalls *(Captiva 1-2)*
Moderator: *Gregory J. Della Rocca, MD, PhD*
Faculty: *John Adams, MD; Mark Gage, MD; Frank Liporace, MD; Kyle Schweser, MD*

6:30 – 7:30 am	CONCURRENT BREAKOUT SESSIONS	*No Tickets Required*

Displaced Femoral Neck Fractures - What Is The Evidence? *(Osceola 1-2)*
Moderator: *John Gorczyca, MD*
Faculty: *Kyle Judd, MD, MS; Robert Dunbar, MD*
David Stephen, MD; Gillian Soles, MD; Robert Simpson, MD

Surgical Approaches and Techniques for Reduction and Fixation of Scapula Fractures *(Miami 1-3)*
Moderator: *Peter Cole, MD*
Faculty: *Stuart Guthrie, MD; Babar Shafiq, MD; Darin Friess, MD*

Challenges in Non-union Treatment *(Naples 1-3)*
Moderator: *Paul Whiting, MD*
Faculty: *Christopher Doro, MD; David Goodspeed, MD;*
Gerald Lang, MD

Value Based Healthcare in Orthopaedic Trauma *(Sun Ballroom B)*
Moderator: *Brian Cunningham, MD*
Faculty: *Marc Swiontkowski, MD; Kevin Bozic, MD;*
Herman Johal, MD, MPH

Malpractice Lawsuits In Orthopedic Trauma: A Case Based Discussion "Better Safe Than Sorry" *(Sun Ballroom C)*
Moderator: *Thomas DeCoster, MD*
Faculty: *Kathleen Hessler, RN, JD; Amr Abdelgawad, MD, MBA;*
Rick Gehlert, MD; Naftaly Attias, MD; Ahmed Thabet Hagag, MD

Concurrent Surgery, HCAPHS, and Level II Trauma Center Proliferation – "The Good, the Bad and the Ugly" *(Sun Ballroom D)*
Moderator: *Douglas Lundy, MD*
Faculty: *Samir Mehta, MD; John Campbell, MD;*
Manish Sethi, MD

Contaminated Open Fractures: Getting It Right and What To Do If It Goes Wrong *(Osceola ABCD)*
Moderator: *Benjamin Ollivere, MD*
Faculty: *Paul Tornetta III, MD; William Ricci, MD;*
Tracy Watson, MD

7:30 – 9:10 am **Concurrent Sessions**
(General Session and Breakout Sessions run concurrently.)
Scientific Paper Session 2: Tibia and Pediatric (7:30 – 9:10 am)
Concurrent Breakout Sessions (8:00 – 9:00 am)

Osceola ABCD

7:30 – 9:10 am

SCIENTIFIC PAPER SESSION II: TIBIA and PEDIATRIC

Moderators - Stephen A. Kottmeier, MD & Yelena Bogdan, MD

7:30 am
Humanitarian Scholar
Billy Haonga, MD - Tanzania

(p. 137) PAPER 75
Intramedullary Nailing Versus External Fixation in the Treatment of Open Tibia Fractures in Tanzania: Results of a Randomized Controlled Trial
Billy Haonga, MD*; Max Liu, BA; Sravya Challa, BS; Kurt Yusi, MD; Edmund Eliezer, MD; David Shearer, MD, MPH; Saam Morshed, MD, PhD*

7:36 am (p. 138) PAPER 76
A Retrospective Comparative Cohort Study Comparing Temporary Internal Fixation to External Fixation at the First-Stage Debridement of Grade IIIB Open Diaphyseal Tibial Fractures
Tim Fowler, MBBS; Michael Whitehouse, PhD; Andrew Riddick, MBBS; ***Michael Kelly, MBBS***

7:42 am (p. 139) PAPER 77
Are All Classification Systems Created Equal? A Comparison of Open Fracture Scoring Systems
Thomas Cloake, BSc*; Emily Homma, MSc; Abby Sureshkumar, BSc; Jayne Ward, FRCS*

7:48 am
Discussion

7:53 am (p. 140) PAPER 78
Intramedullary Nailing Versus Minimally Invasive Plate Osteosynthesis for Distal Tibial Fractures
Liang Sun, MD*; Yao Lu, MD*

7:59 am (p. 141) PAPER 79
Preoperative Regional Anesthesia Decreases Length of Stay in Isolated Tibial Shaft Fractures
Ryan DiGiovanni, MD*; J. Brock Walker, MD; Robert Walker, MD; Clifford B. Jones, MD*

8:05 am (p. 142) PAPER 80
Does Suprapatellar Tibial Nailing Reduce Long-Term Knee Pain?
Marckenley Isaac, MS*; Robert O'Toole, MD; Ugochukwu Udogwu, BA; Daniel Connelly, BS; Mitchell Baker, BS; Yasmin Degani, MPH; Andrea Howe, BS; Katherine Ordonio, BA; Joshua Rudnicki, BS; Mauri Zomar; Nathan O'Hara, MPH; Gerard Slobogean, MD, MPH*

8:11 am
Discussion

8:16 am (p. 143) PAPER 81
Aggressive Nonoperative Treatment of Tibia Fractures: An Evidence-Based Argument for Contemporary Cost-Effective Care
Chad Lasceski, MD*; Luke Latario, BS; Jacob Jo, BA; Uyen-Sa D.T. Nguyen, Dsc; Eric Swart, MD*

8:22 am (p. 144) PAPER 82
Outcomes of Plate Fixation for Periprosthetic Tibia Fractures Around and Below Total Knee Arthroplasty
Michael Morwood, MD*; Sandra Gebhart, MD; Nicholas Zamith, BS; H. Mir, 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.

8:28 am
(p. 145)
PAPER 83

Patient-Reported Function Improves 5 Years Following Tibial Plateau Fracture
Kyle Hildebrandt, BS*; Kurtis Carlock, BS; Sanjit Konda, MD; Kenneth Egol, MD*

8:34 am — Discussion

8:39 am
(p. 146)
PAPER 84

Delayed Unions and Functional Outcomes of Pediatric Lateral Condyle Humerus Fractures: A Prospective Study
Alexander Nazareth, MS; Curtis VandenBerg, MD; Rachel Goldstein, MD, MPH; ***Natalya Sarkisova, BS****; Lindsay Andras, MD; Nina Lightdale-Miric, MD; J. Lee Pace, MD; Paul Choi, MD; David Skaggs, MD*

8:45 am
(p. 147)
PAPER 85

The Impact of Direction of Displacement, Pin Configuration, and Surgeon Training on Clinical and Radiographic Outcomes in Type III Pediatric Supracondylar Humerus Fractures
Andrew Livermore, MD*; Jason Sansone, MD; Maxwell Machurick, BA; Paul Whiting, MD; Scott Hetzel, MS; Kenneth Noonan, MD*

8:51 am
(p. 148)
PAPER 86

Long Leg Splinting for Pediatric Femur Fractures
Bennet Butler, MD*; Cort Lawton, MD; Robert Christian, MD; Ryan Harold, MD; Prasad Gourineni, MD; John Sarwark, MD*

8:57 am
(p. 149)
PAPER 147

Displaced Distal Radius Fractures in Children Younger than 11 Years Old: A Randomised Controlled Trial Comparing Two Treatment Methods
Adriana Hernandez, MD; ***Aurelio Martinez, MD***

9:03 am — Discussion

9:10 am — Continental Breakfast
Visit Scientific Posters & Technical Exhibits
(Exhibit Hall E & F)

8:00 – 9:00 am — **Concurrent Breakout Sessions**

8:00 – 9:00 am — **CONCURRENT BREAKOUT SESSIONS** — ***No Tickets Required***

Geriatric Hip Fractures: Tips and Tricks to Improve Reduction, Implant Position and Stability *(Osceola 1-2)*
Moderator: *Kyle Judd, MD, MS*
Faculty: *John Ketz, MD; Damien Billow, MD; Michael Willey, MD*

Calcaneus Fracture Fixation - Strategies for Success *(Miami 1-3)*
Moderator: *Roy Sanders, MD*
Faculty: *Paul Whiting, MD; H. Mir, MD; Frank Avilucea, MD*

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

Challenging Issues and Treatments of Complex Tibial Plateau Fractures *(Naples 1-3)*
Moderator: *William Obremskey, MD, MPH*
Faculty: *Chad Corrigan, MD; Clay Spitler, MD; Matt Graves, MD*

Managing Complex Humerus Fractures: From Proximal to Distal *(Sun Ballroom B)*
Moderator: *Andrew Choo, MD*
Faculty: *Timothy Achor, MD; Eben Carroll, MD; Michael Gardner, MD*

Innovative Strategies for the Management of the Diabetic Ankle Fracture: An International Perspective *(Sun Ballroom C)*
Moderator: *Jason Strelzow, MD*
Faculty: *Kelly Hynes, MD; Timothy White, MD; Andrea Veljkovic, MD*

Maintaining Mid-Career Quality of Life *(Sun Ballroom D)*
Moderator: *Eric Meinberg, MD*
Faculty: *Lisa Cannada, MD; Gregory Della Rocca, MD, PhD; Samir Mehta, MD; Jeffrey Smith, MD*

9:10 am Continental Breakfast
Visit Scientific Posters & Technical Exhibits
(Exhibit Hall E & F)

Osceola ABCD
9:55 – 11:25 am

SYMPOSIUM II: DOMESTIC MASS CASUALTY AND DISASTER: COMING TO YOUR AREA

Moderator: *David C. Teague, MD*

Introduction
David C. Teague, MD

Individual and Departmental/Hospital Planning and Preparedness
Christopher T. Born, MD

Mass Casualty and Domestic War Game Scenarios
Roman Hayda, MD

Legal/Legislative Vehicles and Barriers to National Response
James R. Ficke, MD, FACS

Areas of Military-Civilian Partnership to Domestic Planning and Response
Christopher LeBrun, MD

Q&A
David C. Teague, MD

SCHEDULE

11:25 – 11:55 am

2018 GUEST NATION
The Netherlands

Double Dutch: The Recent Guidelines on Hip Fracture Care from A Multidisciplinary Perspective
Kees J. Ponsen, MD, PhD; Martin J. Heetveld, MD, PhD; Rutger G. Zuurmond, MD, PhD
It is a great honor to welcome the members of the Dutch 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.

11:55 am – 12:25 pm

JOHN BORDER, MD MEMORIAL LECTURER

(General Session Room - Osceola ABCD)

John H. Wilber, MD
Chairman Department of Orthopedic Surgery
MetroHealth Medical Center,
Cleveland, OH

"The Evolution of the Orthopedic Trauma Surgeon in North America"

12:25 – 1:25 pm

Lunch and
Visit Scientific Posters & Technical Exhibits
(Exhibit Hall E & F)

12:25 – 1:25 pm

OTA ORTHOPAEDIC —TRAUMA— ASSOCIATION

New Member Luncheon
(tickets required)
(St. George 114)

12:25 – 1:25 pm

Women in Orthopaedic Trauma
Kathy Cramer, MD Memorial Luncheon
(tickets required)
(Sun Ballroom A)

Chair: *Leslie Gullahorn Olson, MD*
Co-Chair: *Carmen Quatman, MD, PhD*

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

12:35 – 1:25 pm

PRODUCT THEATER *(Exhibit Hall – Product Theater)*
DePuy Synthes Industry Session:
A Novel Approach to Fixating Difficult Fracture Patterns Utilizing Nitinol Continuous Compression Implants

Faculty: ***Patrick Wiater, MD***

12:40 – 1:25 pm LUNCHTIME GUIDED POSTER AND VIDEO TOURS *Tickets Required*

(PT1) **General Interest** *(Exhibit Hall EF)*
Guide: *Michael Gardner, MD*

(PT2) **Upper Extremity** *(Exhibit Hall EF)*
Guide: *Andrew Choo, MD*

(VT) **Video Tours** *(Exhibit Hall EF)*
Guide: *Rahul Vaidya, MD*

12:45 – 1:25 pm

International Town Hall Lunch Discussion
(Exhibit Hall D – Room 1)

Chairs: ***Theodore Miclau III, MD****, Steering Committee Chair, International Orthopaedic Trauma Association*
Peter Giannoudis, MD*, OTA International Committee Chair*

Forum for open discussion about new ways the OTA can support the international community and hear of the many growing OTA global benefits.

1:30 – 3:30 pm

Concurrent Sessions
(Hand-on Skills Sessions, General Session and Breakout Sessions run concurrently.)
Concurrent Hands-on Skills Sessions (1:30 – 2:30 pm)
Scientific Paper Session 3: Hip, Femur, Geriatric (1:30 – 3:19 pm)
Concurrent Breakout Sessions (2:30 – 3:30 pm)

1:30 – 2:30 pm CONCURRENT HANDS-ON SKILLS SESSIONS

Mini Frag Plate Assisted Reductions *(Sun 1-3)*
Moderator: *Paul Tornetta III, MD*
Faculty: *Philip R. Wolinsky, MD; Samir Mehta, MD; Reza Firoozabadi, MD; Yelana Bogdan, MD; Tracy Watson, MD* and *William M. Ricci, MD*

Periprosthetic Fractures of the Knee *(Sun 4-5)*
Moderator: *Eric Kubiak, MD*
Faculty: *Frank Liporace, MD; Dave Rothberg, MD; Hassan Mir, MD; Justin Haller, 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.

Osceola ABCD

1:30 – 3:19 pm

SESSION III: HIP, FEMUR, GERIATRIC

Moderators - Gerard P. Slobogean, MD & Brett D. Crist, MD

1:30 pm (p. 150) PAPER 87	**A Randomized Comparison Between First-Generation Dynaloc and Cancellous Screws for Treatment of Femoral Neck Fractures** ***Lars Borris, MD***; *Rikke Thorninger, MD; Ole Brink, MD, PhD*
1:36 pm (p. 151) PAPER 88	**The Incidence of Subsequent Fractures in the 2 Years Following a Femoral Neck Fracture Treated With Internal Fixation** ***Earl Bogoch, MD, FRCPC***; *Sheila Sprague, PhD; Sofia Bzovsky, BSc; Qi Zhou, PhD; Mohit Bhandari, MD, PhD; Marc Swiontkowski, MD; Emil Schemitsch, MD; FAITH Investigators*
1:42 pm (p. 152) PAPER 89	**Early Radiographic Union Score for Hip Is Predictive of Femoral Neck Fracture Complications Within 2 Years** ***Martí Bernaus, MD***; *Gerard Slobogean, MD, MPH; Sofia Bzovsky, BSc; Diane Heels-Ansdell, MSc; Qi Zhou, PhD; Mohit Bhandari, MD, PhD; Sheila Sprague, PhD; FAITH Investigators*
1:48 pm	Discussion
1:53 pm (p. 153) PAPER 90	**Computerized Adaptive Testing for Patient-Reported Outcomes in Hip Fracture Surgery** ***Elizabeth Gausden, MD***; *Ashley Levack, MD; Aleksey Dvorzhinskiy, MD; Benedict Nwachukwu, MD; Danielle Sin, MS; David Wellman, MD; Dean Lorich, MD*
1:59 pm (p. 154) PAPER 91	**The Echocardiogram: A Scapegoat for Surgical Delay for Hip Fracture Patients** ***Angelica Pinninti, BS***; *Meera Gonzalez, MD; Rachel Rubin, MD; Frederick Ramsey, PhD; Christopher Haydel, MD*
2:05 pm (p. 155) PAPER 92	**Redefining Risk in Hip Fracture Patients: Does Age Matter?** ***Ariana Lott, MD***; *Rebekah Belayneh, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*
2:11 pm	Discussion
2:16 pm (p. 156) PAPER 93	**Assessment of 30-day Mortality and Complication Rates Associated With Extended Deep Vein Thrombosis Prophylaxis Following Hip Fracture Surgery** *Wesley Durand, BS; Avi Goodman, MD;* ***Joseph Johnson, MD***; *Alan Daniels, MD*
2:22 pm (p. 157) PAPER 94	**Malnutrition Is Associated With Frailty and Postoperative Complications in Hip Fracture Patients** ***Jacob Wilson, MD***; *Adam Boissonneault, MD; Andrew Schwartz, MD; Christopher Staley, BA; Mara Schenker, MD*

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

2:28 pm (p. 158) PAPER 95	**Traumatic Hip Fracture and Primary Elective Total Hip Patients Are Not The Same: A Comparison of Comorbidity Burden, Hospital Course, Postoperative Complications, and Cost of Care Analysis** ***Jason Lowe, MD***; *Sean M. Mitchell, MD; Sumit Agarwal, MD; Clifford B. Jones, MD*
2:34 pm	Discussion
2:39 pm (p. 159) PAPER 96	**The Outcome of Operative Ankle Fracture Fixation in the Elderly** ***Yoram Weil, MD***; *Meir Liebergall, MD; Rami Mosheiff, MD; Raphael Negari, MD; Amal Khoury, MD*
2:45 pm (p. 160) PAPER 97	**Distal Femoral Replacement for Treatment of Complex Distal Femur Fractures** *Charles Mechas, BS;* ***Ryan Mayer, MD***; *Jeffrey Selby, MD; Stephen Duncan, MD; Raymond Wright, MD; Arun Aneja, MD, PhD*
2:51 pm	Discussion
2:56 pm (p. 161) PAPER 98	**Effect of Nail Size, Insertion, and ΔCanal-Nail Diameter on the Development of a Nonunion After Intramedullary Nailing of Femoral Shaft Fractures** ***Rafael Serrano, MD***; *Hassan Mir, MD; Anjan Shah, MD; Anthony Infante, DO; Benjamin Maxson, DO; David Watson, MD; Roy Sanders, MD*
3:02 pm (p. 162) PAPER 99	**The Dislocated Hip on CT Scan: An Argument for the Initial Pelvic Radiograph in Trauma Patients** ***John Adams, MD***; *Michael Koerner, MD; Catherine Long, BS; Stephanie Tanner, BS, MS; Michael Sridhar, MD; Thomas Schaller, MD; Kyle Jeray, MD*
3:08 pm (p. 163) PAPER 100	**Which Technique Is Most Accurate for Assessing Femoral Rotation?** ***Lucas Marchand, MD***; *Lance Jacobson, MD; Ami Stuart, PhD; Angela Presson, PhD; Justin Haller, MD; Thomas Higgins, MD; David Rothberg, MD*
3:14 pm	Discussion
2:30 – 3:30 pm	**Concurrent Breakout Sessions**

2:30 – 3:30 pm — **CONCURRENT BREAKOUT SESSIONS** — ***No Tickets Required***

Fractures About the Knee:
An International Perspective In 2018 *(Osceola 1-2)*
Moderator: *Michael McKee, MD*
Faculty: *Florian Gebhard, MD; Christoph Josten, MD; Bertil Bouillon, MD, PhD; Michael Nerlich, MD; Hans-Christoph Pape, MD*

How Can I Reduce My Surgical Site Infection Rate?
Tips and Tricks On Local Modalities *(Miami 1-3)*
Moderator: *Joshua Parry, MD*
Faculty: *Mark Hake, MD; Gregory J. Della Rocca, MD, PhD; David Hak, MD*

Supracondylar Distal Femur Fractures –
Getting It Right the First Time *(Naples 1-3)*
Moderator: *John Scolaro, MD*
Faculty: *Michael Gardner, MD; Hobie Summers, MD; Cory Collinge, MD*

Complex Pelvis Cases: What Can We Learn From Mistakes *(Sun Ballroom B)*
Moderator: *Anna Miller, MD*
Faculty: *Milton Routt, MD; Conor Kleweno, MD; Timothy Achor, MD; Raymond Wright, MD*

Registries: How Do They Perform?
Can They Answer Our Needs?
Can They Predict The Future? *(Sun Ballroom C)*
Moderator: *Pierre Guy, MD*
Faculty: *Brad Petrisor, MD; Cecilia Rogmark, MD; Tim Chesser, MBBS; Boris Sobolev, PhD*

Current Strategies and Techniques for Operative Fixation
of Complex Ankle Fractures and Fractures of the Tibial Plafond *(Sun Ballroom D)*
Moderator: *Frank Liporace, MD*
Faculty: *Richard Yoon, MD; Mark Gage, MD; Marcus Sciadini, MD; Jason Nascone, MD*

3:30 pm — Refreshment Break
Visit Scientific Posters & Technical Exhibits
(Exhibit Hall E & F)

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

Osceola ABCD
4:00 – 5:30 pm

SYMPOSIUM III: PELVIC FRACTURE TREATMENT: APPROACHES FOR THE POLYTRAUMA PATIENT

Moderators: *Peter V. Giannoudis, MD*
William M. Ricci, MD

INTERNATIONAL ORTHOPAEDIC TRAUMA ASSOCIATION

Introduction
Peter V. Giannoudis, MD
William M. Ricci, MD

Binder, Ex-Fix, or Nothing: Initial Management
Bertil Bouillon, MD, PhD

Hemorrhage Control: Pelvic Embolization and Open Packing
Timothy Chesser, MBBS

Open Pelvic Fractures: Treatment Protocols
Enrique Guerado, MD

Definitive Fixation: What is the Optimal Timing?
Kees Jan Ponsen, MD, PhD

Early and Definitive Fixation Methods: Tips and Tricks
Steven A. Olson, MD

5:30 – 6:30 pm

Military Reception
(Osceola Foyer)
All Active Duty Military, Retired Military, and Landstuhl Distinguished Visiting Scholar participants are welcome to attend.

5:40 – 6:30 pm

SUDS N'SCIENCE GUIDED POSTER AND VIDEO TOURS

Tickets Required

(PT3) **Foot/Ankle** *(Exhibit Hall EF)*
Guide: *Paul Tornetta III, MD*

(PT4) **International** *(Exhibit Hall EF)*
Guide: *Peter V. Giannoudis, MD*

(VT) **Video Tours** *(Exhibit Hall EF)*
Guide: *Anna Miller, 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.

ORTHOPAEDIC
—TRAUMA—
ASSOCIATION

2018 ANNUAL MEETING

Saturday, October 20, 2018

(Osceola ABCD)

SCHEDULE

6:00 am	**Speaker Ready Room** *(Gainesville 1 & 2)*
6:30 am	**Registration**
6:30 – 7:30 am	**Concurrent Breakout Sessions –** Seating available first come, first-served. Case Presentations and Mini Symposium
6:30 am	**Continental Breakfast** *(Outside Breakout Session Rooms)*

6:30 – 7:30 am **CONCURRENT BREAKOUT SESSIONS** ***No Tickets Required***

Bone Loss, Dead Space, and Soft Tissue Defects: What Do I Do Now? *(Osceola 1-2)*
Moderator: *Mark Gage, MD*
Faculty: *Frank Liporace, MD; Jason Nascone, MD; Richard Yoon, MD; Raymond Pensy, MD*

Periprosthetic Femur Fractures Case Presentation *(Miami 1-3)*
Moderator: *John Gorczyca, MD*
Faculty: *Kyle Judd, MD, MS; Matthew Jimenez, MD; Utku Kandemir, MD*

Management of Critical Bone Defects *(Naples 1-3)*
Moderator: *Geoffrey Marecek, MD*
Faculty: *Milton Little, MD; Stephen Kottmeier, MD; Mitchell Bernstein, MD; Jaimo Ahn, MD, PhD*

Complex Intra-articular Distal Humerus Fractures - Keys to Success *(Sun Ballroom B)*
Moderator: *John Scolaro, MD*
Faculty: *Gregory Della Rocca, MD, PhD; Clifford B. Jones, MD; Philip Wolinsky, MD*

Complex Distal Radius Fractures *(Sun Ballroom C)*
Moderator: *William T. Obremskey, MD, MPH*
Faculty: *Lisa K. Cannada, MD; David C. Ring, MD; Michael D. McKee, MD*

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

Atypical Femur Fractures: How to Do It Right *(Sun Ballroom D)*
Moderator: *Yelena Bogdan, MD*
Faculty: *Jörg Schilcher, MD, PhD; Pierre Guy, MD; Tracy Watson, MD; Joseph Lane, MD*

Coding in Orthopaedic Trauma *(Osceola ABCD)*
Moderator: *Paul Appleton, MD*
Faculty: *J. Scott Broderick, MD; Brett Crist, MD; William Creevy, MD; M. Henley, MD*

Osceola ABCD
7:30 – 9:00 am

SYMPOSIUM IV: IS EVIDENCE-BASED MEDICINE HURTING OR HELPING US – WHAT SHOULD CHANGE

Moderator: *Edward Harvey, MD, MsC*

Introduction
Edward Harvey, MD, MsC

Is EBM Changing How We Practice?
Julie Agel, MA

What Is Wrong and Should It Be Changed?
Edward Harvey, MD, MsC

Recent EBM Studies In Orthopaedics
Samir Mehta, MD

What Studies Should Examine
Paul Martineau, MD

Prospective Large Cohorts Are More Important
Emil H. Schemitsch, MD

EBM and RCTs- Why We Do It
Brad Petrisor, MD

9:00 – 10:17 am **Concurrent Sessions**
(General Session and Breakout Sessions run concurrently.)
Scientific Paper Session 4: Pelvis and Acetabulum, Polytrauma, Post-Traumatic Reconstruction (9:00 – 10:17 am)
Concurrent Breakout Sessions (9:05 – 10:05 am)

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Osceola ABCD **9:00 – 10:17 am**	**SESSION IV:** **PELVIS AND ACETABULUM, POLYTRAUMA, POST-TRAUMATIC RECONSTRUCTION** **Moderators - David J. Hak, MD & Joshua Parry, MD**
9:00 am (p. 164) PAPER 101	**Anterior Pelvic External Fixation Versus the Pelvic Bridge for Unstable Pelvic Injuries: A Randomized Controlled Trial** *Anthony Dugarte, MD; Jeff Gilbertson, MD; Brian Hill, MD; Lisa Schroder, MBA;* ***Peter Cole, MD***
9:06 am (p. 165) PAPER 102	**A Randomized Controlled Trial Using Neuromuscular Electrical Stimulation With Pelvic Fracture Rehabilitation. A Randomized, Placebo Controlled Clinical Trial** *Jessica Rich, MSc; Peter Bates, FRCS; Karen Hoffman, PhD; Shihfan Jack Tu, MSc; Dylan Morrissey, PhD;* ***Paul Culpan, FRCS***
9:12 am (p. 166) PAPER 103	**Prevalence, Recovery Patterns and Quality of Life After Pelvic Ring Fractures: The Brabant Injury Outcome Surveillance (BIOS) Study** ***Lars Brouwers, PhD****, Student; Mariska de Jongh, PhD; Leonie de Munter, MSc; Koen Lansink, MD, PhD*
9:18 am (p. 167) PAPER 104	**Incidence and Outcome of Orthopaedic and Nonorthopaedic Sequelae after Operative Fixation of Major Pelvic Ring Fractures** ***Ross Leighton, MD****; Ahmed Alhussain, MD; Islam Elnagar, MD; Khaled Alabbasi, MBBS; Amro Alhoukail, MD*
9:24 am	Discussion
9:29 am (p. 168) PAPER 105	**Nerve Injury With Acetabulum Fractures: Incidence and Factors Affecting Recovery** ***J. Collin Krebs, BS****; Isabella Heimke; Nicholas Scarcella, MD; Heather Vallier, MD*
9:35 am (p. 169) PAPER 106	**Long-Term Function Following Acetabulum Fracture** ***Sahini Pothireddy, BS****; Isabella Heimke; J. Collin Krebs, BS; Mary Breslin, BA; Heather Vallier, MD*
9:41 am (p. 170) PAPER 107	**Impact of Prolonged Skeletal Traction in Patients With Acetabular Fractures** ***Adam Boissonneault, MD****; Christopher Staley, BA; Amalie Erwood, BS; Madeline Roorbach, BA; Michael Maceroli, MD; Mara Schenker, MD*
9:47 am	Discussion
9:52 am (p. 171) PAPER 108	**Operative and Nonoperative Treatment of Traumatic Arthrotomies: A Prospective Observational Study** ***R. Randall McKnight, MD****; Meghan Wally, MPH; Rachel Seymour, PhD; Kyle Jeray, MD; Paul Matuszewski, MD; John Weinlein, MD; Joseph Hsu, MD; Arthrotomy Study Group*

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

9:58 am (p. 172) PAPER 109	**Comparing Radiographic Progression of Bone Healing in Gustilo Anderson IIIB Open Tibial Fractures Treated With Muscle Versus Fasciocutaneous Flaps** ***Devan Mehta, BA****; Salma Abdou, BA; Toni McLaurin, MD; Nirmal Tejwani, MD; John Stranix, MD; Vishal Thanik, MD; Philipp Leucht, MD*
10:04 am (p. 173) PAPER 110	**Intramedullary Nails Have Faster Union and Fewer Secondary Grafts/ Reoperations Than Plates With the Masquelet Technique** ***Benjamin Streufert, MD****; Amy Bauer, BS; Catherine Olinger, MD, MS; Devon Tobey, MD; Michael Beebe, MD; Frank Avilucea, MD; Michael Morwood, MD; Roy Sanders, MD; H. Mir, MD*
10:10 am	Discussion

9:05 – 10:05 am CONCURRENT BREAKOUT SESSIONS *No Tickets Required*

Management of Talus Fractures *(Osceola 1-2)*
Moderator: *Utku Kandemir, MD*
Faculty: *Saam Morshed, MD, PhD; Reza Firoozabadi, MD*

Fragility Fractures and Bone Health: Current State of the Art *(Miami 1-3)*
Moderator: *Michael Gardner, MD*
Faculty: *Kyle Jeray, MD; Joseph Lane, MD; Clifford B. Jones, MD; Kenneth Egol, MD*

Proximal Humerus Fractures: Optimizing Surgical Management and Technique in 2018 *(Naples 1-3)*
Moderator: *Emil Schemitsch, MD*
Faculty: *Niloofar Dehghan, MD; Michael McKee, MD; Edward Harvey, MD, MsC; Aaron Nauth, MD*

Failed Fixation...What Went Wrong and How to Avoid It *(Sun Ballroom B)*
Moderator: *Robert Ostrum, MD*
Faculty: *Paul Tornetta III, MD; Tracy Watson, MD; Philip Wolinsky, MD*

Intra-operative Imaging in Pelvic Ring Injuries *(Sun Ballroom C)*
Moderator: *Pierre Guy, MD*
Faculty: *H. Claude Sagi, MD; Adam Starr, MD; Jason Nascone, MD; Cory Collinge, MD*

The Challenging Periprosthetic Fracture: Case Presentations Highlighting Fixation Strategies *(Sun Ballroom D)*
Moderator: *Harmeeth Uppal, MD, MS*
Faculty: *John Scolaro, MD; Brett Crist, MD; Frank Liporace, MD*

10:17 am	Refreshment Break Visit Scientific Posters & Technical Exhibits *(Exhibit Hall E & F)*

Osceola ABCD

11:02 am – 12:42 pm

SESSION V: GENERAL INTEREST

Moderators - Gregory J. Della Rocca, MD, PhD & Kyle J. Jeray, MD

11:02 am (p. 174) PAPER 111	**RIA Versus Conventional Reaming Combined With Antibiotic-Loaded Cement Spacer: A Randomized Controlled Study of Femur and Tibia Intramedullary Nail Infection Treatment** ***Carlos Finelli, MD***; *Cyril Mauffrey, MD; Fernando Baldy dos Reis, MD, PhD; Helio Alvachian Fernandes, MD, PhD; Adriana Dell'Aquila, MD, PhD; Rogério Carvalho, MD; Natalia Miki; Carlos Franciozi, MD, PhD; Rene Abdalla, MD, PhD; Mauro Salles, PhD, MSc*
11:08 am (p. 175) PAPER 112	**Factors Associated With Treatment Failure of Implant-Related Infections in Fracture Patients** *Lauren Ehrlichman, MD; Forrest Rackard, BS; Michael Sparks, MD; Mitchel Harris, MD;* ***I. Leah Gitajn, MD***
11:14 am (p. 176) PAPER 113	**Are All Nonunions Infected? Comparison of Culture Versus Bacterial DNA Presence** ***Roman Natoli, MD***; *D. Marinos, BS; R. Montalvo, BS; G. Ochenjele, MD; C. Griffith, MD; A. Ding, MD; I. Leah Gitajn, MD; Ted Manson, MD; Manjari Joshi, MD; Mark Shirtliff, PhD; Robert O'Toole, MD*
11:20 am	Discussion
11:25 am (p. 177) PAPER 114	**MRSA Carrier Rate in Orthopaedic Trauma Patients: A Prospective Cohort Study** ***Jordan Shaw, MD***; *Christopher Whalen, MD; Joseph Mitchell, MD; Alexander Siy, BS; Christopher Doro, MD; David Goodspeed, MD; Gerald Lang, MD; Paul Whiting, MD*
11:31 am (p. 178) PAPER 115	**Preoperative Nasal Providone-Iodine Solution Effectively Reduces the Rate of Surgical Site Infection in Orthopaedic Trauma Cases** ***Brian Tonne, MD***; *April Humphrey, RN, MSN; Scott Smith, MD; Robert Heidel, PhD; James Goodin, MD*
11:37 am (p. 179) PAPER 116	**Does Standardization of Surgical Preparation Decrease Infection Rate in Closed Fracture ORIF?** *Conor Smith, BS;* ***Brett Crist, MD***; *David Volgas, MD; Mauricio Kfuri, MD, PhD; James Stannard, MD; Matthew Smith, MD*
11:43 am	Discussion

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

11:48 am (p. 180) PAPER 117	**Factors Associated With Nonunion in Patients With Open Fractures** *Fawaz Findakli, MBBS; Emil Schemitsch, MD; Sheila Sprague, PhD; Diane Heels-Ansdell, MSc; Kyle Jeray, MD; Brad Petrisor, MD; Mohit Bhandari, MD, PhD;* ***Paul Tornetta III, MD****; FLOW Investigators*
11:54 am (p. 181) PAPER 118	**Systemic Absorption and Nephrotoxicity Associated With Topical Vancomycin Powder for Fracture Surgery** ***Robert O'Toole, MD****; Yasmin Degani, MPH; Anthony Carlini, MS; Renan Castillo, PhD; Manjari Joshi, MD; The METRC*
12:00 pm (p. 182) PAPER 119	**Non-Preventable Venous Thromboembolism Following Pelvic and Lower Extremity Trauma Occurs Despite Adherence to Modern Prophylactic Protocols** ***Jason Lowe, MD****; Sean M. Mitchell, MD; Sumit Agarwal, MD; Clifford B. Jones, MD*
12:06 pm	Discussion
12:11 pm (p. 183) PAPER 120	**Significant Improvement in the Value of Operative Treatment of Tibial Plateau Fractures Through Surgeon Intervention** ***Laurence Kempton, MD****; Chris Schneble, BS; Krista Brown, MS; Anthony Sorkin, MD; Walter Virkus, MD*
12:17 pm (p. 184) PAPER 121	**Prospective Randomized Trial on Smoking Cessation in Orthopaedic Trauma Patients: Could the "Hawthorne Effect" of Carbon Monoxide Monitoring Be the Best Treatment?** ***Paul Matuszewski, MD****; Katherine Ordonio, BA; Nathan O'Hara, MPH; Robert O'Toole, MD*
12:23 pm (p. 185) PAPER 122	**3-Dimensional Virtual Reality for Pain Control in Orthopaedic Patients: A Prospective Randomized Control Study** *Milton Little, MD;* ***John Garlich, MD****; Adam Wright-Chisem, MD; Amber Howard, MPH; Carol Lin, MD; Charles Moon, MD; Garth Fuller, MS; Mark Vrahas, MD; Brennan Spiegel, MD, MS*
12:29 pm (p. 186) PAPER 123	**Reduction in Discharge Opioid Prescription Using a Simple Calculator** ***Eric Chen, MD, PhD****; Lulu Li, BS; Paul Tornetta III, MD*
12:35 pm	Discussion
12:42 – 1:42 pm	Lunch and Visit Scientific Posters & Technical Exhibits Exhibit Hall closes at 1:45 pm *(Exhibit Hall E & F)*

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12:55 – 1:40 pm	LUNCHTIME GUIDED POSTER AND VIDEO TOURS	*Tickets Required*

(PT5) **Hip/Femur** *(Exhibit Hall EF)*
Guide: *Julius A. Bishop, MD*

(PT6) **Knee/Tibia** *(Exhibit Hall EF)*
Guide: *Stephen A. Kottmeier, MD*

(VT) **Video Tours** *(Exhibit Hall EF)*
Guide: *Rafael Neiman, MD*

1:42 – 3:24 pm **Concurrent Sessions**
(General Session and Breakout Sessions run concurrently.)
Scientific Paper Session 6: Upper Extremity (1:42 – 3:24 pm)
Concurrent Breakout Sessions (1:45 – 2:45 pm)

SESSION VI: UPPER EXTREMITY

Osceola ABCD

1:42 – 3:24 pm

Moderators - Michael J. Gardner, MD & Andrew M. Choo, MD

1:42 pm (p. 187) PAPER 124	**Hemiarthroplasty Versus Nonoperative Treatment of Comminuted Proximal Humeral Fractures: Results of the ProCon Multicenter Randomized Clinical Trial** ***Dennis den Hartog, MD, PhD***; *Niels Schep, MD, PhD; Kiran Mahabier, MD; Gijs Iordens, MD, PhD; Aron De Zwart, BA; Michael H.J. Verhofstad, MD, PhD; Esther M.M. Van Lieshout, PhD, MSc*
1:48 pm (p. 188) PAPER 125	**The Role of Patients' Overall Expectations of Health on Outcomes Following Proximal Humerus Fracture Repair** ***Rebekah Belayneh, MD***; *Ariana Lott, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*
1:54 pm (p. 189) PAPER 126	**Factors Predicting Poor Functional Outcomes in Patients Following Surgically Managed Proximal Humerus Fractures** ***Rebekah Belayneh, MD***; *Ariana Lott, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*
2:00 pm (p. 190) PAPER 127	**Outcomes Following Open Reduction and Internal Fixation of Proximal Humerus Fractures in Diabetic Patients** ***Isabella Bianco, BA***; *Jessica Mandel, BA; Sanjit Konda, MD; Kenneth Egol, MD*
2:06 pm	Discussion

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

2:13 pm (p. 191) PAPER 128	**Operative Versus Nonoperative Treatment of Humeral Shaft Fractures** ***Brian Cash, MD***; *Elizabeth Lord, MD; Stephen Zoller, MD; Karren Takamura, MD; Devon Jeffcoat, MD; Eric Johnson, MD*
2:19 pm (p. 192) PAPER 129	**Is There a Critical Angle That Portends Poor Functional Outcome Scores in Nonoperative Treatment of Isolated Humeral Shaft Fractures?** ***Brian Hill, MD***; *Lisa Cannada, MD; Lauren Germany, BS; Eben Carroll, MD; Paul Tornetta III, MD; Robert Hymes, MD; Clifford B. Jones, MD; William Obremskey, MD, MPH; Brian Mullis, MD; Michael Tucker, MD; David Teague, MD; Andrew Marcantonio, DO; Robert Ostrum, MD; Michael Del Core, MD; Sarah Dawson, BS; Heidi Israel, PhD*
2:25 pm (p. 193) PAPER 130	**Risk Factors and Recovery of Iatrogenic Radial Nerve Palsy Following Plate Fixation of Humeral Shaft Fractures** ***Benjamin Streufert, MD***; *India Eaford, MS; Thomas Sellers, MD; Joseph Christensen, MD; B. Maxson, DO; A. Infante, DO; D. Watson, MD; Roy Sanders, MD; H. Mir, MD*
2:31 pm (p. 194) PAPER 131	**Case-Match Controlled Comparison of Minimally Invasive Plate Osteosynthesis and Open Reduction and Internal Fixation for the Stabilization of Humeral Shaft Fractures** ***Kevin Tetsworth, MD***; *Matthew Randell, MBBS; Vaida Glatt, PhD*
2:37 pm	Discussion
2:44 pm (p. 195) PAPER 132	**Risk Factors for Elbow Joint Contracture Following Operative Repair of Traumatic Elbow Fracture** ***Kurtis Carlock, BS***; *Isabella Bianco, BA; Sanjit Konda, MD; Kenneth Egol, MD*
2:50 pm (p. 196) PAPER 133	**Regional Anesthesia Improves Early Range of Motion Following Operative Repair of Traumatic Elbow Fractures** *Kurtis Carlock, BS; Isabella Bianco, BA;* ***Sanjit Konda, MD***; *Kenneth Egol, MD*
2:56 pm (p. 197) PAPER 134	**Ketotifen Fumarate Does Not Impair Fracture Healing When Used for Reduction of Posttraumatic Elbow Joint Contracture** ***Prism Schneider, MD, PhD***; *Alexandra Garven, BSc; Stephanie Yee, BSc; Tanja Harrison, MPA; Kevin Hildebrand, MD*
3:02 pm	Discussion
3:07 pm (p. 198) PAPER 135	**A Prospective, Longitudinal, Multicenter Cohort Study to Determine the Factors Affecting the Functional Prognosis of Radial Head Fractures** ***Stephane Pelet, MD, PhD***; *Benoit Lechasseur, MD*
3:13 pm (p. 199) PAPER 136	**Is Cheaper Always Better for Clavicle ORIF?** ***Kyle Schweser, MD***; *Gregory Della Rocca, MD, PhD; David Volgas, MD; James Stannard, MD; Brett Crist, MD*
3:19 pm	Discussion

1:45 – 2:45 pm	CONCURRENT BREAKOUT SESSIONS	*No Tickets Required*

Critical Aspects of Orthopaedic Trauma in 2018 that Can Impact Your Financial Future *(Osceola 1-2)*
Moderator: *Peter Althausen, MD, MBA*
Faculty: *Timothy Bray, MD; Timothy O'Mara, MD; Justin Walker, MD; J. Broderick, MD; Anthony Williams, BA*

Pelvic and Acetabulum Fractures *(Miami 1-3)*
Moderator: *Paul Tornetta III, MD*
Faculty: *David Templeman, MD; Cory Collinge, MD; Reza Firoozabadi, MD; Michael Kain, MD*

Cost Quality and Outcomes: Synergistic or Mutually Exclusive? *(Naples 1-3)*
Moderator: *William Obremskey, MD, MPH*
Faculty: *Andrew Pollak, MD; Steven Olson, MD; Teresa Dail, RN, MSN*

Traumatic Nerve Injury Management in Complex Upper Extremity Trauma *(Sun Ballroom B)*
Moderator: *Asif Ilyas, MD*
Faculty: *Jesse Jupiter, MD; David Ring, MD; Raymond Pensy, MD*

Compartment Syndrome: What You Should Know to Stay Out of Trouble *(Sun Ballroom C)*
Moderator: *Joshua Parry, MD*
Faculty: *David Hak, MD; Andrew Schmidt, MD; Mark Hake, MD*

Controversies in Ankle Fractures *(Sun Ballroom D)*
Moderator: *John Gorczyca, MD*
Faculty: *John Ketz, MD; Raymond Wright, MD; Gillian Soles, MD; Kevin Pugh, MD*

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

Osceola ABCD

3:24 – 4:41 pm

SESSION VII: FOOT and ANKLE, WRIST, HAND

Moderators - Gilbert R. Ortega, MD & David W. Sanders, MD

3:24 pm
(p. 200)
PAPER 137

Efficacy of Multimodal Analgesic Injections in Operatively Treated Ankle Fractures
Kyle Hancock, MD; *Olivia Rice, BS; Natalie Glass, PhD; Matthew Karam, MD; J. Lawrence Marsh, MD; Michael Willey, MD*

3:30 pm
(p. 201)
PAPER 138

Does Intraoperative Multidimensional Fluoroscopy Lead to Syndesmotic Reduction Changes Compared to Conventional Fluoroscopy?
Bryce Cunningham, MD; *Stephen Warner, MD, PhD; Marschall Berkes, MD; John Munz, MD; Andrew Choo, MD; Timothy Achor, MD; Milton Routt, MD; Joshua Gary, MD*

3:36 pm
(p. 202)
PAPER 139

Pilon Fractures in Elderly Patients: Should We Be Fixing These?
Justin Haller, MD; *Michael Githens, MD; David Rothberg, MD; Thomas Higgins, MD; Sean Nork, MD; David Barei, MD*

3:42 pm

Discussion

3:47 pm
(p. 203)
PAPER 140

Evaluating the Educational Utility of 3D Printing for Preoperative Planning in the Treatment of Periarticular Fractures
Kevin Phelps, MD; *John Ruder, MD; Rachel Seymour, PhD; Joshua Patt, MD; Madhav Karunakar, MD; Stephen Sims, MD*

3:53 pm
(p. 204)
PAPER 141

Outcomes After Heel Pad Degloving
Andrew Chen, MD, MPH; *Jason Luly, MS; The METRC*

3:59 pm
(p. 205)
PAPER 142

Platelet-Rich Plasma for Acute Achilles Tendon Rupture: A Double-Blind Multicenter Randomized Placebo-Controlled Trial
David Keene, PhD; ***Joseph Alsousou, PhD***; *Paul Harrison, PhD; Philippa Hulley, PhD; Susan Wagland, PhD; Scott Parsons, PhD; Jacqueline Thompson, MPH; Michael Schlüssel, PhD; Susan Dutton, MSc; Sarah Lamb, PhD; Keith Willett, MBBS*

4:05 pm

Discussion

4:10 pm
(p. 206)
PAPER 143

Physiotherapy, Advice Sheet, or Video Following Nonoperatively Managed Distal Radius Fractures: A Randomized Controlled Trial
Timothy Coughlin, MBBS; *Paul Matthews, PhD; Brigitte Scammell, PhD; Benjamin Ollivere, MD*

4:16 pm
(p. 207)
PAPER 144

Is Routine Radiography in the Follow-up of Trauma Patients With Distal Radius Fractures (Cost) Effective?
Pieter van Gerven, MD; *Mostafa El Moumni, MD, PhD; Wietse Zuidema, MD; Sidney Rubinstein, PhD; Pieta Krijnen, PhD; Maurits van Tulder, PhD; Inger Schipper, MD, PhD; Marco Termaat, MD, PhD*

4:22 pm
(p. 208)
PAPER 145

Volar Plate Fixation in Adults With Displaced Extra-Articular Distal Radius Fractures Is Cost-Effective
Marjolein Mulders, MD, PhD; *Monique Walenkamp, MD, PhD; Susan van Dieren, PhD; J. Carel Goslings, MD, PhD; Niels Schep, MD, PhD*

4:28 pm
(p. 209)
PAPER 146

Operative Treatment of Intra-Articular Distal Radius Fractures With Versus Without Arthroscopy: A Randomized Controlled Trial
Caroline Selles, MD; *Marjolein Mulders, MD, PhD; Joost Colaris, MD, PhD; Mark van Heijl, MD, PhD; Niels Schep, MD, PhD*

4:34 pm — Discussion

4:41 pm — Closing Remarks and Adjourn

See you next year in Denver, Colorado, September 25-28, 2019

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

Quantifying Ionizing Radiation Dosage to Clinicians' Brains During Fluoroscopic-Guided Orthopaedic Surgery: Simulated Cadaver Experiment. QIRDOSC Study

Darryl Ramoutar, FRCS; *Yogesh Thakur, PhD; Vineet Batta, FRCS; Petar Seslija; Vivian Chung; Danmei Liu, PhD; Pierre Guy, MD*

Purpose: Studies have identified a risk of radiation-induced brain cancer in interventional cardiologists and radiologists. Orthopaedic surgeons routinely use fluoroscopy yet the amount of radiation to the brain and the effect of personal protective equipment (PPE) remain unknown. Our aims were to quantify brain radiation exposure during short cephalomedullary nailing, a common orthopaedic procedure, to extrapolate lifetime dose and to determine the effects of various PPE.

Methods: Two cadavers were used: (1) a full body with short cephallomedullary nail inserted on the left; and (2) a head/neck specimen placed at a distance reproducing the surgical procedure. Optically stimulated luminescent (OSL) dosimeters were placed in locations on the head/neck specimen (thyroid, lens, skin, deep brain). The patient-cadaver's left hip was exposed in AP and lateral planes. Radiation measurements made by OSL dosimeters were scaled to clinically relevant air kerma (AK) values. Measurements were performed with the head specimen without PPE and then repeated sequentially with each then all PPE. A 2-tailed t-test was used to compare the different scenarios. We estimated at 16 cases/year a surgeon's annual volume based on our group's 2015-2016 billing data for a 40-year career (25-65 years). The average exposure dosage was based on radiology system data.

Results: The mean brain radiation without PPE was 3.35 μGy. This was significantly reduced in all 4 PPE groups ($P < 0.05$: no PPE vs each group). There was no significant additional reduction when the thyroid collar was used in isolation (2.94 μGy) versus when used with leaded glasses (2.96 μGy, $P = 0.97$), lead cap (3.22 μGy, $P = 0.55$), or both (2.31 μGy, $P = 0.15$). The estimated mean yearly brain exposure was 53.65 μGy with a mean lifetime dose of 2146.11 μGy without PPE. PPE decreased exposure to 1883.24 μGy/lifetime. The right side of the brain recorded higher exposure in all test scenarios with a lifetime dose of 3008 μGy. The thyroid collar reduced it to 2464 μGy. The lead skull cap did not reduce radiation.

Conclusion: The cumulative lifetime radiation to a surgeon's brain from short cephallomedullary nailing is relatively small. However, this represents only one of many fluoroscopy aided procedures of most surgeons and underestimates total lifetime exposure. This study demonstrates that in addition to its primary role, thyroid collars significantly reduce the radiation dose to the brain and should be worn. Lead caps appear to have minimal additional effect and hence their use is not supported.

Infection and Biofilms After Washout In Braided Versus Barbed-Monofilament Sutures: A Murine Model

David Markel, MD; *Christopher Bergum, BS; Bin Wu, MD; Therese Bou-Akl, PhD; Weiping Ren, PhD*

Purpose: There is increased potential for biofilm and infection with braided versus barbed-monofilament sutures. We created a washout model to simulate treatment of early infection and evaluate infection/biofilm behavior in the presence of braided versus barbed-monofilament sutures.

Methods: Mouse air pouches were created in 60 BALB/cJ mice. After maturation, three 1-cm braided or barbed-monofilament suture sections were implanted. Pouches were inoculated with *Staphylococcus aureus* (10 8 CFU [colony-forming units]/pouch). We studied braided, barbed-monofilament and controls, with and without washouts. Pouch irrigation with 3 mL saline was performed day 7 after removing 1 suture segment. The second segment was removed immediately after washout, the third removed on day 14. Contamination was measured via cultures. Biofilm was evaluated via confocal imaging and scanning electron microscopy. Pouch thickness and cellularity were assessed histologically.

Results: Bacterial culture: Day 7, growth was greater in braided versus barbed without wash ($P = 0.007$), and after washout ($P = 0.001$). Pouch thickness: Pouches were generally thicker with braided and without washouts. Cellularity: Cellularity increased in braided washout and barbed without washout (not significant). Biofilm assessment: ESEM (environmental scanning electron microscopy) qualitatively showed more bacterial retention by braided before/after washout. Confocal: Qualitative imaging showed penetration of biofilm within braided and less adhesion in barbed. Barbs did not create a biofilm nidus. Quantitative assessment was limited by sample sizes and confidence interval variability (not significant). Observational outcomes showed more biofilm in braided (biomass was 2x greater, consistently thicker with wider area occupied and surface area before/after washout).

Conclusion: Woven structures can harbor bacteria more than barbed monofilaments. This is concerning for biofilm formation. Biofilm was present on the surface of both sutures, but penetrated the braided weave. When washing out infected pouches to simulate treatment, bacterial/biofilm were not completely eliminated from either suture but qualitatively seemed more effective with barbed monofilament. Larger samples or other detection technologies are required for quantitative results/conclusions.

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Can Dorsal Dermal Fascial Fenestrations Treat Acute Compartment Syndrome of the Foot?

Reuben Lufrano, MD; *Matthew Nies, MD; Benjamin Ebben, MD; Scott Hetzel, MS; Robert O'Toole, MD; Christopher Doro, MD*

Purpose: Treatment of compartment syndrome of the foot with fasciotomies remains controversial. Dorsally based dermal fascial fenestrations (DDFF) have been used to treat severe foot trauma with compartment syndrome. The efficacy of this technique has not been studied. The purpose of this study was to evaluate compartment decompression with DDFF compared to traditional fasciotomies in a foot compartment syndrome model. We hypothesized that fasciotomies and dorsal dermal fenestrations would provide equivalent compartment decompression.

Methods: 10 cadaver limbs were used for this study and intracompartmental pressure was monitored in the first dorsal interosseous (FDIO), abductor(ABD), and superficial plantar (SP) compartments with a Stryker monitor. A compartment syndrome model was created based on similar existing models in the leg using pressurized normal saline in the 3 compartments. Each compartment was pressurized, allowed to equilibrate and recorded. Pressure measurements were repeated in the same manner after completing DDFF and then after standard fasciotomies. Our primary outcome variables were intracompartmental pressure in the 3 compartments for 4 specific conditions: (1) baseline pressure, (2) pressure in the compartment syndrome model, (3) pressure after DDFF, and (4) pressure after fasciotomies. Analysis was completed using repeated-measures analysis of variance.

Results: Fasciotomy decreased compartment pressures within 10 mm Hg of baseline pressure in all compartments tested (average pressure [mmHg] 11.4 vs 5.3 FDIO, 8.5 vs 8.8 ABD, 10.2 vs 7.6 SP; all P values <0.001). DDFF only decreased the average pressure in the first dorsal interosseous compartment to 43 mm Hg (95% confidence interval 28-59 , P <0.001). DDFF did not provide a significant decrease in pressure in the abductor and plantar compartments. Pressure decrease following fasciotomy compared to DDFF was significantly greater in all 3 compartments studied (average pressure [mmHg] 11.4 vs 43.2 FDIO, 8.5 vs 70 ABD, and 10.2 vs 75 SP; all P values <0.005).

Conclusion: Fasciotomies were more effective at decreasing intracompartmental pressure than fenestrations. Our results suggest that DDFF do not provide decompression of the abductor and plantar compartments of the foot and only partial decompression of the dorsal compartments. We recommend caution in using fenestrations alone to treat acute compartment syndrome of the foot.

PAPER ABSTRACTS

Detection of Elevated Compartment Pressure in a Cadaver Model Using Standard Musculoskeletal Ultrasound

Meir Marmor, MD; *Jonathan Charlu, BS; Riley Knox, BS; Safa Herfat, PhD*

Purpose: Acute compartment syndrome (ACS) is a limb-threatening condition often associated with trauma. The current gold standard of compartment pressure (CP) measurements involves direct CP measurements of all compartments suspected of ACS. Patient discomfort, as well as the low reliability of invasive CP measurement, has led to the search for noninvasive methods for diagnosing ACS. Our goal was to test the feasibility of using commercially available ultrasound technology for diagnosis of ACS.

Methods: 6 cadaveric legs were used in this study. Saline was introduced into the anterior compartments to increase CP and simulate ACS. The amount of CP was controlled by creating a saline fluid column between the compartment and a pitcher fixed to an IV pole at variable heights. A standard musculoskeletal ultrasound transducer was combined with a pressure-sensing transducer to obtain a B-mode image of the anterior compartment while controlling the amount of pressure the transducer applied to the skin. The height of the pitcher of saline was raised sequentially to increase CP from 0 to 30, 45, 60, and 75 mm Hg as measured by the intracompartment needle pressure monitor. At each CP the width of the anterior compartment was measured at 50 mbar (CW50) and 100 mbar (CW100) of applied pressure. Additionally, the pressure needed to compress the bulging superficial compartment fascia to a flat plane (CPP [compartment pressure press]) was measured.

Results: All 3 ultrasound indexes showed high correlations to CP in the individual cadavers. The Pearson product-moment correlations indicated strong correlations in all specimens with R values ranging from 0.64103 to 0.97165 for CW50, 0.82571 to 0.99579 for CW100, and 0.66477 to 0.98544 for CPP. The difference in average CW50, CW100, and CPP between baseline and all elevated CP levels were statistically significant ($P < 0.05$). Interclass correlations for CPP were good (0.69) for interrater reliability and excellent (0.81-0.96) for intrarater reliability.

Conclusion: This cadaver study tested the feasibility of using ultrasound in the clinical setting for the diagnosis of ACS. Our ultrasound indexes showed excellent correlations to compartment pressures, suggesting that there is a potential for the clinical use of this modality in the future.

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Fixation of Acetabular Fractures With Precontoured Plates Alone Causes Fracture Malreduction

Nicholas Alfonso, MD; *Weston Ryan, BS; Todd Baldini, MSc; Christopher Joyce, MD; Michael Reiter, MD; Cyril Mauffrey, MD*

Purpose: Anatomic reduction of acetabular fractures remains the aim of surgical treatment. Precontoured quadrilateral surface buttress (PQSB) plates are now available with theoretical advantages compared to traditional plates. However, our experience has pushed us to hypothesize that their application may at times cause fracture malreduction.

Methods: A model was created to investigate the maintenance of acetabular fracture reduction following application of 3 different fixation constructs. A transverse acetabular fracture (OTA 62-B1.1) was created in 18 synthetic hemipelvi followed by anatomic reduction held by two 2.0-mm Kirshner wires. 6 pairs of tracking points were then placed on either side of the osteotomy: Point 1 along the anterior column; Points 2, 3, and 4 within the acetabulum; Point 5 along the posterior column; and Point 6 along the medial wall. Each reduced hemipelvis was fixed using 3 techniques with 6 specimens in each group. Group A fixation included an anterior column lag screw followed by a pelvic reconstruction plate and posterior column screw; Group B fixation consisted of a PQSB plate only; and Group C fixation used an anterior column lag screw followed by a PQSB pate. All screws implanted were 3.5-mm cortical screws with bicortical purchase. The distance between tracking points was measured using a caliper both before and after final fixation to determine if any displacement occurred. One-way analysis of variance (ANOVA) followed by individual Tukey's HSD (honest significant difference) testing for significant ANOVA ($P < 0.05$) results was used to determine significant ($P < 0.05$) difference between groups.

Results: Group B had significant fracture displacement after final fixation along the anterior column and within the acetabulum (Points 1, 2, 3, and 4) when compared to Group A and Group C. The average amount of displacement at the anterior column and within the acetabulum was 1.37 mm (95% confidence interval [CI]: 1.08, 1.65) in Group B constructs compared to 0.32 mm (95% CI: 0.22, 0.42) and 0.26 mm (95% CI: 0.15, 0.38) in Groups A and C constructs, respectively. There were no significant differences in displacement after final fixation between Group A and Group C.

Conclusion: PQSB plates for acetabular fractures can cause malreduction when applied as the only means of fixation. Stiffness of the plate and one-shape-for-all may be the root cause of this problem. We suggest the use of an interfragmentary screw to help maintain anatomic reduction prior to placement of a PQSB plate.

Hybrid Screw Fixation for Femoral Neck Fractures:
Does It Prevent Mechanical Failure?

Derly Cuellar, MD; *J. Bledsoe, PhD; J. Tracy Watson, MD*

Purpose: Conventional femoral neck fracture fixation uses partially threaded cancellous screws to maintain fracture reduction. Fracture collapse and varus deformation can still occur due to posterior medial comminution and lack of calcar support. We hypothesize a fully threaded screw placed in the inferior posterior calcar region will provide improved biomechanical stability, providing fixed angle support with less fracture collapse, thus minimizing varus deformation and screw cutout.

Methods: 10 matched cadaveric pairs (20 femurs) were randomly assigned to 2 groups of screw fixation. Screws were placed in an inverted triangular configuration. Group 1 (Hybrid) utilized 1 fully threaded inferior posterior calcar screw and 2 partially threaded superior screws. Group 2 (PTG) utilized all partially threaded screws. Screws were placed using fluoroscopy with a template guide. Specimens underwent standardized femoral neck osteotomy with cutting guides. Initial neck cut was perpendicular to the neck. A 5-mm posteromedial wedge was then removed to simulate posteromedial comminution, producing an unstable fracture. Specimens were mounted in a materials testing system at 20° from the horizontal to simulate a 1-leg stance. 2 loading sequences were utilized: (1) axial load applied at a rate of 1 N/sec up to 700 N, followed by cyclic loading at 2 Hz in force feedback control with loads of 700 to 1400 N for 10,000 cycles; (2) all surviving constructs were cyclically loaded to failure in a stepwise manner with maximum load of 4000 N. Statistical analysis using paired t-tests compared stiffness, cycles to failure, and maximum load to failure (defined as 15-mm displacement).

Results: Construct stiffness was 2848 ± 344 N/mm in PTG versus 2767 ± 665 for Hybrid ($P = 0.628$). 3 femurs failed during sequence 1 testing, all in PTG group. Load to failure demonstrated Hybrid superiority with maximum cycles to failure (3797 ± 400 cycles vs 2981 ± 856 in PTG, $P = 0.01$). Hybrid superiority was demonstrated with maximum load prior to failure (3290 ± 196 N vs 2891 ± 421 N in PTG, $P = 0.01$). No significant difference in bone mineral density was noted in failure versus surviving groups ($P > 0.05$).

Conclusion: Our study is the first to assess the biomechanical effects of hybrid fixation for femoral neck fracture. Hybrid screw configuration resulted in significantly stronger constructs, with higher axial load and increased cycles to failure. The advantageous mechanical properties demonstrated using a fully threaded inferior calcar screw appears to function as a mini-fixed-angle device and may prevent the common complication of excessive shortening and varus collapse. Further clinical correlation is needed.

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Precontoured Quadrilateral Surface Acetabular Plate Fixation Demonstrates Increased Stability When Compared to Pelvic Reconstruction Plates: A Biomechanical Study

Weston Ryan, BS; *Nicholas Alfonso, MD; Todd Baldini, MSc; Michael Reiter, MD; Christopher Joyce, MD; Wei Chen, MD; Ying-Ze Zhang, MD; Cyril Mauffrey, MD*

Purpose: Precontoured quadrilateral surface buttress (PQSB) plates are now increasingly utilized for fixation of acetabular fractures requiring an anterior approach. There are limited studies comparing these plates to more traditional implants. The purpose of our work is to compare the stability of 3 different means of fixation for a transverse acetabular fracture in a biomechanical model: a reconstruction plate with a 3.5-mm lag screw in the anterior column and a 3.5-mm interfragmentary screw in the posterior column (Group A); a PQSB plate alone (Group B); and an anterior column 3.5-mm lag screw and a PQSB plate (Group C).

Methods: A transverse acetabular fracture (OTA 62-B1.1) was created in 18 synthetic hemipelvi. 6 hemipelvi were fixed by each of the 3 methods described above. The specimens were mounted in a servohydraulic test system and loaded anatomically with a synthetic femur to 2.5x body weight (BW) to simulate normal weight-bearing for 42,000 cycles. The displacements at the anterior and posterior columns were measured with a motion capture system. The specimens were then loaded to 7x BW to simulate a stumble for 50 cycles. The number of cycles to failure was recorded. Displacement data was analyzed with analysis of variance and Tukey HSD (honest significant difference). A Cox proportional hazards regression model was used to determine if there was a difference in survival rate of 7x BW loading. P values <0.05 were considered significant.

Results: During cyclic loading, Group C had significantly less posterior column displacement (0.16 ± 0.06 mm) compared to Group B (0.38 ± 0.37 mm, $P<0.01$) and Group A (0.38 ± 0.37mm, $P<0.01$). During cyclic loading, Group C had significantly less anterior column displacement (0.18 ± 0.09 mm) than Group A (0.28 ± 0.11 mm, $P = 0.01$), and Group B had significantly less displacement (0.22 ± 0.14 mm) than Group A (0.28 ± 0.11 mm, $P = 0.03$). Cox proportional hazard analysis showed that Group B had a 7.27x greater rate of failure than Group C (95% confidence interval: 1.6, 33.2) and there was no significant difference comparing Group A to either Group B or Group C.

Conclusion: PQSB plates show increased stability in a transverse acetabular fracture biomechanical model compared to reconstruction plates. Stability can be increased when these precontoured plates are used in conjunction with a lag screw in the anterior column. Based on our data we support early weight-bearing after transverse acetabular fracture fixation in patients with healthy bone when a PQSB plate is used.

PAPER ABSTRACTS

Δ Elevated Joint Contact Stress Is Associated With Radiographic Measures of Osteoarthritis in Operatively Treated Acetabular Fractures at 2 Years

Holly Thomas-Aitken, MS; *Kevin Dibbern, MS; Tyler Carllee, MD; J. Lawrence Marsh, MD; Michael Willey, MD; Jessica Goetz, PhD; Donald Anderson, PhD*

Purpose: Our purpose was to determine if elevated joint contact stress (JCS) after fixation of acetabular fracture is associated with development of posttraumatic osteoarthritis (PTOA) at 2-year follow-up.

Methods: CT scans from 10 patients with operatively treated acetabular fractures were obtained at >2-year follow-up. 5 had Kellgren-Lawrence (KL) grade <2 (No OA group), and 5 cases had KL grade ≥2 (OA group). Discrete element analysis (DEA) was performed on surface models generated from the CT scans to compute JCS during gait. For each patient, maximum contact stress during the stance phase of gait was compared to their KL grade. Contact stress patterns for these 2 groups of patients were also compared to 5 asymptomatic, uninjured patients.

Results: Maximum JCS for the OA group (10.4 MPa) was significantly higher (P <0.001) than both the No OA patients (7.2 MPa) and normal hips (8.9 MPa). While there was no significant difference in maximum contact stress between No OA and normal hip patients, the No OA group did have lower stress near heel-strike and higher stress near toe-off. There was a positive correlation between the maximum JCS and KL grade ($R^2 = 0.546$).

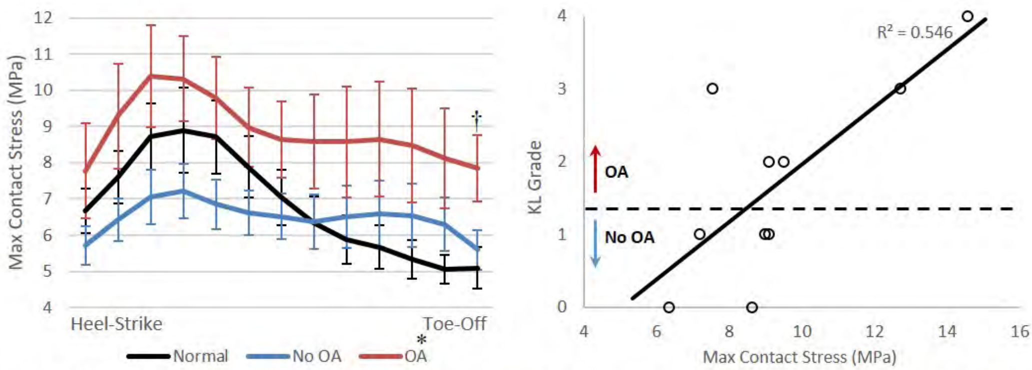

Figure 1: (Left) Over the entire stance phase of gait, the maximum contact stress in the OA group is significantly (*p<0.001) higher than in the No OA patients and normal hips. N=5 per patient group. The No OA patients had higher contact stress near toe-off than individuals with normal hips. †p<0.05, OA vs. normal. (Right) Maximum contact stress positively correlates with KL grade in operatively treated acetabular fractures.

Conclusion: Acetabular fracture patients who developed PTOA had significantly higher JCS, confirming that exposure to abnormally high JCS in the hip leads to the development of osteoarthritis. While not all fracture patients developed PTOA, the shift in maximum contact stress to later in the gait cycle indicated that surgical reduction has not returned fractured hip joints to a normal mechanical state.

Δ OTA Grant

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The Effect of a Dynamic Fixation Construct on Syndesmosis Reduction: A Cadaveric Study

M. Wesley Honeycutt, MD; *John Riehl, MD*

Purpose: Syndesmotic malreduction can be a cause of poor clinical results in ankle fractures. Static fixation will serve to hold any malreduction in place, altering normal ankle biomechanics. The purpose of the current study was to explore what effect the placement of a dynamic fixation construct would have on the final reduction of the syndesmosis.

Methods: Syndesmotic ligaments were sectioned in 10 cadaveric specimens. The syndesmosis was intentionally malreduced and the distance from the anterior edge of the fibula to the anterior incisura of the tibia was measured to quantify the sagittal syndesmotic displacement (SSD). A 3.5-mm quadricortical screw was then placed, clamp was removed, and the SSD measured. The clamp was then replaced, and a suture-button construct (Knotless Tightrope, Arthrex Inc) was then placed through the bone tunnel, the clamp was removed, and the SSD was measured (Fig. 1).

Results: In all cases, the fibula reduced to within 1 mm of its native anatomic position with the dynamic construct. The static screw construct, however, maintained an identical SSD measurement as the clamped malreduction. The dynamic suture-button construct reliably improved the SSD with comparison to the static screw construct (P <0.0001).

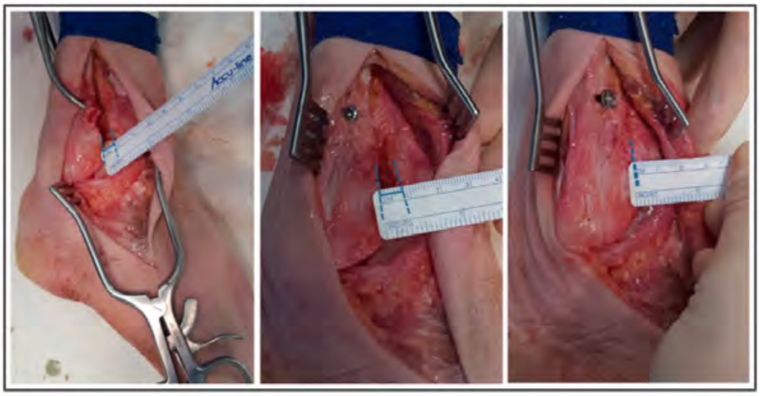

Figure 1. Specimen demonstrating intentional malreduction of the syndesmosis using a static clamp (left) with a sagittal syndesmotic displacement of 8 mm. Placement of a quadricortical static syndesmotic screw maintained the same 8 mm SSD (middle). Placement of a dynamic suture-button construct demonstrating <1 mm of SSD. Note also, the realignment of the previously sectioned syndesmotic ligaments (right).

Conclusion: Our study demonstrates that dynamic fixation constructs can help restore anatomic alignment in the case of syndesmotic malreduction. The size difference between the suture diameter and drill hole effectively allows the fibula to be pulled and seated into the tibial incisura fibularis. These findings should not be viewed as a justification to ignore the syndesmotic reduction; however, they do validate an important benefit of dynamic fixation that has been found in the recent clinical literature.

Calcar Screw Position in Proximal Humerus Fracture Fixation: Don't Miss High

Samir Mehta, MD; Matthew Chin, BS; Surena Namdari, MD; ***Michael Hast, PhD***

Purpose: Locked plate fixation of proximal humerus fractures relies upon the calcar fixation to provide much-needed medial column support. Little is known about the consequences of "missing" the calcar during plate positioning. This study characterized the biomechanics associated with proximal and distal placement of plates in a 2-part fracture model. We hypothesized that missing the calcar in either direction would result in decreased biomechanical strength.

Methods: This experiment was performed with elderly cadaveric specimens and again with osteoporotic sawbones. Proximal, neutral, and distal plate placements were simulated. Nondestructive torsional and axial compression tests were performed prior to an axial fatigue test and ramp to failure. Torsional stiffness, axial stiffness, humeral head displacement, and stiffness during fatigue testing, and ultimate load were compared between groups.

Results: Cadavers: No significant differences between groups. Sawbones: Distal placement increased torsional stiffness and axial stiffness when compared to proximal placement. When compared to neutral placement, distal placement increased torsional stiffness in external rotation, increased axial stiffness, decreased humeral head displacement during fatigue testing, and increased stiffness during fatigue testing.

Conclusion: Missing the calcar proximally is potentially deleterious to fixation strength. It is safe, and perhaps even desirable, to aim slightly distal to the intended target.

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∆ Characterization of a Novel Murine Femur Fracture Model

Joseph Johnson, MD; *Jeremy Truntzer, MD; P. Mansuripur, MD; Nathan Thomas, BS; Justin Kleiner, BS; Sarath Koruprolu, MS; Christopher Born, MD*

Purpose: Closed fracture systems have been used for decades to simulate human fractures in a laboratory setting. Fracture models in mice are attractive because they offer a high-volume, relatively low-cost method of investigating fracture healing characteristics. These methods are technically challenging and require specialized equipment. We report on the development of a novel murine femur fracture model that is rapid, reproducible, and inexpensive.

Methods: Our fracture model involves an open, lateral approach to the murine femur with fracture creation using sharp-tipped surgical scissors at the mid-shaft level. Surgical stabilization and intramedullary fixation are achieved by means of a precut 24-gauge needle introduced antegrade to the canal and reduced retrograde under direct visualization. 3 groups of 5 mice were allowed to survive 14, 28, and 42 days post-surgery, sacrificed, and evaluated with fluoroscopy, microCT, and histology.

Results: 14 mice survived the surgical procedure. Only 2 lost reduction and did not heal. In the 14-day sacrifice group, fluoroscopy and microCT revealed bridging soft callus in all fractures. In the 28-day sacrifice group, fluoroscopy showed bridging hard callus was evident in all fractures. In the 42-day sacrifice group, fluoroscopy demonstrated that remodeling had already begun. MicroCT revealed that from 14 to 42 days, the average callus volume decreased from 101.61 mm^3 to 68.21 mm^3, while the relative bone volume of callus increased from 14 to 42 days (15.2% to 30.62%). At 14 days, the average percent area of callus composed of cartilage is 44.1% (standard deviation [SD] 2.9%), while at 28 days the average percent area of callus composed of cartilage is 19.0% (SD 3.4%) and at 42 days the average percent area of callus composed of cartilage is 8.4% (SD 2.6%).

Conclusion: Our novel technique provides a reproducible and inexpensive method to simulate a fracture and healing in a laboratory setting. The method is rapid (average surgical time 5 minutes) and does not require costly equipment required by other approaches. Additionally, our model demonstrates a reliable progression of radiographic and histologic bone healing similar to previously published models, but without the technical difficulty or expensive specialized equipment. Our radiographic and histologic analysis was able to demonstrate that our novel fracture method can reliably reproduce a model of indirect fracture healing seen clinically with intramedullary and other indirect methods of fracture fixation.

∆ OTA Grant

Wed., 10/17/18 Basic Science: Non-Bone Issues, PAPER #12

Delayed Fixation of Intra-Articular Fractures Increased Cartilage Degeneration in a Large Animal Model

Jessica Goetz, PhD; *Christopher Heck, BS; Emily Petersen, DVM; Douglas Fredericks, BS; Michael Willey, MD*

Purpose: The purpose of this study was to determine if delay from intra-articular fracture (IAF) to surgical fixation results in increased severity of posttraumatic osteoarthritis (PTOA).

Methods: Under Institutional Animal Care and Use Committee approval, 16 adult Yucatan minipigs received a partial articular fracture of the distal tibia. Half of the animals were fixed immediately after fracture with a plate and screws. The other 8 animals were casted in a flexed position to prevent weight-bearing. 3 days after fracture, animals underwent fixation using the same technique as the immediate fixation group. At regular postoperative intervals animals underwent formal gait analysis to quantify limb usage. 12 weeks postoperatively, animals were euthanized and the distal tibia and talar dome were harvested for histological analysis. A semi-automated quantitative Mankin scoring program was used to quantify differences in cartilage degeneration.

Results: There were no differences in limb kinematics between the immediate and delayed fixation groups. Bone healing was less mature and Mankin scores were higher in the delayed fixation group (figure) indicating more severe cartilage degeneration.

Representative safranin-O histology sections from the immediate and delayed fixation groups. Anterior is on the right and superior is on the top. Fracture reduction was excellent in both groups. With the exception of one outlier in the delayed fixation group, Mankin scores in the medial talus were elevated compared to scores in the immediate fixation group ($p=0.09$), indicating more advanced cartilage degeneration, which is visible in the images as thinner tissue and loss of red proteoglycan staining.

Conclusion: The delay between injury and surgical fixation resulted in less robust bone healing of an IAF. PTOA was more severe with delayed fixation, indicating worsening cartilage injury. Our results raise concern that ongoing instability before fixation may lead to worsening joint injury after IAF.

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∆ Progression of Inflammation in Muscle and Callus in a Rat Model of a High-Energy Open Tibia Fracture

Kayla Delaney, BS; *Kayla Delaney, BS; Natalie Taylor, BS; Hans-Christoph Pape, MD; Fletcher White, PhD; Todd McKinley, MD*

Purpose: High-energy open fractures invariably sustain concomitant injury to adjacent muscle. Open fractures with severe soft-tissue injury are at high risk for nonunion. Recent reports suggest that innate and adaptive immune responses in callus and adjacent muscle are primary determinants that initiate fracture healing. This study quantified temporal progression of local immunologic cell populations in callus and adjacent tibialis anterior (TA) muscle during the acute and subacute phases of healing in a rat open tibia fracture model with crush injury to the muscle.

Methods: Male Sprague Dawley rats at the age of 8-10 weeks old were subject to right tibia osteotomy with crush injury of adjacent TA muscle. The injured TA muscle and counterparts from contralateral limb were harvested on post-injury day 3 and 7, and enzymatically digested into single cell suspensions. The callus from tibial fracture site at same time points was harvested and mechanically minced into single cell suspensions. Macrophages (CD45+, CD11b+, SSAlow), neutrophils (CD45+, CD11b+, CD43+, SSAhi), and lymphocytes (CD45+, CD3+) were quantified using flow cytometry.

Results: Macrophage infiltration in the injured TA muscle was significantly reduced from 1420 ± 427 cells/mg muscle on day 3 to 116 ± 24 on day 7. Similarly, neutrophil infiltration was reduced from 294 ± 66 cells/mg muscle on day 3 to 37 ± 9 on day 7 (n = 7/group, P <0.05), whereas lymphocyte infiltration remained stable at 1010 ± 317 cells/mg muscle on day 3 and 795 ± 239 cells/mg muscle on day 7 (n = 7-8/group, P >0.05). In contrast, changes in macrophage and neutrophil infiltrations in the callus were insignificant from day 3 to day 7 (1068 ± 262 to 743 ± 152 cells/mg callus for macrophage and 165 ± 41 to 329 ± 91 cells/mg callus for neutrophil, n = 8/group, P >0.05) whereas lymphocyte infiltration in the callus significantly increased from 224 ± 38 to 1237 ± 281 cells/mg callus (n = 8/group, P <0.05).

Conclusion: The progression of inflammation in callus and muscle demonstrated feature differences with resolution of an innate response in muscle that preceded that in callus, and a delayed adaptive response in callus. Understanding injury inflammation will improve opportunities to prevent nonunions with immunologic-based therapies.

∆ OTA Grant

Mitigating Pathologic Fibrosis Following Volumetric Muscle Loss Injury

Benjamin Corona, PhD*; Jessica Rivera, MD; Sarah Greising, PhD*

Purpose: Volumetric muscle loss (VML) resulting from extremity trauma presents functional deficits, fibrosis, and disability. The extensive fibrotic accumulation is expected to interfere with neural, trophic, vascular, and mechanical connectivity of any possible regenerative or rehabilitative approaches. It is possible that fibrosis following VML injury could be as much of a problem to injured patients as the loss of contractile tissue. Our goal was to quantify the muscle properties and stiffness following injury and investigate if fibrosis could be mitigated using an antifibrotic agent. We hypothesized that muscle stiffness would progressively increase following injury and that antifibrotic treatment could prevent the fibrotic response.

Methods: 10 female Yorkshire Cross pigs were randomized to sham or a non-repaired ~20% VML injury. Immediately following surgery injured pigs were further randomized to nintedanib (Ofev; 300 mg/day) or no treatment for 30 days. Analysis of muscle function via peroneal nerve stimulation, compartment volume, and quantitative muscle stiffness using Shearwave Elastograph was conducted longitudinally 1 month post-injury. Terminally comprehensive histopathologic, biochemical, and genetic investigations were conducted on the skeletal muscle and fibrosis.

Results: Prior to injury there was no difference in the maximal isometric torque (0.28 ± 0.01 Nm/kg) across groups and the sham-operated torque remained stable over time (P = 0.23). Through 1 month post-VML, non-treated muscles presented a significant deficit (24%) in maximal torque compared to the sham-operated (P <0.01). Additionally, antifibrotic-treated muscles presented an even greater strength deficit (39%) compared to uninjured pigs. The stiffness in the VML defect area increased more than 7-fold in the VML-injured untreated leg than the antifibrotic treated by 1 month post injury. This was coupled with the non-repaired muscle having ~40% more collagen per mg of tissue than those receiving antifibrotic treatment (P = 0.01).

Conclusion: VML injury progressively induces fibrosis and muscle stiffness, in particular when left to follow its natural sequela. However, antifibrotic treatment can mitigate the pathologic development of fibrosis although isometric muscle strength remains impaired. Future work should evaluate optimal timing of antifibrotic treatment combined with regenerative medicine approaches in efforts to improve muscle function for this patient population.

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Inflammatory Cytokines Provide Unique Predictive Value Beyond Injury Severity: A Prospective Cohort Study of Orthopaedic Trauma Patients

Arun Aneja, MD, PhD; Alejandro Marquez-Lara, MD; David Landy, PhD; ***Boshen Liu, MD****; Peter Mittwede, MD; Seth Phillips, DO; Lusha Xiang, MD; George Russell, MD*

Purpose: This study was undertaken to determine if the addition of inflammatory cytokine profiles to the injury severity scoring system offer prognostic value for in-hospital patient outcomes and length of stay.

Methods: All patients with orthopaedic injury and New Injury Severity Score (NISS) >5 were prospectively enrolled at a Level I trauma center. Venous blood samples were collected prior to any surgical intervention and analyzed for inflammatory cytokines Interleukin (IL)-6, IL-8, IL-10, and macrophage migration inhibitory factor (MIF). Predictive value of ICU and hospital length of stay (LOS) was compared with NISS alone versus NISS combined with inflammatory cytokine levels.

Results: 58 patients met the inclusion criteria. Median ICU and hospital length of stay were 3 and 14 days, respectively. Baseline models with NISS alone showed significant associations with ICU ($R^2 = 0.27$) and hospital LOS ($R^2 = 0.32$). When IL-6 was used in conjunction with NISS, the prediction of ICU (R^2 change of 0.31, $P < 0.01$) and hospital LOS (R^2 change of 0.16, $P < 0.01$) were improved significantly.

Table 1: Hierarchical multivariate regression model for ICU and hospital stay

Model (unstandardized beta)	R-square	R-square change	p-value
Regression model for ICU stay			
1: NISS (1.4)*	0.272		
2: NISS (1.2)* + IL-6 (0.94)*	**0.510**	**0.308**	**0.003**
3: NISS (1.3)* + IL-8 (0.28)	0.394	0.071	0.140
4: NISS (0.52) + IL-10 (0.05)	0.053	0.003	0.781
5: NISS (0.71) + MIF (0.07)	0.085	0.003	0.782
Regression model for hospital stay			
1: NISS (0.95)*	0.318		
2: NISS (0.59)* + IL-6 (0.38)*	**0.451**	**0.162**	**0.005**
3: NISS (0.76)* + IL-8 (0.12)	0.368	0.039	0.149
4: NISS (0.72)* + IL-10 (0.01)	0.244	0.00	0.902
5: NISS (0.86)* + MIF (0.006)	0.300	0.00	0.969
* indicates p-value associated with beta of $\leq$0.05			

Conclusion: The addition of IL-6 to a predictive model for ICU and hospital LOS significantly improves the ability to explain variability in hospital outcomes compared to NISS alone. This suggests predictive outcome models may benefit from including a measure of the internal physiologic inflammatory response if they are to be optimized.

∆ Beta-Blocker Treatment Prevents Delayed Fracture Healing Observed With Selective Serotonin Reuptake Inhibitors Treatment

Sooyeon Lee, PhD; Vivian Bradaschia Correa, PhD; Nury Yim, MD; Madeleine Wong, BS; ***Philipp Leucht, MD***

Purpose: Selective serotonin reuptake inhibitors (SSRIs) are one of the most commonly prescribed antidepressants worldwide and our recent experiments in mice show significant impairment of fracture healing after treatment with the SSRI fluoxetine (flx). Here, we provide evidence that the negative effects of flx can be overcome by cotreatment with the beta-blocker propranolol.

Methods: In vitro, cell differentiation was assessed with tests including staining for alkaline phosphatase , alizarin red, qRT-PCR (quantitative real-time polymerase chain reaction) for col 1, runx2, and osterix. In vivo, adult C57/BL6 mice were treated with flx, or with flx + propranolol for 3 weeks prior to surgery. Untreated mice and mice treated with propranolol served as controls. A 1-mm cortical defect model and a femoral fracture model were utilized to assess bone formation rate, callus volume, proliferation, differentiation, and remodeling in vivo. Mice were euthanized at 14 and 21 days post-injury.

Results: With the in vitro experiment, we sought to determine whether propranolol had a direct effect on osteoblasts that were treated with flx. We harvested bone marrow-derived MSCs (mesenchymal stem cells), and grew them in osteogenic differentiation media in the presence of flx alone, propranolol alone, and flx + propranolol. Both alkaline phosphatase staining and alizarin red staining, and qRT-PCR for osteogenic markers, revealed that flx treatment resulted in decreased osteogenic differentiation, and that beta-blocker treatment in vitro did not prevent this impairment induced by the flx treatment. Cotreatment of flx and propranolol resulted in increased fracture healing, comparable to that of untreated mice. Finally, we examined the injured tibiae and femurs from control, flx-treated, propranolol-treated, and flx + propranolol-treated mice by microCT. Both at 14 and 21 days, callus volume was significantly lower in mice treated with flx, and returned to normal when mice were also treated with propranolol.

Conclusion: These experiments show for the first time that the negative effects of flx on fracture healing can be overcome by cotreatment with a beta-blocker. As shown by others, the effects of the beta-blocker on osteogenic differentiation are likely through a central mechanism. This matches our in vitro data, which showed no effect on osteogenic differentiation, while the in vivo data clearly show improved fracture healing in the presence of propranolol. These data, albeit in a mouse model, are the first promising results that may help patients with depression, who are treated with flx and suffer from osteoporosis and associated fractures that are prone to nonunion.

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Enhanced Healing of Rat Calvarial Bone Defect With Stem Cell-Seeded Collagen Nanofibers

Therese Bou-Akl, PhD; *Bin Wu, MD; Conor Daly-Seiler, MS; Mario Rossi, BS; Weiping Ren, PhD; David Markel, MD*

Purpose: The limited efficacy of current bone graft materials has encouraged the development of tissue-engineered biomaterials. We used a rat critical calvarial defect model to evaluate the effect of collagen nanofibers alone and in combination with bone marrow stromal cells (BMSCs) on bone regeneration. We hypothesized that (1) the collagen nanofibers will isolate the defect and prevent the overgrowth of fibrous tissue and (2) the nanofibers with BMSCs will promote osteogenesis and will lead to more organized bone repair.

Methods: Electrospun collagen nanofiber disks with 10-mm diameter and 0.2-mm thickness were used for implantation (n = 12). Rat BMSCs were seeded onto the discs and maintained in culture for 3 weeks before implantation. 8-mm-diameter calvarial defects were created in 18 male Fisher 344 rats. The defects were either left untreated (group1, control), or repaired using unseeded discs (group 2) or BMSCs seeded discs (group 3). In the experimental groups 2 and 3, the defects were closed by implanting 1 disc on both sides of the defect, creating a sandwich-like construct with the cells facing the created space in group 3. Defects were scanned in vivo using microCT) at zero time, 6, 12, and 16 weeks post-surgery. MicroCT data were processed using Microview software. The bone volume fraction was calculated using the BMD (bone mineral density) analysis plugin. Animals were sacrificed at 16 weeks after surgery, the defect and the surrounding bone removed and processed for histology.

Results: MicroCT showed increased bone filling of the defect in the experimental groups as compared to the control group. Control group showed no or fragmented new bone growth. Nanofibers without cells showed large connected and disconnected fragments. Nanofibers with BMSCs showed bone growth starting from the periphery toward the center of the defect. Histology: Hematoxylin and eosin showed that for group 1, the defects were filled mostly by fibrous tissue; group 2, the defects were filled with new bone and parts with fibrous tissue and some vascularization; and group 3, the defects were mostly filled with new bone containing a notable amount of blood vessels

Conclusion: The collagen nanofiber sheets allowed complete isolation of the defect therefore preventing fibrotic tissue invasion and enhanced the natural healing process. The sheets with seeded stem cells provided additional cues to promote vascularization and more organized new bone growth.

Effects of Powdered Rifampin and Vancomycin on Biofilm Production of *Staphylococcus aureus* on Orthopaedic Implants

Christian Douthit, MD; *Brent Gudenkauf, BS; Abdul Hamood, PhD; Nithya Mudaliar, MS; Mark Jenkins, MD; Cyrus Caroom, MD*

Purpose: Medical implant infections with biofilm-producing bacteria in orthopaedic surgery, specifically those infected with biofilm-producing bacteria, make the infection highly resistant to serum antibiotics. The purpose was to demonstrate both the preventative and eliminating powers of rifampin and vancomycin solutions (separately and in unison) in vitro on Staphylococcus aureus biofilm samples as grown on stainless steel implants.

Methods: A suspension of *S. aureus* culture containing fluorescent protein plasmid was incubated and applied to 1 x 1-cm sterile stainless steel orthopaedic plating material. Microscopic examination confirmed biofilm production as visualized by the fluorescent bacteria. With this established method of growing biofilm, our experiment was then separated into an inhibition group and an elimination group. In the inhibition group, stainless steel plates were subjected to different concentrations of antibiotic solution and groups of incubated *S. aureus* were then placed on the implant material. These samples were incubated overnight and MICs (minimum inhibitory concentrations) were calculated based on the percentage of bacteria eliminated. These were compared to untreated controls. In the elimination group, incubated biofilm samples were placed on stainless steel mediums that were then subjected to increasing doses of rifampin and vancomycin solutions, both separately and in unison, and incubated overnight. The samples were removed and CFUs (colony-forming units) were evaluated the following morning to assess the degradation of biofilm. These were compared to untreated controls of biofilm grown in parallel on the same material.

Results: Both rifampin and vancomycin solutions were found to successfully inhibit biofilm production of *S. aureus* on stainless steel mediums; the MICs for rifampin and vancomycin to inhibit 100% of biofilm production when used separately were 80 ng/mL and 1 ug/mL, respectively. In the elimination group, vancomycin eliminated 99% of biofilm but at a much higher concentration than its MIC. Rifampin solution was completely eliminated in all biofilm at its MIC. When used in synergism, a vancomycin and rifampin solution was able to eliminate all of the biofilm at MICs compared to untreated controls ($P = 0.0016$).

Conclusion: When applied to orthopaedic stainless steel implants in vitro, solutions of rifampin and vancomycin powder in synergism can completely prevent and eliminate biofilm produced by *S. aureus*.

PAPER ABSTRACTS

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Serum 25(OH)D Alters Bone Turnover Marker Response After Hip Fracture: A Multihospital Prospective Cohort of 296 Elderly Patients

Christopher Stewart, BA; *Nathan O'Hara, MPH; Denise Orwig, PhD; Marc Hochberg, MD, MPH; Sheila Sprague, PhD; Jay Magaziner, PhD; Gerard Slobogean, MD, MPH*

Purpose: C-terminal telopeptide of type I collagen (CTX) and procollagen type I N-terminal propeptide (PINP) are bone turnover markers (BTMs) that are promising surrogate measures of fracture healing. Characteristic changes in their serum concentrations have been identified following a fracture; however, it is unknown if their response is affected by other bone healing metabolites. Since 70% of fracture patients are reported to have insufficient serum vitamin D during the acute fracture healing period, we sought to determine if serum 25(OH) D levels affect changes in CTX and PINP concentration after hip fracture.

Methods: All participants were enrolled in a prospective cohort of hip fracture patients ≥65 years of age admitted to 1 of 8 Baltimore-area hospitals, frequency-matched on gender. Serum samples were prospectively collected from participants at baseline (mean 12 days post-admission), 2, 6, and 12 months. The primary outcomes of this analysis were serum CTX and PINP. Patients with baseline serum 25(OH)D concentrations <20 ng/mL were considered to be vitamin D-deficient. A mixed-model repeated-measures analysis was used to determine the association between vitamin D deficiency and the relative concentrations and trajectory of CTX and PINP levels during the study period.

Results: Baseline laboratory values were obtained for 296 participants (mean age, 80.8 years; 50% male; 55% 25(OH)D < 20 ng/mL). Multivariable analyses confirmed that CTX and PINP concentrations increase during the acute fracture healing period. Specifically, both peaked at 2 months and decreased at 6 and 12 months. However, among participants with baseline vitamin D-deficiency, CTX levels were significantly higher than those with 25(OH)D >20 ng/mL during the study period (P = 0.01).

Conclusion: Data from this large, longitudinal cohort of hip fracture patients support early claims that CTX and PINP concentrations are sensitive BTMs that change during fracture healing; however, the altered response of CTX among vitamin D-deficient patients highlights important questions for its ultimate utility as a reliable surrogate marker of fracture healing.

Diagnosing Orthopaedic Infections: A Novel Serum Screening Tool

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Purpose: Infections after fracture fixation can be devastating and typically involve bacterial biofilms. Diagnosis using cultures can be problematic, and detection prior to clinical presentation might change treatment options and decrease morbidity. A novel test was developed to aid in diagnosing patients with *Staphylococcus aureus* biofilm-related infections. Our hypothesis is that the test will differentiate between patients who do and do not have infections.

Methods: A prospective study was performed with patients with surgically treated fractures at risk of surgical site infection (open fractures, tibial plateau and pilon fractures, and foot fractures) or any patient who presented with a deep surgical site infection defined by Centers for Disease Control and Prevention (CDC) criteria. Enzyme-linked immunosorbent assays (ELISAs) were performed on serum samples to determine the presence of antibodies specific to a novel Staphylococcus antigen SACOL0688, a biofilm-associated manganese transporter. Sensitivity and specificity were calculated, as was a receiver operating characteristic (ROC) curve. 307 patients were enrolled. We excluded 122 patients who had other infections (eg, pneumonia, cellulitis, or non-orthopaedic infections; n = 81), or had non-Staphylococcus infections (n = 41). The final cohort had 197 samples: 52 from Staphylococcus-infected patients, and 145 from patients without evidence of infection at adequate follow-up.

Results: The mean ELISA ratio for the cohort without infection was 2.3 (95% confidence interval [CI]: 2.1-2.5); and for the infected cohort was 3.8 (95% CI: 3.4-4.2, P = 0.0001). The ROC area under the curve of 0.81 indicated reasonable test performance. Using a cutoff value of 2.2 yielded 92% sensitivity, 60% specificity, 45% positive predictive value, and 96% negative predictive value (NPV).

Conclusion: This prospective study verifies this novel test as a promising screening tool, with high sensitivity and NPV, for fracture patients with Staphyloccoccus biofilm-mediated infections. The next steps should involve optimization of its potential clinical benefits by coupling it with other diagnostic tests to aid clinicians in the early detection and treatment of infection.

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Differences in Local O_2 Supply and Consumption After Intramedullary Nailing Depends on the Degree of Injury: A Study in Hemodynamically Stable Pigs

Yannik Kalbas; *Klemens Horst, MD; Zhi Qiao, MD; Michel Teuben, MD; Frank Hildebrand, MD; Hans-Christoph Pape, MD; Roman Pfeifer, MD*

Purpose: Measurements of microcirculatory changes after hemorrhagic shock are known to be more sensitive with regard to the end points of resuscitation than blood pressure and systemic hemodynamic parameters. This may be important for strategies of fracture fixation. We determined whether injury severity influences the local microcirculation after intramedullary fixation in a large animal model.

Methods: Male pigs (German Landrace) weighing 30 ± 3kg were used in this experiment. The following groups were used: polytrauma with femoral fracture and intramedullary nailing (PTIM)--combined trauma consisted of lung contusion (bolt shot, 9 x 17 Dynamit Nobel), femoral fracture, and liver laceration and controlled hemorrhage (HS) (mean arterial pressure [MAP] 40 ± 5 mm Hg) for 90 minutes; and monotrauma group (MTIM) with a femoral fracture an intramedullary nailing after resuscitation. Microcirculation was measured on muscle (M. vastus lateralis) on the fracture site. Microcirculation was measured daily with O_2 consumption on fracture site of these animals.

Results: Both groups included 6 animals per group. During the clinical course systemic blood pressure, pH, lactate, and BE were stable in both groups. Within 2 hours post intramedullary nailing, animals with isolated femur fractures developed a significant increase in local blood flow, soft-tissue O_2 delivery, and O_2 consumption ($P < 0.05$ compared with baseline values). In polytraumatized animals there were no changes in local blood flow during the course, O_2 delivery, and O_2 consumption has decreased over time ($P < 0.05$ compared with baseline). The analysis of microcirculation after fracture fixation in MTIM group has shown a significant improved local circulation in musculature in comparison to the PTIM group.

Conclusion: Our data clearly support the idea of independent microcirculatory changes of local soft tissues after polytrauma. The local trauma-associated changes appear to be more complex than described by systemic parameters alone. This study supports the idea of perioperative monitoring depending on the degree of injury.

Noninvasive Localized Cold Therapy Enhances Angiogenesis in Bone Defect Model

Marianne Comeau-Gauthier, MD; *Daniel Castano, MD; Geraldine Merle, PhD; Justin Drager, MD, MsC; Edward Harvey, MD, MsC*

Purpose: An OTA-funded pilot study investigated local cold therapy on defect repair in a mouse model. Lowering the temperature at the defect site during the healing course resulted in a significant increase in bone volume, despite a decrease of the osteoblast activity, VEGF (vascular endothelial growth factor) expression, and CD34-stained cells. These results did not identify the mechanism for bone growth. We hypothesized that cold therapy stimulates neovascularization by reducing oxygen level at the injured bone, thereby upregulating hypoxia and angiogenesis pathways. We aimed to identify the effect of cold therapy on neovascularization during the early inflammation phase of bone repair.

Methods: Bilateral femoral window defects were drilled in adult wild-type male mice. Starting postoperative day 1, 1 lower extremity was immerged daily in an ice bath for 15 minutes (temperature at bone level = 19°C), whereas the other was used as control. Mice were euthanized at day 7. Bone formation was assessed using micro CT. Histological analysis was performed and stained for alkaline phosphatase (ALP), tartrate resistant acid phosphatase (TRAP), CD34, and VEGF to identify osteogenic cells, osteoclasts, endothelial vascular cells, and angiogenesis, respectively.

Results: As expected no gross new bone appeared in control or experimental groups. At high magnification, ALP-stained sections revealed low bone forming activity for both cold therapy and non-cold therapy groups. Femoral defects that received daily cold treatment were associated with an excessive expression of TRAP ($P = 0.03$) positive cells whereas very little osteoclast activity was detected in control group. CD34 activity was noticeably reduced ($P = 0.03$) in the control group compared with the experimental. It was accompanied by increased VEGF ($P = 0.03$) from 9.33 ± 6.45 for the control limbs to 15.62 ± 3.51 for the experimental limbs.

Conclusion: The highest degree of neovascularization was observed in the defect/medulla of cold-treated bone defects and was accompanied by a higher VEGF expression, indicating that localized cold might support early vascularization through the VEGF angiogenesis pathway. The overexpression of VEGF matched with the increase of osteoclast recruitment, suggesting increased bone turnover. Bearing in mind that maintenance of bone oxygen pressure is closely related to the blood flow, cold applied to the bone defect area may cause hypoxia through vasoconstriction along with the usual disruption of the local blood flow following injury, which in turn has been shown to promote osteogenesis, via its upregulation of the angiogenesis pathway.

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Biological Activity of Human-Induced Membranes: Differences Between Femoral and Tibial Sites

Vaida Glatt, PhD; *Anna Woloszyk, PhD; Kevin Tetsworth, MD*

Purpose: Human-induced membranes formed in association with femoral defects clinically appear to be more robust than those from tibial defects. The anatomical origin of an induced membrane is perhaps more important than the time interval between stages. This study examined the biological activity of human-induced membranes with respect to both their anatomical site and the length of the interval between stages.

Methods: Membranes were harvested from 16 clinical cases of bone defects managed using the Masquelet technique, returning for the second stage between 4 and 20 weeks. Biopsies of induced membranes (n = 16) and control samples (normal fascia, n = 16) were collected from femoral and tibial defects. Samples (10 x 10-mm) were morselized, and then stored at -80°C prior to gene expression analysis of relevant growth factors for bone repair using qRT-PCR (quantitative real time polymerase chain reaction. Different samples (20 x 10-mm) were used for histology, stained with hematoxylin and eosin (H&E). Immunohistochemistry (IHC) was used to localize proteins with osteogenic and angiogenic potential. Comparisons were made between femur and tibia, and corrected for time differences between stages.

Results: Bone-like tissue was observed on the outer layer of the induced membranes with H&E. CD68, a marker of macrophage lineage, was homogenously expressed within the membranes, while in the fascia it was mostly absent. Vascular endothelial growth factor (VEGF), a potent angiogenic factor, was consistently expressed in blood vessels of both fascia and membrane. Quantitative analysis revealed the number of active cell nuclei and the average cell density in induced membranes (2.77 x 105 cells/mm^3), was more than double when compared to fascia (1.14 x 105 cells/mm^3; $P < 0.05$). Gene expression analyses revealed that the growth factors relevant to bone repair were significantly upregulated in membranes as compared to fascia. Membranes revealed significantly upregulated cell proliferation, cell-cell and cell-matrix adhesion, chemokines, interleukins, and platelet activation genes in femurs, as compared to tibias, which had more downregulated genes. Growth factors specific to bone mineral metabolism and skeletal development were similarly expressed in both groups.

Conclusion: The Masquelet technique has been heralded by some as a revolution in the management of skeletal defects. The preferred timing to return for the second stage has been an ongoing topic of considerable debate. Preliminary results from this study suggest the anatomical location of origin of a human-induced membrane might be a more important factor influencing the biological response than the time interval between stages.

hPTH(1-34) Promotes Bone Fracture Healing in Multiple Diabetic Murine Models
Shasta Henderson, MD; *Francis Lee, MD, PhD*

Purpose: Fracture healing is impaired in patients with diabetes mellitus (DM). hPTH(1-34) (human parathyroid hormone) has been demonstrated to improve bone formation when administered systemically. DM patients have been shown to have low levels of PTH; thus, treatment of DM bone fractures with PTH is a worthy subject of investigation. 3 distinct murine models of type 2 DM (T2DM) were developed to identify variations in response to hPTH(1-34) treatment following femur fracture.

Methods: C57BL/6J: C57BL/6J mice, control in our study, had diet-induced obesity, mild to moderate hyperglycemia, and hyperinsulinemia. DIO C57BL/6J: DIO C57BL/6J mice are C57BL/6J mice fed a high fat diet (60% fat) beginning at 6 weeks old. In the DIO C57BL/6J mice model represented the initial stages of T2DM (obesity, mildly elevated nonfasting blood glucose, and increasing glucose intolerance with age). DbLR: DbLR mice are homozygous for the DM mutation (Leprdb), morbidly obese, insulin-resistant, hyperinsulinemic, hyperglycemic, polyphagic, polydipsic, and polyuric. This was a model for T2DM with significant obesity complications. TALLYHO: TALLYHO/Jnj mice are a polygenic model of T2DM, featuring mutations in the Tabw, Tabw2, Tafat, Tanidd1, Tanidd2, and Tanidd3 alleles. The surgical technique involved lateral incision, 23-gauge needle and intramedullary nail, a Gigli saw to perform osteotomy, nail advanced to final position, closure, and subcutaneous administration of hPTH(1-34).

Results: The body weights of DIO C57BL/6J, TALLYHO, and DbLR are greater than C57BL/6J mice; serum glucose levels are also significantly greater than C57BL/6J. Increasing amounts of adipose tissue is seen in DIO C57BL/6J, TALLYHO, and DbLR as compared to C57BL/67. Additionally, T2DM groups treated with hPTH(1-34) show an increase in the size of fracture calluses at day 7. MicroCT analysis of fractures 4 weeks post-surgery showed the BMD (bone mineral density), BV/TV (bone volume fraction), TB.N (trabecular number), and Conn.D (connective density) of the hPTH(1-34) T2DM groups were increased compared to control.

Conclusion: The elevated body weight, increased adipose tissue, and increasing serum glucose levels gives credence to our use of these murine models as models of T2DM. Additionally, PTH is thought to induce mesenchymal stem cell proliferation as well as enhance osteogenic differentiation of those stem cells, and our data support this theory. The use of intermittent hPTH(1-34) may have potential as a therapy for patients with fractures and T2DM.

PAPER ABSTRACTS

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Inflammatory Profile and Osteogenic Potential of Fracture Hematoma in Humans

*Gavin Walters; **Ippokratis Pountos, MD**; Peter Giannoudis, MD*

Purpose: Fracture hematoma forms immediately after fracture and is considered the initial part of the bone healing process. Its molecular composition has been briefly investigated with our current understanding being based on animal studies. This study aims to analyze the inflammatory cytokine content of fracture hematoma in humans and determine its effect on osteoprogenitor cells.

Methods: 23 patients were recruited following informed consent. Peripheral blood, fracture hematoma, and bone were collected. Osteoprogenitor cells (mesenchymal stem cells [MSCs]) were isolated following collagenase digestion and functional assays were performed. Gene expression analysis of 84 key osteogenic molecules was performed. A Luminex assay on the levels of 34 cytokines was performed and peripheral serum was used as control.

Results: 33 inflammatory cytokines were found to be significantly raised in fracture hematoma when compared to peripheral serum ($P < 0.05$). Among the most raised molecules were interleukin (IL)-11, IL-8, and matrix metalloproteinase (MMP)-1, -2, and -3. Fracture hematoma did not significantly affect MSC proliferation, but alkaline phosphatase activity and calcium deposition were significantly increased in the MSCs undergoing osteogenic differentiation. The gene expression analysis reinforced these results.

Conclusion: Fracture hematoma is not the consequence of trauma, but a rich medium in which inflammatory and osteogenic molecules capable to upregulate the osteogenic potential of MSCs.

Δ Mesenchymal Stem Cell Spheroids Augment Myoblast Secretome to Increase Osteoblast Activity

Augustine Saiz, MD; *Marissa Gionet-Gonzales, BS; Jonathan Leach, PhD; Mark Lee, MD*

Purpose: Local muscle loss associated with open fractures is problematic for functional recovery and osseous healing, suggesting the importance of muscle cells on bone repair. Mesenchymal stem cells (MSCs) provide a promising therapy for the regeneration of both muscle and bone through their potent secretome to stimulate responsive cells. We hypothesize that myoblasts stimulated by MSC spheroids will potentiate myokine production to increase osteoblast activity.

Methods: Human MSC spheroids were incubated in media under the conditions of 1% hypoxia, CoCl2-induced hypoxia, or normoxia for 3 days, and harvested media was denoted spheroid-conditioned media (SCM). Media collected and exposed to L6 myoblasts for 24 hours was denoted myoblast-spheroid-conditioned media (MSCM). Dissociated MSCs were cultured on tissue culture plastic under identical conditions and the media denoted dissociated-conditioned media (DCM). MC3T3 preosteoblasts were exposed to conditioned media for 14 days, after which the osteogenic response was measured using assays for osteoblast proliferation, alkaline phosphatase (ALP) activity, and calcium deposition.

Results: Osteoblast proliferation was greatest when stimulated by hypoxic MSCM ($P<0.05$). ALP activity, an early marker of osteogenic differentiation, was greatest in osteoblasts exposed to hypoxic MSCM ($P<0.05$). Similarly, the hypoxic MSCM samples induced the greatest calcium deposition ($P<0.05$), a late marker of osteogenic differentiation, regardless of the means to simulate reduced oxygen. Importantly, MSCM samples exhibited consistently greater calcium deposition than SCM, suggesting interplay between the MSC secretome and myokine secretion. SCM induced significantly greater calcium deposition than DCM in all conditions, confirming the benefit of MSC spheroids over dissociated MSCs. Mass spectrometry revealed differences in the secretion of myokines by stimulated and unstimulated myoblasts.

Conclusion: MSC spheroids stimulate the secretion of potent myokines by myoblasts, which increase the osteogenic potential of stimulated osteoblasts. Signaling from muscle may be important for bone repair and our data confirm that MSC spheroids may enhance bone formation indirectly by activating signaling pathways associated with myoblast activity.

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Biomarkers of Neutrophil Extracellular Trap Formation (NETosis) and Their Relationship to Wound Healing in Ankle Fracture Surgery

William Kent, MD; *Mathew Whittaker, BS; Vitor Martins, BS; Simon Schenk, PhD; Paul Girard, MD; Alexandra Schwartz, MD*

Purpose: A variety of patient factors have been shown to contribute to wound complications after open reduction and internal fixation (ORIF) of ankle fractures. However, there are few studies analyzing molecular biomarkers associated with wound complications in ankle fractures. NETosis is a process by which neutrophils release their nuclear contents to trap and kill pathogens. Originally recognized as a component of host immune defense, NETosis has been demonstrated to contribute to delayed wound healing. The purpose of this study was to investigate biomarkers of NETosis in ankle fracture patients undergoing ORIF and correlate these markers with postoperative wound healing.

Methods: 32 adipose samples were collected from the surgical site in patients (17 male, 15 female) undergoing ORIF of bimalleolar and trimalleolar ankle fractures from September 2016 to May 2017. Total RNA was isolated and used for semiquantitative real-time polymerase chain reaction to assess gene expression for markers of NETosis. Patients were followed at regular postoperative intervals to assess wound healing.

Results: The percentage of patients with detectable protein arginine deiminase 4 (PAD4) was significantly higher in patients with delayed wound healing compared to normal wound healing patients ($P = 0.012$). Gene expression of interleukin 8 (IL-8; $P = 0.02$), IL-6 ($P = 0.002$), and monocyte chemoattractant protein 1 (MCP-1; $P < 0.001$), all neutrophil-related biomarkers, were significantly elevated in abnormal wound healing patients compared to normal wound healing patients.

Conclusion: PAD4 is an enzyme necessary for NETosis, a process shown to contribute to delayed wound healing. The significantly higher percentage of detectable PAD4 in patients who went on to develop delayed wound healing or infection suggests potential predictive value for this biomarker. Furthermore, the significant association between delayed wound healing and expression of cytokines important for neutrophil recruitment (IL-8 and MCP-1), and IL-6, a cytokine released from neutrophils, provide additional support for the role of neutrophils and NETosis in delayed wound healing and associated complications.

PAPER ABSTRACTS

Are RIA-MSCs More Stressed and Proapoptotic Than Bone Marrow-MSCs?
Jehan El-Jawhari, PhD; *Payal Ganguly, MSc; Elena Jones, PhD; Peter Giannoudis, MD*

Purpose: Reamer-irrigator-aspirator (RIA) waste contains mesenchymal stem cells (MSCs) equivalent to those in 1 L of bone marrow (BM) aspirate with an effective osteogenic capability. The MSC ability to survive and adequately function under low oxygen level would affect the therapeutic outcomes. This study aimed to assess the basal and induced stress levels in RIA-MSCs relative to BM-MSCs. The proapoptosis, proliferation, osteogenesis, and senescence of MSCs from both sources were also compared.

Methods: 17 elective orthopaedic patients (12 males and 5 females, median age 48 years) were included in this study. From each patient, RIA waste (400-1000 mL) and iliac crest BM aspirate (15 mL) were collected. The samples were processed to expand MSCs in culture or used directly for further analysis and phenotyped as CD45-low CD271-positive cells. The reactive oxygen species (ROS) levels were measured to indicate cell stress in normoxia, hypoxia, or when treated with terta-butyl hydroperoxide (TBHP). The death of TBHP-treated MSCs was tested using SYTOX dye. The deposition of alkaline phosphatase (ALP) was measured for RIA and BM colonies. The beta-galactosidase (β-gal) and XTT assays were used to assess the MSC senescence and proliferation, respectively.

Results: Uncultured RIA-MSCs have higher ROS levels than BM-MSCs (2-fold, P = 0.0498). When exposed to TBHP, the induced ROS levels were more in RIA-MSCs (mean of 6-fold) than BM-MSCs (mean of 2.6-fold). Under hypoxia, the induction of ROS was similar for RIA-MSCs and BM-MSCs (mean of 1.7- and 1.6-fold, respectively). A higher death susceptibility of uncultured RIA-MSCs than BM-MSCs was noted (P = 0.0234). However, the area of ALP-positive colonies of minimally cultured BM and RIA colonies were equal. After culture, the basal ROS levels or after hypoxia and/or oxidative stress were similar for RIA-MSCs and BM-MSCs (1.5-, 3-, and 7-fold, respectively, for both). There was no significant difference between induced dead cell percentages of cultured RIA-MSCs and BM-MSCs (P = 0.0938, median 16.5% and 14%, respectively). The β-gal and proliferation levels were similar for cultured RIA-MSCs and BM-MSCs.

Conclusion: Uncultured RIA-MSCs appear more stressed and proapoptotic than BM-MSCs probably due to the reaming process. But, when minimally cultured /expanded, the proliferation, osteogenesis, apoptotic liability, and senescence of RIA-MSCs become similar to that of BM-MSCs, confirming the clinical value of using RIA waste as a source of MSCs.

PAPER ABSTRACTS

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The Effect of Different Washing Solutions on the Growth and Function of Primary Human Osteoblasts In Vitro

Therese Bou-Akl, PhD; Jacob Markel, BA; ***Alan Afsari, MD***

Purpose: This study was undertaken to investigate the effect of the irrigation solution clorpactin (normal saline and sodium oxychlorosene) on osteoblast cytotoxicity and inhibition of proliferation.

Methods: Four replicates of 6 conditions at 3 time points (1, 2, and 4 min) were tested: control (normal saline), bacitracin (33 IU/mL), clorpactin (0.05%, 0.1%, 0.2%), and IrriSept (0.05% CHG [chlorhexidine gluconate]). Human osteoblasts (Promocell) were cultured for 48 hours. Treatment solution was then applied and cells were washed 3 times with warm phosphate buffered saline (PBS) then supplemented with fresh medium. After 48 hours, the culture medium was replaced with 10 vol% AlamarBlue medium and incubated for 24 hours. Phase contrast images were taken before and after treatment. Absorbance was measured at 570 nm using 600 nm as a reference and % reduction of AlamarBlue calculated. Cells were then supplemented with fresh medium, and the procedure was repeated at 96 hours.

Results: Control cells increased % reduction of 28.7%, 24.3%, and 27.9% (1, 2, and 4 min) after 5 days. Bacitracin cells showed decreased capability to reduce AlamarBlue compared to controls. The decrease was greater with longer exposure time (17.7%, 14.6%, 15.8%). Clorpactin cells performed similarly to bacitracin cells and higher concentration showed greater decrease (12.2%, 16.9%, 20.9%; 19.6%, 10.3%, 7.3%; 8.8%, 8.1%, 3.1%). Irrisept was deleterious; most cells detached from the plate and remaining cells did not increase AlamarBlue reduction (-20.1%, -23.6%, -33.0%). We observed changes in cell characteristics in all test conditions.

Conclusion: Clorpactin-treated osteoblasts showed a similar recovery to bacitracin-treated cells. Recovery in both sets was worse than controls but better than Irrisept-treated cells.

Functional and Radiological Outcome in 4-Part Proximal Humeral Fractures Treated With the Affinis Fracture Hemi-Arthroplasty Using the Ca Technique

Sigurd Uyttebroek, MD; *Guy Putzeys, MD*

Purpose: The outcome of primary arthroplasty in the treatment of complex humeral fractures is dependent on the position and survival of the tuberosities. Literature shows an unpredictability in outcomes. In this retrospective monocentric single-surgeon consecutive study, we analyzed the clinical and radiographic outcomes in displaced 4-part proximal humeral fractures treated with the Affinis hemi-arthroplasty. An adapted technique was used to fix the tuberosities, made possible by specific features of this prosthesis. We hypothesize that this adapted technique provides better survival of the tuberosities and better clinical outcomes, thus making the outcome of 4-part proximal humeral fractures more predictable.

Methods: Since July 2011, 31 patients have been treated for complex proximal humeral fractures with this technique. The cemented Affinis Fracture prosthetic stem was implanted using a deltopectoral approach. The tuberosities were fixed to the non-mounted interchangeable metaphyseal part of the prosthesis with 2 circular nonabsorbable heavy sutures that, after mounting the metaphyseal part onto the stem, were sequentially tightened. Attention was paid to the 1-piece continuity of rotator cuff and tuberosities, so it could be reduced as a cap onto the proximal prosthesis. Postoperative evaluation consisted of evaluation of the active and passive range of motion as well as the radiological assessment of tuberosity healing.

Results: Of the 31 patients, 24 met the inclusion criteria. The population consisted of 16 female patients and 8 male patients. Follow-up ranged from 6 months to 7 years postoperatively. Mean follow-up was 11.7 months. Mean age at the time of surgery was 75 years. 16 of 24 patients had good to excellent clinical and radiographical results, having no problems in performing activities of daily life and no migration or osteolysis of the tubercula. 4 patients had moderate clinical results with preservation of the tubercula. 4 patients had poor clinical and radiological results, requiring conversion to a reverse shoulder arthroplasty in the short term. 3 of the revisions were performed when the technique was introduced.

Conclusion: The treatment of complex proximal humeral fractures with hemi-arthroplasty remains difficult. However with the cap technique made possible by the interchangeable metaphyseal part of the Affinis prosthesis, we achieve in 70% of patients good clinical results and in 80% of patients good radiological results. This compares favorably with literature. A learning-curve is, however, to be expected.

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Comparison of the Clinical Effect of Internal Fixation Combined With Bone Graft and Replacement of the Humeral Head With the Semi-Shoulder Arthroplasty for the Treatment of Proximal Humerus Fracture

Bin-Fei Zhang, MD; *Shuang Han, MD; Shiming Wen, MD; Yan Zhuang, MD*

Purpose: This was a comparative analysis of allogeneic bone grafting with locking plate fixation and semi-shoulder arthroplasty for the treatment of the proximal humerus fracture of Neer 3- or 4-part fracture.

Methods: In this retrospective analysis of July 2010 to July 2015, our hospital treated 49 cases of age ≥60 years proximal humerus Neer 3 or 4-part fracture of patients' clinical data, of which 27 cases with allogeneic bone graft with locking compression plate (LCP) fixed treatment (bone graft LCP group), semi-shoulder arthroplasty (SSA group) 22 cases. The patients were followed up for 8 to 24 months. The operation time, intraoperative blood loss, Constant score, Neer score, visual analog scale (VAS) pain score, and complications were recorded and compared between the 2 groups.

Results: There were no complications such as infection, nerve injury, prosthesis loosening, fixation screw detachment, or fracture around the joint. There was no significant difference in operation time and intraoperative blood loss between the 2 groups ($P > 0.05$). There was no significant difference ($P > 0.05$) between the mean total score of Neer or the average score of Neer in the SSA group and the LCP group. There were significant differences in VAS score between the 2 groups ($P < 0.05$). The difference of VAS score between the 2 groups was statistically significant ($P < 0.05$).

Conclusion: For the elderly, 3- or 4-part proximal comminuted humerus fractures, allogeneic bone transplantation to strengthen the locking plate fixation and semi-shoulder arthroplasty is an effective treatment, with similar efficacy between the 2 groups. The final choice of treatment options should be based on the patient's physical condition, proximal humerus blood destruction, bone conditions, and the experience of the surgeon.

Hinge External Fixator Combined With Internal Fixation in the Treatment of Complex Elbow Fractures
Lisong Heng, MD

Purpose: This study was conducted to explore the effect of hinge external fixator combined with internal fixation in the treatment of complex elbow fractures.

Methods: From May 2010 to March 2016, 46 patients with complex elbow fractures were treated and analyzed in our department. 26 patients underwent external fixation combined with external fixator, in which the fracture of the "terrible triad" of the elbow comprised 12 cases; the anti-Monteggia fracture, 6 cases; the olecranon fracture and dislocation, 8 cases. 20 patients were treated with internal fixation combined with adjustable protector, in which the fracture of the "terrible triad" of the elbow included 10 cases; the anti-Monteggia fracture, 5 cases; and the olecranon fracture and dislocation, 5 cases. All patients underwent open reduction and internal fixation and external fixator. The elbow function was evaluated at the last follow-up by Mayo Elbow Performance Score (MEPS).

Results: All the patients obtained bone union; there were no significant differences ($P > 0.05$) for the external fixator group, flexion and extension of the elbow joint was 129.98° ± 12.59°, the rotation of the forearm was 142.15° ± 15.35°, MEPS was 91 points (range, 58-96 points); 21 patients were excellent, 2 good, 2 fair, and 1 poor, the excellent to good rate was 88.5%. For the adjustable protector group they were 106.98° ± 10.36°and 121.32° ± 17.67°, MEPS was 82 points (range, 55-92 points); 10 patients were excellent, 4 good, 2 fair, and 4 poor, the excellent to good rate was 70.0%. There were significant differences ($P < 0.05$).

Conclusion: The internal fixation combined with metal hinge external fixation can get better functional recovery for the complex elbow fracture.

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Infected Nonunion of the Forearm: The Masquelet Technique
Naseer Mir, MD

Purpose: Infected nonunion of the forearm bones is a challenge for the orthopaedic surgeon on several fronts. The forearm itself is unique as the difficulties include the relationship between restoration of shaft length with the anatomy and long-term functional outcome of adjacent joints, as well as the risk of elbow and wrist stiffness related to prolonged immobilization. The problem of infection is complex due to the presence of bone necrosis, segmental bone loss, sinus tract formation, fracture instability, and scar adhesion of the soft tissues. Several methods have been used for the management of the infected nonunion of forearm bones. However, the results tend to be unsatisfactory due to the aforementioned factors.

Methods: We used the 2-stage induced membrane technique devised by Alain Masquelet for the management of nonunion. It involves a staged procedure in which a temporary skeletal stabilization is paired with implantation of an antibiotic spacer and left in place for 6 to 8 weeks, during which time a "pseudomembrane" forms around the cement spacer. During the second stage of the procedure, the pseudomembrane is incised, the antibiotic spacer removed, and bone graft is placed. This technique was used for 12 infected forearm nonunions where the defects postdebridement ranged from 3.5 to 7 cm. The preferred type of fixation in most cases of pseudoarthrosis is the external fixator. However, this type of fixation does not always provide rigid enough fixation throughout the process of healing, and fixation of the radius proximally is an issue as the posterior interosseous nerve is likely to get damaged. Therefore we used a plate to stabilize the defect.

Results: All 12 bones united uneventfully. The bones united in a period ranging from 6 to 12 months with a mean of 7.8 months. Although a plate was used to stabilize the fracture, the results were uniformly good without any persistent and recurrent infection at the time of final follow-up. This technique addressed several of the challenges pertinent to the forearm nonunion simultaneously and results are uniformly predictable.

Conclusion: Infected nonunion of the forearm bones is a difficult problem and the treatment options continue to evolve. The Masquelet procedure is an effective procedure for such situations. Traditional bone graft techniques are limited by uncontrollable graft resorption, even when the recipient site is well vascularized. It is proposed that this membrane prevents graft resorption and improves vascularity and corticalization On the basis of our findings, we would suggest that it should be the frontline procedure for the management of infected nonunion of the forearm bones.

The Feasibility of a Randomized Controlled Trial Comparing External Fixation Versus Intramedullary Nailing for Open Tibia Fractures at a Regional Hospital in Uganda

Kisitu Kyengera, MBBS; *David Stockton, MD; Nathan O'Hara, MPH; Gerard Slobogean, MD, MPH; Andrea Howe, BS; D. Marinos, BS; Piotr Blachut, MD; Peter O'Brien, MD, FRCPC*

Purpose: Including low- and middle-income country (LMIC) hospitals into multicenter orthopaedic trials expands the pool of eligible patients and improves the external validity of the evidence. Furthermore, promoting studies in LMIC hospitals defines the optimal treatments for low-resource settings, the conditions under which the majority of musculoskeletal injuries are treated. The objective of this study was to determine the feasibility of a randomized controlled trial comparing external fixation versus intramedullary nailing in patients with an isolated open tibia fracture presenting to a regional hospital in Uganda.

Methods: From July through December 2016, all skeletally mature patients presenting to a regional hospital in Uganda with an isolated Gustilo type II/IIIA open fracture of the tibial shaft were eligible for the study. The primary feasibility outcome was the proportion of eligible patients that were enrolled, randomized, and treated operatively within 24 hours of injury. The secondary outcomes were the proportion of enrolled patients that completed a 1-year follow-up, and a qualitative assessment of reasons for missed enrollment and missed follow-up.

Results: During the 6-month study period, 36% (21/59) of eligible patients were successfully enrolled and operatively treated based on their random allocation. The main reasons that patients declined to participate in the trial were preferences for treatment by traditional bonesetters and prehospital delays related to a disjointed referral system. Of the 21 enrolled patients, 71% completed their 3-month follow-up appointment and 52% completed their 1-year follow-up appointment. Barriers to follow-up included prohibitive transportation costs and community pressure to turn to traditional forms of treatment.

Conclusion: A regional hospital in Uganda can successfully enroll, randomize, and operatively treat over 3 isolated open tibia fracture patients per month, a pace superior to many sites in the SPRINT (Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures) trial. Patient follow-up presents concerns over trial feasibility. Cultural pressure to utilize traditional treatments remains a barrier to study participant enrollment and retention, therefore impeding the development of evidence relevant to this clinical setting.

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The Role of Video-Assisted Thoracoscopic Surgery in the Treatment of Flail Chest Injuries

Nicolaas Roozendaal, Doctoral Student; Lori van Roozendaal, MD; Matthijs van Gool, MD; Antoinette Pijnenburg, MD; Paul Hustinx, MD, PhD; ***Raoul Van Vugt, MD, PhD****; Berry Meesters, MD; Karel Hulsewe, MD, PhD; Yvonne Vissers, MD; Erik de Loos, MD*

Purpose: Rib fractures accompanied by hemothorax and pneumothorax are common and serious injuries following high-energy blunt chest trauma. There is limited evidence for the use of videoassisted thoracoscopic surgery (VATS) in the surgical stabilization of rib fractures (SSRF), eg, for planning of incisions, direct visualization of intrathoracic injuries, and hemothorax evacuation. We performed a single-center cohort study, with the aim to investigate the potential of VATS in the surgical treatment of flail chest.

Methods: From 2013 to 2017, all patients with VATS-assisted SSRF were included. 3-dimensional CT reconstructions of the chest wall were obtained. Flail chest was defined as at least 3 fractured ribs with at least 2 fractures per rib. Patient-related characteristics and complications related to VATS-assisted SSRF were reported.

Results: VATS-assisted SSRF was performed in 56 patients. The mean age was 63 years (range, 21-92). Median ISS was 16 (range, 9-45). Hemothorax was evacuated by VATS in 39 patients (median volume 200 cc; range, 1001100). If needed, entrapped lung was freed from the fracture site. Stabilization was performed using plates (96%), splint fixation (2%), or both (2%). Median postoperative ICU admission was 2 days (range, 0-41). 16 patients (28%) had a postoperative complication (5% wound infections, 14% pneumonia, 9% delirium). 30-day mortality was 2% (n = 1, cause respiratory failure, age 86 years, ISS 16).

Conclusion: VATS-assisted SSRF is effective and safe in the treatment of flail chest. It enables fine-tuning of planned incisions, direct visualization and treatment of intrathoracic injuries, and adequate evacuation of hemothorax.

Treatment of Open Distal Tibia Intra-Articular Fractures (OTA/AO 43) With Circular External Fixators: Multicenter Report of 57 Cases

Ahmed Thabet Hagag, MD*; Francesco Sala, MD; Giovanni Lovisetti, MD; Christopher Gerzina, BS; Gautham Prabhakar, BS; Thomas DeCoster, MD; Amr Abdelgawad, MD, MBA*

Purpose: Open distal tibia intra-articular OTA/AO 43 fractures are associated with bone loss, intra-articular comminution, and significant soft-tissue compromise. Operative goals are restoration of articular congruity, fracture stabilization, limb length, alignment, and rotation. Open reduction and internal fixation (ORIF) is difficult to utilize when there is concomitant soft-tissue injury, bone loss, and comminuted articular surface. Circular external fixators (CEFs) decrease soft-tissue injury, stabilize the fracture, and allow for secondary adjustment of limb alignment as the fracture heals. This study hypothesized that satisfactory outcomes of open OTA/AO 43 fractures can be achieved with CEFs.

Methods: This was a retrospective record review surveying patients' demographics, radiographs, clinical notes, and operating room reports from 3 Level I trauma centers spanning between 2005 through 2017 with minimum 12-month follow-up. Inclusion criteria were patient age 18-79 years, open OTA/AO 43 fractures, and definitive fixation with a CEF. Primary outcome measures were hindfoot AOFAS (American Orthopaedic Foot & Ankle Society) and bony/functional ASAMI (Study and Application of Methods of Ilizarov) score. Secondary outcomes measures were union, complications, and limb alignment (frontal/sagittal) using a-LDTA (lateral distal tibial angle)/a-DTA alignment. Normal a-LDTA was defined as between 86° and 92°. Normal a-DTA was defined as between 78° and 82°. Frames were applied in a standard fashion with or without extension to the foot. Restoration of articular congruity was achieved and fixed with olive wires or screws.

Results: 57 patients presented with an open OTA/AO 43 fracture over a 12-year period. 10 patients (17.5%) had nonunion. 5 patients (8.8%) developed infection. ASAMI bony/functional outcomes showed significant association with a-LDTA alignment ($P = 0.018$, 0.023). No significant association was observed between ASAMI bony/functional outcomes and a-DTA alignments ($P = 0.478$, 0.570). Linear regression modeling showed significant relationships between a-LDTA alignment and AOFAS score, with higher scores in AOFAS at the normal state of a-LDTA compared to the abnormal one ($P = 0.003$).

Conclusion: Definitive fixation with a CEF is a viable option for open OTA/AO 43 fractures. Functional and radiographic outcomes are comparable to those of ORIF. Further surgical interventions following CEF application may be unwarranted due to low rates of complications and satisfactory outcome measures.

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Assessment of Polytraumatized Patients According to the Berlin Definition: Does the Addition of Physiological Data Really Improve Interobserver Reliability?

C. E. M. Pothmann, MD*; Kai Jensen, MD; Ladislav Mica, MD; Georg Osterhoff, MD; H.-P. Simmen, MD; Kai Sprengel, MD*

Purpose: Several definitions for categorizing the severely injured such as the Berlin Definition have been offered. Here, severely injured patients are selected by additive physiological parameters and by the general Abbreviated Injury Scale (AIS)-based assessment. However, all definitions should conform to an AIS severity coding applied by an expert. We examined the dependence of individual coding on defining injury severity in general and in identifying polytrauma.

Methods: We investigated the interobserver reliability (IR) between trauma-scoring systems for identifying polytrauma. 319 patients were included for analyzing IR of trauma scores, with 187 for polytrauma definitions. IR for scoring was assessed by intraclass correlation coefficient Cronbach's alpha (ICC) and Cohen's kappa for the polytrauma definitions.

Results: IR showed good agreement (≥0.80) with ISS, NISS (New Injury Severity Score), maximum AIS of each body region (MAIS), and TRISS (Trauma and Injury Severity Score). IR for identifying polytrauma according to the relevant definitions showed moderate agreement (<0.60) in the ISS cutoff categories (ISS(≥16, (≥18, and (≥20), while ISS ≥25 points just reached substantial agreement (0.62) and the Berlin Definition demonstrated a correlation of 0.77, which is nearly perfect agreement (>0.80).

Conclusion: Compared with the ISS-based definitions of polytrauma, the Berlin Definition proved less dependent on the individual rater. This underlines the need to redefine the selection of severely injured patients. Using the Berlin Definition for identifying polytrauma could improve the comparability of patient data across studies, in trauma center benchmarking, and in quality assurance.

Does the Use of Augmented Compression in Exchange Nailing for Femoral and Tibial Nonunion Accelerate Time to Radiographic Union?

Simon Weil, MRCS; Mark Middleton, FRCS; Myriam Guessoum, MRCS;
Alex Trompeter, FRCS

Purpose: The purpose of this study is to assess whether an additional step, in the form of application of compression to the exchange nail construct, has the predicted benefits of increased stability and thus an increase in the production of callus over standard exchange nailing. Compression can be applied either by use of the design features of a nail with a dedicated active compression bolt added to the construct, or by external compression applied with the use of a femoral distractor in reverse prior to locking the nail construct. Our hypothesis is that the use of this additional compression in exchange nailing, for the management of aseptic nonunion of tibial or femoral fractures, results in a quicker time to union.

Methods: The application of compression in exchange nailing was adopted by the senior author for all exchange nails in the management of aseptic nonunion since 2014. For this study the inclusion criteria were any patient who had intramedullary nail for primary management of a femoral or tibial fracture and went on to have exchange nail performed for aseptic nonunion. Patients with infection, nonunions with initial plates or other implants, or those with bone defects were excluded. An initial RUST (Radiographic Union Scale for Tibial fractures) score was calculated from radiographs performed preoperatively and compared with the RUST score derived from postoperative radiographs at 6 to 8 weeks and eventual time to union. Healing was defined when radiographs demonstrated bridging callus on at least 3 cortices on standard lateral and AP views (RUST score of ≥11).

Results: A total of 91 patients with diaphyseal femoral or tibial nonuninon were identified over the 3-year period from 2014-2017, 24 of which had an exchange nail to nail procedure for nonunion. 4 patients were treated for infection prior to exchange nailing leaving a total of 18 treated for aseptic nonunion. Of the 18 patients found, 10 underwent intraoperative compression exchange nailing and 8 without compression. 6 (60%) of the compression exchange nails achieved radiographic union within 6 to 8 weeks (RUST >11). Only 1 (12.5%) of the 8 non-compressed exchange nails reached radiographic union within 6-8 weeks. The average time to union for the compressed nails was 136 days in comparison to 255 days for the non-compressed nails. Of the 3 compressed nails that took greater than 8 weeks to union, 2 had ununited wedge fragments and 1 was a segmental nonunion.

Conclusion: We found that the the exchange nailing procedures that underwent intraoperative compression had a shorter time to radiographic union. A larger randomized study is indicated to corroborate our findings.

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Dissecting the Mesenchymal Stem Cells Heterogeneity for Clinical Applications

Daisy Canepa, MSc; *Elisa Casanova, PhD; Vinko Tosevski, PhD; Benjamin Eggerschwiler, MSc; Eirini Arvaniti, MSc; Manfred Claassen, PhD; Hans-Christoph Pape, MD; Paolo Cinelli, PhD*

Purpose: Fractures with a critical size bone defect represent a serious issue in orthopaedic surgery. The standard treatment involve autogenous bone grafts combined with allogenic materials, but this procedure implies different drawbacks. Tissue engineering with mesenchymal stem cells (MSCs), more precisely with adipose-derived stem cells (ASCs), represents an interesting alternative to improve the clinical outcomes. However, MSCs/ASCs consist of a heterogeneous, not yet well-characterized population of different stem/progenitor cells. Understanding the heterogeneous composition of human ASCs is essential not only for understanding the biological properties of MSCs but also in the context of their potential outcomes in cell therapy.

Methods: To dissect the heterogeneity of 18 human ASC lines we used the novel single cells real-time analysis Cytometry by Time-of-Flight (CyTOF). CyTOF combines both flow cytometry and mass spectrometry and requires individual cells to be labeled with stable heavy metal isotopes. We generated a panel of 31 markers, which includes classical positive and negative MSC markers, epithelial and neural markers, and several osteogenic, adipogenic, and chondrogenic markers.

Results: 18 human ASC lines were cultivated for 21 days in osteogenic medium, and at different time points real-time quantitative polymerase chain reaction and alizarin red staining were performed. Based on the results, we divided the ASCs into good, intermediate, and bad differentiating cells. In a second step, CyTOF was performed on the first 4 days of differentiation. The T-Stochastic Neighbour Embedding algorithm confirmed the phenotypic heterogeneous composition within the ASC lines. Moreover, the analyses given by the CellCNN (convolutional neural network) revealed distinct cell subpopulations between the good and bad differentiating cells, which also behave differently upon induction of osteogenic differentiation.

Conclusion: The data showed fundamental differences between the patient-specific ASC lines and suggest that the heterogeneity observed in vitro mirrors the heterogeneity observed in the clinic. Thus, identifying populations with enhanced osteogenic differentiation potential would serve as a diagnostic tool to predict clinical outcomes of fractures and would improve therapeutic approaches.

PAPER ABSTRACTS

A Masquelet Animal Model to Evaluate Engineered Induced Membranes for Single-Stage Segmental Bone Healing

Malcolm DeBaun, MD; *Alex Stahl, BS; Yunzhi Yang, PhD; Michael Gardner, MD*

Purpose: The Masquelet technique is a 2-step surgical procedure to heal critical sized segmental bone defects. Our group developed a novel Masquelet-inspired single-stage procedure wherein a synthetic bone graft enveloped by an engineered membrane is implanted into a critical bone defect without prior pseudomembrane induction. The purpose of this study is to establish a 2-stage modified Masquelet animal model and utilize this animal model to introduce novel synthetic membrane technology for single-step healing of critical bone defects.

Methods: Three experimental conditions were investigated for their ability to heal a critical size (8 mm) femoral defect in rats. A 3-dimensional (3D)-printed biodegradable composite polycaprolactone (PCL)/β-tricalcium phosphate (β-TCP) osteoconductive scaffold was used as a bone graft substitute and a synthetic PCL-based microporous polymer film was used as a membrane. Group A underwent a 2-stage procedure with initial insertion of a polymethylmethacrylate spacer and secondary replacement by PCL/β-TCP scaffold. Group B received a single-stage 3D-printed PCL/β-TCP scaffold wrapped in a synthetic membrane. Group C received a single-stage bare PCL/β-TCP scaffold without synthetic membrane sheath. All groups were examined by radiography at 1, 4, 8, and 12 weeks after insertion of the PCL/β-TCP scaffold for callus formation as determined by blinded observers. Callus formation was scored on a 3-point system where a score of 0 = no healing, 1 = partial healing, and 2 = full union. After the final time point, the explanted femurs were analyzed by microCT to quantify the volume of regenerated bone.

Results: One rat in Group A was removed from the study due to fixation failure. Mean callus scores tended to be higher in Group A without significant differences between groups. Bone formation into the defect sites was quantified by microCT with a mean of 158.6 ± 65.3, 93.1 ± 24.0, and 104.1 ± 37.3 mm^3 for Group A, B, and C, respectively. Group A showed significantly greater bone formation compared with other groups.

Conclusion: This study supports the use of a critical size femoral defect in rats as a suitable small animal model for preclinical investigation of acellular alternatives to the traditional Masquelet technique. The presence of a biologically inert synthetic membrane did not improve the rate of fracture union or bone volume regeneration. Future investigations, however, may focus on bioactive synthetic membranes coupled with growth factors for single-step bone healing.

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Comparative Evaluation of Concentrates of Adult Stem Cell Resources Derived by an Innovative Indigenized Algorithm Based on Differential Centrifugation and Ficoll-Hypaque Method

Rajeshwar Srivastava, MS; *Ashok Agrahari, Doctoral Student; Alka Singh, MSc; Saloni Raj, MBBS*

Purpose: Development in the field of use of adult stem cells required the safest, cheapest, and easiest way of obtaining the best content and quality of desired stem cell. Today bone marrow (BM) is one of the most suitable sources of stem/progenitor cells for experimental and clinical use. Earlier a study was conducted to identify the markers based on BM stem cell concentration and its infusion significance in the union of tibial nonunion. The current paper is prepared from same study to evaluate the concentration of the most studied mononuclear stem cell marker, ie, CD34 along with the determination of concentration of osteoblastic stem cell marker, ie, STRO1 of crude BM, purified BM (buffy coat), and peripheral blood. Hypothesis: The current study has been conducted to identify the efficacy of our innovative algorithm over the Ficoll-Hypaque method and also to identify the best infusion sample among the 3 specified adult stem cell resources, based on concentration of CD34+ and STRO1+ cells.

Methods: The different sample types that were used for comparative study of expression were taken from the 20 patients of nonunion tibia. Standardized algorithm of simple differential centrifugation along with automated count, Ficoll Hypaque, FACS (fluorescent-activated cell sorting), etc, has been performed to achieve the calculated desired cells. The total leukocyte count of each type of sample was done using automated cell counter. We have calculated the percentage of CD34+ and STRO1+ expression on the basis of % gated leukocytes of different samples using FACS.

Results: The percent mean and standard deviation of total leukocyte count of peripheral blood and crude BM aspirate were 7.6 ± 3.0 and 16.8 ± 5.37, respectively. Similarly for their % gated leukocytes based on CD34+expression, the percent mean and standard deviations found was 0.29 ± 0.17 and 2.52 ± 1.23, respectively. The % gated leukocytes of BM concentrate (buffy coat/MNC [mononuclear cell] fraction) had shown increased expression of CD34+ (percent mean $\pm$ standard deviation $= 3.27 \pm 1.32$). The percent mean and standard deviation of STRO1 count of crude BM and BM-MNCs samples were found as 0.24 ± 0.1 and 0.312 ± 0.09, respectively, ie, nearly 10% of their respective CD34+ count.

Conclusion: By this study we conclude that the BM marrow concentrate (buffy coat) isolated by simple differential centrifugation is the best material for infusion among all the specified ones.

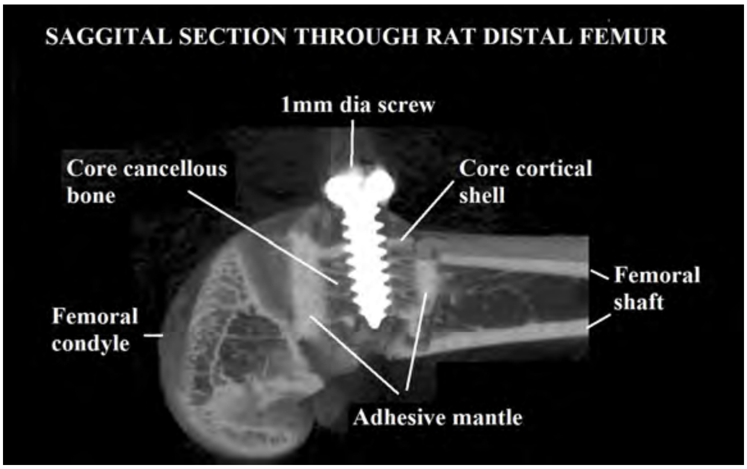
A New Ex Vivo Murine Model for Evaluation of Adhesiveness of a Novel Biomimetic Bone Glue

Philip Procter, PhD; *Sune Larsson, MD, PhD; Gry Hulsart-Bilström, PhD; Gerard Insley, PhD; Håkan Engqvist, PhD; Michael Palmer, PhD*

Purpose: An unmet need in osteochondral fractures is the optimization of anatomical reduction and fixation due to the limitations of standard implants where there are many small fragments. A bone adhesive technology has been developed that mimics human bonding mechanisms and may be an adjunct to current standard treatment methods. Such a biomaterial has no predicate against which to benchmark adhesiveness effect either biomechanically or biologically.

Methods: As a first step towards a standardized "adhesiveness" biomechanical test a murine model has been elaborated. In this, cylindrical core defects (2-mm diameter x 3-mm depth) were made in the distal lateral condyles of rat femurs harvested from adult animals (figure). Each core was removed by fracturing the core base and glued back in position. Tensile load was applied via a screw inserted in the core until failure occurred between the adhesive and bony surfaces.

Results: The glued bone cores consistently showed an abrupt failure at the maximum loads recorded which were in the range 5-8 N. The corresponding stresses were estimated at 25-40 N/cm^2, which is adequate for initial fixation of bone fragments.



Conclusion: The rat distal femoral bone core test was demonstrated to be feasible and reproducible ex vivo and supports evaluation in an in vivo study where the test article is the adhesive and the control is fixed in place using standard techniques.

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The Potential of Scaffolds Loaded With iPSC Extracellular Matrix in Treating Critical Size Bone Defects

Simon Tiziani, MD; *Elisa Casanova, PhD; Daisy Canepa, MSc; Benjamin Eggerschwiler, MSc; Hans-Christoph Pape, MD; Paolo Cinelli, PhD*

Purpose: Large bone defects remain a challenge for orthopaedic surgeons. Usually autologous bone acts as a scaffold to bridge the existing gap and cancellous bone harvested from the patient combined with growth factors are added to it. The amount of autogenous graft usually is small in comparison to the size of the defect; therefore, efforts have been made to integrate scaffolds with stem cells to treat such defects. Traditionally mesenchymal stem cells are chosen for those kind of procedures. However, harvesting and cultivation of mesenchymal stem cells is a tedious process. Induced pluripotent stem cells (iPSCs) represent an intriguing alternative source of stem cells. Unfortunately, the genetic modification associated with their creation precludes them from direct use. Nevertheless, they produce extracellular matrix, which can be used to enhance scaffolds. Scaffolds created in that manner can be easily sterilized and would no longer be bound to the original donor, making their clinical application more feasible.

Methods: Secondary mouse embryonic fibroblasts were reprogrammed to iPSCs by activating c-Myc, Klf-4, Oct-4, and Sox-2. Proof of pluripotency was provided by letting the cells build complete teratoma after implantation. Under fluorescence microscopy, SSEA1 and Oct-4 positivity could be demonstrated. Osteogenic differentiation was conducted for a total of 21 days using 2 different osteoinductive media. RNA samples were taken at d (day)0, d3, d7, d10, d14, and d21 and Alizarin red staining was performed on d3, d7, d14, d17, and d21. An in vivo mouse model is performed comparing fracture healing in mice with critical size defects with (1) plating, (2) plating + PLGA (poly[DL-lactide-co-glycolide] acid) scaffold, (3) plating + PLGA scaffold loaded with iPSC, and (4) plating + PLGA scaffold loaded with iPSC extracellular matrix.

Results: Induction of differentiation of IPSCs results in significantly higher and faster (d3 vs d21) calcium deposition (Alizarin red) compared to mesenchymal stem cells. The decellularized and iPSC-scaffolds were implanted in mouse model critical size defects and the differences between them quantified by microCT and immunohistochemical analysis.

Conclusion: Decellularized scaffold coated with iPSC extracellular matrix are an interesting alternative for the preparation of "off-the-shelf" scaffold for treating critical size fractures.

Does Immunosuppressive Therapy Influence Postoperative Fracture Healing After Organ Transplantation?

C. E. M. Pothmann, MD; *Hans-Christoph Pape, MD; H.-P. Simmen, MD; V. Neuhaus, PD MD*

Purpose: Within the last years, the number of people with transplanted organs, as well as their lifetime and quality of life after organ transplantation (TPL) increased. They actively participate in everyday life and suffer fractures. Do patients after TPL and under immunosuppressive therapy show impaired fracture healing?

Methods: A retrospective analysis of the trauma database of a Level I trauma center was undertaken. Immunosuppressed patients after TPL treated with an osteosynthesis between 2004 and 2016 were included. Patients had regular radiological and clinical follow-up. The fracture healing time was assessed and compared with patients without immunosuppressive therapy at this hospital and of standard surgical reference works. The reference group was matched and paired by age at the time of fracture, gender, type/location of fracture, and technique of osteosynthesis.

Results: 29 patients (15 male, 14 females; mean age 43 years) after TPL with overall 40 fractures were included in the analysis. There were 13 kidney TPL patients, 6 lung TPLs, 5 liver TPLs, 3 heart TPLs, and 2 kidney/pancreas TPLs. All patients got treated with at least 2 immunosuppressive drugs. The age of the reference group was comparable (paired t-test 0.753). Causes of accident were 37.5% sports/leisure, 35% work/household, 12.5% traffic accidents, and 5% without trauma. The operation was performed under perioperative long-term antibiosis, often with a combination of 2 or 3 drugs. Patients were hospitalized for an average duration of 11.3 days and were also examined by the particular organ specialists. Osteosynthesis was analyzed in 90% primary operative fracture treatment and in 10% 2-step procedures. Fracture healing was analyzed in 11 plates distal radius and ulna (healing period 14 weeks), 3 plates tibia (healing period 20 weeks), 3 plates fibula (11 weeks), 9 nails femur (51 weeks), 3 plates clavicle (51 weeks), 4 spondylodesis spinal column (24 weeks), 3 plates/screws pelvis/sacrum (7 weeks), 1 tension band wiring patella (49 weeks), and 3 plates humerus (34 weeks). Compared to the paired references, the time of fracture healing was significantly prolonged ($P < 0.001$). Complications included 1 wound infection, 2 hematomas, 1 nonunion, 2 persistent pains, 2 secondary displacement/lysis/material breakage, and 3 operative revisions.

Conclusion: Fracture healing under immunosuppressive therapy after TPL was significantly delayed. The immunosuppressive therapy may be responsible for these problems. We recommend surgical standard techniques should be applied; rehabilitation of movement and weight-bearing have to be adapted.

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Incidence and Complications of Fractures Managed by Traditional Bone Setters
Riaz Ahmed, MS; *Muhammad Sohail, MS; Junaid Khan, MBBS*

Purpose: This study was conducted to determine the incidence, complications, and reasons behind orthopaedic patients visiting traditional bone setters for treatment.

Methods: This descriptive study was done for a period of 2 years from September 5, 2014 to September 4, 2016. All patients presenting to the orthopaedic emergency and outpatient department (OPD) who had undertaken any treatment for an orthopaedic traumatic injury from a traditional bone setter (TBS) were included. After obtaining an informed consent, all the information regarding injury, number of days to injury, type of treatment done by a TBS, complication, reason for visiting a TBS, and definite treatment done in the hospital were recorded on pre-formed questionnaires. All data were entered into SPSS version 23. P was significant if <0.05.

Results: 652 patients were included in the study--364 (55.83%) male and 288 (44.17%) female. 172 patients (26.38%) belonged to the 11-20 year age group while 181 (27.76%) to >50-year age group. 81% of patients had closed fractures, 10% open fractures, and 9% dislocations. Among the complications, infections (32.67%) were predominant. Among other complications were malunion (20.55%), contractures (13.65%), nonunion (10.58%), avascular necrosis (9.51%), and gangrene (3.37%). In 45.55% of patients, internal fixation was done for definitive treatment. 18 (2.76%) had to undergo amputation. Mostly the patients had primary education (49.85%) while 6.44% were illiterate. Whenasked about reason for visiting the TBS, 42.02% said they had faith in TBS treatment, 21.32% had an opinion that TBS is easily available, while 16.26% opted that TBS treatment is cheaper.

Conclusion: Patients visiting a TBS for orthopaedic injuries and getting complications cannot be neglected especially in underdeveloped countries where there is lack of awareness, poverty, ignorance, or lack of health-care services. Awareness programs and role of media should be increased on a large scale. More research studies need to be done at other major trauma centers to estimate the number of patients affected by TBS treatment.

The Incidence of Deep Venous Thrombosis and the Epidemiological Analysis of Patients With Lower Extremity Fracture in Different Age Groups in Northwest China

Shuang Han, MD; *Shiming Wen, MD; Yan Zhuang, MD*

Purpose: This study was undertaken to investigate the incidence and clinical treatment of deep vein thrombosis in perioperative period in patients with lower limb fractures of different ages in northwest China.

Methods: We retrospective assessed the data of 1185 patients with lower extremity fractures in 5 provinces in Northwest China from July 2014 to March 2017 .There were 723 people in Shaanxi Province, 148 in Gansu Province, 137 in Qinghai Province, Ningxia Hui nationality autonomous regions 128 people, Xinjiang Uygur Autonomous Region 49 people. The age group was divided into young group (≤44 years), middle age group (45-59 years old), young elderly group (60-74 years old), and elderly group (≥75 years old); all patients excluded anticoction taboo (4100 IU qd [1/day]), 12 hours before surgery, 12 hours after surgery, no obvious bleeding. After the taboo, all patients were given physical therapy of the foot vein pump; statistics at different stages of thrombosis and distribution are provided.

Results: 1185 cases included 583 males, 602 females, aged 18 to 102 years, mean age 60.34 ± 19.51 years. According to the age group, divided into youth group (≤44 years) 288 people, middle age group (45-59 years old) 256 people, young elderly group (60-44 years old) 263 people, elderly group (≥75 years) 378 people. There were 62 cases (21.5%) in the preoperative group, 91 cases (35.6%) in the middle age group, 114 cases (43.3%) in the young elderly group, 148 cases (39.2%) in the elderly group; 195 cases in the left lower limb, 165 cases, 55 cases of lower extremities. There were 80 cases (27.8%) in the postoperative group, 143 cases (55.9%) in the middle age group, 170 cases (64.6%) in the young elderly group, 228 cases (60.3%) in the elderly group, 261 cases in the left lower limb, 219 cases, 21 cases of lower extremities (the results of the lack of coagulation-related data); $P < 0.05$. In the postoperative stage, the elderly group and the middle age group were significantly higher than those of the control group ($P < 0.05$). The plasma D-D level in the elderly group was higher than that in the young group ($P < 0.05$) .There was significant difference between the elderly group and the young group ($P < 0.05$).

Conclusion: The incidence of deep venous thrombosis (DVT) in the perioperative period was higher in elderly patients in Northwest China.The rate of DVT was highest in the young elderly group aged 60-74 years. Early identification of DVT-related risk factors can contribute to reduce the incidence of venous thromboembolism.

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Factors Associated With Deep Surgical Site Infection Following Fracture Treatment Using the SIGN Nail

Mamer Rosario, MD; *Romer Ariel Santos, MD; Misael Jonathan Ticman, MD; Geoffrey Battad, MD; Lendell John Gatchalian, MD; Paul Christian Bejosa, MD*

Purpose: Although solid intramedullary (IM) nails have been reported to be less prone to local infection, literature on predictors of deep surgical site infection (SSI) following SIGN (Surgical Implant Generation Network) nailing is scarce. Since deep SSI is extremely costly to treat, more so given that the burden of orthopaedic trauma in developing countries is considerable, identification of factors predictive of deep SSI following SIGN nailing is needed. The present study was undertaken in a single-institutional series of patients treated with the SIGN nail with minimum 1-year follow-up to assess the deep SSI rate and identify predictive factors of deep SSI.

Methods: A total of 334 femoral and tibial diaphyseal fractures treated with the SIGN IM nail and followed for at least 1 year were reviewed. Working diagnoses of deep SSI were made according to the Centers for Disease Control and Prevention criteria. Our primary outcome was deep SSI, and possible patient-, disease-, and treatment-related factors predictive of deep SSI were analyzed. The Pearson chi-squared test was utilized for univariate analysis, and multivariate analysis was done using the logistic regression model on variables for which P values of <0.1 were obtained. All analyses were performed using SPSS version 21.0, with a P value <0.05 considered statistically significant.

Results: 12 (3.6%) out of 334 fractures developed deep SSI. On univariate analysis, a tibial fracture location (6.3% vs 1.9%, P = 0.037), an open fracture type (8.6% vs 2%, P = 0.005), nailing within 2 weeks after injury (7.2% vs 1.4%, P = 0.006), and a history of superficial SSI (63.2% vs 0%, P <0.001) were found to be associated with the development of deep SSI. Following logistic regression analysis, none of the properties were found to be independent predictors of deep SSI.

Conclusion: Incidence of deep SSI following SIGN nailing is within the reported range, but SIGN nail-associated deep SSI seems difficult to predict. Nevertheless, we recommend aggressive wound debridement with soft-tissue reconstruction as needed, upon the development of superficial SSI, especially following treatment of open diaphyseal fractures of the tibia.

The Effect on the Stability of the Knee Joint for Patients With Type IV, V, and VI Tibial Plateau Fracture Through Posteromedial Approaches After the Separation of the Medial Collateral Ligament

Han Zhong Xue, MD; *Cheng Ren, MD; Zhong Li, MD*

Purpose: Several studies evaluate the functional outcome of a tibial plateau fracture after operation.But few studies reported how to manage medial collateral ligament through posteromedial approaches for the treatment of type IV, V, and VI tibial plateau fracture. The aim of this study was to evaluate the prognosis of patients with type IV, V, and VI tibial plateau fracture through posteromedial approaches after separation of the medial collateral ligament.

Methods: Between January 2010 and March 2017, 132 patients with type IV, V, or VI tibial plateau fracture through posteromedial approaches after separation of the medial collateral ligament were included. The outcome measures were knee motion and functional outcome using the Hospital for Special Surgery knee score (HSS).

Results: According to the HSS, the results were excellent in 86 patients, good in 29 patients, with excellent and good rate of 87.12%. The difference of HSS score for Schatzker type IV, V, and VI patients has no statistical significance (F = 0.173, P = 0.859), and the difference between type IV and V (P = 0.635), between type V and VI (P = 0.510), between type IV and VI (P = 0.306) has no statistical significance. At the time of the last follow-up 132 patients had knee joint motion from 100° to 128°, an average of 116.3°. This group of patients was without nerve and vascular injury, infection, loosening, or breaking of internal fixation complications.

Conclusion: Posteromedial approaches after separation of the medial collateral ligament facilitates the reduction and fixation of tibial plateau fracture and has advantages of clear exposure, convenient placement of internal fixation, and good clinical result.

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Varus Mechanism Is Associated With High Incidence of Popliteal Artery Lesions in Multiligament Knee Injuries

Maximiliano Scheu, MD, MS; *Alan Garin, MD; Pedro Díaz, MD; Luis O'Connell, MD; Carolina Mellado, MD; Gonzalo Espinoza, MD*

Purpose: Popliteal injuries can be a devastating complication in multiligament knee injuries. Approach to diagnosis is widely variable and clinical signs of ischemia can be insufficient to rule out vascular injuries. The aim of this study is to assess the incidence of popliteal artery injuries and correlate them with ligament tears and multiligament injury classification in order to identify high-risk patterns of vascular injury.

Methods: This was a retrospective study of a case series with diagnosis of multiligament knee injury between 2012 and 2016 in a Level I trauma center. We included patients with 2 or more torn ligaments as shown by MRI. Computed tomography angiography (CTA) was obtained routinely as a part of a diagnosis protocol in the presence of gross instability during initial workup. Patients with follow-up <3 months and without the aforementioned studies were excluded. Data regarding ligament tear were obtained from MRI (1.5-T) by a musculoskeletal radiologist. Injuries were classified according to Schenck's classification. Demographic data were collected from medical records. Odds ratio was used to establish association between imaging parameters and vascular injuries. Significant P value was set at 0.05. Statistical analysis was performed using STATA software.

Results: 33 knees (32 patients) were included in the analysis. 31 were men with an average age of 41 years (range, 18-82). 6 knees (18%) had a popliteal artery injury. Anterior cruciate ligament (ACL) was the most frequently torn (91%) followed by posterior cruciate ligament (PCL) (85%), posterolateral corner (PLC) (55%), and medial collateral ligament (MCL) (45%). Regarding Schenck's classification, type III was found in 73% (III L 40%, III M 33%), type I in 18%, and types II, IV, and V accounted for the remaining 9%. The likelihood of having vascular injury was increased 11 times when having a type III L dislocation, compared to any other injury pattern (P = 0.02). No significant association was found between isolated ligament tear and vascular injury. These data suggest that varus forces causing enough distraction of the lateral compartment of the knee to tear posterolateral structures as well as both cruciate ligaments can independently be related to popliteal artery injuries.

Conclusion: A multiligamentous knee injury involving the PLC, ACL, and PCL is related to a significant increase in the incidence of popliteal artery injury. This finding should increase awareness for vascular injuries whenever detecting gross varus instability.

Robotic-Assisted Fixation of Sacral Fractures: Initial Experience

Yoram Weil, MD; *Meir Liebergall, MD; Rami Mosheiff, MD; Joshua Shroeder, MD; Amal Khoury, MD*

Purpose: Unstable sacral fractures are challenging for orthopaedic trauma surgeons. In most cases percutaneous fixation techniques are utilized after reduction. However, these techniques are not risk-free mainly due to anatomical considerations. Screw misplacement is quite common and concerning. As spine surgery evolved, a miniature robotic guidance system was successfully utilized in pedicular screw insertion. The aim of the study was to demonstrate the use of the miniature robot in the fixation of unstable sacral fractures.

Methods: 11 patients with unstable sacral fractures without significant displacement were eligible for percutaneous fixation. These included 9 traumatic fractures and 2 pathological fractures. 9 fixation constructs were planned using a preoperative CT scans and 2 cases were operated utilizing intraoperative CT (Arteis Zeego, Siemens). The patients were placed prone and the robot was mounted on a Dynamic Reference Bridge (DRB), in cases of the preoperative CT, 2 verification fluoroscopic images were taken. In the case of the intraoperative imaging, a 3-dimensional scan was performed intraoperatively after fracture reduction and provisional fixation. The robot was mounted on the DRB and was sent by the robotic computer to the desired screw(s) trajectory. The guidewires were inserted through stab wounds and screws were placed subsequently. CT scans were made postoperatively and fluoroscopic and operative time were recorded intraoperatively. In 3 cases lumbopelvic fixation was also added in a percutaneous technique using robotic guidance as well.

Results: Fracture type included traumatic fractures due to motor vehicle accidents and falls (9 patients), 1 insufficiency fracture, and 1 pathological fracture. Number of screws were between 1 (iliosacral) and 6 (lumbopelvic) (average 2). In 3 cases lumbopelvic fixation was used in unstable vertical shear fractures, where pedicle and iliac screws as well as iliosacral screws were placed using the robotic guidance. Operative time ranged from 15 to 90 minutes (average 50 min),. Average fluoroscopic time was 18 seconds (range, 7-42 sec). Postoperative CT detected intraosseus trajectory of all screws without any breaching.

Conclusion: Robotic placement of iliosacral screws for sacral fracture is a promising technique. We demonstrated a high degree of success using robotic guidance for placing iliosacral with or without lumbar and iliac screws in unstable sacral fractures. We achieved a high degree of accuracy while limiting the radiation time to a minimum.

The Clinical Application of Modified Stoppa Approach With Spring Plate for Posterior Column Acetabular Fractures

Cheng Ren, MD; *Han Zhong Xue, MD; Zhong Li, MD*

Purpose: The modified Stoppa intrapelvic approach is gaining wide acceptance for treating several types of acetabulum fractures. But the application of Stoppa approach with spring plate for posterior column acetabular fractures is rarely reported. We investigate the feasibility and effects of modified Stoppa approach with spring plate for posterior column acetabular fractures.

Methods: Between December 2013 and February 2016, 22 patients with involving posterior column acetabular were treated, including 16 males and 6 females. The causes included traffic accident injury (11 cases), crash injury of heavy object (4 cases), and falling injury from height (7 cases). There were 10 cases of the simple posterior column, 7 cases of the posterior column and posterior wall fracture, and 5 cases of both-column fracture. The operation time, blood loss, and complications were recorded. The effectiveness of reduction and the hip function were evaluated according to Matta score system and Merle d'Aubigne and Postel score system.

Results: The operation time was 80 to 150 minutes (mean,100 minutes). The intraoperative blood loss was 300-900 mL (mean, 480mL). Matta radiographic assessment showed anatomical reduction in 15 cases, satisfactory reduction in 6 cases, and unsatisfactory reduction in 1 case. At the time of last follow-up, the results were excellent in 16 cases, good in 2 cases, general in 2 cases, and poor in 1 case, and the excellent and good rate was 90% according to the Merle d'Aubigne and Postel hip score standards.

Conclusion: Posterior column acetabular fractures can be treated with modified Stoppa approach with spring plate to obtain good exposure, less invasion, satisfactory reduction, stable fixation, and low complications.

Minimally Invasive Stabilization of Posterior Pelvic Ring Instabilities With Pedicle Screw Connected to a Transverse Rod

Hu Wang, MD

Purpose: The goal of this study was to evaluate the clinical outcomes, the quality of reduction, and complications of pelvic fractures that were treated by minimally invasive stabilization of posterior pelvic ring instabilities with a pedicle screw connected to a transverse rod.

Methods: This was a retrospective analysis of prospectively collected data in a consecutive patient series with pelvic fractures that were treated by minimally invasive stabilization of posterior pelvic ring instabilities with pedicle screws between January 2010 and January 2016. The functional outcomes were evaluated by Majeed scores, and fracture reduction results were evaluated using the Tornetta and Matta standard. As well as recording the duration of the surgical procedure, intraoperative blood loss, and the times of intraoperative fluoroscopy and complications were noted.

Results: A total of 29 patients (15 males and 14 females, at age range of 21-72 years, mean 40.8 years) could be followed up after an average of 38.2 ± 21.3 months (range,12-84 months). According to the AO/OTA classification, 24 patients had B2 injury, and 5 patients with C1 injury of the pelvic ring. For the sacral fractures, according to the Denis classification, 4 cases were zone I fractures, 25 cases were zone II fractures. The duration of the surgical procedure, intraoperative blood loss, and the times of intraoperative fluoroscopy of the posterior-ring surgical procedure was 28.2 ± 4.6 min (range, 20-38 min), 46.7 ± 4.9 mL (range, 39-56 mL), and 13.1 ± 1.6 s (range,10-17 s), respectively. Posterior-ring fracture reduction was excellent in 11 patients and 15 were good, 3 cases were fair, and the excellent and good rate was 89.7% (26/29). At the final follow-up, the function result was rated as excellent in 10 cases, good in 16, fair in 3, and poor in 0 cases, with excellent and good rate was 89.7% (26/29). There is no incision infection, intraoperative neurovascular injury, pedicle screw loosening or breakage, and nonunion of the posterior arch did not occur. Two patients requested to remove the fixator, including 1 patient with breakage of the anterior-pelvic ring internal fixator and the pedicle screw was also taken out in the same operative session, and another one with moderate pain on the posterior-pelvic ring.

Conclusion: Minimally invasive stabilization of posterior pelvic ring instabilities with a pedicle screw connected to a transverse rod may be a good alternative to sacroiliac screw fixation because it is quick, safe, and associated with a good functional outcome, thus being a useful option in patients who do not qualify for sacroiliac screw fixation.

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Operative Treatment of Intertrochanteric Femoral Fractures: Blade Versus Screw

Joost van Leur, MSc; Tijs Jakma, MD; Sten Willemsen, PhD; ***Bastiaan Punt, MD***

Purpose: This study was conducted to compare the outcomes of the Trochanteric Fixation Nail (TFN) with helical blade versus TFN with femoral neck screw in the treatment of intertrochanteric femoral fractures.

Methods: In this single-center, retrospective cohort study we included all patients >18 years with an intertrochanteric femoral fracture in the period from January 1, 2012 to December 31, 2016. Cutout rate was considered as the primary outcome measure. Intervention variables were considered as secondary outcome measures. The data were obtained from radiographic examinations and the medical patient file. The chi-square test or Student t-test were used for statistical analysis.

Results: A total of 631 patients were treated for an intertrochanteric femoral fracture. Of this group 239 patients (37.9%) were treated with a TFN with helical blade and 392 patients (62.1%) with a TFN with femoral neck screw. There were no statistically significant differences within the baseline characteristics between both groups. A total of 17 (2.7%) cutouts were recorded without statistically significant difference between the 2 groups (9 patients [3.8%] with a helical blade, 8 patients [2.4%] with a femoral neck screw; P = 0.192). In total there were 42 (6.7%) mechanical complications recorded without statistically significant difference between the 2 groups (10 patients [4.2%] with a helical blade, 21 patients [5.4%] with a femoral neck screw; P = 0.573). Within the secondary outcome measures there were no statistically significant differences between the 2 groups. The tip-apex distance within the group with helical blade was averaging 23.39 mm (standard deviation [SD] 7.96), within the femoral neck screw group on average 21.71 mm (SD 7.21); P = 0.454. In 74.5% (n = 470) of all cases the column implant was placed central to the femoral head, corresponding with Cleveland position 5. Operative result allowed full weight-bearing for 585 patients (226 patients [94.6%] with a helical blade vs 359 patients [91.6%] with a femoral neck screw; P = 0.186). The average hospital stay within the helical blade group was 7.5 days (SD 4.45) compared to 8.5 days within the group with a femoral neck screw (SD 6.63); P = 0.516.

Conclusion: Based on this study there is no statistically significant difference in the treatment of intertrochanteric femur fractures with the TFN helical blade or TFN femoral neck screw .There is no preference for the choice of column implant in the surgical treatment of intertrochanteric femur fractures.

Cemented Versus Cementless Femoral Stem Design and the Risk of Revision for Periprosthetic Femoral Fracture in Total Hip Arthroplasty

Tanvir Khan, MBBS; *Brigitte Scammell, PhD; Andrew Manktelow, FRCS; Benjamin Ollivere, MD*

Purpose: The aim of this study was to compare the risk of revision hip arthroplasty for periprosthetic femoral fracture (PFF) using cemented versus cementless femoral fixation for primary total hip arthroplasty (THA) using data from the world's largest national joint registry (NJR).

Methods: All primary THAs performed for osteoarthritis and recorded in the NJR between 2003 and 2015 with details of stem fixation type were included in the analysis. Univariate and multivariate Cox proportional hazards models were used to compare the rate of revision for PFFs between cementless and cemented stems. The assumption of proportional hazards was relaxed to account for time-dependent effects of stem fixation type. In separate analysis, stem brands that had been implanted at least 3500 times were classified into cemented-loaded taper, cemented-other, and cementless. The risk of PFF revision for loaded taper cemented stems was compared with cementless and other cemented stems using covariate-adjusted hazard ratios (HRs).

Results: There were 649,709 primary THAs included in the analysis with a total of 1518 matched revisions for PFF. After adjustment for age, gender, and ASA (American Society of Anesthesiologists) grade, the HR was 1.68 (95% confidence interval [CI] 1.51-1.87, P <0.001). Comparing the rate of PFF revision within and beyond the first 3 months following primary THA in cementless versus cemented stems, the covariate-adjusted HRs were 8.82 (6.89-11.30, P <0.001) and 0.84 (95% CI 0.49-1.41), respectively. The covariate-adjusted HR for PFF revision in loaded-taper cemented stems compared to other cemented and cementless stems was 4.13 (95% CI 2.98-5.72).

Conclusion: This study demonstrates, based on longitudinal registry data, that there is an overall higher risk of PFF revision in THA with cementless stem fixation in the first 3 months following implantation. Loaded-taper cemented stems showed a higher risk of PFF revision compared with other cemented and cementless stem designs.

Pattern of Hip Fractures Over a 10-Year Period in a Major Referral Center

Paa Baidoo, MD; *Agbeko Ocloo, MD; Velarie Ansu, PhD Candidate*

Purpose: The incidence of hip fractures is projected to increase worldwide and so are the associated morbidity, mortality, and cost of managing patients with hip fractures. There is, however, scarcity of data on trend and incidence of hip fractures in sub-Saharan Africa, making planning and management difficult.

Methods: This is a retrospective study that involves all hip fractures seen and admitted to a major referral center from 2007 to 2016. The demographic characteristic (sex and age), mechanism of injury, and the fracture type were documented. Association between age, sex, and mechanism of injury and type of fracture were determined by chi-square, with $P < 0.05$ as the level of significance.

Results: 929 patients were admitted over the 10-year period. There were 492 (53%) females and 437 (47%) males, a ratio of 1.1:1.0. The mean age was 72.2 ± 14.4 years. Falls constituted 726 (78.1%) of cases with 203 (21.9%) resulting from road traffic accidents (RTA). There was an increase in patients with hip fractures from 2007 to 2012 followed by a gradual decline. Approximately 490 (52.7%) and 439 (47.3%) of the cases were extracapsular and intracapsular respectively. There was strong association between age and mechanism of injury (chi-square (2) = 492.10, $P < 0.001$, $\Phi = 0.73$) and moderate association between sex and mechanism of injury (chi-square (1) = 37.50, $P < 0.001$, $\Phi = 0.21$). There was no significant association between sex or age and the type of fracture ($P > 0.05$).

Conclusion: This study shows a 10-year trend of hip fractures in a major referral hospital. It will serve as a great starting point for a nationwide study on the incidence rate of hip fracture in the country. It also has a great implication for future planning and management of these fractures.

A Biomechanical Analysis About Fixing the Locking Compression Plate of Distal Femur Fractures

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Purpose: The stable fixation of a distal femur fracture is essential for early joint motion and ambulation. A locking compression plate with the technique of minimal invasive plate osteosynthesis has been the most commonly used procedure in distal femur fractures. However, because of the pathoanatomical features of the patient and fracture characteristics, it is difficult to fix a sufficient number of screws at the distal part of the plate. This study aimed to identify how biomechanical stability varies according to the numbers of distal part screws of the LCP-DF (Locking Compression Plate-Distal Femur), which is a standard implant for distal femur fractures.

Methods: Biomechanical stability was compared between 3 LCP-DF fixation groups (3-screw group, 4-screw group, and 6-screw group). For each group, 6 synthetic adult-sized femur models (Model 3403, Pacific Research Laboratories) were used for the biomechanical research. The composite replicate femurs was used to simulate the distal femur fracture with comminution. After fixing the LCP-DF, the bone 6 cm and 8.5 cm above the distal edge of the knee part was removed with a gap of 2.5 cm. For the biomechanical analysis, the servo-hydraulic testing machine (MTS 810 Material Testing System) was used. For the cyclic loading, an axial loading of 100 N-1000 N, 3Hz, and 100,000 cycles was given, after a 100-N pre-load was given. For the failure test, an axial load at a velocity of 10 mm/min was given so that the load to failure, mode of failure, and displacement at load to failure were all recorded and analyzed.

Results: During the cyclic loading test, there was no failure in all of the 3-screw, 4-screw, and 6-screw groups. In load-to-failure test, average load to failure was 4214.8 N (range, 4138-4390) for the 3-screw group, 4273.2 N (range, 4143-4329) for 4-screw group, and 4713.3 N (range, 4587-4955) for the 6-screw group (P = 0.007). Every sample taken from the 3 groups showed cracks. The average displacement in the failure showed an average of 10.3 mm (range, 9.6-11.8) for the 3-screw group, 9.1 mm (range, 6.5-11.7) for the 4-screw group, and an average of 8.8 mm (range, 6.4-10.4) for the 6-screw group.

Conclusion: As expected, the 6-screw group was the strongest biomechanical construct of LCP-DF in the fixation of extra-articular distal femur fractures. However, in fractures with difficulty to fix 6 screws at the distal fracture segment, the fixation of 3 to 4 screws also achieved an acceptable stability.

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Satisfactory Postoperative Alignment Following Retrograde SIGN Fin Nailing for Femoral Shaft Fractures: A Case-Control Study

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Purpose: The Surgical Implant Generation Network (SIGN) Fin nail may reduce the challenges of intramedullary femoral nailing without fluoroscopy. Placed in a retrograde fashion, the nail design precludes the need for proximal interlocking screws, instead achieving stability through an interference fit within the proximal femoral canal. The purpose of this study is to compare postoperative alignment in femoral shaft fractures treated with the SIGN Fin nail compared to a standard retrograde SIGN nail.

Methods: Using the SIGN fracture database, we identified all femoral shaft fractures treated with the SIGN Fin nail at 2 African hospitals. Two examiners independently classified fracture patterns using the AO/OTA classification system (32 A-C). Using an on-screen protractor tool, postoperative coronal and sagittal plane alignment was measured and recorded as deviation from anatomic alignment (DFAA), with units in degrees. Patient demographics and surgical techniques were also recorded. Using a case-control model, Fin nail cases were matched in a 1:1 ratio to retrograde SIGN nail cases based on AO/OTA fracture type and, secondarily, based on delay to surgery, open versus closed fracture, reduction method, and age/sex.

Results: 28 Fin nail cases were identified, and 28 matched retrograde SIGN nail cases were selected. The Fin nail and retrograde SIGN nail groups were well matched in terms of demographics, AO/OTA fracture type, and surgical characteristics (Table 1). There was no significant difference in postoperative coronal or sagittal plane alignment between groups (Table 2). There were no cases in either group of postoperative malalignment >5° in any plane.

Conclusion: The SIGN Fin nail achieves satisfactory radiographic alignment without the need for proximal interlocking screws, making it an attractive implant for femoral shaft fracture fixation in resource-limited settings. Further research is required to determine long-term Fin nail outcomes and to investigate potential advantages of the Fin nail.

Table 1: Baseline demographics, injury and operative characteristics between groups

Subject characteristic	Nail type: SIGN Fin Nail (n=28)	Nail type: Traditional SIGN Nail (n=28)	P-value
Age, years (mean±SD)	33.8 ± 12.3	30.3 ± 9.2	0.238
Gender, female [n(%)]	7 (25)	4 (14)	0.503
Laterality, left [n(%)]	15 (53.6)	13 (46.4)	0.790
Mechanism [n (%)]			0.504
Road accident	23 (85.2)	26 (92.9)	
Fall	3 (11.1)	2 (7.1)	
Other	1 (3.7)	0 (0.0)	
Fracture pattern – AO class [n (%))			1
A	21 (75)	21 (75)	
B	6 (21)	6 (21)	
C	1 (3.6)	1 (3.6)	
Stable, yes [n (%)]	23 (82.1)	25 (89.3)	0.705
Open fracture, yes [n (%)]	4 (14.3)	4 (14.3)	1
Time until surgery, days (IQR)	6 (4.8-8.2)	6.0 (3.8-8.0)	0.399
Operating time, minutes (IQR)	90 (60-115)	90 (62-105)	0.931
Reduction time, minutes (IQR)	30 (20-44)	30 (25-45)	0.679
Reduction method, closed [n (%)]	0 (0.0)	7 (25.0)	**0.011**
Nail Diameter, mm (mean±SD)	10.1 (1.0)	10.5 (0.9)	0.227
Nail Length,. mm (mean±SD)	320.7 (33.3)	388.6 (24.0)	**<0.001**

Table 2: Average Deviation from Anatomic Alignment (DFAA), degrees

Measurement	Nail type: SIGN Fin Nail (n=28)	Nail type: Traditional SIGN Nail (n=28)	P-value
AP	1.57 (1.14, 2.01)	1.01 (0.58, 1.43)	0.066
Lateral	1.35 (0.93, 1.77)	0.97 (0.57, 1.38)	0.197
Maximum in any plane	1.93 (1.49, 2.37)	1.48 (1.04, 1.92)	0.153

Reported as mean (95% CI)

Open Diaphyseal Femoral Fractures Treated With Intramedullary Nailing: Incidence of Complications and Health-Related Quality of Life Outcomes

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Purpose: Our objective was to assess the incidence of open diaphyseal femoral fractures, postoperative complications, and outcomes.

Methods: This was a retrospective analysis of adult patients with open diaphyseal femoral fractures between February 2007 and January 2016. Exclusion criteria were proximal or distal articular femoral injuries, closed injuries, pediatric fractures, and fractures stabilized with plating or external fixators. Details documented and analyzed included patient demographics, mechanism of injury, Gustilo and AO classification, other associated injuries, ISS, time to operating theater, method of fixation, type of soft-tissue coverage, need of blood transfusion, length of hospital stay, follow-up period, and incidence of systemic and local complications. Health-related quality of life was assessed using the 5-Level EuroQol 5 Dimensions questionnaire (EQ-5D-5L). Mean follow-up time was 3 years.

Results: 50 patients (12.5%) (43 males) were included with mean age 36 years (range, 18-80). Gustilo classification included: Grade I,10 cases; Grade II, 12; Grade IIIA, 14; Grade IIIB, 11; and Grade IIIC, 3 cases. The mean ISS was 21 (range, 9-57). 12 patients had retrograde reamed nailing due to associated knee/tibial injuries or associated pelvic injuries and 38 had reamed antegrade nailing. Soft-tissue reconstruction included primary closure in 18 cases, secondary closure in 17 cases (average time 2 days [range, 1-4]). 11 cases required skin grafting, 1 case rotational flap, and 3 free flaps. 21 patients necessitated blood transfusion on average 2 units (range, 1-6). Systemic complications included 1 case of pulmonary embolism, 3 cases of compartment syndrome, and 1 case of deep vein thrombosis. The union rate was 78% (39 patients) at a mean time of 7 months (range, 3-9). 11 patients (22%) developed non-union (7 cases of Gustilo III). The overall infection rate was 4%. There were 2 cases with rotational deformity, 1 case with shortening of 2 cm, and 2 patients developed heterotropic ossification Brooker Grade 1 .Patients reported higher levels of anxiety and depression and lower quality of life, compared to healthy controls.

Conclusion: The incidence of nonunion is high and patients should be informed about this complication during the consent process. Moreover, it appears that the overall health-related quality of life and levels of anxiety and depression are higher compared to the healthy controls.

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Outcomes of Neglected Bosworth Fracture-Dislocation

Gisoo Lee, PhD, MD; Chan Kang, MD; ***Yougun Won, MD***

Purpose: Previous epidemiological data on the prevalence and characteristics of patients with Bosworth ankle fractures have been limited. Bosworth fracture-dislocations are often neglected in patients with ankle fractures. We investigated the neglected outcomes and prevalence of Bosworth fracture-dislocation in patients with ankle fractures.

Methods: We conducted a retrospective analysis of inpatients aged 18 years and older with ankle fractures between 2007 and 2016 in 4 Korean hospitals. Patient demographics, risk factors, fracture characteristics, treatment data, outcomes, and complications were analyzed.

Results: We identified 3410 hospital admissions for ankle fractures. During the study period, Bosworth fracture-dislocations were assessed in 51 cases. Men were more commonly affected than women, with a 32:19 ratio. Mean age at admission was 42.78 years (standard deviation, 15) in men and 43.21 (12) years in women. Most of the patients with Bosworth fracture-dislocations were young adults with high-energy traumas. The most frequent mechanism of trauma was falling down stairs (n = 27, 52.94%), followed by traffic accidents. Emergency surgery was performed within 24 hours of injury in 36 cases, and misdiagnosis and delayed surgeries in 15 cases. 12 patients were eventually not diagnosed with Bosworth fracture-dislocations.

Conclusion: The prevalence of Bosworth fracture-dislocations was higher than expected, and often neglected. Patient outcomes were significantly higher in those who underwent emergency surgery within 24 hours of admission than in those with delayed surgery.

Soft-Tissue Complications and Timing of Surgery in Patients With a Tongue-Type Displaced Intra-Articular Calcaneal Fracture: An International Retrospective Cohort Study

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Purpose: Tongue-type displaced intra-articular calcaneal fractures (DIACFs) are associated with a specific pattern of fracture displacement in contrast to joint depression fractures. This may result in tension of soft tissue in the posterior part of the heel. Tension-induced ischemia can result in skin necrosis. The objectives of this study were to investigate whether patients with tongue-type calcaneal fractures exert a higher risk of complications, especially of the posterior soft tissues, than joint depression-type fractures. Also, late interventions (eg, antibiotics, debridements, and amputations) and the effect of timing of surgery on the complication rate was assessed.

Methods: In this international retrospective cohort study, data of adult patients with a DIACF in the period January 1, 2005 to December 31, 2015 were extracted from patients' medical files. Descriptive, univariate, and multivariable analyses were performed in SPSS.

Results: A total of 560 patients with 632 DIACFs were included (295 tongue-type [TT]and 337 non-TT fractures). At hospital presentation, 20.3% of the patients with a TT fracture had compromised posterior soft tissue versus 12.8% with non-TT fractures ($P = 0.032$). However, corrected for potential confounders the risk was no longer statistically significant (odds ratio [OR] 1.497; 95% confidence interval [CI] 0.831-2.696). Patients with a TT-DIACF had a 1.2 to 3.4-fold higher rate of any local wound complication (deep infections, and full-thickness lesions, $P < 0.03$). In addition they had 2.0 to 8.0-fold more intravenous antibiotics, debridements, soft-tissue coverage procedures, and amputations ($P < 0.03$). Patients who underwent surgery within 2 days after trauma had a higher risk to develop any complication, in particular superficial infections, when compared to surgery between 3 and 7 days, but no significant difference between 3 and 7 and ≥8 days could be demonstrated.

Conclusion: Despite the fact that patients with a tongue-type fracture developed posterior skin and soft-tissue compromise nearly twice as often, this difference disappeared after correction for confounders. The overall complication risk was increased in patients with tongue-type calcaneal fractures as compared to patients with a non-tongue-type fracture. Whether or not patients with tongue-type fractures require immediate surgery cannot be concluded from the data.

PAPER ABSTRACTS

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Treatment of Infection Following Intramedullary Nailing of Tibial Shaft Fractures: Results of the ORS/ISFR Expert Group Survey

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Purpose: The lack of universally accepted treatment principles and protocols to manage infected intramedullary (IM) nails following tibial fractures continues to challenge us, eliciting a demand for clear guidelines. Our response to this problem was to create an ORS/ISFR (Orthopaedic Research Society/International Society for Fracture Repair) task force to identify potential solutions and trends based on published evidence and practices globally.

Methods: A questionnaire of reported treatment methods was created based on a published meta-analysis on the topic. Treatment methods were divided in 2 groups: A (retained nail), and B (nail removed). Experts scored the questionnaire items on a scale of 1 to 4 twice, before and after revealing the success rates for each stage of infection. Inter- and intraobserver variability analysis among experts' personal scores and between experts' scores was performed. An agreement mean and correlation degree between experts' scores was calculated. Finally, a success rate report between groups was performed.

Results: Experts underestimated success rate of an individual treatment method compared to published data. The mean difference between experts' scores and published results was +26.3 ± 46 percentage points. Interobserver agreement mean was poor (<0.2) for both rounds. Intraobserver agreement mean across different treatment methods showed a wide variability (18.3% to 64.8%). Experts agree more with published results for nail removal on stage-2 and 3 infection.

Conclusion: Experts' and published data strongly agree to retain the implant for stage-1 infections. A more aggressive approach (nail removal) is favored for infection stages 2 and 3. However, literature supports both treatment strategies.

A Comparison of Knee Pain and Kneeling Pain in Suprapatellar Versus Infrapatellar Tibial Nailing

Mark Middleton, FRCS; Simon Weil, MRCS; Tamer Ads, MScOT; Thomas Anderson, MBBS; Andreas Fontalis, MD; ***Alex Trompeter, FRCS***

Purpose: Intramedullary nailing is the most common technique used to treat fractures of the tibial diaphysis. The suprapatellar method of tibial nail insertion was initially developed for the management of proximal tibial fractures, overcoming the classical deformities associated with these injuries. The suprapatellar method has become more widespread in its use and some have reported a reduction in the common complication of anterior knee pain and kneeling pain seen with traditional infrapatellar approaches. The purpose of this study was to compare the incidence and level of patient-reported knee pain and ability to kneel in patients who had undergone tibial nailing using the suprapatellar and infrapatellar techniques. Our hypothesis was that the suprapatellar technique would result in less anterior knee pain and a higher proportion of patients able to kneel after recovery from their surgery.

Methods: Suprapatellar nailing was introduced in our institution in 2014. All acute tibial shaft fractures (OTA 42) treated with intramedullary nailing were identified. Nailings for nonunion, exchange nails, or nails with associated articular reconstruction were excluded. Of the consecutive 158 acute fracture cases 79 were open fractures. After exclusions, 56 suprapatellar and 92 infrapatellar patients were identified. Outcome, knee pain, kneeling pain/ability, and complications were established by telephone questionnaire. The Kujala anterior knee pain scale was used. Follow-up ranged from 6 to 48 months.

Results: There was a lower incidence of reported anterior knee pain and pain on kneeling in the suprapatellar nailing group that approached but did not meet statistical significance. Similar results were also seen in knee pain scores and pain on kneeling scores. Kujala anterior knee pain scores showed no difference between groups.

Conclusion: We conclude that using the suprapatellar technique for intramedullary nailing potentially reduces the incidence of anterior knee pain and kneeling pain compared with infrapatellar nailing. This is the largest comparative series to date. However, we recommend larger studies to further investigate this correlation.

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Distal Radius Volar Plate Design Predicts Volar Prominence to Watershed Line in Clinical Practice: Comparison of Soong Grading of 2 Common Low-Profile Plates in 400 Patients

Minke Bergsma, MD; *Kimberly Brown, MD; Job Doornberg, MD, PhD; Inger Sierevelt, MSc; Ruurd Jaarsma, MD, PhD; Bhavin Jadav, FRCS*

Purpose: Tendon rupture following volar plate malpositioning in distal radius fracture fixation is a recognized complication when the plate is positioned too volar. Soong et al. demonstrated that plates prominent at the watershed line increased the risk of tendon injury. Plate design may direct plate positioning in clinical practice, and thus increase the chance of tendon rupture based on design factors rather than surgeon factors. Therefore, the purpose of this clinical study is to compare plate positioning in clinical practice of the 2 most commonly used volar locking plate designs with respect to the watershed line as quantified by the Soong grading system.

Methods: A total of 400 patients who underwent open reduction and internal fixation between November 2013 and January 2018 were included in this study. Cohort 1 was defined as 200 consecutive patients treated with DVR plates (Zimmer Biomet) in this period. Cohort 2 were 200 consecutive patients who had volar plate fixation with Variable Angle LCP plates (DePuy Synthes) in this period. There were no differences in baseline demographics between both cohorts. Surgery was carried out by 67 different respective primary surgeons, representing daily practice, and improving generalizability of this study. Two independent reviewers categorized postoperative standardized lateral wrist radiographs into Soong Grade 0, 1, or 2. Chi-square test was applied to determine if the differences in Soong categorical ratings between the 2 cohorts were significant.

Results: In cohort 1, 87 plates (43.5%) were not prominent volar to the watershed line (Grade 0), 95 plates (47.5%) demonstrated Grade 1 prominence and 18 plates (9.0%) demonstrated Grade 2 prominence. In cohort 2, 63 plates (31.5%) were Grade 0, 103 plates (51.5%) were Grade 1, and 34 plates (17%) had Grade 2 prominence on and volar to the watershed line. These radiographic results show a greater incidence of volar plate prominence with respect to the watershed line, as defined as Soong Grades 1 and 2 in cohort 2 (chi-square test, $P = 0.003$).

Conclusion: This non-industry-sponsored study shows that the use of the Variable Angle LCP plate results in more prominent volar positioning with respect to the watershed line in clinical practice in a large cohort of patients in the hands of a large group of orthopaedic trauma surgeons, as compared to the DVR plate.

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∆ A Randomized Controlled Trial Comparing rhBMP-2 Versus Autograft for the Treatment of Tibia Fractures With Critical Size Defects

Lisa Cannada, MD*; Paul Tornetta III, MD; William Obremskey, MD, MPH; Lisa Reider, PhD; Jason Luly, MS; University of Maryland at Baltimore School Medicine, PhD; Ellen MacKenzie, PhD; The METRC*

Purpose: The combination of recombinant human bone morphogenetic protein-2 (rhBMP-2) with allograft has been proposed as an alternative to iliac crest bone graft (ICBG) for tibia shaft fractures with large bone defects. Only 1 study compared rhBMP-2/allograft with ICBG in these patients. However, broad inclusion criteria complicated interpretation of the findings. This study's purpose was to determine if previous findings could be replicated in a randomized trial of open tibia fractures treated with an intramedullary nail (IMN) with bone defects. We hypothesized that radiographic union would be equivalent in the 2 treatment groups.

Methods: This multicenter, U.S. Food and Drug Administration (FDA)-regulated investigational device exemption (IDE) study randomized 30 patients aged 18-65 years with open tibia fracture to the use of either rhBMP-2/allograft (n = 16) or ICBG (n = 14). Inclusion criteria were: (1) circumferential bone defect of at least 1 cm in length and missing at least 50% of the bone circumference, (2) fracture stabilization with an IMN, and (3) bone graft 6-16 weeks following definitive fixation. The main study outcome was radiographic union within 52 weeks. Equivalence was evaluated by testing whether a 90% 2-sided confidence interval (CI) for the difference in the probability of radiographic union between rhBMP-2 or ICBG is contained with the interval -20% to +20%. Secondary outcomes included clinical healing, patient-reported function assessed using the Short Musculoskeletal Function Assessment (SMFA), major complications, and treatment cost.

Results: The status of radiographic union within 52 weeks was determined for 23 patients: 7 of 12 rhBMP-2 patients (58.3%) were judged as radiographically united compared to 9 of 11 ICBG patients (81.8%), resulting in a treatment difference of -0.23 (90% CI: -0.55, 0.10). 5 additional patients had radiographs at visits prior to 26 weeks (3 in the rhBMP-2 group, 2 in the ICBG group); 1 of the 3 rhBMP-2 and 2 of the 2 ICBG patients were judged to be united and were treated as united in a sensitivity analysis. Neither the primary nor the sensitivity analysis provided evidence to support the equivalence hypothesis. Compared with patients treated with ICBG, patients treated with rhBMP-2 had lower rates of clinical healing at 52 weeks (27% vs 54%), had higher SMFA scores (mean dysfunction score of 33.3 vs 23.7; mean bother score of 32.8 vs 21.4), and experienced more complications (5 vs 3). Mean treatment cost for rhBMP-2 was estimated at $13,033 versus $7535 for ICBG.

Conclusion: These data do not provide sufficient evidence to conclude ICBG and rhBMP-2 are statistically equivalent with regard to radiographic union. The data suggest ICBG may yield a higher union rate, fewer complications, and better functional outcomes within 1 year of bone graft.

∆ OTA Grant

A Different Approach to Preventing Thrombosis (ADAPT): A Randomized Controlled Trial Comparing Bleeding Events After Orthopaedic Trauma With Aspirin to Low Molecular Weight Heparin Venous Thromboembolism Prophylaxis

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Purpose: The best venous thromboembolism (VTE) prophylaxis after orthopaedic trauma is unknown. Our goal was to compare bleeding events with aspirin to low molecular weight heparin (LMWH) prophylaxis.

Methods: We conducted a randomized controlled trial (RCT) of patients with operative extremity or any pelvis or acetabular fracture requiring VTE prophylaxis. Patients were randomized to LMWH 30 mg BID or aspirin 81 mg BID and followed for 90 days. The primary outcome was a composite end point of bleeding events including reoperation/procedure for bleeding, gastrointestinal bleed, blood transfusion, or hemoglobin drop >2 g/dL in 24 hours. Secondary exploratory outcomes included deep surgical site infection (SSI), pulmonary embolism (PE), and deep vein thrombosis (DVT). Study end points were compared using chi-squared and Kaplan-Meier curves. Concomitant abdominal, head, and chest injury were tested as possible effect measure modifiers. 329 patients were enrolled (LMWH, 164; aspirin, 165) at an academic trauma center from January through October 2016. There were no differences between groups in baseline demographics (P >0.05).

Results: Of 329 randomized patients, 32% had a bleeding event with no difference between groups (aspirin: 32% vs LMWH: 32%, risk ratio [RR]: 1.01, P = 0.94). All bleeding events occurred within 18 days of injury. 8 patients had deep SSIs (aspirin: 4% vs LMWH: 1%, RR: 2.98, P = 0.15). 8 patients had a PE (aspirin: 1% vs LMWH: 4%, RR: 0.31, P = 0.13). 14 patients had a DVT (aspirin: 6% vs LMWH: 3%, RR: 1.79, P = 0.28). Patients with abdominal injury allocated to aspirin were more likely to have bleeding complications (aspirin: 65% vs LMWH: 21%, RR: 3.02, P = 0.02).

Conclusion: We found no difference in bleeding complications on aspirin compared to an LMWH VTE prophylaxis after orthopaedic trauma, except in patients with concomitant abdominal injury. Larger trials are needed to address the issue of efficacy of these medicines in preventing PE and death.

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Tibia Fractures and NSAIDs: Does It Make a Difference?
A Multicenter Retrospective Study

Lauren Fader, MD; *Rodolfo Zamora, MD; John Whitaker, BS*

Purpose: The purpose of this study was to compare healing time and nonunion rate for diaphyseal tibia fractures (OTA/AO 42A, B, C) treated with intramedullary nailing (IMN) in 1 geographic cohort using nonsteroidal anti-inflammatory drugs (NSAIDs) for postoperative pain control to that of another geographic cohort using narcotic medications. The groups represent differing cultural approaches to postoperative pain control, and we hypothesized there would be no difference in healing time.

Methods: Tibia fractures presenting at two level I trauma centers located in two different countries between January 1, 2010 and December 31, 2017 were retrospectively screened for enrollment. Fractures classified as OTA/AO 42A, B, or C that were treated with IMN and had radiographic follow up to union were included. Post-operatively, one geographic cohort (n=190) was prescribed NSAIDs and the other (n=182) was prescribed narcotics for pain control. Each analgesic method represented the standard of care for that location. Fracture union was defined as cortical bridging in at least 3 out of 4 cortices on AP and lateral radiographs. The primary outcome was healing time on radiographic evaluation.

Results: There was no statistically significant difference in healing time between the two groups (p=0.64; 95% CI, -14.87 – 24.04). Average healing time was 185 days in the narcotic cohort and 180.5 days in the NSAID cohort. Both groups had similar mean age. The narcotic cohort included more polytrauma patients (18.9% vs 13.4%). In the NSAID group, there was one open fracture resulting in infection and nonunion, which was treated with a bone transplant. Nine NSAID patients required additional surgeries to add plate fixation or bone graft, and three underwent revision nailing. The narcotic group had six open and two closed fractures resulting in nonunion. These required revision nails or additional plating. Three patients in the narcotic cohort required antibiotic nails for infection.

Conclusion: In our study, the difference in healing time between the NSAID and narcotic groups was not statistically significant. The deleterious effect of NSAID use on fracture healing has been debated for decades. Numerous animal studies have supported this theory; however, high-quality clinical studies in humans have not provided convincing evidence to substantiate this negative effect. Our study suggests that NSAIDs may be used safely and effectively in the acute phase of fracture healing without significantly increasing the risk of delayed union or nonunion. Prospective randomized studies are necessary to rule out the negative effect of NSAIDs on bone healing.

Short Versus Long Cephalomedullary Nailing of Pertrochanteric Hip Fractures: A Randomized Prospective Study

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Purpose: The purpose of this study was to compare functional and clinical outcomes between patients with pertrochanteric hip fractures treated with either a short (SN) or long (LN) cephalomedullary nail.

Methods: 220 patients with intertrochanteric fractures were prospectively randomized to an SN (n = 110) or LN (n = 110). A total of 168 patients were followed for a minimum of 3 months (SN, n = 80 and LN, n = 88) with a mean follow-up of 8.5 months. 52 patients did not meet minimum follow-up with the majority of these lost to death. Demographics were similar between cohorts with respect to age, gender, diabetes, tobacco use, chronic kidney disease (CKD), body mass index (BMI), and AO/OTA fracture classification. The primary outcome measurement was functional outcome as evaluated by Short Form (SF-36) and Harris hip scores (HHS) at 3 months. Secondary outcomes included implant failure, peri-implant fracture, mortality, operative time, estimated blood loss (EBL), and reoperation.

Results: SN and LN cohorts were comparable in all aspects of the SF-36 and HHS subsections. There was a small, clinically insignificant difference in the HHS between the SN and LN cohorts (76 vs 71, P = 0.02). Patients treated in the SN cohort experienced shorter operative times (51 min vs 80, P <0.0001), less EBL (70 cc vs 207 cc, P <0.001), and shorter hospital length of stay (LOS) (5 vs 7 days, P = 0.01) but did not differ in tip-to-apex distance (TAD) (18.3 vs 18.8, P = 0.51) or subtrochanteric fracture extension (1.89 cm vs 2.15 cm, P = 0.24). There was no difference in lag-screw cutout (SN 3.75% vs LN 2.27%, P = 0.67), deep surgical site infection (SN 1.25% vs LN 2.27%, P = 1.00), and peri-implant fractures (SN 2.49% vs LN 2.27%, P = 1.00) with the SN patients successfully treated nonoperatively and both LN patients requiring open reduction and internal fixation.

Conclusion: Patients treated with a short or long cephalomedullary nail for pertrochanteric hip fractures experienced comparable functional outcomes with regard to SF-36 and HSS. Despite no difference in functional outcomes, patients treated with a short nail had shorter operative times, less EBL, and shorter hospital LOS with no difference in peri-implant fracture or lag-screw cutout when compared to the long nail cohort. Level of evidence: Therapeutic Level I.

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Results of Operative Fixation for Femoral Neck Fractures in Patients Aged 18 to 59 Years: A Study of 16 Centers and 596 Cases

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Purpose: Femoral neck fractures in young adults are highly related to feared complications such as nonunion, failed fixation, malunion, and osteonecrosis. Despite a number of biomechanical and small clinical series, there has been no consensus on the best fixation method for this type of injury. The purpose of this study was to evaluate the results of fixation of these difficult fractures in a large multicenter cohort, including attention to differences between fixation using a sliding hip screw (SHS) and cannulated screws (CS).

Methods: This was a retrospective study of 956 patients from 16 trauma centers in North America aged 18 to 59 years old that were treated for a femoral neck fracture with operative repair during the study period. A retrospective review of medical records and radiographs was performed to evaluate injury and patient factors, details of fixation, and post-injury complications and secondary surgeries.

Results: 596 patients met inclusion criteria, including >6-month follow-up. 191 fractures were treated with a CHS and 405 were treated with CS. Uncomplicated healing occurred in 367 hips (62%; 115 CHS and 252 CS [P = 0.90]). Complications occurred in 38% of patients including nonunion in 17%, fixation failure in 16%, malunion in 10%, and osteonecrosis in 14%. Nonunion was seen in 18 CHS versus 35 CS (P = 0.83), fixation failed in 18 CHS versus 47 CS (P = 0.47), malunion in 12 CHS versus 28 CS (P = 0.91), and osteonecrosis occurred in 13 CHS versus 39 CS (P =0.28).

Conclusion: 38% of patients 18 to 59 years of age treated with surgical repair for a femoral neck fracture had 1 or more significant complications in this large, multicenter study. There were no significant differences in complications rates between fixation using SHS or CS.

Effectiveness of Various Vitamin D Protocols on Raising and Maintaining Blood Serum 25(OH)D3 Levels Over a 3-Month Period: A Randomized, Prospective Study

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Purpose: With heightened interest in the medical community regarding health benefits of vitamin D and vitamin D deficiency remaining commonplace, no standardized dosing strategies have been substantiated in patients with hypovitaminosis D. Our study aims to establish an optimal dosing regimen to elevate and maintain therapeutic 25-hydroxy vitamin D levels in patients with hypovitaminosis D.

Methods: A single hospital system performed this randomized, prospective study with approval through the IRB. Exclusion criteria included those 18 years of age or younger, certain medications and conditions that interfere with vitamin D absorption and metabolism, and serum vitamin D levels greater than 30.0 ng/mL. Subjects were randomized to 1 of 3 dosing regimens: Group 1, 100,000 IU vitamin D2 once; Group 2, 100,000 IU vitamin D2 weekly for 12 weeks; or Group 3, 50,000 IU vitamin D2 daily for 10 days followed by 2,000 IU vitamin D3 daily for 74 additional days. Serum vitamin D levels were drawn at time 0 and weeks 2, 6, and 12.

Results: Data from 48 patients were collected and analyzed; 68% of enrollees were vitamin D-deficient. No significant difference was found between groups with respect to age, race, and timing of blood draws. Group 1 did not show any statistical significance between time points, except for a decrease between weeks 2 and 12. Group 2 showed a significant increase in vitamin D levels between all time points except between weeks 6 and 12. Group 3 showed the greatest change in vitamin D levels between weeks 0 and 2, but had a significant decrease between weeks 2 and 6. No patients in any group reported severe symptoms related to hypervitaminosis D.

Conclusion: Group 2 (100,000 IU vitamin D2 weekly) provided expeditious correction and the greatest positive net change in vitamin D 25(OH)D3 blood levels for subjects with hypovitaminosis D, which was sustained at a satisfactory level over the 12-week course.

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A Multicenter Randomized Trial Evaluating Intrawound Vancomycin Powder for Reducing Surgical Site Infection After Fracture Surgery

Robert O'Toole, MD*; Manjari Joshi, MD; Anthony Carlini, MS; Joshua Gary, MD; William Obremskey, MD, MPH; Clint Murray, MD; Greg Gaski, MD; J Reid, MD; Yasmin Degani, MPH; Tara Taylor, MPH; Susan Collins, MSc; Yanjie Huang, MS; University of Maryland at Baltimore School Medicine; The METRC; Renan Castillo, PhD*

Purpose: There is great clinical interest in the use of intrawound vancomycin powder to reduce surgical site infection (SSI) after fracture surgery; however, there is no high-level evidence to support this practice. Support to date is from retrospective spine research with limited focus on orthopaedic trauma patients. The primary goal of the VANCO study was to determine the efficacy of intrawound vancomycin powder for fracture surgery. Our hypothesis was that there would be a reduced proportion of deep SSI within 6 months of fracture fixation with the use of vancomycin powder in patients with tibial pilon and plateau fractures at high risk of infection.

Methods: This study was a phase III, prospective, randomized clinical trial. The study population consisted of patients aged 18-80 years with tibial plateau or pilon fractures definitively treated with plate and screw fixation. To ensure a population with higher risk of infection, fractures had to be either open (Gustilo Anderson Types I, II, or IIIA) or treated initially with external fixation due to swelling and/or a high-risk fracture pattern. Participants were centrally block-randomized (within center and fracture type) in a 1:1 ratio to either treatment (1000 mg of local vancomycin powder, placed immediately before wound closure) or control (standard of care). Follow-up was done prospectively at 2, 12, and 26 weeks after fixation. The primary outcome measure was deep SSI within 6 months based on Centers for Disease Control and Prevention (CDC) criteria. The targeted sample size for the study was 500 fractures per study arm.

Results: The study randomized 984 eligible patients at 36 Level I trauma centers to either treatment (n = 482) or control (n = 502) arms. The study sample was largely male (62%) and non-Hispanic white (70%) with a mean age of 45.8 years (13.8 standard deviation). Most (81%) fractures were closed, while roughly half of the open fractures were Type IIIA. 98% of all expected follow-up visits were completed and only 4% of the 6-month follow-up data was missing. 96% of enrolled patients received the study treatment per the protocol. Results of the final analysis will be presented at the OTA Annual Meeting.

Conclusion: This study is one of the largest prospective randomized multicenter trials conducted to date within orthopaedic trauma. The final analysis should provide important information regarding the efficacy of intrawound vancomycin powder.

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

Effectiveness of Bone Marrow-Derived Mononuclear Stem Cells for Neurological Recovery in Participants With Spinal Cord Injury: A Randomized Controlled Trial

Rajeshwar Srivastava, MS; *Alka Singh, MSc; Ashok Agrahari, Doctoral Student; Tulika Chandra, MD; Saloni Raj, MBBS*

Purpose: To date, in spite of best efforts, little achievement in terms of neurological recovery of spinal cord injury (SCI) has been found. Presently, researchers are working on methods such as restimulation of damaged neurons using some artificial agents and use of stem cells for neuronal regeneration.

Methods: A total 193 patients of unstable T9-L2 injury with thoracolumbar injury severity score (TLISS) ≥4 and complete paraplegia in ASIA (American Spinal Injury Association) Impairment Scale (AIS) 'A' were enrolled. All the subjects were randomly allocated for 3 different treatment modalities--conventional with stem cell augmentation, conventional, and conservative. Neurological recovery after 1 year was evaluated through AIS grading and sensory and motor scores. Statistical methods used were paired t-test and analysis of variance tests using Graphpad and SPSS software.

Results: Paired t-test values for AIS grading and sensory and motor scores for group 1 for baseline and after 1 year were 0 ± 0, 144.03 ± 14.91, 50 ± 0 and 1.34 ± 0.9, 169.34 ± 18.62, 58.83 ± 10.70, respectively; P = 0.0001. Groups 2 and 3 showed a similar trend with lower values. The intergroup comparison showed the most significant P values in group 1 versus 3. The net percent recovery was greatest in group 1 showing 41.43% and 7.14% as grade C and D, respectively.

Conclusion: Promising neurological recovery was observed in group 1, some in group 2, and virtually none in group 3. AIS grade promotion was also better in group 1 than other 2 groups.

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Prospective Randomized Controlled Trial Comparing the Functional Outcome of Olecranon Osteotomy Versus Triceps Tongue Elevation for Surgical Exposure of Distal Humerus in Adults

Rajiv Maharjan, MD; *Asish Rajak, MD; Bikram Shrestha, MD; Pashupati Chaudhary, MD; Rosan Shah Kalawar, MD*

Purpose: The management of intercondylar fractures of humerus should aim to achieve painless stable elbow with early functional range of motion that can be achieved by anatomical reduction, stable fixation, and early rehabilitation. Distal humerus fractures can be approached posteriorly either by olecranon osteotomy or triceps tongue elevation. We aim to compare the functional outcome using the Mayo Elbow Performance Index (MEPI) and to study associated complications.

Methods: 39 eligible adults were randomizd into triceps tongue elevation (n = 20) and olecranon osteotomy groups (n = 19). All skeletally mature patients with traumatic closed intra-articular fracture of distal humerus (13B1/B2, 13C1/C2) without distal neurovascular deficit were included. Patients with polytrauma, refractures, and/or compromised soft-tissue status were excluded. Similar group, type, and duration of prophylactic antibiotics were administered and operated by their respective technique and followed up at 2, 6, 12, 24, and 52 weeks. Supervised physiotherapy with similar regime was started. Clinicoradiological signs of union, functional outcome, MEPI, and complications were compared.

Results: The demographic profile and fracture personality were similar among the groups ($P > 0.05$). Duration of surgery (96.8 ± 9.4 min vs 118.2 ± 31.37 min) and blood loss (180 ± 28.2 mL. vs 225 ± 18.3 mL) was significantly more for the olecranon osteotomy group ($P = 0.009$). At final follow-up there were no significant differences in the time to union (1 nonunion in olecranon osteotomy group at 52 weeks). MEPI showed excellent, good, fair, and poor results in 11, 5, 4, and 0 patients, respectively, in triceps tongue elevation group while it was 17, 2, 0, and 0, respectively, for the olecranon osteotomy group ($P > 0.05$). There were no infections and no myositic mass in either group, but symptomatic hardware prominence requiring earlier removal were 2 in the triceps tongue group and 1 in olecranon osteotomy group ($P = 0.520$). There was 1 transient iatrogenic ulnar nerve palsy in the triceps tongue elevation group ($P = 0.744$).

Conclusion: The surgical approaches triceps tongue elevation and olecranon osteotomy are identical in terms of union, postoperative function, and rate of complications. There was increased intraoperative time and blood loss in the olecranon osteotomy approach, suggesting that patients who cannot tolerate longer intraoperative time or considerably higher volume of blood loss may benefit from the triceps tongue elevation approach.

Operative Versus Nonoperative Treatment of Isolated Humeral Shaft Fractures: A Prospective Cohort Study

Lisa Cannada, MD*; Lauren Germany, BS; Paul Tornetta III, MD; Robert Hymes, MD; Clifford B. Jones, MD; William Obremskey, MD, MPH; Eben Carroll, MD; Brian Mullis, MD; Michael Tucker, MD; David Teague, MD; Andrew Marcantonio, DO; Robert Ostrum, MD; Michael Del Core, MD; Sarah Dawson, BS; Heidi Israel, PhD*

Purpose: Nonoperative management of humeral shaft fractures has been considered the standard of care. There are little comparative data regarding functional outcomes between operative and nonoperative management. The purpose of this study was to prospectively compare plate and screw fixation (open reduction and internal fixation [ORIF]) and functional bracing (NO) regarding surgical and patient-based outcomes.

Methods: We performed a prospective comparative trial of ORIF versus NO of isolated humeral shaft fractures at 12 centers (Clinical Trials #16589). We excluded pathologic fractures, and those who could not follow-up, complete forms, or give consent. Surgeons counseled patients on treatment options and a patient-centered decision was made. Patients were followed at 2, 4, 8, 12, and 26 weeks clinically and with radiographs until united. The primary outcome was the Disabilities of the Arm, Shoulder and Hand (DASH) score. Complications included nonunion, infection, iatrogenic nerve palsy, and loss of range of motion (ROM).

Results: We enrolled 179 patients, of whom 6-month data were available for 104 (40 F; 64 M) aged 18 to 71 years (average 41). 45 were treated with ORIF and 57 NO. The groups were not different in OTA fracture class, body mass index, smoking, dominance of arm injured, or work-related injuries. At 3 and 6 months, the DASH score was 35 and 20 for the NO group and 28 and 18 for ORIF ($P = 0.24$ and 0.67). Union was present at 3 and 6 months in 64% and 98% of ORIF group and 65% and 86% of NO group without additional intervention. Radial nerve dysfunction (RND) was identified at injury in 6 (13%) of ORIF and 8 (14%) of NO group. An additional 6 patients (15%) of the ORIF group developed a postoperative iatrogenic RND. By 6 months, 7 of 12 RNDs in ORIF group resolved and 4 of 8 in the NO group. Of the 6 iatrogenic injuries, 5 (83%) were persistent at 6 months. There was 1 infection in the ORIF group. Visual analog scale (VAS) pain was higher in the NO group at 2 weeks (4.8 vs 3.7, $P = 0.056$) and 3 months (2.9 vs 1.9, $P < 0.05$). This difference was gone by 6 months (both groups 1.7). Narcotic use was lower at 2 weeks in NO group (56% vs 69%, $P = 0.01$), but not different at 3 months (23% vs 25%) or 6 months (both 9%). There was no difference in elbow motion between the groups (average 1°-133°) or the number who went to physical therapy (both 63%).

Conclusion: We evaluated a prospective cohort with isolated humeral shaft fractures treated NO versus ORIF. We found no difference in the DASH, VAS pain, or elbow ROM at 6 months. However, 14% of the NO group developed nonunion. Complications in the ORIF group included a 2% infection and nonunion rate and 15% iatrogenic RND. 83% of these did not resolve by 6 months. VAS pain scores were lower at 2 weeks and 3 months in ORIF group, but they had greater narcotic use at 2 weeks. ORIF can be expected to result in higher union rates with the inherent risks of infection and RND. Finally, at 6 months, both groups demonstrated higher DASH scores than population norms, indicating a lack of full recovery.

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Humanitarian Scholar Presentation

Intramedullary Nailing Versus External Fixation in the Treatment of Open Tibia Fractures in Tanzania: Results of a Randomized Controlled Trial

Billy Haonga, MD*; Max Liu, BA; Sravya Challa, BS; Kurt Yusi, MD; Edmund Eliezer, MD; David Shearer, MD, MPH; Saam Morshed, MD, PhD*

Purpose: Open tibial fractures are common and devastating traumatic injuries in low- and middle-income countries (LMICs). As surgical management and implants become available in low resource settings, there is no consensus on the superiority of intramedullary nailing (IM) versus external fixation (EF). The purpose of this study was to compare the rate of infection and nonunion in patients undergoing IM versus EF for diaphyseal open tibia fractures.

Methods: This was a randomized controlled trial in Dar es Salaam, Tanzania. Patients with diaphyseal open tibia fractures presenting to the hospital within 24 hours of injury with a wound that could be primarily closed were included in the study. Patients were randomized to either a statically locked IM nail or EF with a monolateral EF device. Patients were followed for 1 year. The primary outcome was deep infection or nonunion requiring secondary intervention, whether or not the subject underwent additional surgery, as determined by an independent adjudication committee. Secondary outcomes included other complications, EuroQol 5 Dimensions (EQ-5D), modified RUST (Radiographic Union Scale for Tibial Fractures) score, and radiographic alignment.

Results: 240 patients, 85.6% of whom were male, with a mean age of 33.1 ± 11.3 years, were enrolled in the study. 120 patients were randomized to each treatment group. 63% percent of the patients completed 1-year follow up. 26 primary events were identified, including 21 deep surgical site infections and 3 cases of nonunion. Primary events occurred in 16.67% of the IM group and 21.31% of the EF group (RR [relative risk] = 1.27, 95% CI [confidence interval] = 0.64, 2.55; P = 0.32). EF patients were more likely to experience a superficial surgical site infection than those who underwent IM nailing (RR: 2.98, P = 0.01, 95% CI = 1.22, 7.31). At 1 year, patients in the EF group were at a higher risk of coronal (P <0.005, CI = 0.52, 0.97) and sagittal (P <0.005, CI = 1.89, 20.4) malalignment. Mean EQ-5D values were higher in the IM group (0.65 ± 0.16) compared to the EF group (0.58 ± 0.22) at 6 weeks (P = 0.01) but not at 1 year (P = 0.22). There was no difference in modified RUST scores between the IM and EF groups at 1 year.

Conclusion: This is the first randomized controlled trial testing the relative effect of IM versus EF on outcomes for patients with open tibial fractures in sub-Saharan Africa. While rates of superficial infection and malalignment are more common with EF, no difference in deep infection or nonunion that require secondary surgery were detected. Further research, including economic analyses, are warranted to determine value and better guide the choice of treatment modality.

A Retrospective Comparative Cohort Study Comparing Temporary Internal Fixation to External Fixation at the First-Stage Debridement of Grade IIIB Open Diaphyseal Tibial Fractures

Tim Fowler, MBBS; Michael Whitehouse, PhD; Andrew Riddick, MBBS;
Michael Kelly, MBBS

Purpose: Grade IIIB open tibial fractures are severe, limb-threatening injuries that are associated with significant damage to bone and the surrounding soft tissues. Definitive reconstruction is rarely undertaken at the first operation in favor of a staged approach, which necessitates a method of temporary fracture stabilization. It is not known if temporary internal fixation is effective in place of traditional methods of external fixation. We compared the outcomes of temporary internal fixation (TIF), to external fixation (ex-fix), when used in the context of a 2-stage orthoplastic reconstruction.

Methods: We reviewed the medical notes for 47 consecutive patients, who had 2-stage reconstruction of a grade IIIB open fracture of the tibial diaphysis (minimum 1.2-year follow-up). All patients had definitive fixation with an intrameduillry nail and soft-tissue reconstruction in a single operation following initial debridement. We compared the rates of deep infection, nonunion, and flap failure in patients who had TIF versus ex-fix. The primary outcome measure was deep infection.

Results: There were 4 complications in the ex-fix group (3 infection and 1 nonunion) and 2 complications in the TIF group (1 infection and 1 flap failure). The incidence of infection was lower in the TIF group (4% vs 13%). Multiple regression modelling revealed infection ($P = 0.610$), nonunion ($P = 0.918$), and flap failure ($P = 0.112$) were not significantly associated with the method of temporary fixation, or other demographic and treatment variables. The odds ratio of patients treated with TIF developing an infection compared to those treated with an ex-fix was 0.29 (95% confidence interval 0.03-3.01).

Conclusion: Temporary internal fixation of grade IIIB open diaphyseal tibial fractures does not increase the risk of deep infection when compared to external fixation in the context of a combined orthoplastic service. It appears to be at least as safe as external fixation and may confer some additional advantages in terms of longer term deep infection.

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Are All Classification Systems Created Equal?
A Comparison of Open Fracture Scoring Systems

Thomas Cloake, BSc; *Emily Homma, MSc; Abby Sureshkumar, BSc; Jayne Ward, FRCS*

Purpose: The classification of open fractures is troublesome. A number of systems exist that aim to standardize the description of these injuries and aid surgical decision-making. Traditionally the Gustilo-Anderson (GA) classification has been used to categorize injuries into 3 broad groups; however, it has been criticized for a high level of interobserver variability and lack of reliability. More recently the OTA proposed a system based on assessment of 5 essential categories based on expert consensus. A number of groups have since demonstrated this classification to be both reliable and predictive of outcome. Furthermore the Ganga Hospital Open Injury Score (GHOIS) introduces consideration of patient comorbid factors to a 3-component limb assessment. Early results suggest this system is useful, particularly in the grading of GA grade IIIB injuries. Nevertheless, there is no widespread consensus on the most effective classification system. This study aims to investigate the utility of the GA, OTA-OFC (Open Fracture Classification), and GHOIS classification systems in predicting outcome following lower limb open fractures.

Methods: 175 open lower limb fractures sustained between January 2015 and October 2017 at a Level I trauma center were retrospectively classified using the GA, OTA-OFC, and GHOIS systems. Primary outcome was rate of complications (defined as a complication requiring return to theater).

Results: The OTA-OFC was the only system that showed a significant correlation with outcome ($P = 0.00025$). Subcategory analysis of the OTA-OFC demonstrated a high muscle injury score significantly influenced complication rate ($P = 0.048$); no other subcategories displayed statistical significance. A score of 9 or above using the OTA-OFC showed significantly greater complication rates ($P < 0.0001$) and a specificity of 97.1% while a GHOIS score of greater than 14 was associated with significantly more complications ($P = 0.033$).

Conclusion: The OTA-OFC is a superior predictor of outcome following open lower limb fractures compared to the GA and GHOIS. Injuries with significant muscle damage are associated with significantly worse outcomes. An OTA-OFC threshold score of 9 and a GHOIS score of greater than 14 predicts poor outcome. To our knowledge this is the first study comparing the utility of GA, OTA-OFC, and GHOIS systems and these figures may be used by surgeons when initially assessing and counseling patients with open injuries.

PAPER ABSTRACTS

Intramedullary Nailing Versus Minimally Invasive Plate Osteosynthesis for Distal Tibial Fractures

Liang Sun, MD; *Yao Lu, MD*

Purpose: This study compared intramedullary nailing (IMN) versus minimally invasive plate osteosynthesis (MIPO) for the treatment of distal tibial fractures.

Methods: From 2012 through 2015, 59 patients with distal tibial fractures were randomly assigned into IMN or MIPO treatment groups. Time interval between the injury and operation, duration of operation, intraoperative fluoroscopy time, intraoperative blood loss, Foot Function Index, and union time were compared between groups

Results: Follow-ups with 12-24 months were carried out on all the patients.The IMN healed within 17 ± 3 weeks; MIPO healed within 17.5 ± 5 weeks. Time interval between the injury and operation and intraoperative blood loss were lower in the IMN group; intraoperative fluoroscopy time was higher in the IMN group. Foot Function Index and union time were similar between groups.

Conclusion: IMN and MIPO have similar therapeutic efficacy to treat distal tibial fractures, and should be selected according to the specific condition of the patients, deparments, and their own proficiency.

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Preoperative Regional Anesthesia Decreases Length of Stay in Isolated Tibial Shaft Fractures

Ryan DiGiovanni, MD; *J. Brock Walker, MD; Robert Walker, MD; Clifford B. Jones, MD*

Purpose: Recently our institution augmented standard treatment protocols with the addition of single shot adductor canal local anesthetic block preoperatively in isolated tibia shaft fractures without compartment syndrome on presentation. The purpose of this study is to evaluate if the addition of preoperative regional anesthesia is an effective pain control tool that allows for earlier and safe discharge for the patient with an isolated tibial shaft fracture.

Methods: Retrospective review of patients with isolated tibia shaft fractures in 12 regional hospitals including 2 Level I trauma centers. Records were quarried using ICD-9 and ICD-10 codes for tibia shaft fractures. Exclusion criteria included age less than 18 years, polytrauma, open fractures, nonoperative management, operative management other than intramedullary nail, and compartment syndrome on admission. 102 patients were identified between January 2014 and December 2016. Radiographs, consult notes, operative notes, anesthesia notes, and any subsequent clinic notes and emergency department notes were reviewed. Of the 102 patients identified, 23 had preoperative regional anesthesia nerve block with general anesthesia and 79 had only general anesthesia. Statistical analysis was done using a 2-tailed Student t-test to evaluate the null hypothesis between the 2 groups. A P values of <0.05 was used for statistical significance.

Results: 59 males and 43 females with an average age of 47 were identified. 23 patients who received a regional nerve block prior to surgery had a postoperative length of stay of 21.6 hours (range, 2.2 hours-2.4 days) compared to 59.7 hours (range, 3.9 hours-7.9 days) for those without a preoperative regional block ($P = 0.000013$). There were no cases of compartment syndrome in either group. In the patients who received regional anesthesia there was 1 emergency room visit within the first 30 days for pain control without evidence of compartment syndrome. In the group that did not receive a nerve block there were 6 emergency room visits within 30 days, none with compartment syndrome.

Conclusion: Early results show that patients with isolated tibia shaft fractures who receive pre-operative regional anesthesia have decreased hospital lengths of stay after surgical fixation with reamed intramedullary nailing (21.6 hours vs 59.7 hours ($P = 0.000013$). No increase in complications or return to emergency room visits were seen in our evaluation.

Does Suprapatellar Tibial Nailing Reduce Long-Term Knee Pain?

Marckenley Isaac, MS*; Robert O'Toole, MD; Ugochukwu Udogwu, BA; Daniel Connelly, BS; Mitchell Baker, BS; Yasmin Degani, MPH; Andrea Howe, BS; Katherine Ordonio, BA; Joshua Rudnicki, BS; Mauri Zomar; Nathan O'Hara, MPH; Gerard Slobogean, MD, MPH*

Purpose: Preliminary studies suggest suprapatellar tibial nailing reduces anterior knee pain in comparison to the infrapatellar approach. These small studies, however, have not determined if differences in knee pain persist beyond 1 year. The purpose of this study is to compare the magnitude of knee pain between the suprapatellar (SP) and infrapatellar (IP) start points in patients who are more than 1 year post-injury.

Methods: All tibia fracture patients ages 18-80 years treated with an intramedullary tibial nail between 2011 and 2016 were retrospectively reviewed for inclusion. Patients were excluded if they did not speak English, were a prisoner, diagnosed with a severe psychiatric condition, or unable to provide consent. The surgical approach was determined by surgeon preference, with 3 surgeons routinely using the SP approach. A blinded reviewer assessed knee pain via telephone, using the 0-10 Numeric Rating Scale (NRS). The primary outcome was knee pain during kneeling, with secondary assessments comparing pain during resting, walking, and the past 24 hours. A difference of >1.0 was considered to be clinically meaningful.

Results: The study group consisted of 262 patients (SP, n = 91; IP, n = 171) with a mean age of 41.4 years (standard deviation = 16.6). The median follow-up was 3.8 years (range, 1.5-7.0). There was no significant difference in knee pain during kneeling between surgical approaches (IP: 3.9, SP: 3.8; P = 0.90; mean difference: -0.06, 95% confidence interval -1 to 0.9). Similarly, there were no differences in average pain scores at rest (IP: 2.0, SP: 2.0; P = 1.00), walking (IP: 2.7, SP: 3.0; P = 0.51), or the last 24 hours (IP: 2.6, SP: 2.9; P = 0.45).

Conclusion: In contrast to recent literature, we were unable to detect a difference in knee pain between the SP and IP surgical approaches among patients with greater than 12 months of follow-up.

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Aggressive Nonoperative Treatment of Tibia Fractures:
An Evidence-Based Argument for Contemporary Cost-Effective Care

Chad Lasceski, MD; *Luke Latario, BS; Jacob Jo, BA; Uyen-Sa D.T. Nguyen, Dsc; Eric Swart, MD*

Purpose: The decision to attempt closed treatment on tibial shaft fractures can be challenging. Although there are selected case series describing high success rates with closed treatment, contemporary treatment of tibial shaft fractures is predominantly surgical. At our institution, we perform closed reduction of all closed, isolated tibial shaft fractures with sedation, long-leg casting, and transition to functional bracing. The purpose of this study was to report the results of 10 years of experience, describe radiographic and patient factors that predict success or failure of nonoperative treatment, and develop a cost-effective treatment algorithm.

Methods: This was a retrospective review of all patients seen at a Level I trauma center over a 10-year period. Patients with tibial shaft fractures (AO-OTA classification 41A, 42A-C, 43A) were identified. Patients with closed, isolated injuries underwent sedation, closed reduction, long-leg casting, and outpatient follow-up. Conversion to surgical treatment was done for inability to maintain acceptable alignment or patient intolerance. Radiographic fracture characteristics, patient demographics, and final clinical outcomes were extracted. Multivariate logistic regression analysis was used to determine which patient and injury characteristics predict success of nonoperative treatment. A cost-benefit model was constructed that evaluated overall treatment costs of different management strategies.

Results: There were 634 patients with tibial shaft injuries. Immediate surgery was performed in 228 patients with open fractures, and 72 polytrauma patients. The remaining 334 were reduced and treated in a long-leg cast. 234 patients converted to surgical treatment due to inability to maintain alignment (97 patients), patient intolerance (127 patients), and nonunion (10 patients). In a regression model, initial coronal and sagittal translation, sagittal angulation, fracture morphology, and smoking status were shown to be significant predictors of success of nonoperative treatment ($P < 0.05$). In an economic model, a strategy of selective closed reduction and casting was 23% less expensive than universal operative treatment, 4% less expensive than universal attempted closed treatment.

Conclusion: Nonoperative treatment of tibial shaft fractures is feasible, although there is a relatively high conversion rate to operative treatment. However, it is possible to use injury characteristics to predict success of closed treatment, which can be incorporated into a cost-effective algorithm.

Outcomes of Plate Fixation for Periprosthetic Tibia Fractures Around and Below Total Knee Arthroplasty

Michael Morwood, MD; *Sandra Gebhart, MD; Nicholas Zamith, BS; H. Mir, MD*

Purpose: The incidence of periprosthetic fractures after total knee arthroplasty (TKA) is rising due to an increasing number of TKAs performed annually and the growing elderly population. Periprosthetic fractures of the tibia are less common than periprosthetic fractures of the distal femur. Like periprosthetic fractures of the distal femur, periprosthetic tibia fractures are primarily treated with operative fixation; however, there is limited scientific literature that has reported outcomes of periprosthetic tibia fractures treated with modern plating techniques. To our knowledge, this is the largest series of non-intraoperative periprosthetic tibia fractures treated with open reduction and internal fixation (ORIF) ever reported.

Methods: This was a retrospective chart review of 4557 operatively treated tibia fractures over a 16-year period at 2 Level I trauma centers.

Results: 52 patients (37 women and 15 men; average age 68.2 years) with tibia fractures around and below an ipsilateral TKA were identified. Patients without follow-up to clinical and radiographic union were excluded, leaving 37 patients for final statistical analysis with an average follow-up of 15.3 months (range, 3-24 months). Injuries were sustained through both high-energy (55.3%) and low-energy (44.7%) mechanisms. Overall, 75.7% (28/37) of fractures united by 6 months following the index procedure, leaving 9 nonunions. Nonunion occurred in 36.4% (4/11) of proximal, 20% (1/5) of midshaft, and 19.0% (4/21) of distal tibia fractures, respectively. The overall reoperation rate was 27.0% (10/37), which included debridement and irrigation (4), nonunion repair (3), amputation (1 above and 1 below knee), and revision arthroplasty (1 megaprosthesis). Dual plating of the tibia on the medial and lateral surface was not correlated with improved union rates overall or in any of the 3 subsections (proximal, midshaft, distal) ($P = 1.00$). There were no significant differences in rates of reoperation ($P = 0.66$), superficial infection ($P = 0.66$), or deep infection ($P = 0.31$) in patients treated with single versus dual plating.

Conclusion: Periprosthetic tibia fractures are difficult to treat and have a high risk of nonunion and reoperation even with modern plating techniques. Most patients can be treated to union with operative fixation and do not require revision arthroplasty. Although not statistically significant, proximal third tibial fractures trended toward an increased risk for nonunion. Dual plating did not result in statistically significant increased rates of union in this limited series, but also did not increase complication rates or adverse outcomes.

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Patient-Reported Function Improves 5 Years Following Tibial Plateau Fracture

Kyle Hildebrandt, BS*; Kurtis Carlock, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: Tibial plateau fractures have the potential to affect long-term function of the knee. There is little evidence assessing long-term outcomes following these injuries. To our knowledge, this is the first study to use patient-reported outcomes (PROs) to assess the long-term outcome of tibial plateau fractures treated using modern techniques.

Methods: 80 patients who sustained a displaced tibial plateau and underwent operative repair and had a minimum of 5 years (mean 6.4 years) follow-up were identified. The majority of fracture patterns were Schatzker II (51%) and VI (30%). Follow-up data obtained included: Visual Analog Scale (VAS) pain scores, Short Musculoskeletal Functional Assessment (SMFA), and knee range of motion (ROM). Data at latest follow-up were then compared to 12-month data using a paired t-test.

Results: Patient-reported function as assessed by overall SMFA was significantly improved (P = 0.024) compared to 12-month data. Patients reported an improvement in the Standardized Mobility Index (P = 0.001) and Standardized Emotional Index (P = 0.038), as well as a decrease in Standardized Functional Index (P = 0.042) between the first year and latest follow-up. Patient-reported pain, other SMFA subdivisions, and knee ROM were similar to 12-month follow-up. 15 of the patients (19%) had undergone additional orthopedic surgery at time of most recent follow-up. Of note, none of the patients had undergone knee arthroplasty following plateau fixation.

Conclusion: Functional outcome does not decay at 5 years following tibial plateau open reduction and internal fixation compared to 1 year following injury. Patients displayed an improvement in mobility and overall function over time.

Delayed Unions and Functional Outcomes of Pediatric Lateral Condyle Humerus Fractures: A Prospective Study

Alexander Nazareth, MS; Curtis VandenBerg, MD; Rachel Goldstein, MD, MPH; ***Natalya Sarkisova, BS****; Lindsay Andras, MD; Nina Lightdale-Miric, MD; J. Lee Pace, MD; Paul Choi, MD; David Skaggs, MD*

Purpose: This prospective study was undertaken to evaluate outcomes in lateral condyle humerus fractures (LCHFs) using validated outcome measures.

Methods: A prospective enrollment of consecutive children with LCHFs treated at 1 institution from 2013 to 2016 was performed. Fractures were classified based on fracture displacement (I: <2 mm, II: 2-4 mm, III: >4 mm). A delayed union is defined as casting for persistent fracture for >8 weeks. Functional outcomes were assessed at 6-12 weeks and at 1-year follow-up using the Pediatric Outcomes Data Collection Instrument (PODCI).

Results: 55 patients with a lateral condyle fracture (mean age at injury: 5.7 ± 2.0 years) met inclusion criteria. There were 17 (31%) Type I fractures treated with a long arm cast, 8 (15%) Type II fractures treated with closed reduction and percutaneous pinning (CRPP), and 30 (54%) Type III fractures treated with open reduction and percutaneous pinning (ORPP). Postoperative complications were observed in in 8 of 55 patients, which included delayed union (N = 5) and superficial pin site infection (N = 3). Delayed unions based on fracture type were Type I (1/17, 6%), Type II (1/8, 13%), and Type III (3/30, 10%). Mean PODCI global functioning at 6-12 weeks was 90 ± 11 and at 1 year was 95 ± 8. No significant differences were found across all PODCI subdomains at 1-year follow-up when comparing our study population to normative data.

Conclusion: In this prospective study of LCHFs there was a 11% risk of delayed unions in patients treated with Kirschner-wire fixation. Children with LCHFs achieve excellent functional outcomes at both early and 1-year follow-up regardless of postoperative complications.

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The Impact of Direction of Displacement, Pin Configuration, and Surgeon Training on Clinical and Radiographic Outcomes in Type III Pediatric Supracondylar Humerus Fractures

Andrew Livermore, MD; *Jason Sansone, MD; Maxwell Machurick, BA; Paul Whiting, MD; Scott Hetzel, MS; Kenneth Noonan, MD*

Purpose: Lateral-entry pinning is the standard of care for displaced pediatric supracondylar humerus (SCH) fractures. Since posterolateral (PL) fracture displacement often disrupts the medial periosteum, we hypothesized that all-lateral pinning in this fracture pattern may be associated with higher rates of fixation failure and malunion.

Methods: We identified all patients aged 2-12 years with Gartland type III SCH fractures over a 10-year period. Direction of displacement was recorded, as were operative characteristics including pin configuration and surgeon training. Coronal and sagittal plane alignment were measured postoperatively and at final follow-up. Complications including permanent neurovascular deficits, malalignment, rotational instability (rotational malunion or loss of reduction), and reoperation were recorded. A minimum of 6 weeks of follow-up was required for inclusion.

Results: 99 of the 151 type III supracondylar humerus fractures treated operatively during the study period met inclusion criteria. Posteromedial (PM) displacement was associated with a higher rate of coronal malunion compared to PL (18.2% vs 0%, post hoc P = 0.024). Compared to fractures with coronal plane displacement (either PL or PM), fractures with direct posterior displacement had a lower rate of extension malunion (0% vs 14.3%, P = 0.032). Fractures with direct posterior displacement also had a lower composite (coronal and/or sagittal) malunion rate compared to those with PL or PM displacement (6.9% vs 28.6%, P = 0.018). All-lateral constructs resulted in more rotational instability (20.9% vs 1.8%, P = 0.002) than crossed pinning constructs. There was no difference in neurovascular complications between all-lateral and crossed pinning configurations. Fractures with PL displacement treated with all-lateral fixation showed a trend toward increased rotational instability (23.8% vs 1.3%, P = 0.073). There were no differences in outcomes based on surgeon training.

Conclusion: Type III SCH fractures with posteromedial or posterolateral displacement were associated with higher rates of combined coronal and sagittal malunion, while fractures with direct posterior displacement appear to be more stable. All-lateral fixation was associated with higher rates of rotational instability, particularly in fractures with posterolateral displacement.

Long Leg Splinting for Pediatric Femur Fractures

Bennet Butler, MD; *Cort Lawton, MD; Robert Christian, MD; Ryan Harold, MD; Prasad Gourineni, MD; John Sarwark, MD*

Purpose: Spica casts for pediatric femur fractures can be burdensome to patients' families and are frequently applied in an operating room, increasing health-care costs. An alternative to spica casting is long leg splinting, which can be applied in clinic and may be easier to maintain than a spica cast. This study compares long leg splinting to spica casting with respect to union rates and final radiographic alignment.

Methods: Patients aged 6 months to 5 years treated for a femoral shaft fracture with a long leg splint were identified. Each of these patients was matched for age and fracture pattern with a patient treated for a femoral shaft fracture with a spica cast applied in the operating room. Demographic and outcomes data from the 2 groups were compared.

Results: 26 patients treated with long leg splinting and 26 matched controls treated with spica casts were included in the study. On presentation, there were no differences between the groups with respect to any of the alignment parameters. Following initial reduction the spica cast group had significantly better alignment with respect to all alignment parameters except shortening. At the time of healing, the alignment in the spica cast group was only significantly better with respect to coronal angulation. There were no differences between the groups with respect to union rate or time to union (Table 1).

Table 1- Outcomes				
Alignment		Splint (N=26)	Cast (N=26)	p-value
Presentation	Sagittal Angulation (deg)	8.15	6.88	0.56
	Coronal Angulation (deg)	9.42	5.50	0.18
	Shortening (mm)	8.50	12.40	0.09
	Coronal Translation (%)	33%	23%	0.24
Post-splinting v casting	Sagittal Angulation (deg)	7.88	4.16	**0.03**
	Coronal Angulation (deg)	8.33	4.08	**<0.01**
	Shortening (mm)	8.42	11.80	0.11
	Coronal Translation (%)	29%	10%	**0.01**
Union	Sagittal Angulation (deg)	8.96	7.96	0.63
	Coronal Angulation (deg)	8.64	5.32	**0.04**
	Shortening (mm)	9.08	11.70	0.22
	Coronal Translation (%)	32%	18%	0.10
[redacted]	Secondary Procedure (%)	4%	4%	>0.99
	Time to Union (days)	44.58	40.83	0.28

Conclusion: Long leg splinting may be a reasonable alternative to spica casting for pediatric femur fractures.

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Displaced Distal Radius Fractures in Children Younger than 11 Years Old: A Randomised Controlled Trial Comparing Two Treatment Methods

Adriana Hernandez, MD; ***Aurelio Martinez, MD***

Purpose: The objective of this work is comparing in a randomised controlled trial the standard treatment of closed reduction and casting under anaesthesia versus only improving the fracture angular alignment, accepting an overriding position, and casting.

Methods: Sixty consecutive patients younger than 11 years old (who presented to our Emergency Department) with completely displaced distal radius fractures with or without ulnar fracture, were randomised into two groups. Group 1, 30 patients, were treated with an anatomic reduction under anaesthesia. Group 2, 30 patients, were carefully manipulated without anaesthesia or sedation, in order to improve the angular alignment, and left in an overriding position. Both groups were immobilised with a short arm cast. We analysed time to consolidation and remodelling, complications, functional scores, length of stay and overall costs, as well as radiographic parameters; An Upper Extremity Functional Index (UEFI) was performed in both groups at discharge from the clinic. The reviewers were blinded as to treatment group.

Results: The demographics, initial fracture overriding and angulation were similar in both groups. Time until consolidation and remodeling were significantly shorter in the non-reduction group, the same trend was observed in the length of hospital stay and final hospital costs, findings that are depicted in Table 1. No difference was found in terms of function, pain and residual deformity as shown in Table 2.

Conclusion: Accepting an overriding position when treating displaced distal radius fractures in children younger than 11 years old is a cost-effective alternative to the standard reduction procedure without affecting functional scores, time to union or remodelling.

A Randomized Comparison Between First-Generation Dynaloc and Cancellous Screws for Treatment of Femoral Neck Fractures

Lars Borris, MD; *Rikke Thorninger, MD; Ole Brink, MD, PhD*

Purpose: Dynaloc is a new implant for fixation of femoral neck fractures (FNFs), AO/OTA 31 B1, consisting of 3 cancellous screws fixed in a small side plate. In biomechanical studies Dynaloc reduced stress and deformation in the fracture more than 50% better compared to screws. Thus theoretically Dynaloc could have the advantage of being able to reduce the risk of fracture collapse, varus deformity, and femoral head necrosis after FNF. We performed a randomized comparison of first-generation Dynaloc versus cancellous screws in patients with FNF.

Methods: The primary end point was postoperative fracture collapse with leg shortening. Secondary end points were generic health status and functional outcome with Short Form-12, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), EuroQol 5 dimensions (EQ-5D), and Harris hip score after 1 year, in addition to healing properties and safety features with 2-year follow-up. We planned to include 75 patients in each group. However, due to a high rate of hardware-associated discomfort in the Dynaloc group, necessitating removal, the study was prematurely discontinued after inclusion of 40 patients, 22 in the Dynaloc group and 18 in the screw group.

Results: Mean age was 71.9 years (standard deviation [SD], 11.8); 60% were women. Fracture types were mainly Garden I and II. The 2 groups were well matched in terms of demographics and fracture type. No significant differences were observed between the 2 groups concerning the primary or any of the secondary end points. A total of 20 reoperations were performed or planned in the groups. In the Dynaloc group 4 patients had total hip arthroplasty (THA), 6 had the hardware removed, 1 patient was operated for wound infection. In the screw group, 4 patients had an arthroplasty (3 THA and 1 HHA [hip hemiarthroplasty) and 5 had the hardware removed. Two Dynaloc patients died and there was 1 death in the screw group. A man of 53 years in the Dynaloc group experienced a serious adverse event when one of the guidewires during operation penetrated into the pelvis resulting in a painful intrapelvic hematoma formation with a fall in the hemoglobin level. Due to abdominal pain and fever, a CT scan was performed to exclude an intraabdominal injury. No injuries were found and he recovered completely. Femoral head necrosis developed exclusively in 4 Dynaloc group patients, 3 of which were objectively proven and 1 suspected.

Conclusion: No significant advantages of the new implant were found. After discontinuation of this study the plate has been redesigned to improve the patient compliance.

The Incidence of Subsequent Fractures in the 2 Years Following a Femoral Neck Fracture Treated With Internal Fixation

Earl Bogoch, MD, FRCPC*; Sheila Sprague, PhD; Sofia Bzovsky, BSc; Qi Zhou, PhD; Mohit Bhandari, MD, PhD; Marc Swiontkowski, MD; Emil Schemitsch, MD; FAITH Investigators*

Purpose: Osteoporosis is a major health concern, causing >8.9 million fractures annually. The risk of a fragility fracture, especially a hip fracture, increases with age and in adults >50 who have sustained a fracture. Using data from a multicenter trial of 1079 femoral neck fracture patients aged 50 years or older, we described incidence of secondary fragility fractures in the 2 years subsequent to the index femoral neck fracture. We also quantified use of osteoporosis medications in this patient population and investigated the association between the baseline use of osteoporosis medications and reoperation.

Methods: We conducted a descriptive analysis to quantify the number of patients who suffered another fracture after their index hip fracture and the use of osteoporosis medication during the subsequent 2 years. We performed a logistic regression to investigate the association between the baseline use of osteoporosis medications and having a reoperation within 2 years post index hip fracture. Results were reported as odds ratios, 95% confidence intervals, and P values. Tests were 2-tailed with alpha = 0.05.

Results: 70 of 1079 patients (6.5%) experienced another fracture within 2 years after their index hip fracture. The mean time of refracture occurrence was 12.1 months (standard deviation 7.4 months). 51 (72.9%), 13 (18.6%), 5 (7.1%), and 1 (1.4%) patients suffered 1, 2, 3, and 4 additional fractures, respectively, within 2 years following hip fracture. The most common secondary fractures were of the hip (2.2%) and pelvis (1.1%). 1 of 70 patients (1.4%) who sustained a secondary fracture was taking osteoporosis medications at the time of the additional fracture. 40 patients (57.1%) who sustained a secondary fracture were taking vitamin D supplementations and 41 patients (58.6%) who sustained a secondary fracture were taking calcium supplementations at the time of their additional fracture. Use of osteoporosis medication at baseline was not associated with reoperation (P = 0.88).

Conclusion: 6.5 in 100 patients experienced a subsequent fracture after index low-energy hip fracture. Given the low proportion of patients taking osteoporosis medication post fracture, an increase in referrals for medication use may help reduce refractures.

Early Radiographic Union Score for Hip Is Predictive of Femoral Neck Fracture Complications Within 2 Years

Martí Bernaus, MD; *Gerard Slobogean, MD, MPH; Sofia Bzovsky, BSc; Diane Heels-Ansdell, MSc; Qi Zhou, PhD; Mohit Bhandari, MD, PhD; Sheila Sprague, PhD; FAITH Investigators*

Purpose: Up to 30% of femoral neck fractures managed with internal fixation suffer complications severe enough to require reoperation. The Radiographic Union Score for Hip (RUSH) assesses radiographic fracture healing with a numerical score ranging from 10 to 30. The purpose of this study is to determine if early RUSH is associated with complications occurring within 24 months of initial surgery.

Methods: Prospective data from 734 clinical trial participants with high-quality radiographs at 3 and 6 months after femoral neck fracture fixation were included. A reviewer blinded to the patients' outcomes independently assigned a RUSH at each time point. Logistic regression was performed to investigate the associations between RUSH and a composite of patient-important complications (reoperation, femoral head osteonecrosis, severe femoral neck malunion, or nonunion). Subgroup analyses for age and fracture displacement were explored as potential effect modifiers. Results were reported as odds ratios (ORs), 95% confidence intervals (CIs), and associated P values. All tests were 2-tailed with alpha = 0.05.

Results: Lower RUSH at both 3 and 6 months was associated with increased odds of complications within 24 months of fixation. For every 2-point decrease in RUSH at 3 months, there was a 16% increase in the odds of a patient experiencing a significant complication (OR 1.16, 95% CI 1.10-1.22; P <0.0001). A similar association was observed at the 6-month radiographic assessment for every 2-point decrease (OR 1.05, 95% CI 1.01-1.09; P = 0.005). Neither age nor fracture displacement affected the association between RUSH and complications.

Conclusion: Decreased radiographic healing as early as 3 months after fixation is highly associated with developing patient-important femoral neck fracture complications. This relationship may guide early treatment decisions, and suggests that the 3- and 6-month RUSH is a useful surrogate measure of complications within 24 months of fixation.

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Fri., 10/19/18 AM18: Hip, Femur, Geriatric, PAPER #90

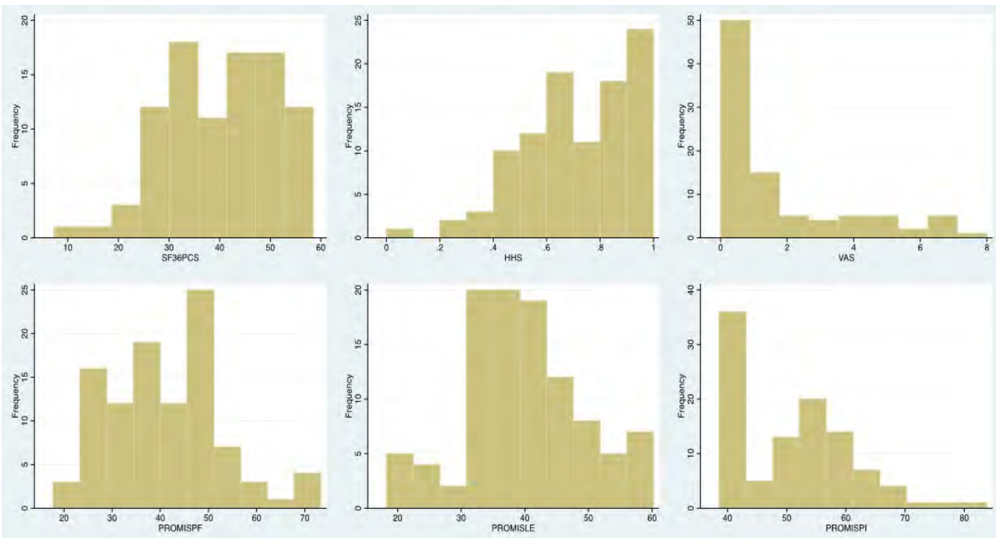
Computerized Adaptive Testing for Patient-Reported Outcomes in Hip Fracture Surgery

Elizabeth Gausden, MD*; Ashley Levack, MD; Aleksey Dvorzhinskiy, MD; Benedict Nwachukwu, MD; Danielle Sin, MS; David Wellman, MD; Dean Lorich, MD*

Purpose: The use of computerized adaptive testing (CAT) for patient-reported outcomes (PROs) is growing within orthopaedic surgery. The goal of this study was to compare the legacy PRO scores used in hip fracture surgery to the Patient Reported Outcomes Measurement Information System (PROMIS) scores in terms of floor and ceiling effects.

Methods: Patients who underwent osteosynthesis for an intertrochanteric hip fracture were prospectively enrolled and completed legacy outcome scores as well as the PROMIS Physical Function (PROMIS PF), PROMIS Pain Interference (PROMIS PI), and PROMIS Lower Extremity (PROMIS LE) in their CAT versions. Patients first completed the Harris hip score (HHS), Short Form-36 Physical Component Summary (SF-36 PCS), Short Form-36 Mental Component Summary (SF-36 MCS), and visual analog scale (VAS) for pain.

Results: 74 patients (average age, 71 years) were included. The correlation between the PROMIS LE and HHS was strong (rho = 0.73, P <0.001), as well as the correlation between the PROMIS LE and SF-36 PCS (rho = 0.68, P <0.001), and the VAS and the PROMIS PI (rho = 0.64, P <0.001). There was no absolute floor or ceiling effect in either of the PROMIS CAT scores (Figure 1). Only the VAS for pain had significant ceiling effect (34%). However, there was significant relative ceiling effect observed in the PROMIS PI CAT (35%).



Conclusion: This study supports continued development of PROMIS CAT for use in hip fracture patients. Both the VAS for pain and the PROMIS PI demonstrated significant ceiling effects, while none of the other legacy outcome scores or PROMIS CAT demonstrated ceiling or floor effects.

The Echocardiogram: A Scapegoat for Surgical Delay for Hip Fracture Patients

Angelica Pinninti, BS; *Meera Gonzalez, MD; Rachel Rubin, MD; Frederick Ramsey, PhD; Christopher Haydel, MD*

Purpose: Preoperative transthoracic echocardiography (TTE) is used for evaluating geriatric hip fracture patients and may delay time to operative fixation. The aim of this study was to evaluate TTE utilization at a single institution based on specific guidelines to determine rate of appropriate indication, rate of change in intraoperative management, and association with delayed time to the operating room.

Methods: A retrospective study was performed at an urban trauma center over a 5-year period during which geriatric patients received operative treatment for hip fractures. If TTE was ordered, indications were reviewed for adherence to American College of Cardiology/American Heart Association clinical practice guidelines (ACC/AHA CPGs). Echocardiogram reports were reviewed to identify cardiac conditions that warrant intraoperative management change by anesthesiology: moderate to severe aortic or mitral valve regurgitation or stenosis, left ventricular ejection fraction <25%, or right ventricle systolic pressure >55 mm Hg. Time from admission to surgery and admission to TTE (if TTE was done) were calculated.

Results: Data from 336 patients (64.9% female; mean age, 74.9 years [range, 50-98]) were analyzed and 21.7% (73) received preoperative TTE. According to ACC/AHA CPGs, 45.2% (33) of TTE orders were appropriately indicated, while 92.4% (243) of patients who did not have TTE were properly excluded. In 20.5% (15) of all TTE orders and 42.4% (14) of appropriately indicated TTEs, a cardiac condition that could alter intraoperative management was identified. Sensitivity and specificity of the echocardiogram were 0.933 (95% confidence interval [CI] 0.807, 1.000) and 0.672 (95% CI 0.552, 0.793), respectively. Non-guideline-indicated TTE order was most associated with history of transient ischemic attack (TIA), insulin-dependent diabetes mellitus (IDDM), and myocardial infarction (MI), indicated by an odds ratio of 5.6, 2.5, and 2.8, respectively. The median time from admission to surgery with TTE was 33.5 hours versus 20.5 hours without TTE (P <0.001). Time from admission to TTE was 18.5 hours.

Conclusion: History of TIA, IDDM, and MI increased the likelihood of a TTE order. TTE was associated with increased admission to surgery time. Less than half of the echocardiograms ordered were stringently indicated per ACC/AHA criteria, and only 20.5% of those ordered diagnosed a cardiac condition that could change intraoperative management by an anesthesiologist. Adherence to ACC/AHA guidelines will decrease the number of perioperatively ordered echocardiograms, may decrease time to surgery, and is unlikely to alter intraoperative management.

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Redefining Risk in Hip Fracture Patients: Does Age Matter?

Ariana Lott, MD; *Rebekah Belayneh, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: With the aging population, more elderly patients are being treated for hip fractures. With the mortality of patients who elect nonoperative treatment approaching 90% within the first month post-injury, an increasing number of patients in their 90s are undergoing surgery for these injuries. The purpose of this study was to analyze the perioperative complication rate and inpatient hospitalization costs associated with hip fracture patients over 90 years old compared to patients younger than 90 years old.

Methods: Patients with hip fractures treated operatively aged 60 and older at 2 academic medical centers between February 2014 and September 2016 were analyzed. Patient demographics, comorbidities, length of stay, procedure performed, and inpatient complications were analyzed. Comorbidities were analyzed using the Charlson Comorbidity Index (CCI). Procedures were divided into closed reduction and internal fixation, open reduction and internal fixation, and arthroplasty procedures. Complications included acute renal failure, surgical site infection, urinary tract infection, acute anemia, sepsis, pneumonia, deep vein thrombosis/pulmonary embolism, acute myocardial infarction, stroke, surgical site infection, decubitus ulcer, acute respiratory failure, cardiac arrest, and death. Total cost of admission was obtained from the hospital finance department. Outcomes were compared between patients over 90 years old and those younger than 90 using a P value of <0.05 as significant.

Results: A total of 500 hip fracture patients were included in this study. There were 109 (21.8%) patients over age 90 (mean 94.0 years, range 90-101), and 391 (78.2%) patients aged 60-90 years old (mean 78.9 years). There was no difference in operation performed or CCI between the 2 age groups. There was no difference in length of stay between the 2 cohorts; mean length of stay for hip fracture patients 90 years and older was 7.8 ± 4.3 days and the mean length of stay for the younger cohort was 7.6 ± 4.2 days ($P = 0.552$). In addition, there was no observed difference in perioperative complications between patients over 90 years of age and those between 60 and 90 years of age. Lastly, there was no difference in total mean cost of admission between the 2 patient cohorts.

Conclusion: Orthopaedic surgeons should be comfortable counseling their patients over 90 years old that they are at no greater risk for perioperative complications based on age alone. They are also no more likely to require longer or more costly hospitalizations than their younger counterparts.

PAPER ABSTRACTS

Assessment of 30-day Mortality and Complication Rates Associated With Extended Deep Vein Thrombosis Prophylaxis Following Hip Fracture Surgery

Wesley Durand, BS; Avi Goodman, MD; ***Joseph Johnson, MD****; Alan Daniels, MD*

Purpose: Deep vein thrombosis (DVT) is a common complication following lower extremity surgery, occurring in up to 60% of patients undergoing hip fracture surgery without postoperative anticoagulation. The risk of fatal pulmonary embolism (PE) continues well beyond 2 weeks postoperatively, thus extended DVT prophylaxis beyond 14 days may be warranted. This investigation sought to examine the association between prescription of extended DVT prophylaxis and 30-day postoperative complications following hip fracture surgery.

Methods: This study utilized the ACS NSQIP (American College of Surgeons National Surgical Quality Improvement Program) Hip Fracture Procedure Targeted dataset. The outcome measures were death, occurrence of any postoperative complication, complication subtype, readmission or reoperation within 30-days postoperatively, and length of stay. The primary independent variable was DVT prophylaxis continued 28 days postoperatively ("extended DVT prophylaxis"). The control group contains both patients receiving no prophylaxis and those receiving short-duration prophylaxis. Multivariate stepwise logistic regression was utilized.

Results: In total, 7533 surgically treated hip fracture patients treated in 2016 were analyzed. Overall, 57.8% of patients (n = 4354) were prescribed extended DVT prophylaxis. On bivariate analysis, prescription of extended DVT prophylaxis was associated with lower incidence of death (7.7% without vs 2.7% with; NSQIP; P <0.0001) and stroke/cerebrovascular accident (CVA) (1.4% vs 0.6%, P = 0.0016). In multivariate analysis, prescription of extended DVT prophylaxis was associated with lower odds of death (odds ratio [OR] 0.33, P <0.0001), stroke/CVA (OR 0.44, P = 0.0010), and acute kidney injury (AKI) (OR 0.31, P = 0.0010).

Conclusion: Hip fracture surgery patients prescribed ≥28 days of postoperative DVT prophylaxis exhibited 67% lower odds of death and significantly lower rates of AKI and stroke/CVA as compared to those prescribed short-duration prophylaxis. Prescription of extended DVT prophylaxis for ≥28 days following hip fracture should be strongly considered. In patients with a contraindication to pharmacological prophylaxis, sequential compression devices can be prescribed. Additional studies specifically examining the association between extended DVT prophylaxis and postoperative complications and mortality following hip fracture surgery are warranted.

PAPER ABSTRACTS

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Malnutrition Is Associated With Frailty and Postoperative Complications in Hip Fracture Patients

Jacob Wilson, MD; *Adam Boissonneault, MD; Andrew Schwartz, MD; Christopher Staley, BA; Mara Schenker, MD*

Purpose: Frail patients are at elevated risk for complications in the perioperative phase. In addition to being a marker of overall malnutrition, hypoalbuminemia and decreased total lymphocyte count (TLC) have been implied to be markers of frailty. The aim of this study was to examine the relationship of nutrition parameters with the modified frailty index (mFI) as well as postoperative complications in patients with hip fractures. We hypothesized that frailty and malnutrition would be correlated and that patients who were both frail and malnourished would have increased postoperative risk.

Methods: We retrospectively reviewed 377 consecutive patients admitted to a Level I trauma center for isolated hip fractures. Admission laboratory values (albumin and TLC) and complication data were collected. Additionally, mFI scores were calculated. Pearson correlation, independent samples t-test, and multivariate regression were then used to analyze the association between frailty, malnutrition, and postoperative complications.

Results: 62.6% and 17.5% of patients were malnourished as defined by TLC <1500 cells/mm^3 and albumin <3.5 g/dL, respectively. Both TLC (r = -0.12, P = 0.024) and albumin (r = -0.23, P <0.001) were inversely correlated with frailty as indicated by mFI. Patients with albumin <3.5 g/dL were twice as likely to suffer a postoperative complication, even when controlling for mFI, age, smoking status, sex, and weight (odds ratio [OR] 2.22, 95% confidence interval [CI] 1.26-3.92, P <0.001). The mean albumin was also significantly different between patients who suffered mortality and those who did not (3.16 vs 3.9 g/dL, respectively; P <0.001). Combining malnutrition and frailty revealed predictive synergy. In patients with albumin <3.5 g/dL and mFI ≥0.27 the positive predictive value for mortality was 0.23, with an 8.52 likelihood ratio (95% CI 4.49-16.2). Lastly, while TLC <1500 cells/mm^3 alone was 100% sensitive for mortality, the specificity of this index was improved from 36.1% to 67.5% when TLC <1500 cells/mm^3 and mFI ≥0.18 were combined.

Conclusion: Decreased admission albumin and TLC values are associated with a frail state, as indicated by increased mFI in hip fracture patients. Additionally, malnutrition is highly predictive of postoperative complications independent of frailty and other comorbid data. The frail and malnourished patient represents an especially vulnerable group and should be recognized as such to optimize care. There is a clinical opportunity to improve outcomes in frail hip fracture patients as malnutrition represents a potentially modifiable risk factor.

Traumatic Hip Fracture and Primary Elective Total Hip Patients Are Not The Same: A Comparison of Comorbidity Burden, Hospital Course, Postoperative Complications, and Cost of Care Analysis

Jason Lowe, MD*; Sean M. Mitchell, MD; Sumit Agarwal, MD; Clifford B. Jones, MD*

Purpose: Diminishing reimbursement and financial penalties levied for complications of medical care have driven quality improvement in medicine. Elective surgical patients can be screened and medically optimized whereas acute care surgical patients cannot. Geriatric trauma hip fracture (HF) and elective total hip arthroplasty (THA) patients represent 2 such disparate populations. The purpose of this study was to compare patient comorbidity burden, hospital course, postoperative complications, and cost of care between acute trauma HF and elective THA patients.

Methods: We retrospectively reviewed all geriatric trauma patients between 2010 and 2017 from a single, multicenter health-care system patient database who underwent operative fixation or arthroplasty of a femoral neck or intertrochanteric hip fracture, and compared them to all elective THA patients over the same period. Patients with a history of hip fracture, deformity, or ipsilateral injuries were excluded. Patient comorbidity profiles, length of stay, readmission rate, postoperative complications, mortality rate, and cost of care were compared.

Results: 18,042 trauma HF and 8761 elective THA patients were included with mean ages of 76.8 and 67.9 years (P <0.001). Medical comorbidities such as chronic pulmonary disease, renal failure, coronary artery disease, cerebrovascular disease, and heart failure were all higher in HF patients as was mean Charlson Comorbidity Index (P <0.001). Additionally, albumin was lower and hemoglobin A1c higher in HF patients (P <0.001). Average length of stay was 5.0 versus 2.6 days (P <0.001) with 8.5% of HF patients being managed in the ICU versus 1.8% of THA patients. Readmission rates for HF and THA patients were 21.4% and 6.2%, respectively (P <0.001). Minor and major complications were higher in the HF cohort (P <0.001), as were 30-day (1.97% vs 0.17%) and 1-year mortality rates (3.49% vs 0.40%) (P <0.001). Mean hospital cost of care was also significantly higher in HF patients.

Conclusion: Hip fracture patients have increased comorbidity burdens, length of stay, ICU admission, readmission rate, complications, mortality, and cost of care than elective total hip arthroplasty. Paradoxically, elective total hip procedures are reimbursed at a higher rate and with lower outcome-based financial penalties than trauma surgery. In the era of pay for quality performance, it is important for health systems and auditing agencies to reconcile the difference between these 2 patient cohorts.

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The Outcome of Operative Ankle Fracture Fixation in the Elderly

Yoram Weil, MD; *Meir Liebergall, MD; Rami Mosheiff, MD; Raphael Negari, MD; Amal Khoury, MD*

Purpose: Ankle fractures are among the most common in all age groups. Unstable ankle fractures require open reduction and internal fixation surgery (ORIF). Although the results of these procedures are predictable, little is known of the outcome of geriatric patients undergoing ORIF. The purpose of this study was to assess the outcome of patients over 60 years of age undergoing ORIF of unstable ankle fractures.

Methods: This retrospective study included 74 patients over 60 years of age who underwent operative fixation of unstable ankle fractures between 2009 to 2015 and were available for radiographic follow-up for at least 1 year. Patient data included risk factors for failure (diabetes, smoking, renal disease, etc). Outcome included reoperation, and surgical complications. The injury radiographs were assessed for AO/OTA classification. The latest postoperative radiographs were analyzed for lateral clear space (LTS), medial clear space (MCS), talar tilt, and talocrural angle (TCA). Clinical outcome scores were obtained for 51 patients at 3-8 years post surgery and included Foot and Ankle Disability Index (FADI) and Short Form-12 (SF-12)

Results: 70% of fractures were AO 44B. Overall complication rate was 54% and included infection (9.5%), delayed wound healing (9.5%), tibiofibular synostosis(14.9%) and traumatic arthritis (12.2%). The only factors that were significantly correlated with complications included age and initial pathologic LCS; repeatability of measurement was acceptable (intraclass correlation coefficient kappa coeffecient of 0.7). Average FADI score was 86.6 ± 24; SF-12 scores were 92 ± 14.8 for the mental domain (Mental Component Summary [MCS]) and 84 ± 22 for the physical domain. Multiple regression analysis showed a significantly negative correlation between clinical outcome and intial age at presentation and increased TCA. The presence of the arthritis was also significantly associated with poorer clinical outcome. The rest of the clinical and radiographic parameters did not have a statistically significant correlation with outcome.

Conclusion: Operative ankle fractures in the elderly result in higher complication rates both clinically and radiographic than expected, although the overall clinical long-term outcome is reasonable. Age at presentation remains the single most important prognostic factor in our analysis for a worse outcome. Loss of reduction as demonstrated in the LCS and TCA was associated with poorer outcome. Modification of fixation technique as well as adequate patient counseling regarding the outcome might be needed.

Distal Femoral Replacement for Treatment of Complex Distal Femur Fractures
Charles Mechas, BS; ***Ryan Mayer, MD****; Jeffrey Selby, MD; Stephen Duncan, MD; Raymond Wright, MD; Arun Aneja, MD, PhD*

Purpose: Treatment of comminuted distal femur fractures and periprosthetic distal femur fractures can be challenging. These patients are often elderly with multiple medical co-morbidities. As they often have osteoporotic bone with limited bone stock and potential implant instability, these fractures are not always amenable to internal fixation. Distal femoral replacement or endoprosthesis has been increasingly used to treat these complex injuries. To best assess the indications and outcomes of this fracture fixation method, we performed a systematic review of the literature on endoprosthesis use for patients with distal femur fractures.

Methods: A PubMed search including the terms "periprosthetic distal femur fracture," "distal femur fracture," and "distal femoral replacement" identified a total of 331 articles. After narrowing the search to articles published within the last 10 years, full text articles, and those published in English, a total of 122 articles remained. Biomechanical studies, non-human studies, and technique articles were further excluded, resulting in 14 studies assessing the use of distal femoral replacement as a treatment option for distal femur fractures.

Results: A total of 303 reported cases from 14 studies were evaluated. The average patient was 78.3 years old (standard deviation [SD] = 3.7). 10 of these studies included specific comorbidity data, which showed 70% of patients having greater than 1 comorbidity, with 8 of the studies having an average American Society of Anesthesiologists class of 2.7, and 2 studies reporting an average age-adjusted Charlson Comorbidity Index of 5.3. The overall complication rate was 22.7% (69/303) with 18 patients (5.9%) developing a deep infection. The average length of stay was 10.7 days (SD = 7.4; recorded in 9/14 studies). There were 8 studies that included function outcomes, which showed that only 77/193 patients (39.9%) regained or exceeded their preoperative functional status. 7 studies included data regarding the 1-year mortality rate, which was calculated to be 13.3% (21/158 patients).

Conclusion: This represents the largest systematic review to date about the use of endoprostheses for distal femur fractures and periprosthetic distal femur fractures. These studies showed that distal femoral replacement is a viable treatment option for complex distal femoral fractures, but it should be reserved as a salvage procedure given the limited number of patients that regained their functional status, the high complication rate, and high 1-year mortality rate.

Effect of Nail Size, Insertion, and ΔCanal-Nail Diameter on the Development of a Nonunion After Intramedullary Nailing of Femoral Shaft Fractures

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Purpose: To determine if nail diameter, antegrade vs retrograde insertion, or the difference between the canal and nail diameter affect fracture healing.

Methods: All femoral shaft fractures treated with a closed section, interlocked, titanium alloy IMN (Trigen, Smith & Nephew) between 1999 and 2017 were retrospectively reviewed. Data included demographics, injury mechanism, comorbidities, open/closed fracture, and location. Exclusion criteria were follow-up <12 months, pathologic/periprosthetic fractures, ≤16 years of age, ipsilateral femur fractures, unreamed nails, existing nonunions (NUs), and confirmed infections. Operative reports noted the IMN diameter in millimeters (10, 11.5, 13). Radiographs were reviewed to determine number/position (static/dynamic) of interlocking screws, location of the fracture, ΔCanal-Nail Diameter (ΔD) after reaming (<1 mm, 1 to 2 mm or >2 mm), and fracture-healing (RUST criteria). Fractures were grouped by (A) nail diameter, (B) ΔD, (C) fracture location, and (D) nail insertion. Healing rates were compared by groups.

Results: 484 patients met criteria (proximal third [Prox] = 77, middle third [Mid] = 289, distal third [Dist] = 118). Mean age was 34 years (18-97). 67% of patients were male, and 90% of the fractures were closed. IMN diameters used were: 314/10-mm (64%), 137/11.5-mm (28%), and 33/13-mm (8%). 45% were placed in the antegrade vs 55% retrograde. All IMNs were locked with at least 1 screw proximally and distally. 457 fractures (94.4%) healed uneventfully. 27 (5.6%) developed NU. There were no IMN failures. 10/484 IMNs (2%) had broken interlocking screws; only 4 were associated with a NU. Average time to union was 23 weeks (12-119). There was no statistical correlation between A) the NU rate and nail diameter: 10-mm, 6.7%; 11.5-mm, 5.8%; 13-mm, 3% (P = 0.8, power = 0.85). B) the NU rate and ΔD: 6.2% <1 mm, 5.4% 1-2 mm, 8.3% >2 mm (P = 0.9). C) the NU rate and fracture location: Prox = 9%, Mid = 5.1%, Dist = 2.5% (P = 0.13). And D) the NU rate and antegrade (7.3%) vs retrograde (4.1%) insertion (P = 0.16).

Conclusion: Similar healing rates occurred regardless of IMN diameter, Δcanal-nail diameter, or insertion site. Based on these data, a 10-mm closed section, titanium alloy IMN inserted with a minimum of reaming appears to be equivalent to larger diameter IMNs. This study questions the need for larger diameter nails, which negatively affect inventories and costs, and would allow decision-making to IMN length alone.

The Dislocated Hip on CT Scan: An Argument for the Initial Pelvic Radiograph in Trauma Patients

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Purpose: As computed tomography (CT) becomes more accessible, there have been trends nationally to take trauma patients straight to CT scan, skipping the pelvic radiograph (PXR), despite Advanced Trauma Life Support continuing to recommend PXR on all trauma patients. By leaving out the PXR, patients may be sent CT with a dislocated hip. The primary purpose of this study is to evaluate the frequency in which a hip dislocation is first diagnosed by CT scan. The incidence of repeat CT was also evaluated.

Methods: A retrospective review was conducted of orthopaedic trauma patients with a hip dislocation that presented to a Level I trauma center over a 3-year period. We recorded whether the patient first received a PXR or CT scan of the pelvis, if the patient underwent closed reduction of the hip prior to CT scan, and if a repeat pelvis CT scan was done.

Results: Of 83 hip dislocations reviewed, 64 patients (77%) were sent to the CT scanner dislocated. Of these 64, 24 (37.5%) underwent repeat pelvis CT scan after hip reduction. 19 patients had an initial PXR and underwent closed reduction of the hip prior to CT scan. In this group, only 2 (11%) patients required a repeat CT scan. By obtaining a PXR, reducing the hip prior to CT, the incidence of repeat CT scan was decreased from 37% to 11% (P = 0.046).

Conclusion: The initial PXR of trauma patients remains a useful tool and should not be replaced by CT as the initial screening tool in trauma patients. The PXR allows for early diagnosis and reduction of a hip dislocation. By continuing to use the PXR, the number of repeat CT scans can be reduced, thus decreasing cost and radiation exposure to patients.

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Which Technique Is Most Accurate for Assessing Femoral Rotation?

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Purpose: The difficulty in obtaining acceptable rotation following treatment of femoral shaft fractures is evident by high rates of postoperative malrotation. Several techniques have been reported to prevent this complication. This study was designed to compare the accuracy of predicting femoral malrotation using 3 described techniques.

Methods: 10 intact human cadaveric pelvis-to-knee specimens were used to create a fracture model. Fluoroscopic images were obtained of the intact control femur and the test femur on each specimen. A comminuted diaphyseal femur fracture was created on the test femur and it was internally and externally rotated in 5° intervals up to 20° malrotated in each direction. Images were saved at each increment of malrotation. Surgeons completed 1 of 8 surveys generated with 25 randomly selected images per survey via the OTA website. The accuracy of predicting femoral malrotation using the true lateral technique (TLT), neck horizontal angle method (NHA), and lesser trochanter profile (LTP) was recorded.

Results: 85 surgeons completed a survey with a total of ,116 images reviewed. Surgeons included: 11 (12%) residents, 9 (11%) fellows, and 65 (77%) practicing orthopaedic trauma surgeons. 80 (94%) surgeons acknowledged using a described fluoroscopic method for rotational assessment. Surgeons correctly accepted a fracture rotated <20° and rejected a fracture rotated >20° 63% of the time. Using the LTP and NHA methods 67% of surgeons responded correctly compared to 53% correct responses with the TLT (P <0.0001). Using a logistic regression model adjusting for cadaver, surgeon, level of training, prior technique use, and number of fractures repaired annually the TLT had 50% lower odds of correct identification of 20° malroation than the LTP (odds ratio [OR] = 0.50, 95% confidence interval [CI] = 0.38-0.67, P <0.001). Compared to the LTP, both the TLT and NHA show significant lower odds of determining correct internal and external malrotation (OR = 0.61, 95% CI = 0.46-0.80, P = 0.0004; OR = 0.44, 95% CI = 0.34-0.59, P <0.001) indicating that the LTP more accurately determined internal versus external malrotation.

Conclusion: Surgeons using described fluoroscopic methods to identify acceptable rotation in femoral shaft fractures are correct 63% of the time. The LTP and NHA techniques are equally reliable and more accurate than the TLT at detecting femoral malrotation greater than 20°. Most concerning of all, even with this low threshold for accuracy (20°) surgeons were still incorrect with the 2 best methds one-third of the time.

Anterior Pelvic External Fixation Versus the Pelvic Bridge for Unstable Pelvic Injuries: A Randomized Controlled Trial

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Purpose: Pelvic ring management is associated with morbidity and mortality. Anterior pelvic external fixation (APEF) is the current standard, although complications are common and include wound infection, fixator loosening, and impingement of the fixator upon the skin. The Pelvic Bridge is an anterior pelvic internal fixation technique that has been developed to minimize these complications through subcutaneous application of the implant. The purpose of this prospective trial was to compare the clinical outcomes of APEF versus the Pelvic Bridge.

Methods: 60 patients presented to a Level I trauma center from November 2010 through October 2015 with unstable anterior pelvic ring disruptions requiring surgical fixation (Anterior-Posterior Compression [APC] II, Lateral Compression [LC] II, Crescent fracture, APC III, vertical shear, or a combination of these). Randomization to either APEF or Pelvic Bridge treatment groups was attempted. If patients did not consent to randomization, they were invited to participate in an observational arm. Follow-up visits were scheduled at 2, 6, 12, 26, and 52 weeks. Adverse events included infection, deep venous thrombosis (DVT), and lateral femoral cutaneous nerve (LFCN) or perineal dysesthesias. Adverse event rates for the combined randomized and non-randomized groups were compared using Wilcoxon rank sum test.

Results: The study cohort included 28 randomized and 32 non-randomized patients, with 37/60 (62%) patients achieving follow-up at 6 months or greater. Non-randomization was due either to surgeon judgment or patient decision against inclusion. 25 of the non-randomized patients received internal fixation: 14 refused APEF, while the 11 remaining were due to surgeon judgment. 7 of the non-randomized patients received APEF: 2 refused the Pelvic Bridge, while the remaining 5 were due to surgeon judgment. 2 randomized patients were excluded because anterior fixation was later deemed unnecessary. There was a trend toward fewer infections in the Pelvic Bridge group (1 [2.6%] vs 3 [18%]; P = 0.052). DVT occurred at lower rates in the Pelvic Bridge group (2 [5.3%] vs 2 [12%]; P = 0.906), although not significant, and rates for dysesthesia were similar (16 [42%] vs 7 [41%]; P = 0.820).

Conclusion: The Pelvic Bridge is as safe as the current standard of care for unstable anterior pelvic ring disruptions. Patient implant preference may warrant further investigation.

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A Randomized Controlled Trial Using Neuromuscular Electrical Stimulation With Pelvic Fracture Rehabilitation. A Randomized, Placebo Controlled Clinical Trial

Jessica Rich, MSc; Peter Bates, FRCS; Karen Hoffman, PhD; Shihfan Jack Tu, MSc; Dylan Morrissey, PhD; ***Paul Culpan, FRCS***

Purpose: Pelvic fracture annual incidence is estimated to be 19 to 37 per 100,000 people, with up to 25% of these injuries occurring in polytrauma cases. Acute management has improved markedly although there remain no formal evidence-based guidelines for rehabilitation. Patients who survive these fractures endure long periods of non-weight-bearing with associated marked muscle atrophy. Neuromuscular electrical stimulation (NMES) has been proven to minimize muscle loss and enhance recovery but its effectiveness has not been investigated in a trauma patient population.

Methods: 57 participants with surgically fixed pelvic fractures were randomly allocated to 10 weeks of NMES compared to placebo transcutaneous electrical nerve stimulation (TENS). Resultant compliance was assessed using a patient diary. Peak muscle strength, normalized to the contralateral limb, was measured using the Cybex HUMAC isokinetic dynamometer at 12 weeks. Function was assessed with instrumented gait analysis at 12 weeks post fracture and quality of life by the 5-level EuroQol 5 Dimensions (EQ-5D-5L) at 6 and 12 weeks postoperatively.

Results: There were no significant hip abduction strength differences between operated and nonoperated limbs in the intervention group at 12 weeks post fixation ($P = 0.244$). However, the placebo group showed a significant hip abduction weakness between operated and nonoperated limbs at the same time point ($P = 0.0006$). Gait analysis showed a trend toward a Trendelenburg gait around heel strike in the placebo group only ($P = 0.07$). Quality of life improved equally in both groups between 6 and 12 weeks postoperatively.

Conclusion: This was the first randomized controlled study to investigate the use of NMES during rehabilitation of traumatic pelvic fractures. The encouraging results suggest that hip abduction strength can be maintained following periods of immobility and should therefore be considered as an adjunct to standard bed exercise rehabilitation in this population. There were indications of carryover to improved gait quality at 12 weeks, with encouraging trends seen during weight acceptance following electrical muscle stimulation.

Prevalence, Recovery Patterns and Quality of Life After Pelvic Ring Fractures: The Brabant Injury Outcome Surveillance (BIOS) Study

***Lars Brouwers, PhD**, Student; Mariska de Jongh, PhD; Leonie de Munter, MSc; Koen Lansink, MD, PhD*

Purpose: Pelvic ring fractures typically occur as a result of high-energy trauma and might have long-term consequences on health-related quality of Life (HRQoL). Overall, improved understanding of the full spectrum of the societal impact and burden of pelvic ring injury is needed. The main purpose of this study was to provide insight into prevalence and recovery patterns of short-term and long-term HRQoL after pelvic ring injury.

Methods: This is a prospective, observational, multicenter, follow-up cohort study in which HRQoL and functional outcome was assessed during 12-month follow-up within injured adult patients admitted to 1 of 10 hospitals in the county Noord-Brabant, the Netherlands. Data were collected by self-reported questionnaires at 1 week (including preinjury assessment), and 1, 3, 6, and 12 months after injury. EuroQoL-5 Dimensions (EQ-5D), visual analog scale (VAS), and the Majeed Pelvic Score (MPS) score were used to assess the HRQoL and functional outcome after pelvic ring trauma. Subsets were created based on Tile classification. Differences in HRQoL between the subsets at different time points were assessed using multivariable linear regression.

Results: 125 patients with pelvic fractures were identified between 2015 and 2016; 71 Tile A, 44 Tile B, and 10 Tile C fractures according to the Tile classification; 48% male, mean age 58 years, mean ISS 10.4. 22% of the patients underwent primary pelvic surgery. The mainly affected dimensions of the MPS were: pain, sitting, and walking, especially in the first 3 months after injury. At 6 and 12 months after injury ceiling effects were noticed regarding the different MPS dimensions. The mean EQ-5D Index was 0.53, 0.75, 0.79, and 0.80 at 1, 3, 6, and 12 months after injury, respectively. When compared with patients with Tile A fracture, patients with Tile B and C fractures obtained lower scores on the EQ-5D Index 1 month after injury, respectively (beta: 0.14 and 0.34 ($P < 0.05$) and 3 months after injury, respectively (beta: 0.14 and 0.40 ($P < 0.05$). No significant differences were seen between the Tile groups 6 and 12 months after injury. The mean EQ-VAS 1, 3, 6, and 12 months after injury was, respectively, 57, 69, 75, and 73. No significant differences were seen between the Tile groups regarding the EQ-VAS 1, 3, 6, and 12 months after injury.

Conclusion: Patients with pelvic ring fractures experience a significant reduction of their HRQoL and functional outcome, especially within the first 3 months after injury. Physicians should concentrate on the recovery of patients with pelvic ring fractures, especially in the 3 months after injury.

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Incidence and Outcome of Orthopaedic and Nonorthopaedic Sequelae after Operative Fixation of Major Pelvic Ring Fractures

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Purpose: The purpose of this study is to review the outcomes of major pelvic ring fractures over the past 20 years to quantify the early and late outcomes after operative fixation.

Methods: Medical records were reviewed for all patients with operatively treated pelvic ring injuries from 1995 to 2014. Acute and delayed fixation was included for fractures with vertical, rotational, and combined instability. Patients with Anterior-Posterior Compression (APC) I or Lateral Compression I injuries were excluded, as were those with less than 2 years of follow-up. Complications of interest included sacroiliac (SI) joint pain, lower back pain, urological symptoms, distal lower extremity neurological injury, sexual dysfunction, deep vein thrombosis (DVT), pulmonary embolism (PE), malunion, and nonunion.

Results: 324 pelvic ring fractures were identified, of which 220 were deemed eligible based on above criteria. Early complications included DVT and PE, nerve root injuries, screw failure, malreduction, bladder and urethral injuries (pelvic sling injuries) including erectile dysfunction and dyspareunia. Late complications included a number of previously under-reported issues and injury-related problems. Significant urinary incompetence in females (15%-22%), dyspareunia in females (6%), hernias (6%), severe back pain (4%), chronic back pain (14%-28%), and symphyseal plate removal (4%). These late complications had a significant effect on patient satisfaction and despite very anatomic pelvic ring reductions and unions (ie, the pelvis healed), these patients continued to be unhappy and required much more long-term support than has previously been reported for pelvic ring fractures.

Conclusion: The early complications noted above are similar to other pelvic ring studies. The late complications added some very interesting issues due to the long-term follow up of 2 years or longer. Quantifying the incidence of these complications allows surgeons to counsel patients about potential outcomes and access appropriate consultations earlier, which may improve patient satisfaction following this severe injury. Urological consultation in males and females, gynecological consultations, and long-term treatment of back pain would be 3 areas that should be contemplated very early in the rehabilitation of these patients (3-6 months post injury). Late consultations in these areas bring with them a larger number of treatment failures and long-term issues.

Nerve Injury With Acetabulum Fractures: Incidence and Factors Affecting Recovery

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Purpose: Sciatic nerve injury occurs occasionally with acetabulum fracture and has an adverse impact on recovery by generating dysesthesia and/or motor weakness, with ensuing functional impairment. The purpose was to determine factors associated with nerve injury and to evaluate subsequent recovery and outcomes.

Methods: 975 adult patients treated for fracture of the native acetabulum at a single institution were reviewed. Demographic, injury, and treatment information were recorded, including surgical approach and duration. Nerve injuries were categorized as traumatic or iatrogenic and regarding recovery (none, partial or complete). Musculoskeletal Function Assessment (MFA) scores were obtained after minimum 12-month follow-up.

Results: 31 patients (3.2%) experienced nerve injury with 24 (77%) resulting from trauma, 22 of which had an associated posterior hip dislocation, while 7 (23%) injuries were iatrogenic. 30 injuries (97%) occurred in patients with operative fractures (n = 682, 4.4%). The most common fracture pattern associated with nerve injury was transverse posterior wall (31% of injuries). Obese patients were more likely to sustain nerve injury: mean body mass index (BMI) 33.6 versus 30.1 for non-obese (P <0.001). Nerve injury was not related to age or gender. 72% of sciatic nerve injuries were to the common peroneal division only, while none were isolated to the tibial division. Most of the iatrogenic injuries (85%) occurred after ilioinguinal approach. Mean surgery duration for patients experiencing iatrogenic injury was 205 minutes versus 233 minutes (NS). 55% of all patients experienced partial nerve recovery, 19% had complete recovery, and 26% had no recovery after 12 months. Common peroneal injuries were most likely to experience some recovery (61%). Tobacco smokers experienced no nerve recovery in 33% (vs 28% of nonsmokers without recovery). Mean MFA score for patients who sustained a nerve injury was 35.2 (vs 33.8 for control group without nerve injury).

Conclusion: Posterior acetabulum fracture dislocations are associated with more risk of traumatic nerve injury, although 23% of nerve injuries were iatrogenic. Nerve injuries are more common in obese patients, and modifiable risk factors, such as tobacco smoking and BMI, may affect recovery. 26% of patients experienced no recovery of nerve function. Further data collection to determine effects of nerve injury on long-term functional outcomes would be beneficial.

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Long-Term Function Following Acetabulum Fracture

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Purpose: Acetabulum fractures occur in 2 populations: those incurring high-energy trauma and elderly patients sustaining low-energy falls. While there are multiple variables that may affect recovery such as type of injury and treatment, baseline medical and psychosocial status likely have important impact on recovery and long-term function. The purposes of this project were to evaluate functional outcomes more than 5 years after acetabulum fracture and to determine factors related to function.

Methods: Adult patients treated for acetabulum fracture at a Level I trauma center were evaluated with the Musculoskeletal Function Assessment (MFA) a minimum of 5 years following injury. The MFA includes survey of daily activities, gross and fine mobility, social and work function, sleeping, and mood. Higher scores indicate worse function.

Results: 158 patients, 66% of whom were male, with a mean age of 48 years at time of injury and mean body mass index (BMI) of 30 were included. Fracture patterns included AO/OTA 62A (37%), 62B (42%), or 62C (19%), and 72% were treated surgically. One-third of patients had isolated acetabulum fractures, the majority of which occurred after low-energy fall (14% of all patients). Late complications were noted in 30% including posttraumatic arthrosis (PTA: 28%), osteonecrosis, and/or heterotopic ossification. Mean MFA of all patients was 32.3, indicating substantial residual dysfunction. Fracture pattern was not associated with MFA scores: 62A, 30; 62B, 32; 62C, 25. Worse MFA scores were associated with age <45 years at the time of injury (34 vs 26, P = 0.014), obesity (BMI >30: 38 vs 27, P = 0.01), and current tobacco smoking history versus former versus nonsmoker (43 vs 36 vs 23, P <0.001). Early complications were not associated with worse outcomes; however, those with late complications had worse mean MFA scores (36 vs 26, P = 0.009).

Conclusion: More than 5 years following acetabulum fracture, substantial residual dysfunction was noted, as demonstrated by mean MFA. Worse outcomes were associated with younger age, obesity, and tobacco smoking. While fracture pattern was not associated with outcome, those patients who had late complications, mostly PTA, had worse outcomes.

Impact of Prolonged Skeletal Traction in Patients With Acetabular Fractures

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Purpose: This study was undertaken to determine the association between prolonged skeletal traction and pulmonary complications in patients with operative acetabular fractures.

Methods: This study reports on 193 consecutive patients from a single American College of Surgeons-verified Level I trauma center that presented with an operative acetabular fracture. It includes all patients placed in skeletal traction in the emergency department. The primary outcome measure was pulmonary complication, defined as pulmonary embolus, acute respiratory distress syndrome, or hospital-acquired pneumonia. Multivariate logistic regression was performed to determine the association between length of time in traction (in days) and pulmonary complications. Time in traction was evaluated as both a continuous variable and also a categorical variable at 1-, 3-, and 5-day cut-off intervals. Covariates included in the regression model included ISS and chest injury, determined by the Abbreviated Injury Scale (AIS).

Results: The overall mean (and SD) time spent in skeletal traction was 3.2 (SD 3.1) days, and the overall pulmonary complication rate was 6.2%. The mean ISS for those that suffered a pulmonary complication was 25.9 (SD 14.9) compared to 14.0 (SD 9.4) for those that did not ($P < 0.001$). ISS and total days in traction had a direct correlation ($r = 0.32$, $P < 0.001$). An increased total length of time in traction was associated with an increased rate of pulmonary complication ($P < 0.001$). After controlling for ISS and chest injury, patients that spent longer than 5 days in skeletal traction were over 5 times as likely to suffer a pulmonary complication (odds ratio [OR] 5.1, 95% confidence interval [CI] 1.3-19.5; $P = 0.018$). There was no significant increased risk of pulmonary complication at 1-day (OR 1.1, 95% CI 0.3-4.5; $P = 0.908$) or 3-day (OR 1.7, 95% CI 0.4-5.9; $P = 0.440$) time intervals. Of the 193 patients, 122 (63%) had a fracture associated with a hip dislocation. There was no significant association between hip dislocation and pulmonary complication ($P = 0.382$).

Conclusion: This study demonstrates an ISS-independent increased risk of pulmonary complication in patients with acetabular fractures who spend longer than 5 days in skeletal traction. While there has been an emphasis on early long-bone stabilization in polytraumatized patients, the current study suggests a similar effort to operate on acetabular fractures within 5 days may allow patients to mobilize sooner and potentially decrease the risk of pulmonary complications.

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Operative and Nonoperative Treatment of Traumatic Arthrotomies: A Prospective Observational Study

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Purpose: Orthopaedic dogma dictates that traumatic arthrotomies (TAs) require formal irrigation and debridement to minimize septic arthritis risk, regardless of size. To date, there is no evidence for or against nonoperative (nonop) treatment of small TAs. The purpose of this study was to evaluate the incidence of adverse events (AEs) in patients undergoing operative and nonop treatment of TAs. We hypothesized that nonop treatment of small (<1 cm) TAs would have an extremely low rate of subsequent septic arthritis and surgery.

Methods: We prospectively enrolled all patients with a TA to a major joint diagnosed via saline load test, direct visualization, or intra-articular air on imaging. Patients were treated in the operative group (OG) or nonop group (NOG) based on the preference of the treating surgeon. Nonop patients received bedside irrigation, primary closure in the emergency department, and discharge on an oral antibiotic regimen. Primary outcomes were AEs including septic arthritis (SA) and other complications.

Results: 104 patients met inclusion criteria, 27 in the NOG and 77 in the OG. Mean age was 36.4 years for the NOG and 33.3 years for the OG. 96% of NOG patients returned for at least 1 follow-up visit and 88% of the OG. 81% and 55% of NOG and OG TAs were <5 cm, while 11% and 21% of the NOG and OG TAs were 5-10 cm. Mechanism of injury included abrasions, lacerations, punctures, and high and low-energy gunshot wounds. All NOG TAs had minimal to no contamination compared to 49% of OG TAs (P <0.05). There was 1 SA case and no other complications in the NOG compared to 4 SA cases and 8 complications in the OG, with no statistical differences between groups. Of the OG, indications for surgery were: 49% went to the operating room for an additional injury, 5.2% had an intra-articular fracture, 20% had heavy contamination, 34% had large TAs, and 3.9% had an intra-articular loose body.

Conclusion: This series demonstrated a low rate of AEs (3.7%) in nonop-treated TAs. These results suggest challenging the current dogma requiring formal irrigation and debridement in the operating room for all TAs. We believe that small (<5 cm), minimally contaminated TAs with no associated fracture may be safely treated with bedside irrigation, primary closure, and a short course of oral antibiotics. This may reduce unnecessary spending, free operative time, and prevent surgical morbidity.

Comparing Radiographic Progression of Bone Healing in Gustilo Anderson IIIB Open Tibial Fractures Treated With Muscle Versus Fasciocutaneous Flaps

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Purpose: In Gustilo Anderson IIIB (GA3B) tibial fractures, soft-tissue coverage with muscle or fasciocutaneous (FC) flaps is essential. Animal models suggest faster callus formation and higher bone mineral density under muscle flaps, but there are no analogous clinical data comparing the bone regenerative milieu generated by each flap. The purpose of this study is to compare muscle versus FC flaps for the treatment of GA3B tibial fractures with the primary outcome of radiographic union.

Methods: We identified patients with GA3B tibial fractures at our institution that received muscle or FC flaps and had primary radiographic follow-up for at least 6 months. The radiographs of each patient were reviewed by a single, blinded author and assigned a Radiographic Union Score for Tibial (RUST) fractures. Number of patients reaching bony union (RUST ≥10) as well as mean RUST scores in each group were compared at time of injury, 3 months, 6 months, and 12 months from the original fracture date.

Results: 39 patients (40 lower extremities) met our inclusion criteria. 12 injuries received FC flaps (30%) and 28 injuries received muscle flaps (70%). There was a significant difference ($P = 0.026$) in the mean RUST score at 6 months between the muscle group (8.54 ± 1.81) and the FC group (6.92 ± 2.46). There was no significant difference in the mean RUST score at 3 months ($P = 0.056$) and at 12 months ($P = 0.947$) between the 2 groups. There was also significance in the number of fractures reaching union, favoring muscle flaps, at 6 months ($P = 0.020$).

Conclusion: Traditional teaching supports muscle flaps as the superior tissue of choice in providing vascularity and mesenchymal stem cells to healing bone. This data demonstrates that while patients with GA3B fractures who received muscle flaps have faster radiographic progression of bone healing in the first 6 months than patients who received FC flaps, ultimately, the difference in bone healing at 12 months is not statistically significant. This may suggest that muscle flaps have more of a positive impact on the earlier stages of fracture healing. Whether these data correlate to differences in bone quality is a subject for further research.

Intramedullary Nails Have Faster Union and Fewer Secondary Grafts/ Reoperations Than Plates With the Masquelet Technique

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Purpose: The induced membrane (Masquelet) technique is a staged procedure used to treat injuries with significant bone loss. This technique has been shown to produce good outcomes for complex problems, though not without complications. We hypothesized that the fixation method (intramedullary nail [IMN] versus plate) for injuries treated with the Masquelet technique impacts time to union, secondary grafting, and reoperations.

Methods: Retrospective chart review was performed of all patients treated with the Masquelet technique between 2005 and 2017 at 3 Level I trauma institutions. Charts were reviewed for injury type, defect size, type of fixation during spacer placement (IMN, plate), number/reason for reoperations, union time, and complications.

Results: Overall 94 patients (43 tibias and 51 femurs) were treated with mean follow-up of 34 months (range, 8-112 months). IMNs were used in 43 patients and plates in 51 patients. Union was achieved in 88% of both groups, at an average of 7.1 months (range, 3-33) with IMN versus 8.7 months (range 3-18) with plating (P = 0.022). Multiple grafting procedures were required in 16.3% (7/43) of those with IMN and 33.3% (17/51) of those with plating (P = 0.059). Reoperation for all causes occurred in 25.6% (11/43) with IMN and 51% (26/51) with plating (P = 0.012). Tibial defects had similar time to union and secondary grafting rates for IMN and plates. However, reoperation for all causes occurred in 30.7% (8/26) with IMN versus 58.8% (10/17) with plating (P = 0.068). Femoral defects achieved union in 5.8 months in IMN versus 9.8 months with plating (P <0.001). Union rate was 100% (17/17) with IMN versus 88% (30/34) with plating (P = 0.29). Secondary grafting occurred in 0% with IMN versus 32% plating (P = 0.009). Reoperation for all causes occurred in 0% with IMN versus 35% with plating (P = 0.004).

Conclusion: The fixation method used in the Masquelet technique seems to affect union time, secondary grafting, and reoperation rates. The establishment of a more anatomic (recreating intramedullary canal) and biomechanically favorable construct with IMNs may play a role, but further study is required. Patients treated with IMNs had faster union, fewer grafting procedures, and fewer reoperations for all causes than those treated with plates, with differences more evident in the femur.

PAPER ABSTRACTS

RIA Versus Conventional Reaming Combined With Antibiotic-Loaded Cement Spacer: A Randomized Controlled Study of Femur and Tibia Intramedullary Nail Infection Treatment

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Purpose: Studies addressing the management of infected intramedullary nailing (IMN) are mainly retrospective and with a limited number of cases. Reaming can be performed either conventionally or using the reamer/irrigator/aspirator (RIA) system. Until now there have been no comparative studies between these 2 methods. We aimed to compare the efficacy of RIA with conventional reaming (CR), followed by insertion of antibiotic-loaded cement, for the treatment of intramedullary nail infection (IMNI) of long bones. We assessed the rate of remission and control of infection between the 2 groups after 2 years of follow-up and identified microorganisms using tissue cultures and sonication of explanted IMN.

Methods: A randomized clinical trial was carried out between October 2013 and August 2015 involving 44 patients of whom a locked IMN implant of the femur and/or tibia was retrieved and who all met the clinical diagnostic and radiological criteria for IMN-associated osteomyelitis. Patients were randomized into 2 groups: RIA alone and CR followed by antibiotic-loaded cement insertion. Both groups also underwent 6 weeks of antibiotic treatment that varied according to the results of the antibiogram. Patients were evaluated after 1, 3, 6, 12, and 24 months for radiological and clinical follow-up.

Results: After 24 months, the rate of infection remission was similar between the 2 groups, 87% in the RIA group and 95.5% in the CR group ($p = 0.60$). Among 4 patients who had recurrence of infection, the time to reappearance of symptoms varied from 20 days to 1 year and 10 months. *Staphylococcus aureus* and coagulase-negative Staphylococci were isolated in 23 (40.4%) and 13 (22.9%) patients, respectively. Interestingly, we identified 20% with polymicrobial infection.

Conclusion: This study concludes that the RIA system alone is as effective as conventional reaming followed by antibiotic cement spacer in the treatment of IMN infection.

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Factors Associated With Treatment Failure of Implant-Related Infections in Fracture Patients

Lauren Ehrlichman, MD; Forrest Rackard, BS; Michael Sparks, MD; Mitchel Harris, MD; ***I. Leah Gitajn, MD***

Purpose: Infection remains relatively common after treatment of high-energy fractures and has profound implications for patient outcomes. Successful treatment algorithms for hardware-associated infections are complex and not well-established. In general, patients undergo surgical debridement with or without hardware removal followed by antibiotics. Treatment failure may result in exponentially worse outcomes and cause a limb-threatening situation. The aims of the present study were to (1) document the rate of treatment failure or recurrent infection at 3 Level I trauma centers and (2) identify risk factors for treatment failure.

Methods: 230 patients with implant-related infections following fracture fixation were identified from databases at 3 Level I trauma centers. The medical record was reviewed for demographic, treatment, and admission characteristics. The primary outcome was the need for secondary surgical debridement or hardware revision occurring at least 7 days following the presumed final procedure for the initial plan of management.

Results: In this cohort, 61 patients (27%) failed the initial course of treatment and required additional surgery for recurrent infection. Multivariate analysis revealed an independent association between treatment failure and female gender (odds ratio [OR] 0.25, 95% confidence interval [CI] 0.07-0.92), having undergone more than 1 irrigation and debridement during index treatment of the infection (OR 18.4, 95% CI 6.8-49.9), and the presence of an enterococcus infection (OR 8.4, 95% CI 1.5-46.5). Methicillin-resistant *Staphylococcus aureus* (MRSA) was not identified on univariate or multivariate regression analysis as being associated with treatment failure.

Conclusion: The rate of treatment failure of an implant-associated infection in trauma patients remains unacceptably high at nearly 30%. Factors independently associated with treatment failure in this study included gender, the need for 2 or more debridements at index diagnosis, and enterococcal infection. Unlike in the arthroplasty literature, MRSA was not independently associated with higher rate of treatment failure. Among patients who required more than 1 debridement in the initial management of the infection, 79% went on to treatment failure, suggesting that the extent of infection was not appreciated at index diagnosis. More research is needed to investigate ways to effectively treat implant-associated infection in the setting of fractures.

Are All Nonunions Infected? Comparison of Culture Versus Bacterial DNA Presence

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Purpose: Previous work suggests the majority of culture negative nonunions may be infected based upon molecular diagnostics. It is unknown if this reflects greater accuracy/ sensitivity of molecular methods over culture versus "over sensitivity" and detection of clinically irrelevant amounts of bacteria. This study compares traditional culture to molecular methods for detecting bioburden present in fracture nonunions by examining 3 groups of orthopaedic trauma patients. We hypothesized that molecular techniques would detect bacterial presence at similar rates in each group.

Methods: This was a prospective cohort study at an academic Level I trauma hospital. Using a priori inclusion criteria 3 groups of patients were enrolled: (1) closed fracture undergoing index surgery, (2) healed fracture undergoing symptomatic implant removal, and (3) fracture nonunion undergoing index nonunion procedure. Tissue from the fracture, implant removal, or nonunion site was collected during surgery and sent for culture using standard methodology or molecular analysis via detection of the 16S ribosomal RNA (present in bacteria but not humans). The chi-square test was used for categorical data and 1-way analysis of variance for continuous data with $P < 0.017$ considered statistically significant.

Results: A total of 111 surgical sites were included: 43 group 1, 41 group 2, and 27 group 3. Groups were similar with respect to age, body mass index, American Society of Anesthesiology class, gender, race, low/high-energy injury, presence of compartment syndrome, and whether preoperative antibiotics were given. The proportion of open fractures was different, with group 3 having significantly more. Cultures were positive in 2.3% of group 1 (1/43), 7.3% of group 2 (3/41), and 11.1% of group 3 (3/27) ($P = 0.32$). The 16S ribosomal subunit was detected in 23.3% of group 1 (10/43), 64.9% of group 2 (24/37), and 74.0% of group 3 (20/27) (significant, $P < 0.00002$). All positive cultures had detectable 16S ribosomal RNA.

Conclusion: As previously reported, we also found molecular methods identified bacterial presence more often than culture. However, the data show that while molecular methods detected bacteria more often in nonunions or implant removal compared to index fracture surgery, there was similar detection comparing nonunions to implant removal. It is possible that the increased frequency of bacterial detection by molecular methods is reflective of biofilm presence on metal and not clinically relevant infection responsible for nonunion.

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MRSA Carrier Rate in Orthopaedic Trauma Patients: A Prospective Cohort Study

Jordan Shaw, MD; *Christopher Whalen, MD; Joseph Mitchell, MD; Alexander Siy, BS; Christopher Doro, MD; David Goodspeed, MD; Gerald Lang, MD; Paul Whiting, MD*

Purpose: Screening for methicillin-resistant *Staphylococcus aureus* (MRSA) is commonly performed prior to elective orthopaedic surgery in order to identify carriers, enable decolonization, and ensure adequate antibiotic prophylaxis. However, due to the acute nature of orthopaedic trauma, the MRSA colonization status of these patients is often unknown at the time of surgery. The aims of this study were (1) to identify the MRSA colonization rate among patients undergoing surgical treatment by the orthopaedic trauma service, and (2) to determine if screening may be an effective tool for reducing postoperative infection in this patient population.

Methods: An MRSA screening protocol was initiated for all patients undergoing surgical treatment by the orthopaedic trauma service at an academic Level I trauma center over a 3-month period. Patient demographics, American Society of Anesthesiologists status, medical comorbidities, and tobacco/substance use were recorded. Patients with follow-up of less than 6 weeks were excluded. Patients were divided into 2 groups: “acute” (immediate or delayed definitive surgery for an acute fracture) and “non-acute.” The non-acute group included patients requiring surgical intervention for nonunion, malunion, hardware removal, infection eradication, or any other non-fracture-related condition.

Results: Our screening protocol captured 71% (175/248) of eligible patients during the study period. The overall MRSA carrier rate was 3.4% (6/175). When separated by group, the acute cohort had an MRSA carrier rate of 1.4% (2/143). Only 1 MRSA infection was identified in the acute group, occurring in a patient who tested negative for MRSA. The non-acute group had a significantly higher carrier rate at 12.5% (4/32, $P = 0.01$). In this group, a single MRSA infection occurred in an MRSA-positive patient. Compared to the acute group, the odds ratio for MRSA colonization in the non-acute group was 10.1 (95% confidence interval 1.87, 75.2).

Conclusion: There is a low MRSA colonization rate (1.4%) in patients presenting to our institution for acute fracture care. An MRSA screening protocol for this group was not found to be an efficient or cost-effective tool for reducing surgical site infection. Orthopaedic trauma patients undergoing non-acute or elective surgery have a significantly higher MRSA carrier rate (12.5%). This patient group, which includes patients with nonunion and malunion or those requiring hardware removal or infection eradication surgery, may benefit from MRSA screening. Further research is required to determine the potential benefit of MRSA decolonization prior to elective fracture-related surgery.

Preoperative Nasal Providone-Iodine Solution Effectively Reduces the Rate of Surgical Site Infection in Orthopaedic Trauma Cases

Brian Tonne, MD; *April Humphrey, RN, MSN; Scott Smith, MD; Robert Heidel, PhD; James Goodin, MD*

Purpose: The purpose of this study was to determine whether immediate preoperative application of nasal providone-iodine solution reduced postoperative surgical site infections in this cross-sectional observational study at a Level I trauma center.

Methods: We compared 2 groups of patients in order to determine the effectiveness of preoperative application of nasal providone-iodine solution for infection prophylaxis. Group I, the treatment group, consisted of 1056 orthopaedic trauma patients who received immediate preoperative application of nasal providone-iodine solution and were prospectively evaluated. Group II, the historical control group, consisted of a matched group of 1042 orthopaedic trauma patients who did not receive the application. We recorded the outcome measure of postoperative surgical site infection as defined by return to the operating room for infection or readmission for IV antibiotics. Results were compared in order to determine the effectiveness of preoperative application of nasal providone-iodine solution for infection prophylaxis.

Results: There was a statistically significant difference in the rates of postoperative infection between the groups (treatment group 7/1056, control group 24/1042, P = 0.002). Patients in the treatment group were 71.7% less likely to develop postoperative infection compared to the control group (95% confidence interval [CI] 34.0%-87.9%). In subgroup analyses evaluating only open or closed fractures, there remained significantly decreased rates of infection between groups for both open (treatment group 1/226, control group 7/171, P = 0.02) and closed fractures (treatment group 6/830, control group 17/871, P = 0.02). Patients with open fractures in the treatment group were 89.6% less likely to develop postoperative infection compared to the control group (95% CI, 14.5%-98.7%). Patients with closed fractures in the treatment group were 65.5% less likely to develop postoperative infection compared to the control group (95% CI, 12.6%-86.4%).

Conclusion: Immediate preoperative application of nasal providone-iodine solution significantly reduced the rate of postoperative surgical site infection in this cross-sectional observational study. Application was effective in cases of both open and closed fractures.

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Does Standardization of Surgical Preparation Decrease Infection Rate in Closed Fracture ORIF?

Conor Smith, BS; ***Brett Crist, MD****; David Volgas, MD; Mauricio Kfuri, MD, PhD; James Stannard, MD; Matthew Smith, MD*

Purpose: This study was undertaken to evaluate the effect of standardization of surgical preparation on the deep infection rate for open reduction and internal fixation (ORIF) of closed fractures.

Methods: As part of a quality improvement project, a total of 795 patients were identified with 893 discrete, new-onset, operatively treated closed fractures following standardization of practice for surgical preparation from September 2016 through November 2017 at an ACS Level I trauma center. A retrospective chart review included prep type, compliance with dry times of surgical prep, and the surgical procedure. Patients with multiple fractures were given separate entries for fractures that occurred at different anatomical sites. Adequate follow-up for patients to be included in the study group was a minimum of 6 weeks to identify an acute infection. The end point was return to the operating room (OR) for deep infection prior to fracture healing. Return to the OR for only nonunion/malunion was not included in the study group, unless an infection was also present. Periprosthetic fractures and re-fractures were given separate entries as new fractures. Results were recorded and stratified by rate of infections per month. Data from 2 years prior to instituting the protocol served as the historical control group. Z-test was performed for statistical analysis.

Results: 31 of the 795 patients returned to the OR for deep infection. The historical control infection rate for the previous 2 years was 5.7% (105/1827). Therefore the standardization project led to a decrease infection rate of 2.34%. A Z-test showed a statistically significant decrease in infection risk with a Z-score of 2.788 ($P = 0.003$, 95% confidence interval 0.01-1.0).

Conclusion: Standardization of surgical prep in the setting of ORIF of closed fractures significantly decreased the risk of deep infection. Standardizing the surgical prep minimizes confusion by staff who perform the prepping, and increases consistency because there is no difference between providers. These effects were seen in the setting of using an alcohol pre-prep followed by use of an alcohol-based chlorhexidine final prep.

Factors Associated With Nonunion in Patients With Open Fractures

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Purpose: The purpose of this study was to identify factors associated with increased risk for nonunion after open fracture surgery using a large prospective study.

Methods: To identify factors associated with nonunion, we used a database of 2447 participants with open upper and lower-extremity fractures previously randomized by irrigation solution and pressure. The coinvestigators selected the factors to be evaluated based on prior literature and expertise, and grouped them into the following categories: baseline patient characteristics, baseline injury characteristics, fracture characteristics, treatment characteristics, and postoperative complications. We used a multivariable logistic regression analysis to calculate adjusted odds ratios (ORs) for 14 factors that were potentially associated with an increased risk of nonunion.

Results: The analysis included 2260 patients with a mean age of 44.4 years (standard deviation 17.5) of whom 68.6% were male. There were 702 (31.1%) upper extremity, 849 (37.6%) tibia, and 709 (31.4%) non-tibia lower limb fractures. Nonunion developed in 220 fractures (9.7%). The risk factors statistically associated with nonunion were: smoking (OR = 1.40; 95% confidence interval [CI], 1.05 to 1.88), Gustilo-Anderson type III fracture (OR = 1.24; 95% CI, 1.06 to 1.46), tibia fracture (as compared to upper extremity fractures) (OR = 1.76; 95% CI, 1.07 to 2.94), bone loss (OR = 1.59; 95% CI 1.14 to 2.22), comminuted fracture (OR = 1.45; 95% CI, 1.03 to 2.03), and deep wound infection (OR = 2.85; 95% CI, 2.02 to 4.00).

Conclusion: In a large prospective dataset of open fractures, nonunion was found to be associated with patient and fracture characteristics, but not treatment characteristics. Patients with tibia fractures, comminution, type III open fractures, associated bone loss, smoking history, or who had developed a deep wound infection were most at risk for nonunion. Using current fracture management protocols of early and complete debridement, stabilization, and soft-tissue coverage, attempts to reduce infection may be expected to further decrease the risk of nonunion.

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Systemic Absorption and Nephrotoxicity Associated With Topical Vancomycin Powder for Fracture Surgery

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Purpose: The topical application of vancomycin powder during fracture surgery has been proposed as a possible method to reduce surgical site infection in orthopaedic fracture surgery. It is unknown whether vancomycin powder used in this manner results in systemic absorption. Our hypothesis was that the use of topical vancomycin powder in fracture surgery would result in low levels of vancomycin in the serum and would not result in nephrotoxicity.

Methods: A sub-study was performed as part of the VANCO study, a multicenter randomized controlled trial of the efficacy of 1000 mg of topical vancomycin powder to reduce surgical site infection after fracture fixation of high-energy tibial plateau and pilon fractures. Patients at a single site were prospectively enrolled and had vancomycin levels checked from blood drawn in the recovery room and 6-8 hours later. Serum creatinine was obtained prior to surgery, the day after surgery and at 2 weeks post-surgery. The study group included 58 patients who had vancomycin levels drawn at both time points: 56 received IV cefazolin perioperatively and 2 received IV vancomycin. The study group had an average age of 44 years and was composed of 38 tibial plateau and 20 pilon fractures. Serum creatinine was obtained in 56 patients 6-8 hours after surgery and in 46 patients 2 weeks after surgery.

Results: 0 of 56 patients who received cefazolin perioperatively (0%, 95% confidence interval [CI]: 0-4.4%) had detectable (>5 μg/mL) serum levels of vancomycin powder at 1 hour and 6-8 hours. The 2 patients who received IV vancomycin had detectable levels that were either below or within the recommended therapeutic level of 12-15 μg/mL. One patient with a prior history of elevation of serum creatinine had a minor increase of serum creatinine but had undetectable vancomycin levels. None of the other patients at any of the time points had a clinically significant increase in creatinine.

Conclusion: Despite its relatively widespread usage, there are few data regarding the systemic levels and nephrotoxicity associated with the topical use of vancomycin powder in orthopaedic fracture surgery. These prospective data indicate that there appears to be little clinical concern for toxicity associated with systemic absorption of vancomycin powder in this specific clinical application.

PAPER ABSTRACTS

Non-Preventable Venous Thromboembolism Following Pelvic and Lower Extremity Trauma Occurs Despite Adherence to Modern Prophylactic Protocols

Jason Lowe, MD; *Sean M. Mitchell, MD; Sumit Agarwal, MD; Clifford B. Jones, MD*

Purpose: The majority of venous thromboembolism (VTE) incidence data in orthopaedic trauma predates US Food and Drug Administration approval of current VTE prophylaxis (VTEp), low molecular-weight heparin. Yet despite prophylaxis, VTE is known to occur. To date no study has examined the incidence of VTE in orthopaedic trauma patients who are on modern VTEp. The purpose of this study was to describe the current incidence of VTE, pulmonary embolism (PE), and deep venous thrombosis (DVT) in patients with pelvic and lower extremity trauma. Specifically, the authors sought to determine if (non-preventable) VTE occurred in the setting of modern VTEp.

Methods: We retrospectively reviewed VTE rates of all adult trauma patients between 2010 and 2017 from a single, multicenter health-care system database. Patients were included if they underwent operative fixation of the pelvis, acetabulum, femoral neck, or intertrochanteric region, along with intramedullary nailing (IMN) of the femoral or tibial shaft. Patients with prior history of VTE were excluded. Diagnosis was confirmed by imaging when clinically indicated. Chart review verified appropriate VTEp (chemical and mechanical), or medical contraindication.

Results: 11,313 patients met inclusion criteria. There were 93 (0.82%) VTE events, 44 (0.39%) DVTs and 49 (0.43%) PEs. Each patient with VTE was determined to be on appropriate prophylaxis and thus non-preventable. All 93 patients were on mechanical prophylaxis. 81 patients were also on appropriate chemoprophylaxis while 12 had a documented medical contraindication (7 intracranial hemorrhages, 2 intra-pelvic hemorrhages, 2 aortic injuries, and 1 intra-abdominal hemorrhage). By procedure, pelvic open reduction and internal fixation (ORIF) had the highest rate of VTE at 1.65% (DVT 0.87% and PE 0.78%). Femoral IMN had a VTE rate of 1.33% (DVT 0.75% and PE 0.58%), while tibial IMN had the lowest incidence rate of 0.34% (DVT 0.17% and PE 0.17%). Among hip fractures, femoral neck ORIF had VTE, DVT, PE rates of 0.98%, 0.59% and 0.39%, and intertrochanteric ORIF had rates of 0.59%, 0.20% and 0.39%, respectively. Acetabular ORIF had rates of 0.42%, 0.0% and 0.42%.

Conclusion: Despite adherence to modern VTEp protocols, non-preventable VTE occurs in 0.82% of orthopaedic trauma patients. Incidence ranged from 0.34% to 1.65% depending on injury/fixation method with the highest rate seen in pelvic ORIF followed by femoral IMN. In the era of pay for quality performance, it is important for health systems and auditing agencies to reconcile the presence of non-preventable VTE.

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Significant Improvement in the Value of Operative Treatment of Tibial Plateau Fractures Through Surgeon Intervention

Laurence Kempton, MD; *Chris Schneble, BS; Krista Brown, MS; Anthony Sorkin, MD; Walter Virkus, MD*

Purpose: It is unclear whether cost-conscious decisions to improve value in surgical care (value:cost ratio) affect patient outcomes. Our hypothesis was that surgeon-directed reductions in tibial plateau fracture fixation surgical costs would lead to similar patient outcomes, thus improving treatment value.

Methods: This was a prospective observational study with retrospective control data. All surgically treated tibial plateau fractures from 2013 to October 2014 served as a control (Group 1). Patients receiving multiple procedures were excluded. Material costs for each case were calculated (implants, disposables, etc.). Practices were modified to remove allegedly unnecessary costs. Next, cost data were collected on similar patients from November 2014 through 2015 (Group 2). Costs were compared between groups, analyzing unicondylar fractures (UCF) and bicondylar fractures (BCF) separately. After minimum 1-year follow-up (f/u), patients were contacted to collect the following data: Patient-Reported Outcomes Measurement Information System (PROMIS) physical function (PF) and pain interference (PI) domains, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), visual analog pain scale, infection, nonunion, unplanned return to surgery, demographics, injury characteristics, and comorbidities.

Results: Group 1 included 83 BCF and 31 UCF. Group 2 included 50 BCF and 19 UCF. Median cost of BCF decreased from \$2503 to \$1938 ($P = 0.0021$), and median cost of UCF decreased from \$1645 to \$1313 ($P = 0.011$). Group 1 had 55 patients who consented to clinical f/u; Group 2 had 39. In this subset of patients, Group 2 costs were still significantly lower than those of Group 1 for BCF and UCF ($P = 0.0414$ and 0.0178, respectively). Median PROMIS PF score was 40 for Group 1 and 43 for Group 2 ($P = 0.2301$). There were no significant differences between the groups for clinical outcomes, demographics, injury characteristics, or other comorbidities. Median f/u in Group 1 was 31 months versus 15 months in Group 2 ($P < 0.0001$).

Conclusion: We have demonstrated that surgeons can improve value of operative care by reducing surgical costs while maintaining clinical outcomes. The major limitation of this study was significantly longer f/u in Group 1, which may affect clinical outcome comparisons despite our minimum 1-year f/u requirement. Research was aided by a grant from the Orthopaedic Research and Education Foundation, with funding provided by Zimmer Holdings, Inc.

Prospective Randomized Trial on Smoking Cessation in Orthopaedic Trauma Patients: Could the "Hawthorne Effect" of Carbon Monoxide Monitoring Be the Best Treatment?

Paul Matuszewski, MD; *Katherine Ordonio, BA; Nathan O'Hara, MPH; Robert O'Toole, MD*

Purpose: Smoking is common in orthopaedic trauma patients and has been associated with increased complications including poor wound healing, nonunion, and infection. However, little research has been conducted on how to best help these unique patients quit. The purpose of this study was to determine if inpatient counseling coupled with or without additional counseling could increase smoking cessation. We hypothesized that more intense counseling would perform best.

Methods: We performed a single-center, 3-arm randomized controlled prospective study. All patients who were current smokers with an operative fracture were eligible. Once enrolled, participants were randomly assigned to either a 1 "Control Group" (no counseling), 2 "Brief Counseling" (10-minute inpatient counseling), or 3 "Intense Counseling" ("brief counseling" plus follow-up during routine postoperative visits). Groups were randomized in 1:3:3 ratios and stratified by half versus full pack/day smokers. Smoking cessation, defined as 7-day abstinence confirmed by exhaled carbon monoxide, was recorded at 2, 6, 12, and 26 weeks, with 12 and 26 weeks being the primary end points. Our power analysis indicated 97 patients were needed in each counseling group. We enrolled 237--102 in the Brief Counseling, 105 in the Intense Counseling, and 30 in the Control Group.

Results: At 3 months, 30% (6/20) of Control versus 27% (19/70) and 21% (16/77) Brief and Intense Counseling groups quit smoking, respectively (P = 0.33). At 6 months, 35% of Control, and 21% and 30% of the respective counseling groups quit (P = 0.43). Overall, 26% of patients quit at 6 months. Patients were 4 times more likely to quit if they expressed high "readiness to quit" at baseline (odds ratio [OR]: 3.9, 95% confidence interval [CI] 1.5-10.2, P <0.01). When compared to historical controls of physician-directed cessation (6-14%), all groups had significantly higher rates of cessation (Control: OR 3.8, 95% CI 1.4-9.7; Brief: OR 1.9, 95% CI 1.0-3.4; Intense: OR 2.9, 95% C: 1.7-4.9; P <0.05).

Conclusion: More intense inpatient counseling in orthopaedic trauma patients did not appear to improve smoking cessation. However, all groups, including the control group, had surprisingly high levels of cessation, suggesting a large "Hawthorne effect" (a change in behavior based on being observed) from enrollment and monitoring via exhaled carbon monoxide. This unexpected result might indicate that regular measurement of exhaled carbon monoxide alone may be an inexpensive tool to improve quit rates and should be investigated further.

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3-Dimensional Virtual Reality for Pain Control in Orthopaedic Patients: A Prospective Randomized Control Study

Milton Little, MD; ***John Garlich, MD****; Adam Wright-Chisem, MD; Amber Howard, MPH; Carol Lin, MD; Charles Moon, MD; Garth Fuller, MS; Mark Vrahas, MD; Brennan Spiegel, MD, MS*

Purpose: There is increasing interest in nonpharmacologic modalities to reduce opioid use. Growing evidence suggests 3-dimensional (3D) virtual reality (VR) is an effective pain management adjunct. The purpose of this study was to compare 3D VR (VR) to a 2D audio-visual (2D) experience for postoperative pain control and opioid use in orthopaedic inpatients. We hypothesized that VR would decrease pain and opioid intake (morphine milliequivalents [MME]).

Methods: We performed a prospective randomized control trial (RCT) at a single Level I trauma center from November 2017 to July 2017. Patients with visual analog scale pain scores (VAS) >3 and an orthopaedic extremity surgery were consented and randomized to receive either VR or 2D as an adjunct to standard pain management. The VR cohort was given an immersive headset and 21 possible VR experiences while the 2D cohort utilized the hospital health and wellness TV channel for guided relaxation. The 2D cohort was an active control receiving the current standard of care for postoperative pain control. Mean VAS and opioid use (MME) were pulled from patients' charts for the 48 hours prior to enrollment and 48 hours after enrollment. Patients had 24-hour access to their assigned treatment and were instructed to use the VR or 2D treatment 3 times per day and as needed (PRN) for uncontrolled pain. Likelihood to recommend the modality was assessed on a 5-point Likert scale. VAS and MME were compared using a linear mixed model.

Results: 54 patients (2D: 30 and VR: 24) completed the study. Demographics, orthopaedic injuries, and pre-intervention VAS and MME were not significantly different between cohorts. Multivariate analysis demonstrated that VR patients could expect a post-intervention VAS score of 0.54 points lower than 2D. Post-intervention MME trended toward less opioid use in the VR cohort (78.45 vs 92.22 MME). 95% of VR patients recommended VR versus 50% in the 2D cohort.

Conclusion: In this prospective RCT pilot study, there was a statistically significant reduction in VAS pain scores in the VR group compared to the 2D intervention, and a nonsignificant trend towards decreased MME. Patients were more likely to recommend VR as a future pain management modality. Virtual reality is a novel adjunct to pain control that warrants further investigation.

Reduction in Discharge Opioid Prescription Using a Simple Calculator
***Eric Chen, MD, PhD**; Lulu Li, BS; Paul Tornetta III, MD*

Purpose: Previous work has demonstrated a poor correlation between inpatient opioid use and the amount of opioids prescribed at discharge. We hypothesize that quantity and variation in opioid prescription after fracture surgery would be reduced with implementation of a standardized, patient-specific prescription calculator based on the actual opioid use 24 hours prior to discharge (d/c).

Methods: We instituted a protocol for opioids prescribed at d/c based on the actual opioid use over the 24 hours prior to d/c. We compared a sample of patients treated 1 year prior to and 5 months after this intervention. Discharge prescriptions were a written 1 or 2-week opioid taper determined by a simple calculator tool as a function of patients' actual PRN (as-needed) opioid use over the 24 hours prior to d/c. We included patients admitted for ≥24 hours after fracture surgery discharged by the orthopaedic service. Patients discharged to a facility were excluded. We collected demographic information, inpatient opioid use, d/c prescription, protocol compliance, and prescription opioid refills. The calculator translated all medications to morphine equivalents (MME) based on our pharmacy. Follow-up prescriptions after d/c were tracked using a mandated statewide opioid registry.

Results: 41 patients (31 male, 10 female) with a mean age of 40 years (range, 12-64) who had 48 fracture surgeries were discharged after protocol implementation and were compared with 135 patients (81 male, 54 female) mean age 40 years (range, 18-73) treated prior to implementation. The most common surgical procedures patients had were open reduction and internal fixation (ORIF) ankle, ORIF tibial plateau, intramedullary (IM) nail femur, and IM nail tibia. There was no difference in the groups regarding length of stay (3.8 vs 4.4 days, $P = 0.20$) or surgical time (88 vs 91 minutes, $P = 0.80$). A 28.9% reduction in d/c opioid prescriptions was seen (454 vs 323) after the intervention ($P < 0.01$). The Pearson correlation of the pre-d/c opioid use with the d/c prescription improved from 0.46 to 0.68 after implementation. 83% of the post intervention patients used only their d/c prescription and did not get any refills. Similarly, the average amount of prescribed opioids filled per patient differed between the pre-implementation and post-implementation groups (138 vs 255, $P = 0.297$).

Conclusion: The use of a simple opioid calculator based on the actual use of PRN opioids prior to hospital discharge reduced the opioids prescribed at d/c to fracture patients by 28.9%. The calculator prints out a taper that defines by day the amount of opioids a patient can maximally take. There was no increase in the need for refills after the initial prescription.

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Hemiarthroplasty Versus Nonoperative Treatment of Comminuted Proximal Humeral Fractures: Results of the ProCon Multicenter Randomized Clinical Trial

Dennis den Hartog, MD, PhD; *Niels Schep, MD, PhD; Kiran Mahabier, MD; Gijs Iordens, MD, PhD; Aron De Zwart, BA; Michael H.J. Verhofstad, MD, PhD; Esther M.M. Van Lieshout, PhD, MSc*

Purpose: The best treatment of comminuted fractures of the proximal humerus (3-part, 4-part, and split head fractures) in the elderly is an unresolved clinical problem. Literature suggests that hemiarthroplasty may be superior to nonoperative treatment, but the scientific level of evidence is inadequate. The aim of this study was to compare the outcome of hemiarthroplasty and nonoperative treatment in elderly patients with a comminuted proximal humeral fracture.

Methods: This international randomized clinical trial enrolled patients aged 65 years or older with a comminuted proximal humeral fracture. Patients were randomized to hemiarthroplasty (HA) or nonoperative treatment and were followed for 2 years. Outcome measures included the Constant-Murley score (primary outcome), Disabilities of the Arm, Shoulder and Hand (DASH), pain (Visual Analog Scale [VAS]), quality of life (Short Form-36 [SF-36] and 3-level EuroQoL 5 dimensions [EQ-5D]), and revision operation.

Results: Between October 6, 2009 and April 26, 2017, 30 patients were assigned to HA and 28 to nonoperative treatment. Patients had a median age of 77 years, and 89% were female. According to the Hertel classification, most fractures were type 12 (41%) or 9 (27%). This was similar in both groups. The median Constant-Murley score increased from 22 (25th percentile-75th percentile, 14-32) at 6 weeks to 48 (32-63) at 24 months in the HA group, and from 26 (19-39) to 67 (53-72) in the nonoperative group. Only at 24 months, this was significantly different in favor of the nonoperative group (P = 0.020). Although pain levels did not differ significantly between the groups, a 1-point lower VAS score is reported by nonoperatively treated patients from 6 weeks onward. DASH, SF-36, and EQ-5D were similar in both groups throughout follow-up. Currently, 4 revision surgeries have been performed--conversion to a reversed shoulder prosthesis in 2 patients in the HA group and 1 in the nonoperative group. A third patient in the HA group required an ulnar nerve release.

Conclusion: The data of this randomized controlled trial do not confirm superiority of either one of the treatments compared. The only difference found was a significantly higher Constant-Murley score in the nonoperative group at 24 months. 3 out of 4 revision surgery were done in the HA group. Based on these results, HA is not indicated for all comminuted proximal humeral fractures in the elderly.

The Role of Patients' Overall Expectations of Health on Outcomes Following Proximal Humerus Fracture Repair

Rebekah Belayneh, MD; *Ariana Lott, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: A growing body of literature suggests that patient expectations may serve as an important predictor for treatment outcomes. The objective of this study is to evaluate the relationship between patients' health expectations and treatment outcomes in patients after surgical repair of proximal humerus fractures.

Methods: Patients with a displaced proximal humerus fracture who underwent open reduction and internal fixation were prospectively followed at 1 academic institution. Patient-reported functional outcome data were obtained from the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaires and patients were classified as having good functional outcomes if their DASH score was >21. DASH survey responses regarding health expectations were recorded at enrollment and converted to dichotomous variables. Two groups were formed: the high expectations group included patients who expected their health to improve in the future whereas the low expectations group included patients who were not sure if their health would improve or thought their health would worsen in the future. Shoulder range of motion for the last follow-up visit was also obtained. Statistical analysis comparing the 2 groups and their functional and clinical outcomes was performed.

Results: Overall, there were 164 patients available for analysis (mean follow-up, 22.1 months). 76 patients had low expectations and 88 patients had high expectations. The mean DASH score at the latest follow-up for patients with low expectations was 30.65 ± 22.8, whereas the mean for those with high expectations was 16.98 ± 20.6, showing a statistically significant difference. Range of motion, as measured by forward flexion, was also statistically significantly different between both groups. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for the cohort, revealing a PPV of 71.5%.

Conclusion: Patients with high expectations for their health early after injury had statistically significant greater functional outcomes as determined by the patient-reported DASH score. These high expectations also appeared to have an optimal influence on range of shoulder motion, as forward flexion differed significantly between the group with high expectations versus the group with low expectations. These data suggest attitudinal and psychological factors that affect patient expectations early on in the course of treatment may also influence patients' functional and clinical outcomes.

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Factors Predicting Poor Functional Outcomes in Patients Following Surgically Managed Proximal Humerus Fractures

Rebekah Belayneh, MD; *Ariana Lott, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to use risk-adjusted analysis to determine which patient characteristics could serve as predictors of poor outcomes in proximal humerus fracture patients treated with open reduction and internal fixation using locking plates.

Methods: Complete data were available for 115 eligible patients with a minimum 12-month follow-up. Patients were seen at routine time points, where prospectively collected patient-reported long-term functional outcome data were obtained from the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaires. Based on previous reports of population averages and minimal clinical important differences, patients were classified as having a poor outcome if their DASH was >21. Demographic data were also prospectively collected. Binomial logistic regression was performed with IBM SPSS. Adjusted odds ratios (ORs) were calculated after adjusting for age, gender, race, body mass index (BMI), Charlson Comorbidity Index (CCI), smoking status, number of fracture parts, radiographic time to heal, follow-up length, and history of psychiatric illness.

Results: The mean patient age 60.2 ± 13.4 years (range, 21-89) with average follow-up being 22.7 ± 16 months. 80 patients (69.6%) were women and 19 (16.5%)were smokers. 17 patients (14.8%) had a history of psychiatric illness. Mean DASH score for this cohort was 22.4 ± 22.0. The odds of obtaining a poor DASH score increased with race other than white (OR 1.934), higher CCI (OR 1.694), and increased number of fracture parts (OR 2.000). The ORs for other factors such as age, gender, BMI, smoking status, radiographic time to heal, follow-up length, and history of psychiatric illness were not statistically significant.

Conclusion: Patient race, CCI, and number of fracture parts all significantly influenced patient-reported functional outcomes following fixation of proximal humerus fractures. Analysis of confounding variables should be included when reporting the functional outcomes after proximal humerus fixation. Orthopaedic trauma surgeons should be aware of these factors and look for early interventions to improve patients' recovery.

Outcomes Following Open Reduction and Internal Fixation of Proximal Humerus Fractures in Diabetic Patients

Isabella Bianco, BA; *Jessica Mandel, BA; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: Patients with diabetes who sustain a fracture tend to have a longer time to union and a higher risk of complications. This study aims to examine the effect of diabetes on outcomes following open reduction and internal fixation (ORIF) of a proximal humerus fracture.

Methods: 177 patients who sustained a proximal humerus fracture and underwent ORIF with a locking compression plate were identified. Patients included in the study underwent ORIF via a deltopectoral approach, were prescribed a standard protocol of therapy, and seen on standard follow-up intervals at which time radiographic, clinical, and patient-reported functional data were obtained. Of the 177, 36 (20%) were diabetic and 141 (80%) were not. A test of 2 proportions was run between those patients with diabetes and those without to investigate differences in postoperative complications between them. Mann-Whitney-U tests were run to determine if there was a significant difference in functional outcome scores (Disabilities of the Arm, Shoulder and Hand [DASH]), range of motion, pain, age, and gender, and to determine if there was a difference in the difference between baseline and 12-month DASH scores.

Results: There was no difference in gender or age ($p = 0.545$) with 61 as the median age for both groups. Diabetic patients had both larger body mass indexes and Charlson Comorbidity Index scores than the nondiabetic patients ($P < 0.001$). Furthermore, the diabetic group had poorer functional outcomes ($U = 3751$, $P < 0.001$) and a larger difference between their baseline and their 12-month DASH scores. The median difference in DASH scores for the non-diabetic group was 10.0 whereas the median for diabetics was 28.3 ($U = 3722$, $P < 0.001$). Diabetes did not predict a greater complication rate ($P = 0.121$). With regard to range of shoulder motion, there was less active forward elevation and external rotation with the diabetic medians at 135° and 40°, respectively, and the non-diabetic medians at 155° and 45°, respectively ($U = 1958.5$, $P = 0.050$; $U = 1673$, $P = 0.033$).

Conclusion: The functional outcomes of diabetic patients who underwent ORIF of proximal humerus fractures were significantly worse than those in patients without diabetes. Diabetic patients had less active forward flexion and external rotation and a greater difference in baseline and 12-month DASH scores, indicating that the diabetic group had functional outcomes that were both worse than non-diabetics and farther away from or worse than their baseline prior to injury. Interestingly, the diabetic cohort did not have a greater complication rate than those without.

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Operative Versus Nonoperative Treatment of Humeral Shaft Fractures

Brian Cash, MD; *Elizabeth Lord, MD; Stephen Zoller, MD; Karren Takamura, MD; Devon Jeffcoat, MD; Eric Johnson, MD*

Purpose: This review was conducted to compare outcomes for operative and nonoperative treatment of humeral shaft fractures (OTA/AO 12).

Methods: Using ICD-9 codes for humerus fractures, a total of 796 patient records from a Level I trauma center between 2001 and 2015 were obtained and reviewed. Inclusion criteria were diaphyseal fractures in patients with closed physes. Patients with ipsilateral proximal or distal humerus fractures, younger than 16 years old, lost to follow-up prior to union or 6 months (whichever occurred soonest), pathologic fractures, and those presenting as nonunions were excluded. A total of 42 operative and 30 nonoperative patients met criteria. Results were analyzed using 2-tailed Mann-Whitney U tests and Fisher exact tests with significance level of $P < 0.05$. Additionally, patients were contacted and administered the Disabilities of the Arm, Shoulder and Hand (DASH) survey, asked if they would prefer the same treatment if they had an identical injury in the future, and asked to rate their satisfaction with their treatment on a 1-5 scale. A total of 20 operative and 10 nonoperative patients were surveyed.

Results: There were no significant differences in age, demographics, and OTA/AO classification between groups. Malunions, defined as angulation greater than 20° in any plane, were more common in the nonoperative group than the operative group (30% vs 0%, $P < 0.05$). Overall angulation and amount of displacement were also significantly greater in the nonoperative group ($P < 0.05$). Average time to union was 143 days for the operative group compared to 209 days for the nonoperative group ($P = 0.23$). There were no differences in the rates of nonunion, infection, radial nerve palsy, or requirement for additional operations. The patients surveyed were similar in age and demographics. The average DASH scores were 12.8 in the operative group and 18.7 in the nonoperative group ($P = 0.41$). Of note, nonoperative patients were less satisfied with their treatment ($P < 0.05$), and were more likely to indicate that they would prefer the alternate treatment strategy if they suffered a similar injury in the future ($P < 0.05$).

Conclusion: Compared to surgery, nonoperative treatment of humeral shaft fractures was associated with increased angulation, displacement, and malunions. The functional significance of these malunions is unclear. We did not find differences in time to union or presence of nonunion between the groups. While DASH scores did not significantly differ between groups, patients treated nonoperatively were less satisfied with their treatment. The reasons for dissatisfaction with nonoperative treatment warrant further investigation.

PAPER ABSTRACTS

Is There a Critical Angle That Portends Poor Functional Outcome Scores in Nonoperative Treatment of Isolated Humeral Shaft Fractures?

Brian Hill, MD; *Lisa Cannada, MD; Lauren Germany, BS; Eben Carroll, MD; Paul Tornetta III, MD; Robert Hymes, MD; Clifford B. Jones, MD; William Obremskey, MD, MPH; Brian Mullis, MD; Michael Tucker, MD; David Teague, MD; Andrew Marcantonio, DO; Robert Ostrum, MD; Michael Del Core, MD; Sarah Dawson, BS; Heidi Israel, PhD*

Purpose: Current tolerances of humeral shaft fracture radiographic malalignment are contingent on outdated research without associated functional outcomes. Our purpose was to evaluate radiographic alignment of nonoperatively treated humerus fractures and determine if there is a critical angle associated with worse outcomes.

Methods: All patients with humeral shaft fractures that were prospectively followed as part of a larger multicenter trial (Clinical Trials #01363518) were reviewed for this study. These patients were selected for nonoperative management based on the surgeon's and patient's discretion. The patients were then followed at regular clinical intervals with radiographs as well as Disability of the Arm, Shoulder and Hand (DASH) scores. The coronal and sagittal radiographic alignment of the patients was correlated with the functional outcome scores for all patients with healed fractures at 3 and 6 months utilizing the receiver operating characteristic (ROC) curve to determine if there is a critical angle associated with worse functional outcomes.

Results: There were 41 nonoperative patients that were healed and had data reported for the 3-month visit of the study. The mean age was 39 years (range, 18-65) with 17 females and 24 males. There were 58% OTA 12A, 33% B, and 9% C fractures. 56% had a fracture of their dominant arm, 38% had a high-energy injury, and 10% were work-related. There were 48 patients for the 6-month visit. The mean age was 41 years (range, 18-69) with 19 females and 29 males. There were 56% OTA 12A, 33% B, and 11% C fractures. 58% of the patients had a fracture of their dominant arm, 40% had a high-energy injury, and 8% were work-related. The ROC curve at 3 months had best fit with coronal angle of 10° (area under curve [AUC] 0.60). The DASH scores at this angle had 67% predictability at 4 with rapid increase and predictable decline in outcome measures at greater angles. The ROC curve had best fit with sagittal angle of 15° (AUC 0.67). The DASH scores had 67% predictability at 13 with rapid increase at greater angles. At 6 months the ROC curve had best fit with coronal angle of 10°(AUC 0.65). The DASH scores had 67% predictability at 3 with rapid increase at greater angles. The ROC curve had best fit with sagittal angle of 10° (AUC 0.60). The DASH scores had 67% predictability at 5 with rapid increase at greater angles.

Conclusion: In our study, poor DASH scores were observed in humeral shaft fractures at angles lower than previously accepted for nonoperative treatment. We found increased DASH scores with >15° sagittal alignment or 10° of coronal alignment at 3 months and 10° for both coronal and sagittal alignment in healed fractures at 6 months. These findings should be useful in the decision-making and guidance of patient management.

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Risk Factors and Recovery of Iatrogenic Radial Nerve Palsy Following Plate Fixation of Humeral Shaft Fractures

Benjamin Streufert, MD*; India Eaford, MS; Thomas Sellers, MD; Joseph Christensen, MD; B. Maxson, DO; A. Infante, DO; D. Watson, MD; Roy Sanders, MD; H. Mir, MD*

Purpose: Plate fixation of humeral shaft fractures presents unique challenges for fixation while protecting vital neurovascular structures. Different surgical approaches have been utilized but large studies comparing rates of iatrogenic nerve injury and recovery with common surgical approaches are unavailable. The goal of this study was to analyze the incidence of nerve injury and recovery associated with the different surgical approaches for fixation of humeral shaft fractures.

Methods: A retrospective review of our orthopaedic trauma registry at 2 trauma centers identified extra-articular humeral shaft fractures treated with plating. Pathologic fractures and patients under 18 years of age were excluded. Chart review identified rates of nerve injury, fracture location, palsy resolution, fracture union, and complications. Descriptive statistics and analyses of variance are reported.

Results: From 2008 to 2016, 253 plated extra-articular humeral shaft fractures met inclusion criteria. The rate of preoperative nerve palsy was 17.8% (45/253), with radial nerve palsy (RNP) present in 17.4% (44/253), ulnar palsy in 3.1%, and median palsy in 1.6%. Iatrogenic (postoperative) RNP occurred in 12.0% and iatrogenic ulnar palsy in 1.2%. No iatrogenic palsies occurred in proximal one-third fractures. Of the 58 middle-third fractures, iatrogenic RNP occurred in 14% overall and in 25% of posterior triceps-sparing, 17% posterior triceps-splitting, and 11% anterolateral approaches (P =0.56). Of the 103 distal one-third fractures, iatrogenic RNP occurred in 16.5% overall and 18.8% posterior triceps-sparing and 12.1% triceps-splitting approaches (P = 0.39). Follow-up data were available for 118 patients at an average of 11 months (range, 3-96). Preoperative RNP fully resolved in 58% (14/24) at an average of 5 months (range, 1-12); 4 patients required tendon transfers and 1 wrist fusion. Iatrogenic RNP fully resolved in 78% (14/18) at an average of 5 months (range, 1-12); no patients underwent tendon transfer. Rates of postoperative complication and fracture union did not differ based on surgical approach.

Conclusion: Plate fixation of humeral shaft fractures carries a significant risk of injury to neurovascular structures, most commonly the radial nerve. The risk of iatrogenic RNP is significant with all commonly utilized surgical approaches for middle and distal-third fractures. Rates of resolution of preoperative and iatrogenic postoperative RNP palsy are similar. Most patients gain full recovery but a significant subset require late tendon transfers.

Case-Match Controlled Comparison of Minimally Invasive Plate Osteosynthesis and Open Reduction and Internal Fixation for the Stabilization of Humeral Shaft Fractures

Kevin Tetsworth, MD; *Matthew Randell, MBBS; Vaida Glatt, PhD*

Purpose: This study was undertaken to compare minimally invasive plate osteosynthesis (MIPO) to open reduction and internal fixation (ORIF) for humeral shaft fractures, to determine which technique minimized complications while optimizing clinical outcomes.

Methods: This was a retrospective case-match controlled cohort from a tertiary referral trauma center. All patients with humeral shaft fractures between April 2010 and September 2015 were identified, a total of 123 fractures. Of these, 31 were treated by MIPO and 54 by ORIF. Indications for surgical management included polytrauma, floating elbow, and failure of nonoperative treatment. A case-matched cohort was assembled according to fracture pattern, gender, age, and comorbidities, with a total of 56 patients (28 per group). The pooled complication rate was the primary outcome measure (radial nerve injury, nonunion, infection, prominent implants, and reoperation). Radiographic alignment and the Disabilities of the Arm, Shoulder and Hand (DASH) score were secondary outcome measures.

Results: Cumulative complication rates were 3.6% following MIPO and 42.9% after ORIF (P = 0.0004). The mean DASH score following MIPO was 17.0 ± 18.0, and after ORIF was 24.9 ± 19.5, but this difference was not significantly different (P = 0.140). The mean coronal plane angulation following MIPO was 1.8° ± 1.3°, and after ORIF was 1.0° ± 1.2° (P = 0.022). The mean sagittal plane angulation following MIPO was 3.0° ± 2.9°, and after ORIF was 1.0° ± 1.2° (P = 0.002). These radiographic findings were not considered clinically meaningful.

Conclusion: The cumulative complication rate was 12 times higher following ORIF of humeral shaft fractures compared to MIPO. MIPO achieved nearly equivalent radiographic alignment, with no clinically meaningful differences observed. Although the patient-reported DASH score was better after MIPO, this difference was not significant. This study demonstrates MIPO of humeral shaft fractures can achieve highly comparable clinical results with a dramatically lower risk of postoperative complications compared to ORIF. It is an attractive treatment option for those patients with humeral shaft fractures unsuitable for nonoperative management.

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Risk Factors for Elbow Joint Contracture Following Operative Repair of Traumatic Elbow Fracture

Kurtis Carlock, BS*; Isabella Bianco, BA; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The ability to predict contracture development following traumatic elbow injury would benefit patients and physicians. This study aimed to identify factors associated with the development of posttraumatic elbow joint contracture.

Methods: A retrospective review of elbow fractures (OTA/AO type 13 and 21) treated at 1 institution over 4.5 years was performed. Data collected included demographics, injury information, treatment, and postoperative elbow range of motion. A multivariate analysis was performed using logistic regression to identify factors associated with contracture development. Significant contracture was defined as an arc of motion (AOM) <100° flexion-extension associated with reduced ability to perform activities of daily living.

Results: 278 patients at least 18 years of age underwent operative repair of an elbow fracture or fracture dislocation during the study period and had at least 6 months of postoperative follow-up. 37 (13.3%) developed a clinically significant elbow contracture. Multivariate analysis demonstrated that multiple noncontiguous fractures (odds ratio [OR] 5.02, P = 0.010), ulnohumeral dislocation at time of injury (OR 5.09, P = 0.012), and limited elbow AOM at 6 weeks postoperatively (OR 0.94, P <0.0005) were associated with contracture development after controlling for possible confounding variables.

Conclusion: Ulnohumeral dislocation, multiple fractures, and limited elbow AOM at 6 weeks postoperatively are associated with significant contracture development following operative elbow fracture repair. Patients with these risk factors should receive aggressive physical therapy and be counseled as to the possible development of a contracture requiring intervention.

Regional Anesthesia Improves Early Range of Motion Following Operative Repair of Traumatic Elbow Fractures

Kurtis Carlock, BS; *Isabella Bianco, BA; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: Peripheral nerve blocks have seen an increase in use during upper extremity orthopaedic trauma surgery. The purpose of this study was to determine if the use of a peripheral nerve block during surgical repair of elbow fractures was associated with improved postoperative elbow range of motion and functional outcomes after controlling for fracture type.

Methods: A retrospective review of patients who sustained elbow fractures (AO/OTA type 13 and 21) treated at a single institution between March 2011 and September 2015 was performed. Data collected included patient demographics, injury information, surgical management, anesthesia type, postoperative elbow arc of motion (AOM), and complications (infection, hardware failure, nonunion, contracture). Mayo Elbow Performance Index (MEPI) scores were calculated at latest follow-up for each patient. Data were analyzed using 1-way analysis of covariance (ANCOVA) tests and logistic regression to control for fracture type based on the AO/OTA fracture classification system.

Results: There were 285 surgically repaired elbow fractures with at least 6 months of postoperative follow-up treated during the study period. Of these, 52.6% (150/285) received a peripheral nerve block during operative repair. Average duration of follow-up was 11.2 months (range, 6-62 months) for patients who received a nerve block and 13.9 months (range, 6-84 months) for patients who did not (P = 0.027). There were no differences in age, sex, body mass index, or Charlson Comorbidity Index between groups. Patients who received an upper extremity peripheral nerve block had significantly greater elbow AOM at 3 months postoperatively (P = 0.036) and improved MEPI scores at latest follow-up (P = 0.008) after controlling for fracture type. There were no differences between groups with respect to elbow AOM at 6 months (P = 0.127), 12 months (P = 0.089), or latest follow-up (P = 0.066). Additionally, there was no difference in the frequency of postoperative complications between groups (P = 0.397).

Conclusion: In this cohort, peripheral nerve block during operative repair of a traumatic elbow fracture was associated with improved early elbow range of motion and better functional outcome at latest follow-up.

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Ketotifen Fumarate Does Not Impair Fracture Healing When Used for Reduction of Posttraumatic Elbow Joint Contracture

Prism Schneider, MD, PhD; *Alexandra Garven, BSc; Stephanie Yee, BSc; Tanja Harrison, MPA; Kevin Hildebrand, MD*

Purpose: Our prior research has established that a myofibroblast-mast cell-neuropeptide axis underlies the joint capsule fibrosis associated with posttraumatic joint contractures (PTJCs). Ketotifen fumarate (KF), a mast cell stabilizer, decreased PTJCs, concomitant with decreased measures of fibrosis, in our rabbit model and is being studied for clinical utility for PTJC reduction. However, concern exists regarding the effect of mast cell inhibition on fracture healing. This study aimed to quantify fracture healing in patients with fractures about the elbow treated with ketotifen compared with placebo.

Methods: This is a subgroup analysis of a larger multicenter, placebo-controlled, randomized clinical trial comparing 6 weeks of oral KF 5 mg twice daily to a lactose placebo for distal humerus and proximal radius ± ulna fractures. Radiographs were reviewed at each follow-up time point by an independent radiologist to assess osseous union. Statistical analysis consisted of chi-square for categorical variables and t-tests for continuous variables.

Results: 105 patients were analyzed (53 KF, 52 placebo) at 12-week follow-up. 55 patients were treated nonoperatively (52%), at the discretion of treating surgeons. There was no difference between groups for the mean age (47.9 ± 12.1 years for KF vs 50.7 ± 17.1 years for placebo), sex (60% male for KF vs 46% for placebo), injury classification, or surgical treatment (all $P > 0.05$). At 12-week follow-up, only 17% of patients had complete resolution of visible fracture lines on AP, lateral, and oblique radiographs in the KF group, and 15% in the placebo group ($P = 0.8$). By 52-week follow-up, 77% of patients treated with KF ($N = 39$) and 89% of patients in the placebo group ($N = 36$) had complete resolution of any visible fracture lines ($P = 0.2$). Persistent fracture lines were most commonly reported on oblique radiographs for both groups. Only 1 patient required surgical treatment for nonunion and that patient was in the placebo group.

Conclusion: There was no difference in rate of fracture healing for patients with fractures about the elbow treated with ketotifen compared with placebo. There was only 1 patient who required surgical intervention for nonunion (placebo group). This study further supports the safety profile for KF use for PTJC reduction.

PAPER ABSTRACTS

A Prospective, Longitudinal, Multicenter Cohort Study to Determine the Factors Affecting the Functional Prognosis of Radial Head Fractures

Stephane Pelet, MD, PhD; *Benoit Lechasseur, MD*

Purpose: Radial head fractures are common and mainly require a functional conservative treatment. About 20% of patients will present an unsatisfactory final functional result. There is, however, little data allowing us to predict which patients are at risk of bad evolve. This makes it difficult to optimize our therapeutic strategies in these patients. The aim of this study is to determine the personal and environmental factors that influence the functional prognosis of patients with a radial head fracture.

Methods: We realized over a 1-year period a prospective observational longitudinal cohort study including 125 consecutive patients referred for a fracture of the radial head in a tertiary trauma center. We originally collected the factors believed to be prognostic indicators: age, sex, socioeconomic status, factors related to trauma or fracture, alcohol, tobacco, detection of depression scale, and financial compensation. A clinical and radiological follow-up took place at 6 weeks, 3 months, 6 months, and 1 year. The main functional measurement tool is the Mayo Elbow Performance Score (MEPS) and the Disabilities of the Arm, Shoulder and Hand (DASH).

Results: 123 patients were included in the study. 114 patients required nonsurgical management. 102 patients completed the 1-year follow-up for the main outcome (89 for the DASH score). Two patients required an unplanned surgery and were excluded from analyses. At 1 year, the average MEPS was 96.5 (range, 65-100) and 81% of subjects had an excellent result (MEPS $\geq$90). The most constant factor to predict an unsatisfactory functional outcome (MEPS <90 or DASH >17) is the presence of depressive symptoms at the initial time of the study ($P = 0.03$ and $P = 0.0009$, respectively). This factor is present throughout the follow-up. Other observed factors include a higher socioeconomic status ($P = 0.009$), the presence of financial compensation ($P = 0.027$), and a high-velocity trauma ($P = 0.04$). The severity of the fracture, advanced age, female sex, and the nature of the treatment does not influence the result at 1 year. No factor has been associated with a reduction in range of motion.

Conclusion: The vast majority of the radial head fractures heal successfully. We identified for the first time, with a valid tool, the presence of depressive symptoms at the time of the fracture as a significant factor for an unsatisfactory functional result. Early detection is simple and fast and would allow patients at risk to adopt complementary strategies to optimize the final result.

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Is Cheaper Always Better for Clavicle ORIF?

Kyle Schweser, MD; *Gregory Della Rocca, MD, PhD; David Volgas, MD; James Stannard, MD; Brett Crist, MD*

Purpose: This study was conducted to determine the clinical outcomes of a single 2.7-mm non-locking plate compared to anatomically precontoured and 3.5-mm plates including cost and secondary surgery rate.

Methods: After IRB approval, a retrospective CPT code search was performed for treatment of clavicle fractures from September 1, 2005 to July 1, 2016. Inclusion criteria included patients over 18 years old who were treated with plate fixation within 8 weeks of injury, and survived their hospital course. Exclusion criteria included revision surgery, distal and medial clavicle fractures, and intramedullary nailing open reduction and internal fixation (ORIF). Data points included the primary construct used, secondary surgery rate, and the reason for secondary surgery. The list price for a standard construct including precontoured anatomical plating constructs from multiple vendors, as well as 2.7-mm and 3.5-mm reconstruction non-locking constructs was obtained. Chi-squares and Fisher exact tests were used on all data collected.

Results: After inclusion/exclusion criteria were applied, 469 clavicles were identified--176 precontoured plates, 219 2.7-mm plates, and 74 3.5-mm reconstruction plates. Although fracture type varied, all fractures met the classic indications for ORIF clavicle. Average follow-up was similar. Secondary surgery rates for precontoured and mini-fragment plates were similar (9.7% and 9.1%), with similar hardware removal versus revision ORIF (5% vs 5%, 4% vs 4%), while reconstruction plates had a much higher revision rate (27.6%). There was no significant difference between precontoured and mini-fragment plating regarding secondary surgery. Cost differences varied between implant companies. Cost difference for 2.7-mm non-locking plates ranged from $10 to $1800 between vendors. The difference increased to a range of $700 to $2600 for precontoured locking constructs. Reconstruction plate constructs were similar in cost to 2.7-mm plates.

Conclusion: There were no significant differences between precontoured and 2.7-mm non-locking plates in terms of hardware removal or revision ORIF. Our study confirmed that 3.5-mm reconstruction plates have an unacceptably high failure rate when compared to other plating constructs. 2.7-mm plates were cheaper than their precontoured locking counterparts. With the cost of health care at the forefront of medical discussions, 2.7-mm plating should be considered for clavicle fractures, due to lower cost and similar reoperation rates when compared to precontoured locking plates.

Efficacy of Multimodal Analgesic Injections in Operatively Treated Ankle Fractures
Kyle Hancock, MD; *Olivia Rice, BS; Natalie Glass, PhD; Matthew Karam, MD; J. Lawrence Marsh, MD; Michael Willey, MD*

Purpose: The purpose of this study is to evaluate the effectiveness of a periarticular multimodal injection (MMI) as an adjunct to postoperative pain management in patients with operatively treated, closed, rotational ankle fractures. We hypothesized that the MMI will result in significantly reduced pain scores, lower narcotic requirements, and shorter length of stay.

Methods: Patients indicated for operative fixation of closed, rotational ankle fractures (OTA 44A-C) were randomized to receive MMI (ropivacaine 200 mg, epinephrine 0.6 mg, and morphine 5 mg) or no injection (control). Visual analog pain scale (VAS) scores were collected in the recovery unit and then mean VAS scores and total morphine equivalent doses (MEDs) were collected every 4 hours until discharge from the hospital. Patients responded to automated text messages to report VAS and opioid usage during the first 2 weeks after discharge.

Results: 67 patients were enrolled (31 MMI; 36 control). Demographic data between the 2 groups were similar with no statistically significant differences in age, sex, or gender proportions. Median preoperative pain scores were also similar (4 for MMI, 3 for control, $P = 0.57$). VAS scores in the PACU (post-anesthesia care unit) immediately postoperatively were 2.4 ± 3.4 and 4.3 ± 3.8 in the MMI and control groups ($P = 0.11$). Mean VAS from PACU to 24 hours postoperatively were 4.0 ± 1.6 and 5.1 ± 3.0 in the MMI and control groups ($P = 0.08$). Mean opioid requirements over the first 24 hours postoperatively were 5.6 ± 3.9 and 6.0 ± 3.4 MEDs per 4-hour period ($P = 0.19$), total per patient narcotic requirements from the time of PACU admission to discharge were 30.0 and 33.0 MEDs ($P = 0.34$), and total average narcotic consumption for the first 2 weeks after discharge was 109.48 and 144.45 MEDs ($P = 0.72$) for the MMI and control groups, respectively. Length of stay in hours was 22.7 for the MMI group and 22.9 for control group ($P = 0.41$). For those patients who participated in the text messaging follow-up, response rate for the post-discharge automated text messages was 89.3%.

Conclusion: Use of MMIs in operative ankle fractures demonstrates an insignificant trend toward lower pain scores in the immediate postoperative period and over the initial 24 hours postoperatively. The use of these injections also insignificantly trends toward lower opioid requirements over the first 24 hours postoperatively. Use of these injections does not appear to affect length of stay or long-term narcotic consumption. Automated text messaging was an effective means of following postoperative pain levels and analgesic requirements.

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Does Intraoperative Multidimensional Fluoroscopy Lead to Syndesmotic Reduction Changes Compared to Conventional Fluoroscopy?

Bryce Cunningham, MD; *Stephen Warner, MD, PhD; Marschall Berkes, MD; John Munz, MD; Andrew Choo, MD; Timothy Achor, MD; Milton Routt, MD; Joshua Gary, MD*

Purpose: Despite multiple techniques to improve syndesmotic reduction accuracy, syndesmotic malreduction remains prevalent. We performed a prospective, observational study to assess the ability of intraoperative multidimensional fluoroscopy to lead a surgeon to change in syndesmotic reduction obtained by conventional fluoroscopic techniques with the goal of achieving an anatomic reduction.

Methods: Patients with unilateral syndesmotic instability were enrolled. Following fixation of the malleoli fractures, the syndesmosis was provisionally reduced. Once the surgeon believed excellent reduction was obtained by comparing to the contralateral, uninjured ankle fluoroscopic images, provisional fixation was used to maintain reduction. Intraoperative, multidimensional fluoroscopy generated cross-sectional images to assess the reduction. The surgeon then decided if a change in the reduction was needed, and fixation proceeded per surgeon preference. Postoperative bilateral ankle CT scans were used to assess the reduction.

Results: In 12 of 22 cases (55%), the surgeon elected to change the initial syndesmotic reduction obtained using the conventional technique after multidimension fluoroscopy was performed. This resulted in a low overall malreduction rate of 14% (3/22).

Conclusion: Intraoperative multidimensional fluoroscopy provides the surgeon information that frequently leads to changes in syndesmotic reduction, resulting in a low malreduction rate. Multidimensional fluoroscopy appears to improve the ability to accurately assess intraoperative syndesmotic reduction.

Pilon Fractures in Elderly Patients: Should We Be Fixing These?

Justin Haller, MD; *Michael Githens, MD; David Rothberg, MD; Thomas Higgins, MD; Sean Nork, MD; David Barei, MD*

Purpose: Pilon fractures are associated with high rates of complication and reoperation. With the damage to the cartilage from injury and limited healing capacity in older patients, both acute arthrodesis and open reduction and internal fixation (ORIF) have been proposed as appropriate treatments. Given the guarded prognosis of this injury in the elderly we sought to compare outcomes in elderly patients (>60 years of age) with younger patients.

Methods: We retrospectively reviewed pilon fractures (OTA 43-B and 43-C) treated at 2 academic Level I trauma centers from 2006-2016. Our inclusion criteria were patients >18 years of age with 12 months minimum follow-up. Our primary outcome was failure defined as either nonunion or significant radiographic arthrosis. Nonunion was defined as failure to achieve cortical bridging on at least 3 cortices on orthogonal radiographs with pain after 9 months, catastrophic implant failure, or failure of radiographic progression on sequential visits at least 2 months apart. Arthrosis was defined as Marsh grade 2 or 3 on standing ankle radiographs. Infection and malunion were also compared. We performed multivariate regression for factors potentially associated with nonunion and arthrosis.

Results: 488 patients met inclusion criteria with 67 patients in the elderly group (mean age, 66 years) and 421 patients in the younger group (mean age 44 years) (P <0.001). Besides tobacco use being significantly more common in the younger group, patient demographics and fracture characteristics including mechanism, compartment syndrome, open fracture, OTA/AO classification, and bone loss did not differ between the groups. Locking plates were used significantly more in elderly patients (47% vs 32%, P = 0.01). Using chi-square analysis, we were unable to detect a difference in treatment failure (elderly 43% vs young 37%, P = 0.33), infection (elderly 10% vs young 13%, P = 0.4), or malunion (elderly 3% vs young 4%, P = 1.0). Using regression analysis, age >60 years was not associated with treatment failure (odds ratio [OR] 1.2 [confidence interval 0.7-2.1], P = 0.52). Bone loss (OR 2.7 [1.8-4.1], P <0.001), open fracture (OR 1.6 [1-2.5], P = 0.03), and malreduction (OR 4.2 [2.5-7.3], P <0.001) were all associated with treatment failure.

Conclusion: Age >60 years is not an independent predictor of surgical treatment failure of pilon fractures as defined by nonunion or arthrosis when compared to a younger cohort. Treatment failure in our patients was influenced by bone loss, open fracture, and malreduction. This is the largest cohort of this fracture in elderly patients and indicates that we should continue to treat elderly patients similar to their younger counterparts using ORIF as the primary treatment option.

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Evaluating the Educational Utility of 3D Printing for Preoperative Planning in the Treatment of Periarticular Fractures

Kevin Phelps, MD; *John Ruder, MD; Rachel Seymour, PhD; Joshua Patt, MD; Madhav Karunakar, MD; Stephen Sims, MD*

Purpose: This study was conducted to assess the feasibility and utility of preoperative planning using a 3D-printed periarticular fracture model in the education of orthopaedic surgery residents.

Methods: A stratified, randomized controlled study involving 20 orthopaedic surgery residents was performed. A complex pilon fracture with articular impaction and metaphyseal extension was 3D-printed and a standardized preoperative plan was developed. The preoperative plan was divided into a series of 4 distinct components based on reduction and fixation of the main fracture fragments. Residents were randomized into 1 of 2 groups. One group performed routine preoperative planning (routine group--lecture, radiographs, 2D and 3D CT) while the other group practiced plan execution on a 3D-printed construct in addition to routine preoperative planning (3D group). All residents then performed video-recorded fixation of the 3D-printed pilon model in a simulated operative environment while wearing gloves and a black long-sleeved shirt. Resident performance was evaluated using hand motion captured by a Qualysis motion capture system and by fellowship-trained orthopaedic surgeons who were blinded to the group allocations and the resident being evaluated. The video reviewers completed procedural checklists, time-to-completion records, objective structured assessment for technical skills (OSATS) checklists, and global rating scale (GRS) forms for each resident. Residents were also given questionnaires to assess their opinions on the impact of the model.

Results: 20 orthopaedic surgery residents participated in the study for a total of 10 in each group. 3 residents in the 3D group completed fracture fixation of the model within the 45-minute allotted time. Cumulative hand motion distance was similar between groups (241 vs 229 m, P = 0.36). The 3D group had better overall performance on 3 of the 4 components involved in fracture fixation and had more constructs that were deemed to be acceptable reductions (6 vs 0, P = 0.009). The average GRS was significantly higher in the 3D group (3.0 vs 1.7, P = 0.0095). Those residents in the 3D group outperformed the routine group on the GRS in all areas except principles of fracture fixation and definitive fixation. Resident opinions of the model were widely positive, with 80% recommending the model as an educational tool prior to actual complex cases.

Conclusion: The use of 3D-printed fracture models for preoperative planning improved resident performance in a simulated operative environment.

Outcomes After Heel Pad Degloving

Andrew Chen, MD, MPH; *Jason Luly, MS; The METRC*

Purpose: The best strategy for heel degloving injuries remains unclear. Reconstruction is challenging and requires adequate soft-tissue coverage, a stable heel, and a durable weight-bearing surface. We hypothesized that patients who require a fla, would have had better outcomes if they undergone amputation.

Methods: The study included patients aged 18-60 years with open pilon, ankle, and/or foot fractures with heel degloving treated with primary/secondary skin closure (n = 69) or flap (n = 31), and transtibial amputees (n = 112) enrolled in 1 of 2 prospective multicenter studies. Primary outcome was patient-reported function measured by the Short Musculoskeletal Function Assessment (SMFA) at 18 months. We compared observed outcomes for those requiring (1) flap and (2) skin closure to outcomes they would have had been expected to have if they had undergone amputation. This causal analysis assumes that, after accounting for baseline characteristics and non-study injuries, there are no more factors associated with both an individual's outcome after amputation and the treatment decision. A 9-point difference was considered clinically meaningful.

Results: SMFA was captured on 53 patients (77%) with skin closure, 20 (65%) with flaps, and 87 (78%) amputees. For all domains, outcomes were predicted to be better under amputation, regardless of coverage. With the exception of dysfunction, flap patients were estimated to have clinically meaningful improvements had they undergone amputation. The largest differences were observed in mobility (10.6) and bother (10.6). For patients who underwent skin closure, the estimated differences were not clinically meaningful.

Conclusion: This study suggests that for heel degloving that requires a flap, patient-reported outcomes may be improved with amputation.

	Primary/Secondary Closure			Flap Closure		
SMFA Domain	Observed Mean (SD)	Predicted Mean under Amputation Mean (SD)	Difference in Means* (95%CI)	Observed Mean (SD)	Predicted Mean under Amputation Mean (SD)	Difference in Means** (95% CI)
Mobility	38.7 (21.8)	29.9 (5.6)	8.8 (0.1, 17.6)	43.1 (20.1)	32.4 (13.3)	10.6 (-0.8, 22.0)
Dysfunction	28.7 (16.6)	23.3 (4.4)	5.4 (-1.7, 12.4)	32.1 (14.4)	24.9 (8.7)	7.3 (-1.5, 16)
Daily Activities	35.1 (23.9)	27.1 (6.3)	8 (-1.9, 17.9)	38.3 (19.6)	29.0 (13.0)	9.3 (-2.8, 21.3)
Bother	26.4 (17.5)	22.9 (4.0)	3.5 (-4.4, 11.4)	34.5 (20)	23.9 (6.7)	10.6 (-0.7, 21.9)
Emotional	35.7 (21.6)	30.3 (3.8)	5.4 (-3.4, 14.3)	41.1 (22.8)	31.8 (7.9)	9.3 (-3.2, 21.7)

*The difference between the average observed SMFA scores for heel degloving patients treated with primary or secondary closure and the average estimated SMFA score for those same patients had they underwent amputation

** The difference between the average observed SMFA scores for heel degloving patients treated with flap closure and the average estimated SMFA score for those same patients had they underwent amputation

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Platelet-Rich Plasma for Acute Achilles Tendon Rupture:
A Double-Blind Multicenter Randomized Placebo-Controlled Trial

David Keene, PhD; ***Joseph Alsousou, PhD****; Paul Harrison, PhD; Philippa Hulley, PhD; Susan Wagland, PhD; Scott Parsons, PhD; Jacqueline Thompson, MPH; Michael Schlüssel, PhD; Susan Dutton, MSc; Sarah Lamb, PhD; Keith Willett, MBBS*

Purpose: Slow recovery and disability after Achilles tendon rupture are major challenges. Improving the rate and quality of repair tissue is desirable. Platelet Rich Plasma (PRP) is an autologous supraphysiological concentration of platelets from whole blood that has demonstrated positive cellular and physiological effects on healing in the laboratory. The appeal of PRP as a therapy has resulted in its use in musculoskeletal treatments. However, evidence from adequately powered robust clinical trials is lacking. We aimed to determine the clinical efficacy of PRP for treatment of acute Achilles tendon rupture.

Methods: We randomized 230 adults starting Achilles rupture non-surgical management within 12 days of injury from 19 trauma units between July 2015 and September 2017. Patients with confounding or contraindicated concurrent medical conditions were excluded. Participants were randomized to a PRP injection or dry needle insertion to the rupture gap under local anaesthetic. Participants were blinded to the study treatment and received standardized rehabilitation. Blinded outcome assessments were at 4, 7, 13, and 24 weeks. Muscle-tendon function assessed by the heel-rise endurance test (HRET) and measured with the Limb Symmetry Index (LSI) (0-100%; 100% denotes full recovery) at 24 weeks was the primary outcome. Secondary outcomes were the Achilles Tendon Rupture Score (ATRS), quality of life (SF-12), pain and goal attainment. Whole blood and PRP samples were analysed at a central laboratory. The trial was prospectively registered.

Results: Of 230 participants randomized, 114 were randomized to PRP injection; 103 received PRP, while 116 received placebo. At 24 weeks, 201/230 (87%) completed the HRET and 214/230 (93%) completed patient reported outcomes (PROs). One participant withdrew. Participant characteristics between the arms were similar.
There was no difference between PRP and placebo groups at 24 weeks in LSI (mean difference = -4.373; 95% CI -11.217 to 2.471; p=0.195), ATRS, SF-12 or in pain or goal attainment, or in the PROs at 4, 7 and 13 weeks. There was no correlation with blood or PRP components to LSI or PROs. Complications were distributed evenly between groups. A 2-year follow-up will complete in April 2020.

Conclusion: This trial design and standardized PRP preparation secure the first robust clinical trial evidence to define the role of PRP in managing Achilles tendon rupture, and suggest that PRP offers no patient benefit. The use of PRP in soft tissue injuries must be questionable unless supported by equally robust evidence indicating positive outcomes.

Physiotherapy, Advice Sheet, or Video Following Nonoperatively Managed Distal Radius Fractures: A Randomized Controlled Trial

Timothy Coughlin, MBBS; *Paul Matthews, PhD; Brigitte Scammell, PhD; Benjamin Ollivere, MD*

Purpose: Around 71,000 adults sustain a distal radius fracture (DRF) in Britain each year. Many patients have persisting symptoms with 8% to 11% reporting pain and 16% disability rated as moderate to severe at 1 year. There is no consensus on whether physiotherapy interventions improve outcomes and which mode of advice is best delivered to patients. There is also increasing use of video as a means to provide advice, but there is virtually nothing published to support the efficacy of this as an intervention.

Methods: A 3-arm equivalence randomized controlled trial (RCT) of 120 participants was conducted, to examine whether the mode of delivery of physiotherapy advice affects outcomes comparing 3 methods: leaflet, video, and in-person physiotherapy. The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 6 weeks post intervention. All nonoperatively managed DRFs were included with the only exclusion criteria being evidence of complex regional pain syndrome and excessive finger stiffness.

Results: In-person physiotherapy showed a statistically significant difference in function at work on the DASH for those patients in work at 6 weeks compared to leaflet ($P < 0.01$). The difference in mean score was 17 and is therefore highly likely to be clinically relevant. Most patients were happy with all 3 interventions and would pick the same interventions again. However, there was a significant difference in satisfaction scores in favor of in-person physiotherapy ($P = 0.04$). There was no significant difference in the standard DASH score 6 weeks post intervention and there was a narrow range of mean DASH scores between the groups of 12 to 15 (standard error of measurement [SEM] 2.5). Secondary outcomes (Patient Evaluation Measure [PEM], EuroQol 5 Dimensions [EQ-5D], range of motion [ROM], and grip strength) were not significantly affected by intervention.

Conclusion: This RCT shows that in adult patients who sustain a DRF, in-person physiotherapy significantly improves in work function at 6 weeks compared to leaflet and shows higher patient satisfaction. However, in those who show no signs predictive of a complicated recovery, simple advice provided by leaflet or video is as effective as in-person physiotherapy at 6 weeks on all other measures of function.

Is Routine Radiography in the Follow-up of Trauma Patients With Distal Radius Fractures (Cost) Effective?

Pieter van Gerven, MD; *Mostafa El Moumni, MD, PhD; Wietse Zuidema, MD; Sidney Rubinstein, PhD; Pieta Krijnen, PhD; Maurits van Tulder, PhD; Inger Schipper, MD, PhD; Marco Termaat, MD, PhD*

Purpose: The clinical consequences of follow-up radiographs in wrist fractures are unclear and indications for these radiographs are seldom well-defined. Routine radiographic imaging in the follow-up of patients with a distal radius 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 Disabilities of the Arm, Shoulder and Hand (DASH) and Patient-Rated Wrist/Hand Evaluation (PRWHE) questionnaires; quality of life was measured with the 3-level EuroQol 5 Dimensions (EQ-5D-3L) and Short Form-36 (SF-36) questionnaire. 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 326 participants, of which 41 (13%) received operative treatment. Patients in the reduced imaging group received on average 3.3 radiographs, while patients in the usual care group received on average 4.3 radiographs (P <0.005). DASH and PRHWE scores, quality of life, pain levels, health perception, and self-perceived recovery did not differ between groups. We observed 18 complications in the reduced imaging group. This did not differ significantly from the usual care group (19 complications; P = 0.96). A significant reduction in radiographic imaging costs was observed (-€48 per patient, 95% confidence interval [CI] -68 to -27). Overall costs per patient were €400 lower in the reduced imaging group (95% CI -2453 to 1251).

Conclusion: Implementation of a reduced imaging protocol in the follow-up of distal radius fractures leads to cost savings and more importantly does not lead to worse functional outcomes. Given the large number of people who suffer from a distal radius fracture annually, this reduction in routine follow-up radiographs could have a substantial economic impact.

Volar Plate Fixation in Adults With Displaced Extra-Articular Distal Radius Fractures Is Cost-Effective

Marjolein Mulders, MD, PhD*; Monique Walenkamp, MD, PhD; Susan van Dieren, PhD; J. Carel Goslings, MD, PhD; Niels Schep, MD, PhD*

Purpose: A health economic evaluation of volar plate fixation versus plaster immobilization in patients with a displaced extra-articular distal radius fracture was assessed in the present study.

Methods: A cost-effectiveness analysis (cost per quality-adjusted life year [QALY]) was performed from a multicenter randomized controlled trial conducted in 14 hospitals in the Netherlands (VIPER trial). 90 patients were randomly assigned to volar plate fixation or plaster immobilization. Resource use per included patient was documented prospectively for up to 12 months after randomization and included direct medical costs, direct non-medical costs, and indirect non-medical costs due to the distal radius fracture and the received treatment.

Results: The mean total cost per patient was lower in the operative group than in the non-operatively treated group (mean difference €273; 95% bcaCI [bias-corrected and accelerated confidence interval] 1587 to 860). The mean total QALY at 12 months was significantly higher in the operative group than in the nonoperative group (mean difference 0.16; 95% bcaCI 0.059 to 0.266). The incremental cost-effectiveness ratio (ICER) was €1676 (95% bcaCI 13012 to 7440) per QALY, in favor of volar plate fixation. In subgroup analysis on patients having a paid job, the ICER was €6851 (95% bcaCI 19588 to 2468) per QALY, in favor of volar plate fixation.

Conclusion: In adult patients with a displaced extra-articular distal radius fracture, volar plate fixation is a cost-effective intervention, especially in patients with a paid job. Besides the better functional results, volar plate fixation is less expensive and provides a better quality of life than plaster immobilization.

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Operative Treatment of Intra-Articular Distal Radius Fractures With Versus Without Arthroscopy: A Randomized Controlled Trial

Caroline Selles, MD; *Marjolein Mulders, MD, PhD; Joost Colaris, MD, PhD; Mark van Heijl, MD, PhD; Niels Schep, MD, PhD*

Purpose: An increase in open reduction and internal fixation (ORIF) for intra-articular distal radius fractures has been observed. This technique leads to a quicker recovery of function compared to nonoperative treatment. However, some patients continue to have a painful and stiff wrists postoperatively. Arthroscopically assisted removal of intra-articular fracture hematoma and debris may improve the functional outcomes following operative treatment of intra-articular distal radius fractures. The purpose of this randomized controlled trial is to determine the difference in functional outcome, assessed with the Patient-Rated Wrist Evaluation (PRWE) score, after ORIF with and without an additional wrist arthroscopy in adult patients with displaced complete articular distal radius fractures.

Methods: In this multicenter trial adult patients with a displaced complete articular distal radius fracture were randomized between ORIF with an additional wrist arthroscopy to remove fracture haematoma and debris (intervention group) and conventional fluoroscopic-assisted ORIF (control group). The primary outcome was functional outcome assessed with the PRWE score after 3 months. Secondary outcomes are the Disability of the Arm, Shoulder and Hand (DASH) score, postoperative pain, range of motion, grip strength, complications, and cost-effectiveness. Additionally, in the intervention group the quality of reduction, associated ligamentous injuries, and cartilage damage wereassessed. A total of 50 patients were included in this study.

Results: A total of 50 patients were randomized, 25 to the intervention group and 25 to the control group. All patients who had arthroscopic treatment had a hematoma which was removed. Other arthroscopic findings were: TFCC (triangular fibrocartilage complex) injury in 91%, scaph-lunate injury in 50%, lunotriquetral injury in 50%, damage of the fossa lunata in 68%, and damage of the scaphoid fossa in 55%. Mean PRWE was not significantly better for the intervention group at 3 weeks (49 [range, 28-66] vs 59 [49-66], P = 0.08), and at 6 weeks (41 [range, 20-58] vs 38 [29-45], P = 0.61). Mean PRWE was significantly worse for the intervention group at 3 months (30 [range, 8.2-46] vs 14 [5-21], P = 0.01).

Conclusion: Patients treated with additional arthroscopy to remove hematoma and debris do not have better functional outcomes compared to the non-arthroscopically treated group.

PAPER ABSTRACTS

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Topical Cutaneous Application of Carbon Dioxide Using a Hydrogel Is a New Treatment Option to Assist Fracture Repair: Results of a Clinical Trial
(IOTA - Japan best poster submission)

Takahiro Niikura, MD; *Takashi Iwakura, MD; Sang Yang Lee, MD; Tomoaki Fukui, MD; Keisuke Oe, MD; Yoshitada Sakai, MD; Toshihiro Akisue, MD; Ryosuke Kuroda, MD*

Purpose: We have reported that topical cutaneous application of carbon dioxide (CO_2) using a hydrogel accelerates fracture repair by increasing blood flow, angiogenesis, and promoting endochondral ossification in rats. Now we apply this novel therapy to human subjects, and assess the safety and efficacy.

Methods: We conducted a prospective clinical trial with approval by the IRB and informed consent. Inclusion criteria are adult patients, and patients with fractures of lower extremities whose fractures are surgically treated. Exclusion criteria are infection, pathological fractures, active bleeding postoperatively, and use of low-intensity pulsed ultrasound. The CO_2 absorption-enhancing hydrogel was applied to the treated limbs. A polyethylene bag, which seals the body surface and retains the gas inside, was attached to the limbs and sealed, and 100% CO_2 was administered into the bag for 20 minutes. This treatment was performed every day for 4 weeks postoperatively. The safety was assessed by adverse events, vital signs checked before and after the CO_2 therapy every day, and blood examination every week. The safety was also assessed using arterial gas analysis and expired gas analysis performed before and after the CO_2 therapy on day 14. The blood flow of the limbs was recorded using a laser Doppler blood flowmeter. Fracture union was assessed radiographically.

Results: 19 patients (13 men and 6 women, age 48.5 ± 14.6 years) were included. The fractured bone was femur in 8 patients and tibia in 11 patients. There were 7 fresh fractures and 12 nonunions. No adverse events were observed for all patients. There was no remarkable change of vital signs and deviation of standard postoperative course in the blood examination. The analyses of arterial gas and expired gas revealed no adverse systemic effects including hypercapnia. The blood flow of the fractured limbs was increased 1.5 times, 1.9 times, and 2.1 times by the CO_2 treatment compared to the blood flow before the treatment at the first day, 2 weeks, and 4 weeks. Same tendency of the increase of blood flow was observed both in femur and tibia, both in fresh fracture and nonunion. Fracture union was obtained for all patients.

Conclusion: Our CO_2 therapy can be a novel strategy for assisting fracture repair with safety in clinics.

Altering Spacer Material and Micro-Topography in the Masquelet Technique: Effects on Mechanics and Barrier Properties

Natalie Gaio, BS; Alice Martino, BS; Tracy Watson, MD; Daemeon Nicolaou, MD;
***Sara McBride-Gagyi**, PhD*

Purpose: The goals of this project were to determine if changing the spacer's material or topology changed the membrane's matrix composition, mechanics, or barrier properties during execution of the Masquelet technique. Alterations could affect stage 2 bone formation.

Methods: An externally stabilized, critical-sized defect (6 mm) was created in the right femora of 10-week-old, male Sprague Dawley rats. The defect was filled with a prefabricated cylindrical spacer made of either PMMA (polymethylmethacrylate) or medical grade titanium (Ti) with smooth (~1 um) or roughened (~8 um) surfaces. Four weeks later, the animals were euthanized for tissue harvest. The membranes' matrix composition, material properties, and barrier properties were quantified with immunohistochemistry, tensile and shrinkage testing, and diffusion of different sized dextrans (10 kDa, 70kDa, and 500kDa), respectively.

Results: All membranes had similar distributions of collagen type 1 and elastin. Roughening spacers resulted in more compliant membranes that shrank more in the circumferential direction (Fig. 1). Titanium spacers created membranes that inhibited solute transport more (ie, were better barriers) (Fig. 2).

Conclusion: Ti membranes may inhibit biochemical or cellular movement more than PMMA induced membranes. Alternatively, the altered tissue mechanics produced by roughened spacers may impart different mechanical forces to the residing cells thus changing mechanically sensitive signals such as WNTs. Further experiments are necessary to test these hypotheses. Regardless, the induced membrane is very distinct from the periosteum, which is anisotropic and pre-stressed.

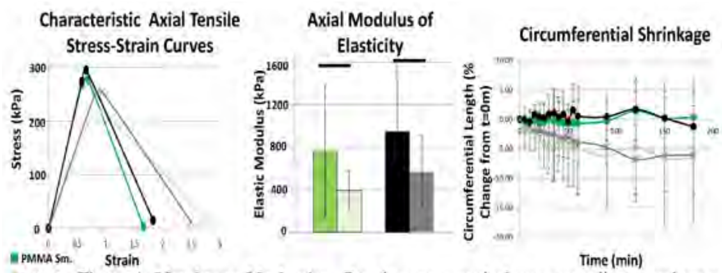

Figure 1. Membrane Mechanics. Rough spacers evoked more compliant membranes that stretched more before failing **(A-B)** and shrank more in the circumferential direction **(C).**

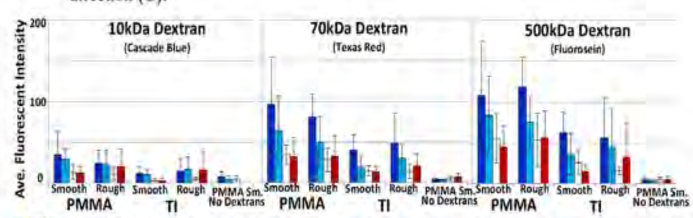

Figure 2. Barrier Properties. TI evoked membranes inhibited solute transport more so than PMMA evoked membranes. All membranes trapped significantly more of the larger two dextrans in the inner membrane regions (NB & BR) than in the outer two regions.

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An Intact Fibula May Contribute to Allow Early Weight Bearing in Surgically Treated Tibial Plateau Fractures

Ion Carrera, MD, PhD; ***Julio De Caso**, **MD, MsC;*** *Mireia Gomez Masdeu, MD; Angelica Millan, MD; Esther Moya-Gomez, MD*

Purpose: The role of the proximal tibiofibular joint (PTFJ) in tibial plateau fractures is unknown. The purpose of this study was to assess, with finite-element (FE) calculations, differences in interfragmentary movement (IFM) in a split fracture of lateral tibial plateau, with and without intact fibula. It was hypothesized that an intact fibula could positively contribute to the mechanical stabilization of surgically reduced lateral tibial plateau fractures. The aim of the study was to determine whether an intact fibula could positively contribute to the mechanical stabilization of surgically reduced lateral tibial plateau fractures, increasing the load-bearing capacity of the tibia-fragment system, allowing immediate weight bearing after surgery.

Methods: A split fracture of the lateral tibial plateau was recreated in an FE model of a human tibia. A matching set of tibia, fibula, and femur bone models from the VAKHUM (Virtual Animation of the Kinematics of the Human) project database was used, and was built from CT images from a subject with normal bone morphologies and normal alignment. The fracture was reproduced using geometrical data from patient radiographs, and 2 models were created: 1 with intact fibula and other without fibula. A locking screw plate (LPS) and cannulated screw systems (CSS) were modeled to virtually reduce the fracture, and 80 kg static body weight was simulated.

Results: Under mechanical loads, the maximum IFM achieved with the fibula was about 30% lower than without fibula, with both the cannulated screws and the locking plate. Interfragmentary reaction forces (FIRF) were lateromedial with the locking plate and mediolateral with the cannulated screws. Lateromedial interfragmentary reaction forces reveal a compression of the fragment against the tibia at the fracture site, whereas mediolateral interfragmentary reaction forces would be interpreted as distraction forces at the fracture site. The intact fibula increased the magnitude of the lateromedial FIRF component with the locking plate, and it reduced the mediolateral FIRF magnitude by 66% with the cannulated screws.

Conclusion: This FE model showed that an intact fibula contributes to mechanical stability of lateral tibial plateau fractures, and combined with the locking plate system, the mechanical integrity of both the fibula and of the PTFJ may allow early weight bearing without significant interfragmentary movement.

How Often Does Osteonecrosis After Talar Neck Fractures Result in Treatment Failure?

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Purpose: Talar neck fractures are rare injuries that can be challenging to treat. In some cases, osteonecrosis (ON) following talar neck fractures results in treatment failure due to complications such as collapse of the talar body, implant failure, nonunion, and posttraumatic arthritis (PTA). The aims of this study were to estimate the frequency of clinically important ON (CION) and to identify risk factors for the development of CION.

Methods: A billing and coding query was used to identify all skeletally mature individuals with talar neck fractures initially treated at our institution between January 1, 2000 and December 31, 2015. We included all fractures involving the neck of the talus (OTA classification 81-B), with or without extension into another part of the talus, such as the head, body, or lateral process. We excluded fractures of the talus not involving the talar neck and those occurring in skeletally immature patients. Radiographically detectable ON (RDON) was defined based on ankle and foot radiographs as increased radiographic density of the talar dome relative to the adjacent osseous structures. CION was defined as ON resulting in collapse of the talar body or requiring further surgical intervention to facilitate recovery.

Results: 138 talar neck fractures were reviewed. Mean follow-up was 15.7 months, mean age was 35.5 years, 69 patients (50%) were male, and 28 fractures (20%) were open. There were 5 (4%) Hawkins type I fractures, 84 (61%) type II fractures, 43 (31%) type III fractures, and 6 (4%) type IV fractures. 44 (32%, 95% confidence interval [CI]: 24% to 40%) developed RDON, but only 16 (12%, 95% CI: 7% to 18%) developed CION. All cases of CION showed early signs of radiographic sclerosis, initially detected within 33 to 78 days after injury. RDON rates were 0%, 23%, 49%, and 67% for type I, II, III, and IV fractures, respectively. CION rates were 0%, 7%, 19%, and 33%, respectively. RDON was significantly more likely to occur in patients with higher Hawkins types ($P = 0.0001$), open fractures ($P = 0.0064$), and talar body fractures ($P = 0.051$). CION was significantly more likely to occur in patients with higher Hawkins types ($P = 0.0083$), open fractures ($P = 0.0048$), associated lateral process fractures ($P = 0.047$), and greater age (mean age 44.1 years vs 34.4 years, $P = 0.0071$).

Conclusion: 12% of patients, or roughly one-third of patients with RDON, developed CION.

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Ankle Motion and Off-Loading in Short Leg Cast and Low and High Fracture Boots
***Nickolas Nahm**, **MD;** Michael Bey, PhD; Serena Liu, BS; Stuart Guthrie, MD*

Purpose: The choice to use short leg casts (SLCs) or fracture boots is often subjective. By preventing motion and redistributing force to the proximal leg, these devices promote healing and protect the foot and ankle. This study compares the impact of SLCs and low and high fracture boots on ankle motion and off-loading. We hypothesize that SLCs more effectively immobilizes and offloads the ankle compared to the high and low fracture boots.

Methods: Skeletally mature, healthy subjects were recruited. High-speed dynamic radiography was utilized to determine tibiotalar motion in the sagittal plane in weight-bearing (WB) and non-weightbearing (NWB) in a shoe (control), SLC (fiberglass), and low (Aircast Short Pneumatic Walker, DJO Global) and high fracture boot (Aircast Foam Pneumatic Walker, DJO Global). Sensors (F-Scan Sensor, Tekscan) captured plantar surface forces, and force was expressed as a percentage of body weight (% BW).

Results: A total of 20 patients (10 male and 10 female) were included. Mean age was 29 years (range, 18-59 years) with a mean body mass index of 23 (range, 18-32). In NWB, the low fracture boot (2.2 ± 2.0°), high fracture boot (2.3 ± 1.6°), and SLC (2.3 ± 1.5°) had significantly less motion compared to control (3.6 ± 2.1°, $P \leq 0.026$). During WB, the SLC (3.4 ± 1.4°) and high fracture boot (4.8 ± 2.0°) had less motion compared to the low fracture boot (7.8 ± 3.4° $P < 0.001$). Finally, the SLC (172.6 ± 48.3% BW) and low (165.1 ± 36.2% BW) and high (154.5 ± 32.9% BW) fracture boots were associated with less peak plantar surface force compared to control (195.0 ± 43.8% BW, $P \leq 0.087$).

Conclusion: The SLC and high fracture boot immobilize the ankle in NWB and off-load and immobilize the ankle in WB. The low fracture boot also immobilizes the ankle in NWB, but in WB, the low fracture boot only off-loads the ankle and does not immobilize. Therefore, the low fracture boot is more suited for NWB conditions while the SLC and high fracture boot are effective in WB and NWB.

Anterolateral Distal Tibia Locking Plate Osteosynthesis and Its Ability to Capture OTA 43-C3 Pilon Fragments

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Purpose: This study was undertaken to compare the efficacy of anterolateral distal tibial locking plates in capturing main fracture fragments in OTA 43-C3 pilon fractures.

Methods: 169 OTA 43-C3 pilon fractures were retrospectively identified. Each fracture lines were superimposed to create a compilation of fracture lines. Based on these averaged measurements, 3 distal tibia Sawbones had 3 anterolateral plates applied. CT was used to determine the efficacy of main fracture fragments captured.

Results: The Smith & Nephew PERI-LOC plate secured the largest number of fracture lines (90.1%) but missed the Volkmann fragment (VF) with greatest frequency at 3.6%. The Synthes 2.7/3.5-mm Variable Angle-Locking Compression Plate (VA-LCP) captured 87.3% of the fracture lines while missing the VF 3.2% of the time. The Synthes 3.5-mm LCP captured 86.5% of the fracture lines but was the best at securing the VF (1.2% missed). All 3 implants were deficient in capturing the medial malleolar fragment (MMF). The PERI-LOC and 2.7/3.5-mm VA-LCP did not differ in the percentage of fragments captured (P = 0.721) but both outperformed the Synthes 3.5-mm LCP (P = 0.021 and P = 0.05, respectively).

Table 1: The frequencies of fracture fragments captured amongst the three anterolateral distal tibia plates tested.

	Captured fragments (%, out of 252)	Missed fragments (%)			P-value
		Anterolateral (Chaput)	Posterolateral (Volkmann)	Medial malleolar	
Smith & Nephew 3.5 mm PERI-LOC plate	227 (90.1)	1 (0.4)	9 (3.6)	15 (6.0)	0.060
DePuy Synthes 2.7/3.5 mm variable angle locking compression plate (VA-LCP)	226 (89.7)	0 (0)	8 (3.2)	18 (7.1)	
DePuy Synthes 3.5 mm locking compression plate (LCP)	218 (86.5)	0 (0)	3 (1.2)	31 (12.3)	
Smith & Nephew PERI-LOC vs DePuy Synthes LCP: p=0.021 Smith & Nephew PERi-LOC vs DePuy Synthes VA-LCP: p=0.721 DePuy Synthes LCP vs DePuy Synthes VA-LCP: p=0.050					

Conclusion: The present study is the largest study to describe and confirm the 3 main pilon fracture fragments. All 3 plates were deficient in capturing the MMF. The PERI-LOC plate secured the most number of fracture lines, while the Synthes 3.5-mm LCP was least likely to miss the VF and most likely to miss the MMF. No plate was superior to the other in capturing all fracture lines of the OTA 43-C3 pilon fragments.

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POSTER ABSTRACTS

Can Surgeons Predict Outcomes After Fixation of Pilon Fractures?

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Purpose: Pilons have been shown to generally have poor outcomes but surgeons commonly claim to be able to predict injury and fixation results that are more likely to result in poor outcomes. Our hypothesis was that surgeons can accurately predict functional outcomes of pilon fractures based on injury and postoperative radiographs and that more experienced surgeons would be better at predicting outcome.

Methods: We constructed a data set for surgeons to review that consisted of 95 pilon fractures in random order. Injury radiographs, initial postoperative radiographs, and brief histories were provided. To be included in the cohort, each patient had to have at least 18 months follow-up with functional outcome scores (AAOS Foot and Ankle Questionnaire) provided by phone interview at a mean 4.9 years after open reduction and internal fixation (ORIF). The data set was reviewed by 11 surgeons of varying experience at 1 academic Level I trauma center (7 orthopaedic trauma faculty, 4 trauma fellows) who were blinded to outcome and asked to predict the functional outcome. Pearson correlation coefficient assessed functional outcomes and surgeon-predicted outcomes. A mixed-effect model determined the association between patients' characteristics and surgeons' prediction scores.

Results: There was a minimal positive correlation between functional outcome and the surgeon's prediction scores ($r = 0.11$, 95% confidence interval [CI]: 0.05-0.17). There was also no difference noted between the attending group and fellow group in their ability to predict correct functional outcome scores ($r = 0.08$ vs $r = 0.16$, $P = 0.21$). When the surgeons' confidence in their prediction was >1 standard deviation above the mean confidence level, the correlation between functional outcome and the prediction improved to $r = 0.26$, although this still signified poor correlation. AO/OTA type 43C fractures, high-energy mechanisms, and advanced age were characteristics associated with lower prediction scores by the study participants.

Conclusion: Surgeons appear to have poor ability to predict functional outcomes of patients with pilon fractures even when the injury and initial postoperative radiographs along with a clinical history were provided. These data should alert clinicians that our evaluation of clinical and radiographic data does not allow us to accurately predict for patients the likelihood of poor outcomes.

Posterior Malleolar Fixation Reduces the Need for Syndesmotic Screw Fixation in Rotational Ankle Injuries

***Omar Behery*, MD;** *Rajkishen Narayanan, MS; Abdullah Qatu, BS; Sanjit Konda, MD; Nirmal Tejwani, MD; Kenneth Egol, MD*

Purpose: Inaccuracy of syndesmotic repair following rotational ankle injury can lead to significant problems with ankle kinematics. The relationship between the posterior malleolus (PM) and the syndesmotic complex is well established. Accurate reduction and fixation of this fragment can often be achieved intraoperatively, and, theoretically, may preclude independent syndesmotic fixation. The goal of this study was to determine whether PM fragment fixation reduces the need for independent syndesmotic fixation.

Methods: An IRB-approved review was performed for a consecutive series of patients treated operatively for a rotationally unstable ankle fracture between 2011 and 2017. Radiographs were reviewed to identify cases with PM involvement. Patient demographics and injury characteristics were recorded. All fractures underwent surgery using standardized techniques. Intraoperative ankle stress evaluation was done following fixation to evaluate syndesmotic instability. The decision to fix the PM was made by the surgeon. The 2 groups (PM fixed vs not fixed) were compared for demographics, fracture characteristics, and intraoperative instability and transsyndesmotic fixation using Fisher's exact test or independent t-tests as appropriate. Binary logistic regression was used to re-test the association between need for syndesmotic fixation and PM fixation group after adjusting for PM fragment size.

Results: 85 patients with 85 unstable ankle fractures with a PM fragment were included. 43 fractures underwent PM fixation and 42 did not. There were no differences between the PM fixation groups with regard to age, gender, body mass index, or fracture pattern ($P = 0.183$ for all). The average size of the PM fragment in the fixed group was larger than among those not fixed ($P < 0.001$). There were significantly lower odds of needing syndesmotic fixation if the PM fragment was fixed (odds ratio: 0.011, 95% confidence interval [CI] 0.002-0.058). Only 2 out of 43 ankles with a fixed PM fragment underwent syndesmotic fixation compared with 34 out of 42 non-fixed PM fragments.

Conclusion: The decision to fix PM fragments as part of ankle fracture repair surgery is multifactorial. This clinical study lends evidence to the fact that PM fixation imparts syndesmotic stability and may be considered as an alternative to transsyndesmotic fixation for restoring dynamic ankle mortise congruence.

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Patterns and Implications of Syndesmotic Screw Failure in Rotational Ankle Fractures,
Jessica Mandel**, **BA; *Omar Behery, MD; Sanjit Konda, MD; Nirmal Tejwani, MD; Kenneth Egol, MD*

Purpose: Open reduction and transsyndesmotic fixation with metal screws is the "gold standard" for treating unstable syndesmotic injuries. Postoperatively, hardware failure can occur; however, the rates and patterns of syndesmotic screw (SS) backout and breakage and the effect on clinical outcomes are unclear. The purpose of this study is to identify any characteristic patterns of SS failure and the related effects on clinical outcome.

Methods: An IRB-approved database of 400 subjects with rotational ankle fractures treated operatively and nonoperatively from 2015 to 2017 was used to identify 90 adult subjects who underwent fixation of an unstable ankle injury with transsyndesmotic screws. Radiographs were reviewed and injury patterns were classified using the AO/OTA and Lauge-Hansen (LH) systems and the timeline and pattern of SS backout or breakage was noted. Functional outcome was assessed using Maryland Foot Score (MFS). Data were analyzed using Welch's analysis of variance and Fisher exact tests.

Results: Out of the 90 identified ankle fractures, 62 (69%) required only 1 SS for fixation, and 28 (31%) required more than 1 screw. 15 ankles (17%) were noted to have screw breakage at a mean of 6.5 months and 4 others (4%) demonstrated screw backout at an average of 9 months postoperatively. There was no difference in reoperation rate between subjects without hardware failure, and those with screw backout or breakage (P = 0.446). However, those with broken screws were found to have better MFS scores than patients without hardware failure or with screw backout (P = 0.004). 14 screws (93%) were broken at a single site and 1 was broken in multiple sites. There was no association between number of SSs placed and screw breakage (P = 0.173). There was a higher rate of hardware failure in LH SER (supination external rotation) and PER (pronation external rotation) fractures (P = 0.024, P = 0.001), but there was no association between AO/OTA types of rotational ankle fractures and the incidence of screw backout or breakage (P = 0.39).

Conclusion: A higher rate of syndesmotic screw failure is associated with PER and SER rotational ankle fractures. Subjects with broken screws had better functional outcome ankle scores as compared to patients without hardware failure or screw backout. It is unclear whether this is related to improved kinematics and physiologic motion at the healed syndesmosis, leading to screw breakage. This finding potentially suggests that unbroken transsyndesmotic screws could be removed after sufficient healing, in order to promote normal tibiofibular kinematics.

Predicting Unplanned Return to the Operating Room After Fixation of Tibial Pilon Fractures

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Purpose: Open reduction and internal fixation (ORIF) of tibial pilon fractures has historically been associated with some of the highest complication rates and poorest functional outcomes of any extremity fracture. Despite the advent of staged protocols and less invasive approaches, there remains concern that the rate of wound complications and unplanned return to the operating room may still be high. The goal of this study was to investigate the rate and risk factors for unplanned secondary procedures in pilon fractures treated with ORIF.

Methods: All patients diagnosed with a pilon fracture (AO/OTA 43B or 43C) from 2007 to 2016 who underwent ORIF were retrospectively screened for inclusion. Unplanned return to the operating room was defined as a surgery at any time point after definitive ORIF and included irrigation and debridement for deep surgical site infection (SSI), hardware removal, nonunion or malunion revision, arthrodesis, and amputation. Multiple patient, injury, and treatment characteristics hypothesized to contribute to the outcome were evaluated and multivariate regression analysis was performed. 522 pilon fractures in 508 patients were included, with an average follow-up of 14 months. 27% of the fractures (n = 139) were open.

Results: The overall rate of return to the operating room was 167/522 (32%). 19.5% underwent symptomatic hardware removal, 13.8% required irrigation and debridement for deep SSI, 8.2% had nonunion or malunion revision, 4.0% underwent arthrodesis, and 1.3% had an amputation. The rate of return to the operating room for deep SSI in open fractures was 24% versus 10% in closed fractures (P <0.001). Severity of open fracture (Gustilo Type III, odds ratio [OR] 4.1, P <0.001]) and severity of injury (43C fractures, OR 2.2, P = 0.02) were significantly associated with return to the operating room for deep SSI. Additionally, 2 other factors were close enough to significance to merit inclusion in the model for deep SSI: smoking (OR 1.6, P = 0.1) and mental illness (OR 2.1, P = 0.07). Age, associated injuries, work and payor status, American Society of Anesthesiologists (ASA) score, and fibular fixation had no significant effect on return to the operating room.

Conclusion: Unplanned return to the operating room after ORIF of a tibial pilon fracture remains prevalent, even for surgeons who commonly treat these complex injuries using modern techniques. Treatment plans should take into account the elevated risk of infection with complete articular involvement or severe open wounds.

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Open Reduction and Syndesmosis Pin Fixation Under Direct Visualization for Syndesmosis Injury

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Purpose: Anatomical reduction of the fibula into the fibular incisura of the tibia is a key element to manage syndesmosis injury in ankle fracture. In case of traditional syndesmosis screw fixation under fluoroscopic guidance, a high rate of malreduction was reported. And broken syndesmosis screw is also problematic. If reduction and fixation of syndesmosis is performed under direct visualization, we can evaluate the reduction status more accurately in the whole procedure. Also, we assumed the fixation using pins would enable more flexible fixation. We analyzed results of open reduction and syndesmosis pin fixation of syndesmosis injury under direct visualization using the clinical cases.

Methods: From January 2009 to January 2014, 31 consecutive patients who received surgery for acute syndesmosis injury and ankle fracture were enrolled. After open reduction of the fibula into the fibular incisura, the fixation using 2-mm-diameter Kirschner wires was performed from the lateral fibular cortex to the medial tibial cortex as checking the reduction status continuously under direction visualization. Postoperative symptoms, range of motion (ROM), and radiographic parameters were measured and analyzed.

Results: The mean age of the patients was 44 years (range, 18-70), and the mean follow-up period was 31 months (range, 10-50). Favorable results of clinical and radiographic aspects were obtained, and no significant complaints were reported at the last follow-up. Postoperative ROM was 16° dorsiflexion (range, 7° to 25°) and 38° plantar flexion (range, 33° to 40°). The mean American Orthopaedic Foot & Ankle Society Ankle-Hindfoot Scale was 95 (range, 82-100) at the last follow-up. Postoperatively, the tibiofibular clear space and the medial clear space significantly decreased, and the tibiofibular overlap significantly increased ($P < 0.05$). There was no breakage of syndesmosis pins even when full weight-bearing was allowed before removal of syndesmosis pins.

Conclusion: Open reduction and syndesmosis pin fixation under direct visualization can be a reliable method for treating syndesmosis injury.

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

Posterior Malleolus Fractures: Changes in Treatment Over Time and Associations With Outcomes

***Megan Audet**, **BA;** Chang-Yeon Kim, MD; Heather Vallier, MD*

Purpose: Fractures of the posterior malleolus are common after torsional ankle fractures and may portend worse outcomes. Recently, open reduction and internal fixation (ORIF) using a posterior approach has been emphasized. The purposes were to describe treatment and to determine when ORIF improves clinical and functional outcomes.

Methods: 1404 patients with ankle fractures during 2003-2016 were reviewed. 519 had posterior malleolus fractures (37.6%); 68 underwent fixation (13.1%). Clinical and radiographic results were reviewed after minimum 6-month follow-up. Functional outcomes were assessed after 12 months using Foot Function Index (FFI) and Short Musculoskeletal Function Assessment (SMFA) surveys.

Results: Posterior malleolus fractures were treated surgically more often over time: 11.4% in 2003-2008, 12.2% in 2008-2012, and 15.2% in 2012-2016. Mean fragment size for ORIF was 10.9 mm (25.3% of the articular surface), versus 4.0 mm (10.4% of the articular surface, P <0.0001) for nonoperative treatment. Mean size of stabilized posterior malleolar fragments decreased over time: 5.4 mm (16.0%) during 2003-2008, 5.0 mm (13.8%) during 2008-2012, and 4.7 mm (8.5%) during 2012-2016. Fixation of the posterior malleolus was associated with more early complications (20.6% vs 8.9%, P = 0.003), mainly infections and wound healing problems. Mean age and body mass index (BMI) were similar between patients with and without fixation. However, greater fracture displacement was noted as measured by Weber C injuries (33.8% vs 27.0%) and dislocations (60.3% vs 41.7%, P = 0.004) among patients who had fixation of the posterior malleolus. Patients who had fixation also reported more pain (85.0% vs 59.8%, P = 0.033) and inability to return to work at full capacity (19.4% vs 2.8%, P = 0.003) after 1 year, irrespective of size of posterior malleolus. Fixation of the posterior malleolus was associated with comparable FFI scores (29.1 vs 32.7 [no fixation]) and SMFA Dysfunction scores (26.6 vs 27.2, NS) were also unaffected by fragment size.

Conclusion: Reduction and fixation of posterior malleolus fractures has become frequent over time, and is being performed for smaller fragments. Fixation was associated with more early complications but comparable FFI and SMFA scores. The size of the posterior malleolar fragment or percent articular surface involvement did not impact the clinical or functional outcomes after ORIF compared with nonoperative treatment. Further study is needed to determine the outcomes after posterior approach for posterior malleolus fractures, which may afford more accurate reduction and more rigid fixation.

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Assessing Soft-Tissue Perfusion Using Laser-Assisted Angiography in Tibial Plateau and Pilon Fractures: A Feasibility Study

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Purpose: The decision on when it is safe to undergo internal fixation for tibial plateau and pilon fractures remains controversial. At present, no objective measure has been employed to assess the relative perfusion of the soft tissue and therefore the ability of the skin to tolerate the incisions necessary for fracture treatment. The objective of this study was to determine if laser-assisted indocyanine green angiography (LA-ICGA, a U.S. Food and Drug Administration [FDA]-approved technology that has been applied in other non-orthopaedic domains) could provide valid data in this clinical application. Our hypothesis was that laser-assisted angiography would show less perfusion in skin surrounding fractures compared to the uninjured limb and that the order of testing of the limbs would have no effect.

Methods: A convenience sample of 19 patients (n = 8 pilons, 11 plateaus) requiring surgical intervention for closed tibial plateau and pilon fractures were prospectively enrolled at a Level I trauma center. Laser-assisted angiography was used to assess soft-tissue perfusion in fluorescence units (fu) on a scale of 0 to 255, at predefined locations on the skin over the fracture. Mean differences in skin perfusion rates were compared between injured and uninjured legs and the order in which the 2 legs were assessed using mixed-effects linear regression.

Results: Laser-assisted angiography was able to record valid data in all cases (100%, 19/19). As hypothesized, the mean perfusion was lower in the injured than uninjured side (mean difference: -3.6 fu, 95% confidence interval [CI]: -10.6 to 3.4). Overall mean perfusion was significantly higher in pilon fractures (61.0 fu, standard deviation [SD] 24.2) compared to tibial plateau fractures (37.9 fu, SD 13.3; P <0.01), perhaps indicating more blood flow in the skin of pilon fractures at the time of injury. The first recorded limb had significantly greater mean perfusion than the second limb (mean difference: 8.8 fu, 95% CI: 3.4-14.2, P <0.01).

Conclusion: This study is the first to demonstrate that laser-assisted angiography appears to provide useful data regarding the overlying skin perfusion of tibial plateau and pilon fractures. This technique could potentially assist surgeons in objectively determining which fractures can safely undergo early definitive fixation.

Lack of Displacement of the Fibula is NOT Confirmation of Ankle Stability in SE Pattern Ankle Fractures

Paul Tornetta, III, MD; ***Amir Shahien, MD***

Purpose: Patients who present with isolated lateral malleolar fractures and an intact mortise may have instability on stress examination. A recent paper concluded minimal (<2-mm) displacement of the fibula on the lateral view predicts a stable joint. The purpose of this study was to evaluate and compare radiographic findings in stress (+) supination-external rotation (SE)4 injuries versus SE2 injuries.

Methods: We reviewed the initial and stress radiographs of a sequential series of patients presenting with an isolated SE pattern Weber B lateral malleolar fracture. Ankles with an intact mortise had a stress view upon presentation. We recorded the medial clear space (MCS) pre- and post-stress and the maximal displacement of the fibular fracture on the lateral radiograph at presentation. Ankles with widened MCS and subluxation at presentation were considered SE4 injuries, those with a negative stress view (normal MCS and no subluxation) were considered SE2 injuries, and those presenting with an intact mortise whose ankles subluxated only on stress radiograph were considered stress (+) SE4 injuries. We compared the MCS, stress MCS, and maximal displacement of the fibula (lateral view) at presentation.

Results: We reviewed 350 patients (185 M, 165 F) aged 18-95 years (average 45) with isolated SE pattern lateral malleolar fractures. 109 had SE4 injuries (MCS = 8.3 mm). 241 ankles were stressed; 164 were unstable and 77 were stable (SE2). Average MCS before and on stress radiographs was 3.59 mm for the SE2 (no widening) and 3.86 mm and 5.94 mm for the stress (+) SE4 group. The fibular displacement for the SE2, stress (+) SE4, and SE4 groups were: 1.3 (0-4.5), 1.9 (0-6.6), and 4.1 (0-30.5). 16 of 77 (20%) SE2 and 24 of 164 (15%) stress (+) SE4 fractures had NO displacement of the fibula on the lateral view. Similarly, 53 of 77 (68%) SE2 and 91/164 (55%) stress (+) SE4 had ≤2 mm of fibular displacement.

Conclusion: Previous work indicated that patients with an isolated SE pattern fibula fracture, a normal MCS, and ≤2 mm of fibular displacement on the lateral radiograph are uniformly stable. We did not find this to be true. 15% of unstable ankles had no displacement and 55% had ≤2 mm. We conclude that stability may not be inferred from a lack of fibular displacement on the lateral view in this population of patients. If stability is to be determined, it must be tested irrespective of fibular displacement on the lateral radiograph.

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Δ Dynamic CT Can Distinguish Differences in Tibiofibular Motion Following Syndesmotic Injury

Prism Schneider, MD, PhD; *Charmaine Wiens, MD; Richard Buckley, MD, FRCPC; Paul Duffy, MD; Robert Korley, MD; C. Ryan Martin, MD; Tanja Harrison, MPA; David Sanders, MD*

Purpose: The syndesmosis ligament complex stabilizes the distal tibiofibular joint, while allowing for the subtle fibular motion that is essential for ankle congruity. Flexible fixation with anatomic syndesmosis reduction results in substantial improvements in functional outcomes. New dynamic CT technology allows real-time imaging, as the ankle moves through a range of motion. The aim of this study was to determine if dynamic CT analysis is a feasible method for evaluating syndesmosis reduction and motion following static and flexible syndesmosis fixation.

Methods: This is a subgroup analysis of a larger multicenter randomized clinical trial, in which patients with AO 44-C injuries were randomized to either Tightrope (1 knotless Tightrope, Group T) or screw fixation (2 x 3.5-mm cortical screws, Group S). Surgical techniques and rehabilitation were standardized. Bilateral ankle CT scans were performed at 1 year post-injury, while patients moved from maximal dorsiflexion (DF) to maximal plantar flexion (PF). 3 measurements were taken at 1 cm proximal to the ankle joint line in maximal DF and maximal PF: anterior, midpoint, and posterior tibiofibular distances. T-tests compared Group T and Group S, and injured and uninjured ankles in each group.

Results: 15 patients (6 Group T [3 male]; 9 Group S [8 male]) were included. There was no difference for mean age (T = 42.8 ± 14.1 years, S = 37.0 ± 12.6; P = 0.4) or time between injury and CT scan (T = 13.0 ± 1.8 months, S = 13.2 ± 1.8; P = 0.8). Of note in Group S, 7 of 9 patients had at least 1 broken screw and 1 additional patient had screws removed by the time of their dynamic CT. There was no significant difference between treatment groups for tibiofibular distance measurements in maximal PF or DF. Group T showed no significant difference between the injured and uninjured side for tibiofibular measurements in maximal PF and DF, suggesting anatomic reduction. For Group S, however, there was a significantly larger distance for all 3 measurements at maximal PF compared to the uninjured ankle (all P <0.05).

Conclusion: In all but 1 Group S patient, screws were broken or removed prior to their dynamic CT, allowing possible increased syndesmotic motion, similar to Group T. Despite this, dynamic CT analysis detected increased tibiofibular distance in Group S as ankles moved into maximal PF when compared with the uninjured ankle. Given the importance of anatomic syndesmosis reduction, dynamic ankle CT technology may provide valuable physiologic information warranting further investigation.

POSTER ABSTRACTS

Δ OTA Grant

What Are the Risk Factors for Deep Infection in 43C Tibial Pilon Fractures?

Clay Spitler*, *MD; *Robert Hulick, MD; John Weldy, BS; Katie Howell, BS; Patrick Bergin, MD; Matt Graves, MD*

Purpose: Pilon fracture care remains technically challenging and avoiding soft-tissue complications is of the utmost concern in their management. While staged management has decreased the rates of complication, not all risk factors for deep infection are clearly defined. The purpose of this study is to determine what patient factors, injury characteristics, and surgical choices are associated with deep infection in AO/OTA 43C type fractures.

Methods: A retrospective review was performed of all 43C fractures treated at a single Level I trauma center over a 5-year period. Patient demographics, fracture characteristics, associated soft-tissue injuries, and surgical treatment decisions were analyzed to evaluate their relationship with deep infection, which was the primary outcome. Deep infection was defined as the need for antibiotics and surgical debridement after definitive fixation. Chi-square test, Student's t-test, and descriptive statistics were used for analysis.

Results: A total of 169 43C pilon fractures were identified, and 15 were excluded due to inadequate follow-up. Average follow-up was 404 days. Average age was 42.8 years, 57% were male, and 37% of fractures were open. Overall incidence of deep infection was 13.8%. Age (P = 0.19), sex (P = 0.18), BMI (body mass index) (P = 0.54), smoking (P = 0.49), and diabetes (P = 0.72) were not significantly associated with deep infection. Diaphyseal fracture extension (P = 0.48), and lateral open fracture wound (P = 0.07) were not significantly associated with deep infection. When assessing all fractures, medial (P = 0.026) and anterior (P = 0.02) open fracture wounds, the need for flap coverage (P <0.001), segmental bone loss (P <0.001), and placement of fixation through a traumatic wound (P = 0.016) were significantly more commonly associated with deep infection. Choice of surgical approach (anterolateral P = 0.20, anteromedial P = 0.12) and a "prepped in" external fixator (P = 0.39) were not significantly associated with deep infection. Assessing only open injuries, using the traumatic wound to place fixation led to a 35% infection rate compared to 15% when it was avoided (P = 0.098).

Conclusion: The risk factors for deep infection following fixation of 43C pilon fractures include medial or anterior open fracture wound, segmental bone loss, the need for flap coverage, and placement of fixation through an open fracture wound. Unfortunately most of these risk factors are not modifiable. However, placement of fixation through a traumatic wound is a potentially modifiable factor, and we recommend using caution when using traumatic wounds for placement of fixation in open pilon fractures.

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Eliminating Syndesmotic Reduction Variability: A Novel Elastic Wrap Reduction Tool
Dan Schlatterer**, **DO; *Michelle Ramirez, MD; Chetan Deshpande, MD*

Purpose: Malreductions following the surgical treatment of syndesmotic injuries (SIs) reportedly occurs in up to 50% of patients. The purpose of this study was to determine if an elastic wrap (EW) results in better SI reductions than a periarticular clamp (PAC).

Methods: In Part I, a cadaveric ankle SI was created via an anterior 4-cm longitudinal ankle incision. A marking pen marked the fibula's reduced position. All ligaments were sectioned sharply and 8 cm of the interosseous ligament. 18 SI reductions were attempted with the PAC and 12 were attempted with an Esmark bandage. Participants placed the clamp tines wherever they wanted to. Direct visualization through the anterior skin incision looking for pen marking realignment determined reduction. In Part II, an O-arm fluoroscopy image intensifier obtained a baseline image of the fibula dislocated posteriorly. The EW was applied from calf to foot. The effort was enough to keep the wrap taught, and without redundancy. As the EW approached the syndesmosis the foot was put in a neutral dorsiflexed position. O-arm images were converted to 2-dimensional axial images. The reduction was graded by 2 orthopaedic trauma surgeons. Alternate EW directions were repeated several times and then ceased because the radiation for the O-arm imaging is substantial and no deviations from a perfect reduction were noted. In Part III, the EW was completed on 5 patient ankles with an SI followed by a postoperative CT scan.

Results: In Part I, successful anatomical reduction of the SI was achieved 100% with the EW compared to only a 5% success rate with the PAC. On the medial side of the ankle, the second tine of the PAC was placed in highly variable positions (authors' observations), some more anterior than the others, resulting in malreductions. In Part II, in every EW direction a perfect reduction of the syndesmosis occurred as seen on the O-arm axial images. In Part III, in all 5 patient ankles the EW was substituted for the PAC with 100% anatomic reduction on CT scans.

Conclusion: This series of experiments demonstrates that an elastic wrap improves reduction forces and results in perfect SI reductions. Further clinical studies are warranted.

Midterm Prospective Follow-up of Ankle Fracture Fixation Using Patient-Reported Outcome Measures: Which Aspects of Reduction Are Most Important?

Paul Rai**, **MRCS; *Melinda Hau, MRCS; Nick Johnson, PhD; Jitendra Mangwani, FRCS*

Purpose: Open reduction and internal fixation (ORIF) is a common procedure to stabilize unstable ankle fractures. Anatomical reduction and stable fixation is desirable to achieve good clinical and radiological outcome after this injury. This prospective study examines the correlation between midterm patient-reported outcome measures (PROMs) and quality of fracture reduction of adult patients with ankle fractures treated with ORIF.

Methods: A total of 100 patients with unstable ankle fracture who underwent ORIF were prospectively entered into the study between November 2013 and October 2014. Exclusion criteria were: age <18 years, pathological or open fractures, and patients with cognitive impairment. Two independent observers assessed fracture patterns and quality of reduction. Fixations were analyzed using Pettrone's criteria including assessment of fracture displacement, medial clear space, and tibiofibular overlap. Patients were followed up at 2 years postoperatively with postal questionnaires. Validated PROMs, Olerud-Molander Score (OMAS), and the Lower Extremity Functional Scale (LEFS) were used. For both scores a higher number indicated a better result.

Results: At 2 years postoperatively there were 5 deceased patients, 17 did not have accessible radiographs, and there was a 65% response rate to questionnaires. 46 patients were included in the final study group with a mean age of 45 years (range, 16-90). 4 fractures were classified as 44-A, 26 44-B, and 16 44-C. The mean OMAS score was 71.4 (standard deviation [SD] 26.9) and LEFS score 56.7 (SD 25.9). There was no significant difference in PROM scores when fracture fragment reduction was optimized. There was a significant improvement in PROMs with low medial clear space and high tibiofibular overlap.

Conclusion: This study reports a good correlation between quality of reduction and favourable PROMs at 2 years post ORIF of ankle fracture. Reduced medial clear space and increased tibiofibular overlap were most associated with good outcome scores. There was very little infection in this cohort to confound the results. We would advise careful consideration of medial clear space and tibiofibular overlap in particular at time of fixation of unstable ankle fractures.

Can the Contralateral Ankle Be Used as a Template for Syndesmotic Reduction?

Patrick Kellam**, **MD; *Lucas Marchand, MD; Graham Dekeyser, MD; Travis Bailey, MD; Thomas Higgins, MD; David Rothberg, MD; Justin Haller, MD*

Purpose: Precise reduction of the syndesmosis following disruption is critical to maximize patient outcomes. CT studies have shown tibiofibular intervals did not vary by greater than 2.3 mm in individuals. Clinical practice utilizes intraoperative lateral radiographs of the unaffected ankle as a template for anatomic syndesmotic reduction; however, this practice has not been validated. The aim of this study was to determine if anatomic differences were evident when comparing bilateral lateral radiographs of uninjured patients.

Methods: This radiographic analysis was conducted at a tertiary center. Skeletally mature individuals who underwent bilateral weight-bearing radiographs of the ankles were included. Radiographs that were a good representation of the lateral talus and plafond without previous trauma were included for final analysis. Student t-test and intraclass correlation coefficients were utilized for statistical analysis.

Results: 248 patients were initially evaluated with 137 patients meeting inclusion criteria. Posterior ($P = 0.91$), anterior ($P = 0.67$), and fibular length ($P = 0.13$) ratios did not differ between sides. Interobserver and intraobserver reliability was excellent for the posterior ratio (>0.9), good to excellent for the anterior ratio (>0.75), and moderate for the fibular length ratio (>0.5).

Conclusion: This is the first study to demonstrate the symmetry of the syndesmotic tibiofibular relationship on lateral ankle radiographs. We conclude that there is validity to the practice of using the lateral of the uninjured ankle to assess syndesmotic reduction.

Anterior Impaction-Type Pilon Fractures With Anterior Talar Subluxation or Dislocation: The Worst of the Worst?

Sally Jo*, *BS; *Justin Tilan, MD; Christopher McAndrew, MD, MS; Anna Miller, MD*

Purpose: Anterior impaction pilon fractures with anterior talar subluxation or dislocation, produced by axial loading on a dorsiflexed foot, are a unique pattern of fracture-dislocation whose long-term outcomes are unknown. This study sought to examine whether patients with anterior pilon fractures with talar subluxation or dislocation have worse outcomes compared to pilon fractures without anterior impaction.

Methods: A retrospective review of AO/OTA 43B or C pilon fractures treated at a single Level I trauma center between 2012 and 2017 were evaluated and divided into 2 groups: anteriorly impacted (AI) and non-anteriorly impacted (non-AI) pilon fractures. AI was defined on lateral radiograph and sagittal CT scan as anterior talar subluxation/dislocation with impaction to the anterior plafond. Exclusion criteria were patients without 1 year of follow-up. Radiographic measurements included anterior talar displacement (mm) and posttraumatic osteoarthritis (PTOA) using modified-Kellgren and Lawrence (KL) criteria. Charts were reviewed to assess rates of secondary surgeries, nonunion, malunion, infection, and PROMIS (Patient-Reported Outcomes Measurement Information System) scores in depression, anxiety, physical function, and pain interference. Statistical analysis was performed using chi-square analysis for categorical variables and Student t-test for continuous variables. $P < 0.05$ was considered to be statistically significant.

Results: 40 pilon fractures in 37 patients were evaluated. In the AI pilon group, mean age was 39 years (range, 19 to 63; n = 17) with average follow-up of 20 months (range, 12 to 45). For the non-AI group, mean age was 42 years (range, 24 to 59; n = 23) with 20 months of follow-up (range, 12 to 62). No demographic differences were noted between the groups. The AI group showed radiographic evidence of more advanced PTOA (KL score 3.3 vs 2.3, P = 0.003). Greater anterior talar displacement at the time of injury correlated with a higher KL score (Pearson correlation coefficient = 0.475, P = 0.002). The AI group showed significantly higher rates of implant removal (47.1% vs 17.4%, P = 0.043) and osteomyelitis (29.4% vs 4.3%, P = 0.028 for osteomyelitis). No significant differences were observed in pain, PROMIS scores, rate of arthrodesis, nonunion, or malunion.

Conclusion: Anterior impaction-type pilon fractures are associated with higher rates of PTOA, implant removal, and infection compared with pilon fractures without anterior impaction.

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Screw Removal Effects Within the Syndesmosis (ScREWS Trial)

***Austin Nabet**, **DO;** Nicholas Erdle, MD; Christopher Skeehan, MD; Christopher Smith, MD*

Purpose: Ankle fractures are one of the most common orthopaedic injuries in the military health-care system, with a subset having syndesmotic injury. No standards regarding routine removal or retention of syndesmotic screws exist. The purpose of this study was to prospectively compare 1-year functional outcome and CT data of randomized patients to removal versus retention of syndesmotic screw fixation.

Methods: This was an IRB-approved randomized prospective functional and radiographic study of patients over 18 years of age treated at 1 institution with syndesmotic screw fixation after ankle fracture. Axial CT scans were obtained of bilateral ankles 2 weeks postoperatively. Syndesmotic screws were either removed or retained at 3 months, and full weight bearing initiated. A second CT scan was obtained of the operative extremity at 38 weeks. Functional outcome was collected at 7 scheduled follow-ups over 1 year. Axial CT images were utilized to assess syndesmotic reduction utilizing published methods. 32 patients were enrolled and 16 patients completed 1 year of follow-up (7 removal vs 9 retained).

Results: One year postoperatively, there was no difference in Foot and Ankle Outcome Scores (FAOS) between groups. After patients with broken and/or loose screws were removed from the retained cohort a subgroup analysis was performed (7 removal vs 5 intact). A clinical trend toward improved FAOS (385.9 removal vs 283.8 intact, P = 0.385) was noted when screws were either removed or functionally removed (broken and/or loose). There were no correlations noted between any of the 3 axial CT methods for assessing syndesmotic reduction and any FAOS domains.

Conclusion: With the available numbers, we conclude surgical or functional removal of syndesmotic screws resulted in a clinical correlation toward improvement in functional outcome at 1 year, and despite not reaching statistical significance, these findings suggest patients may benefit from routine removal. Axial CT methods for assessing syndesmotic reduction failed to demonstrate any correlation with functional outcome.

The Association Between Frailty and 30-day Morbidity and Mortality in Patients With Intertrochanteric Femur Fractures

***Adam Boissonneault**, MD;* *Andrew Schwartz, MD; Christopher Staley, BA; Jacob Wilson, MD; Mara Schenker, MD*

Purpose: Increased frailty index scores have been associated with increased morbidity and mortality in patients with hip fractures. The current literature has focused on geriatric femoral neck fractures but there is a paucity of data related to patients with intertrochanteric femur fractures. The aim of the study was to evaluate the association between frailty and 30-day morbidity and mortality in patients with intertrochanteric femur fractures.

Methods: This study reports on 229 consecutive patients aged 50 years or older that presented to a single Level I trauma center for treatment of low-energy intertrochanteric hip fracture over a 4-year period. Frailty was determined by the modified frailty index (mFI) using a previously validated 11-point mFI scale. Outcome variables included 30-day morbidity and mortality. mFI was evaluated as a continuous and categorical variable separately. Mean mFI was compared using independent-samples t-test. mFI was further characterized as a categorical variable with progressive cut-offs. Chi-square analyses and receiver operating characteristic (ROC) curve analyses were performed to determine the sensitivity and specificity of mFI in predicting 30-day morbidity and mortality.

Results: Of the 229 total patients, 82 patients had postoperative complications, with 10 mortalities. The mean mFI for those with a complication was 0.24 compared to 0.14 for those that did not (P <0.001). The mean mFI for the mortality group was 0.31 compared to 0.17 for the non-mortality group (P = 0.010). The sensitivity and specificity for mFI to predict 30-day morbidity and mortality varied by mFI cut-off. ROC curve analyses revealed the most robust predictor of morbidity and mortality was an mFI score of 0.27 or more (P <0.001). The mortality rate increased from 0% for mFI of 0 to 11% for mFI of 0.27 or more. Patients with an mFI of 0.27 or more were over 9 times as likely to have a mortality compared to patients with an mFI less than 0.27 (P = 0.006).

Conclusion: Our study demonstrates mFI is associated with 30-day morbidity and mortality in patients aged 50 years or older with intertrochanteric femur fractures. These findings may be used to both communicate risk to patients, and also to preoperatively identify patients who may benefit from a more structured, interdisciplinary care pathway.

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Higher Risk for Reoperation After Surgical Treatment of Atypical Fractures Compared With Common Fractures of the Femoral Shaft

Hans Peter Bögl**, **MD; *Georg Zdolsek; Per Aspenberg, MD, PhD; Karl Michaëlsson, MD, PhD; Jörg Schilcher, MD, PhD*

Purpose: Our goal was to test the hypothesis that patients with complete atypical femur fractures do not have a higher risk for reoperations related to healing complications compared to non-atypical (common) femur fractures.

Methods: In Sweden, 5475 women and men 55 years of age or older sustained a fracture in the diaphyseal and subtrochanteric femur between 2008 and 2010. We reviewed all individual radiographs from the initial fracture until December 2015 for 164 patients with atypical femoral fractures and 862 with common fractures of the femur. The remaining 4449 patients were excluded due to either incomplete imaging, periprosthetic or pathological fractures, condylar or trochanteric fractures, or otherwise mechanically altered femurs. All reoperations were identified with data from the National Swedish Patient Registries and by radiographic review. Among these, we identified patients who underwent reoperation due to healing complications of the initial fracture (implant failure or delayed healing).

Results: Any type of reoperation was performed in 28 of 164 patients with atypical femoral fractures compared with 66 of 862 patients with common fractures (odds ratio [OR] 2.5, 95% confidence interval [CI] 1.5 to 4.0). The difference remained, when corrected for age, sex, and Charlson Comorbidity Index (OR 1.9, 95% CI 1.2 to 3.2). Also, the odds for reoperation related to healing complications was higher for patients with atypical femoral fractures (10 of 164 compared to 22 of 862) (OR 2.5, 95% CI 1.2 to 5.3), even when corrected for age, sex, and Charlson Comorbidity Index (OR 2.2, 95% CI 1.0 to 4.9).

Conclusion: In contrast to our expectations, the reoperation rate for patients with atypical femoral fractures was higher when compared with common femoral fractures, even when only reoperations due to healing complications were considered and when adjusted for cofactors. We have recently shown that the biological capacity to heal in patients with atypical femoral fractures seems undisturbed. Therefore, the higher odds for reoperation due to healing complications might be related to biomechanical properties of the specific fracture pattern in atypical femoral fractures (simple, transverse) or other reasons.

The Clinical and Economic Impact of Value-Based Cephalomedullary Nail Utilization

Alastair Moody, BS; William Haug, BS; ***Kyle Lybrand, MD***

Purpose: In this era of rapidly rising health-care costs, the economic and ethical need for transition to value-based health-care models is a topic of significant importance. Our institution has been committed to value-based implant usage to decrease the cost of care while providing high-quality outcomes in hip fracture care. The purpose of this study was to compare the clinical outcomes and economic impact of "value based" versus "conventional" cephalomedullary nail implant utilization for treatment of intertrochanteric hip fractures.

Methods: After IRB approval, our institution adopted the use of a value-based cephalomedullary nail for the treatment of intertrochanteric hip fractures. Despite a significantly lower cost, these constructs were biomechanically tested as equivalent to conventional products prior to the initiation of the project. Review of our trauma database identified patients treated with value-based implants. These patients were compared to patients treated over the same time period with conventional implants. Chart review was undertaken to obtain basic demographic variables. Operative records were analyzed to identify intraoperative complications, operative time, and estimated blood loss (EBL). Patient charts and radiographs were assessed to identify fracture type, cases of deep infection, malunion, nonunion, need for repeat surgery, and implant failure. Hospital financial records were reviewed to determine operative implant costs.

Results: 137 patients were treated with the value-based implant while 142 patients were treated with conventional intramedullary implants over the same time period. There were no significant differences in age, sex, ASA (American Society of Anesthesiologists) score, or fracture type between groups. No difference in EBL or intraoperative complication rate was observed ($p = 0.14$). No increase in postoperative deep infection rate, implant failure, malunion, nonunion, or need for repeat surgery was observed. Operative time was significantly less in the value-based implant group (35.3 min vs 24.5 min, $P = 0.003$). Overall the hospital realized a significant reduction in implant costs averaging $1158 per case, amounting to a total savings of $158,646. These implant savings were vital to our success in the BPCI (Bundled Payments for Care Improvement) initiative.

Conclusion: Use of value-based implants has been a successful endeavor at our institution. Implant costs decreased significantly without any increase in complication rate or change in radiographic outcome. Savings can be reinvested in the hospital trauma program to support OTA/AAOS position statement guidelines, assist in gain-sharing and comanagement efforts, and positively affect the cost of fracture implants.

POSTER ABSTRACTS

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DVT Prophylaxis for Hip Fractures: Is Aspirin Enough?

Jonathan Copp**, **MD; *Lakshmanan Sivasundaram, MD; Christopher Wang, BS; Chang-Yeon Kim, MD; Zorica Buser, PhD; Jeffrey Wang, MD; G. Ochenjele, MD*

Purpose: Deep vein thrombosis (DVT) and pulmonary embolus (PE) are known complications in patients undergoing hip fracture surgery. Following total joint arthroplasty, aspirin has been shown to have similar rates of venous thromboembolism (VTE) and a better safety profile compared to other anticoagulation agents; however, a similar study has not been reported for hip fractures. The purpose of this study was to (1) compare the rates of DVT and PE and (2) compare the overall complication rates of aspirin, warfarin, and low molecular-weight heparin (LMWH) in patients undergoing operative fixation of hip fractures.

Methods: Patients who had hip fracture surgery from 2007 to 2016 and were prescribed aspirin, warfarin, or LMWH postoperatively were identified in the PearlDiver database using ICD-9, CPT, and National Drug codes. Patients were excluded if they had a preoperative diagnosis that has been shown in prior studies to increase rates of DVT and PE or if their fracture was pathologic or periprosthetic. The primary outcome measures were rates of DVT and PE. To evaluate for confounding factors, comparisons of preoperative comorbidities among all 3 groups were made. A bivariate chi-square analysis was used to identify statistically significant associations (0.05 for all analyses) between anticoagulation choice and postoperative complications.

Results: From 2007 to 2016, 7139 procedures were identified. In our cohort, 3544 patients (49.7%) were prescribed warfarin, 3241 (45.4%) LMWH, and 354 (5.0%) aspirin. The median Charlson Comorbidity Index was 3.17 for aspirin patients, 2.38 for LMWH patients, and 2.88 for warfarin patients. Patients prescribed aspirin had similar rates of DVT (3.1% vs 3.7%, P = 0.10) and PE (0.8% vs 1.8%, P = 0.28) compared to those prescribed LMWH. Patients on aspirin had lower rates of DVT (3.1% vs 9.8%, P <0.01) and PE (0.8% vs 6.2%, P <0.01) compared to those prescribed warfarin. Patients in all 3 groups had similar rates of total complications (warfarin 13.1% vs LMWH 14.1% vs aspirin 13.6%, P = 0.19).

Conclusion: In patients undergoing operative fixation for hip fractures, patients prescribed aspirin as chemoprophylaxis had similar incidence of DVT and PE compared to those prescribed LMWH and a lower incidence compared to those prescribed warfarin with similar rates of total complications when compared those on warfarin or LMWH. Aspirin may be a safe and effective choice for chemoprophylaxis in patients undergoing operative fixation of hip fractures.

Functional Outcomes Following the Operative Treatment of Elbow Fractures in the Elderly

***Isabella Bianco**, BA;* *Kurtis Carlock, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to compare the functional outcomes of patients aged 70 years and older to those less than 70 years after open reduction and internal fixation of elbow fractures.

Methods: 248 patients who sustained a fracture about the elbow (OTA / AO type 13 and 21) at 1 institution between March 2011 and September 2015 were identified and demographic, injury, treatment, and postoperative functional information was obtained via retrospective chart review. All patients had at least 6 months of documented follow-up. A Mann-Whitney U test was run to determine if there were differences in body mass index (BMI), Charlson Comorbidity Index (CCI), time to surgery, 6-week elbow range of motion (ROM), 3-month arc of motion (AOM), 6-month AOM, 12-month AOM, time to heal, and Mayo Elbow Performance (MEPI) scores between the under 70 and ≥70 patients. A Fisher exact test was run to determine if there were differences in gender, OTA Fracture Classification, or the rate of complications between the 2 groups.

Results: Of the 248 patients, 184 were under the age of 70 and 64 were ≥70 years. While there were no differences in the distribution of fracture types (P = 0.051), the older group had more women (P <0.001). The older age group was found to have a greater median CCI and a smaller median BMI than the under-70 group (P = .013, P <0.001). However, while the younger group had better AOM at 6 weeks (P = .021), there were no differences in ROM at any time point, time to fracture healing (P = 0.768), or MEPI (P = 0.257). Moreover, the older group had a lower rate of complications (6.8%) than the younger group (19.8%), (P = 0.02).

Conclusion: Patients who are 70 years old or older can achieve similar functional outcomes as those who are younger following the operative fixation of unstable elbow fractures with no increased risk for complications. Thus, age should not play a role in the surgeon's decision-making process for treating unstable elbow fractures.

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Factors Predictive of 30-Day Readmission in Middle-Aged and Geriatric Orthopaedic Trauma Patients With Lower Extremity Fracture

Ariana Lott*, *MD; *Rebekah Belayneh, MD; Jack Haglin, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: As health-care costs rise, 1 area of high spending that the government is targeting is 30-day readmissions. Preventing 30-day readmissions is not only helpful in combating excessive health-care spending but also in improving patient satisfaction. Orthopaedic surgeons and hospitals should be aware of factors that can predict future readmissions in their patients. The purpose of this study was to determine which patient factors are associated with increased risk of 30-day readmission in middle-aged and geriatric orthopaedic trauma patients with lower extremity injuries.

Methods: Patients with lower extremity fractures aged 55 years and older at 1 academic medical center between October 2014 and September 2016 were analyzed. Exclusion criteria included any patient who died during their inpatient admission. Patient factors including age, injury details, Charlson Comorbidity Index (CCI), ambulatory status, and albumin on admission were collected. Health-care quality measures including length of stay, discharge location, need for ICU/SDU (intensive care unit/step down unit) level care, and complication rate were also recorded. Patients were followed prospectively for 30 days to assess for unplanned readmissions. A multivariate logistic regression was performed to identify factors that were predictive of 30-day readmission.

Results: A total of 797 patients were included in this analysis. The mean age of the cohort was 77.1 ± 12.0 years. The mean length of stay was 8.1 ± 5.7 days with an overall 30-day readmission rate of 7.2 ± 25.8%. A multivariate logistic regression model using 30-day readmission as the outcome revealed that the following factors were significant predictors of readmission: (1) CCI (odds ratio [OR] = 1.333, 95% confidence interval [CI] = 1.109-1.604, P = 0.002), (2) development of pneumonia during index hospitalization (OR = 2.959, 95% CI = 1.069-8.193, P = 0.037), and (3) albumin on admission (OR = 0.513, 95% CI = 0.277-0.948, P = 0.033).

Conclusion: In middle-aged and geriatric lower extremity orthopaedic trauma patients, a patient's preadmission comorbidities, nutritional status, and development of pneumonia during their index hospitalization are associated with readmission within 30 days of discharge. These factors can be used to help physicians identify these high-risk patients for readmission so as to improve patient care and prevent these avoidable added health-care costs.

Acute Total Hip Reconstruction Following Displaced Acetabular Fractures in the Elderly

Ross Leighton**, **MD; *Paul Duffy, MD; Amro Alhoukail, MD*

Purpose: Frail elderly patients with acetabular fractures have a high mortality rate if left untreated, yet have up to a 30% revision rate if treated with open reduction and internal fixation (ORIF). The magnitude of ORIF surgery and the need to reduce weight-bearing for a significant period of time postoperatively do not always allow this to be a viable option in this population. The purpose of this study was to look at a consecutive cohort of elderly patients with displaced acetabular fractures treated with ORIF and total hip replacement (THR) or impaction grafting and cage arthroplasty in order to quantify the length of surgery, amount of blood loss, and mortality.

Methods: A multicenter, retrospective review of acetabular fractures was conducted. Those with THR as part of the initial treatment and 1 year of follow-up were included. In addition, patients must have been allowed to weight-bear at least 50% immediately after surgery. The surgical technique was surgeon-dependent: ORIF of the acetabulum plus a standard THR (ORIF-THR group) or impaction grafting, limited stabilization of the dome and posterior column, and a cage arthroplasty with a cemented cup, ignoring anterior and medial deformity (Cage-THR group). All were geriatric patients with multiple medical comorbidities who the surgeons felt would not be able to cooperate with a non-weight-bearing protocol.

Results: 32 patients were included in this study, 18 Cage-THR and 14 ORIF-THR. Surgical time was significantly less for the Cage-THR group, 122 minutes versus 181 minutes. Blood loss was double in the ORIF-THR group, 1200 mL versus 600 mL. Perioperative death rate was not significantly different, 2 in the Cage-THR group and 1 in the ORIF-THR group. A minimum of 50% weight-bearing was achieved in all patients with 70% of the entire group prescribed "weight bearing as tolerated" immediately postoperatively. This was performed with the assistance of a walker or crutches for at least 3 months. There were no reoperations for implant failure in either group. Both groups had fewer complications and mobilized earlier when compared to traditional ORIF for geriatric acetabular fractures.

Conclusion: Geriatric acetabular fractures need a safe, low-impact operation that will allow recovery from this very significant fracture and attain early weight-bearing and early mobilization. Acute total hip reconstruction may provide the solution to our perioperative goals. Either technique would appear to be superior to a standard ORIF in this geriatric population with respect to early weight-bearing and the requirement for a secondary surgery.

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The STTGMA Risk Tool Has Better Predictive Utility than ASA for Hospital Quality Measures in Geriatric Orthopaedic Trauma Patients

Sanjit Konda, MD; *Jordan Hall, BS; Jessica Mandel, BA; Kyle Hildebrandt, BS; Thomas Lyons, MD; Kenneth Egol, MD*

Purpose: The Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA) has demonstrated utility in detecting mortality risk for older orthopaedic trauma patients. This study aims to demonstrate the capability of the tool in predicting postoperative hospital quality measures in comparison to a widely used grading system, the American Society of Anesthesiologists (ASA) physical health classification.

Methods: Patients >55 years old who sustained traumatic injuries and were operatively treated at 2 academic medical centers from 2015 to 2017 were included. Each patient's demographics, injury severity, and functional status were used to calculate a STTGMA score at time of admission, and patients were stratified by their calculated risk of inpatient mortality into minimal, low, moderate, and high-risk cohort groups of <0.24%, 0.24-1.1%, 1.1-7%, and >7%, respectively. Anesthesia notes were examined to collect preoperative ASA scores. Information regarding length of stay, inpatient complications, inpatient mortality, and unplanned 90-day readmissions were additionally recorded. Multivariate logistic regression analyses were performed using occurrence of inpatient complications, inpatient mortality, and unplanned 90-day readmissions as dependent variables, whereas a linear regression analysis was used for length of stay. A P value <0.05 was considered significant for all tests.

Results: A total of 1242 patients were prospectively enrolled. The mean age of the cohort was 78.4 ± 11.4 years and 1113 (89.6%) of injuries were secondary to a low-energy mechanism. Multivariate analysis revealed that risk stratification by STTGMA was an independent predictor of inpatient mortality (odds ratio [OR]: 1.57, 95% confidence interval [CI]: 2.62-38.3, P = 0.001), inpatient complication (OR: 1.70, 95% CI 1.08-2.66, P = 0.023), 90-day readmission (OR: 1.70, 95% CI: 0.89-2.24, P <0.0001), and length of stay (B: 1.57, 95% CI: 0.89-2.24, P <0.0001). ASA, however, was demonstrated to independently predict only length of stay (B: 0.903, 95% CI: 0.07-1.74, P = 0.034).

Conclusion: When compared to the ASA classification, STTGMA has improved independent predictive utility for vital hospital quality measures for orthopaedic trauma patients. Use of this tool at time of admission can aid physicians in early identification of patients at increased risk of postoperative complications.

POSTER ABSTRACTS

Surgical Fixation of Geriatric Sacral U-Type Insufficiency Fractures: A Retrospective Analysis

Benjamin Pulley, MD; *Steven Cotman, MD; T. Fowler, MD*

Purpose: U-type fractures of the sacrum have typically been defined as high-energy traumatic injuries. This fracture is underreported in the setting of low-energy geriatric trauma. We seek to define its incidence as an insufficiency fracture and describe management of a series of patients with this injury.

Methods: Over 36 months, 114 elderly patients with low-energy pelvic ring fractures were treated at a Level II trauma center. 19 patients (16.7%) were identified to have sacral U-type insufficiency fractures and 17 were ultimately treated surgically. Patients were indicated for surgery if they had posterior pelvic pain that prohibited mobilization. Fracture stabilization was accomplished by percutaneous transiliac-transsacral screws or bilateral iliosacral screws. Screws were positioned to provide rotational control of the upper sacral segment. Patients were allowed to weight bear as tolerated after surgery. Outcome measures included distance ambulated on postoperative day (POD) 1, visual analog scale (VAS) for pain, and clinical/radiographic assessment of fracture healing.

Results: The average patient age with sacral U-type fractures was 74.3 years. In 63.1% (12/19), initial management of the fracture was nonoperative; 10 patients ultimately failed nonoperative treatment and were treated with delayed surgery at an average 82.8 days post-injury; 2 were lost to follow-up. In 31.6% (6/19), fracture pain at initial presentation was severe enough to warrant hospitalization; all 6 patients were treated with acute surgery at an average 6.8 days post-injury. One patient (5.3%; 1/19) was referred after failing to unite a sacral U-type fracture 6 months after it was incompletely surgically stabilized by another provider; this patient was treated with revision surgery at 226 days post-injury. For the 17 patients treated surgically, average distance ambulated on POD 1 was 93.9 feet; average VAS for pain decreased from 6.1 (95% confidence interval [CI] 1.4-10) preoperatively to 2.6 (95% CI 0-5.0) postoperatively; $P < 0.01$. The fractures healed clinically without interval displacement in all patients by 6 weeks postoperatively and the outcome was maintained at 12-month follow-up.

Conclusion: The sacral U-type fracture is a rare injury that has not been previously described as an insufficiency fracture. Fracture stabilization by percutaneous screw fixation may provide pain relief in this frail patient population, permit early mobilization, prevent progressive deformity, and increase union rates.

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Patient-Centered Care: Total Hip Arthroplasty for Displaced Femoral Neck Fracture Does Not Increase Complication Risk

Abigail Campbell, MD, MsC; ***Ariana Lott, MD;*** *Leah Gonzalez, BS; Benjamin Kester, MD; Kenneth Egol, MD*

Purpose: Total hip arthroplasty (THA) is often utilized for displaced femoral neck fracture. In this study, institutional hip arthroplasty data was analyzed and compared to American College of Surgeons National Surgical Quality Improvement Program (NSQIP) data to ascertain any differences in outcomes between our hospital, with an integrated hip fracture care pathway, and that of the country as a whole. The purpose of this study is to determine if the risk for surgical complications, specifically infection, following hip arthroplasty procedures performed for fracture differs from those performed electively using both our institutional data for hip arthroplasty patients and the national NSQIP database.

Methods: Assessing institutional (2012-2017) and national data, THA performed electively was compared to THA and hemiarthroplasty (HA) performed for acute fracture. Outcomes for both groups included thromboembolic event (VTE), death, and deep prosthetic infection requiring return to the operating room.

Results: Institutional data revealed no increased rate of infection after THA for fracture compared to elective. HA had higher deep infection rates than the elective THA (3.4% HA vs 0.6% THA elective, P = 0.003). There was a greater VTE rate in both fracture groups compared to elective THA (2.0% HA vs 0.3% THA elective vs 3.6% THA fracture). In contrast, NSQIP data demonstrated that both THA and HA performed for fracture had significantly increased rates of VTE and deep infection compared to elective THA. Within fracture groups, HA patients had significantly more postoperative complications when controlling for demographics and comorbidities.

Conclusion: When performed at an academic medical center with an integrated care program, THA for fracture can have similar outcomes to elective THA. In contrast, national data showed significantly higher rates of infection and VTE for arthroplasty for fracture compared to elective. The contrast in complication rates may be related to well-functioning comprehensive interdisciplinary pathways. Patient-centered care pathways rather than blanket algorithmic treatment decisions may be optimal for select hip fracture patients.

Strategies for Blood Transfusion in Hip Fracture Patients in the Modern Era

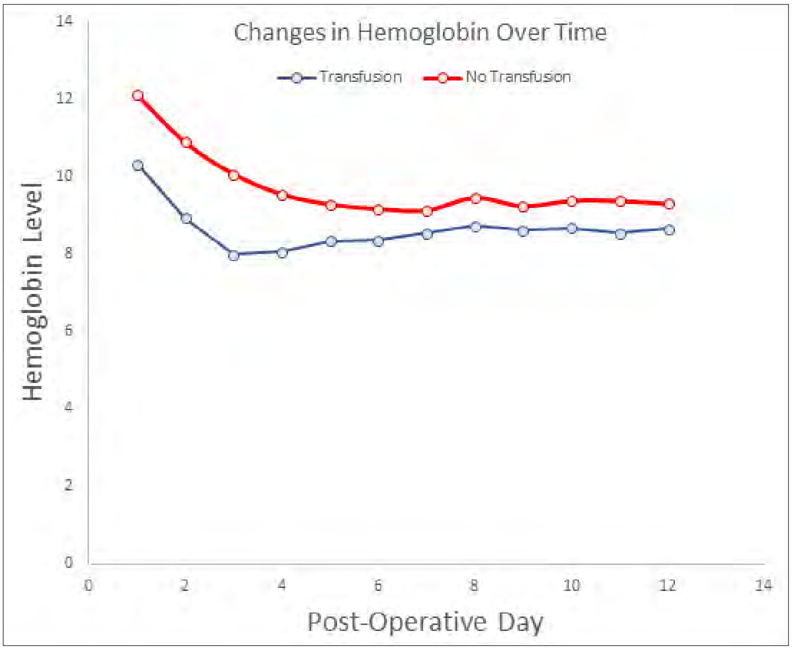
Taylor D'Amore, BA; *Kyle Judd, MD, MS; Gillian Soles, MD; Catherine Humphrey, MD; John Ketz, MD; Christina Seifert, MD; Jeff Houck, PhD; John Gorczyca, MD*

Purpose: This study aims to review hemoglobin (Hgb) and transfusion data in recent hip fracture patients to identify opportunities for decreasing hospital stay. Our hypotheses are that Hgb levels continue to fall for more than 3 days postoperatively, and that earlier transfusion of more blood will be associated with shorter hospital stays.

Methods: Data were collected from patients older than 60 years with hip fractures (AO/OTA 31-A and 31-B) from 2 teaching hospitals from 2015 to 2017. Charts were retrospectively reviewed for demographic information, Hgb levels, and transfusions.

Results: 898 patients met the inclusion criteria. 375 patients (41.8%) were transfused an average of 1.9 (range, 1-6) units over an average of 1.5 (range, 1-5) transfusions. The mean age was 80 years. The Hgb level continued to fall for 5 days postoperatively before beginning to recover on day 6 (Figure 1). 105 patients required a transfusion on postoperative day (POD)1 and received only 1 unit of blood: 53 (50.4%) required a secnd transfusion in the following days, compared to 10 of 39 (26%, chi-square = 36.068) who received 2 units on POD1. Patients who received transfusions on POD3 or later had an average length of stay >2.5 days longer (P = 0.001). Estimated blood loss was higher in the transfused group (246 cc vs 168 cc, P <0.001).

Conclusion: Our hypotheses were confirmed. After hip fracture surgery, the Hgb continually decreases for 5 days postoperatively. If transfusion is indicated on POD1, transfusion of 2 units will decrease the need for repeat transfusion. Late (POD3 or later) transfusion is associated with a longer hospital stay. This information will provide utility in the population health management of hip fracture patients.



POSTER ABSTRACTS

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Time-to-Block: Early Fascia Iliaca Block Reduces Opioid Use in Geriatric Hip Fractures

John Garlich*, *MD; *Eytan Debbi, MD, PhD; Dheeraj Yalamanchili, MD; Samuel Stephenson, MD, PhD; Stephen Stephan, MD; Landon Polakof, MD; Milton Little, MD; Charles Moon, MD; Mark Vrahas, MD; Kapil Anand, MD; Carol Lin, MD*

Purpose: Fascia iliaca blocks (FIBs) have emerged as a promising method to reduce opioid use in geriatric hip fractures. No study has evaluated the timing of block placement and its effect on perioperative outcomes. We hypothesized that earlier block placement reduces opioid intake, opioid-related complications, time to ambulation, delirium, and length of stay (LOS).

Methods: From March 2017 to November 2017, 177 hip fracture patients 60 years and older were enrolled in a comprehensive hip fracture pain management program at an urban Level I academic trauma center. Upon diagnosis, patients received preoperative FIB. Block administration time and hospital arrival time was recorded prospectively to determine the time-to-block for each patient. We divided patients into Group 1 (0-8 hours) and Group 2 (8+ hours). Only patients who had surgery within 48 hours of arrival were included. We compared pre- and postoperative morphine equivalent doses (MED), opioid-related complications, delirium, time to ambulation, and LOS between groups.

Results: 76 patients (42.9%) received a block preoperatively and had surgery within 48 hours. 37 (48.7%) of these patients received the block within 8 hours (Group 1), and 39 (51.3%) received the block after 8 hours (Group 2). Mean preoperative MED was significantly less in Group 1 compared to Group 2 (mean ± standard deviation [SD] = 23.13 ± 24.85 vs 39.01 ± 34.44, P = 0.025). Postoperatively, Group 1 trended toward decreased opioid use, but did not reach statistical significance (mean ± SD = 16.49 ± 17.40 vs 23.45 ± 27.32, P = 0.192). On postoperative day 2, Group 1 had significantly less opioid intake (mean ± SD = 8.42 ± 10.31 vs 16.95 ± 22.88, P = 0.041). Multiple linear regression was calculated to predict preoperative MED use based on Time-to-Block, time to surgery, and age. Preoperative MED increased 1.14 MED for each 1 hour from admission to block placement. Time-to-Block and age were both significant predictors of MED (P = 0.03). There was no significant difference in opioid-related complications, time to ambulation, delirium, or LOS between groups.

Conclusion: Fascia iliaca blocks placed within 8 hours of admission reduces both pre- and postoperative opioid intake compared to blocks administered after 8 hours. Expeditious use of regional anesthesia in geriatric hip fractures may reduce opioid use and complications in these patients. Further investigation is needed to determine the most appropriate Time-to-Block and its impact on patient outcomes.

Geriatric Hip Fractures: Regional Anesthesia with Multimodal Pain Management

John Garlich*, *MD; *Zachary Moak, MD; Eytan Debbi, MD, PhD; Dheeraj Yalamanchili, MD; Samuel Stephenson, MD, PhD; Stephen Stephan, MD; Kapil Anand, MD; Milton Little, MD; Charles Moon, MD; Mark Vrahas, MD; Carol Lin, MD*

Purpose: Elderly hip fracture patients are at increased risk of opioid adverse effects, prolonged opioid use, and delirium. We implemented a pain management strategy using preoperatively placed fascia iliaca blocks (FIBs) and a specific pain medication regimen to reduce opioid consumption and related adverse effects. The purpose of this study is to report the perioperative outcomes of our pain management strategy on opioid consumption, complications, delirium, and length of stay.

Methods: From March 2017 to November 2017 we enrolled hip fracture patients aged 60 years and over in a hip fracture pain management program. Upon diagnosis, patients underwent FIB. We placed patients on a standardized regimen of scheduled non-opioid analgesics (Tylenol and Meloxicam), PRN (as needed) Tramadol, and breakthrough Dilaudid. Complications, delirium, hospital stay, and morphine-equivalent doses (MED) were recorded.

Results: 177 patients presented with a hip fracture; 84 (47.5%) received a block preoperatively and were included. The average age was 83.6 years ± 8.7; the median time to preoperative fascia iliaca block was 8.3 hours (range, 4.5-15.3). The median time from admission to surgery was 1.0 days (range, 0.9-1.4). The median length of stay was 4.7 days (range, 3.6-6.6). The incidence of delirium was 22.6%. The overall rate of opioid-related adverse events was 19.0% and included constipation (5), urinary retention (7), and urinary tract infections (4). No patient required naloxone for respiratory depression. Preoperatively, total MED/day consumption was 21.6 mg/day (range, 10.2-41.3). MED usage significantly decreased Pre-Block to Post-Block: mean ± standard deviation [SC] = 24.4 ± 25.2 to 11.8 ± 18.9, median (Q1-Q3) = 16.1 (range, 6-38.6) to 0 (range, 0-13.7), P <0.0001 for each comparison. After acounting for time, MED/hour significanly decreased Pre-Block to Post-Block: mean ± SD = 2.7 ± 2.9 to 0.6 ± 0.9, median (Q1-Q3) = 2.1 (range, 0.8-3.2) to 0.0 (range, 0.0-0.9), P <0.0001 for each comparison. A Wilcoxon signed rank test shows a significant decrease between Pre- and Post-Block MED/hour (Δ = -2.03 ± 2.73 mg/hr, confidence interval [CI] -2.6 to -1.4; P <0.0001). Median postoperative morphine equivalent consumption was 15.0 (0-30) and 6.0 (0-24) mg on postoperative days 1 and 2.

Conclusion: Regional anesthesia as part of a multimodal pain management strategy has a low rate of opioid consumption and opioid adverse events and should be strongly considered for geriatric hip fracture patients.

POSTER ABSTRACTS

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Mediating Effect of Postoperative Complications in the Association Between Surgical Timing and Mortality After Hip Fracture

Pierre Guy, MD; *Katie Sheehan, PhD; James Blair, MD; KC Chan, PhD; Boris Sobolev, PhD*

Purpose: Hip fracture patients are at high risk of postoperative mortality. Published works have demonstrated a variable-to-absent association between timing of surgery and mortality. The clinical trend has, however, been to avoid delay to operative care. To better understand the mechanisms that underpin mortality and to better focus our clinical efforts, we sought to characterize the timing-mortality association in the presence of complications as a mediating factor.

Methods: Using hospital records from a population cohort, we contrasted postoperative mortality between 2 patterns of timing of surgery and occurrence of complications in the same patient population: (1) if all had been treated after 2 days in hospital; and (2) if all had been treated within the first 2 admission days, but the proportion of complications would have attained the level as if all had been treated after 2 days in hospital. The study population was medically stable patients who underwent surgery for a first non-pathological hip fracture between January 1, 2004 and December 31, 2012 in a single country. Timing of surgery was within 2 inpatient days (early surgery) or after inpatient day 2 (delayed surgery). Main outcomes and measures were death within 30 inpatient days after surgery, and any post-surgical complication. Risks and risk differences are reported per 1000 surgeries.

Results: Among 139,119 patients (74.3% women, 45.8% 85 years or older), 66.6% underwent early surgery; risk of death and of complications was 45.8 and 60.2 per 1000 surgeries, respectively. The total effect of early surgery is estimated to produce 7.9 (95% confidence interval [CI] 5.5 to 10.3) fewer deaths per 1000 surgeries, while the direct effect (that is, with complication rate not affected by early timing) is estimated at 4.0 (95% CI 1.6 to 6.3) fewer deaths per 1000 surgeries.

Conclusion: Approximately half of the reduction in in-hospital postoperative mortality, currently attributed to early surgery, was due to fewer postoperative complications after shorter delays. In addition to efforts aimed at avoiding surgical delays, reducing postoperative mortality will require timely recognition and effective management of the other cases (approximately half) where complications occurred. Reducing mortality after postoperative complications (as a failure-to-rescue metric) could prove useful in measuring quality of hip fracture care.

Trend and Economic Implications of Implant Selection in the Treatment of Intertrochanteric Hip Fractures: A Review of the American Board of Orthopaedic Surgery Database 1999-2017

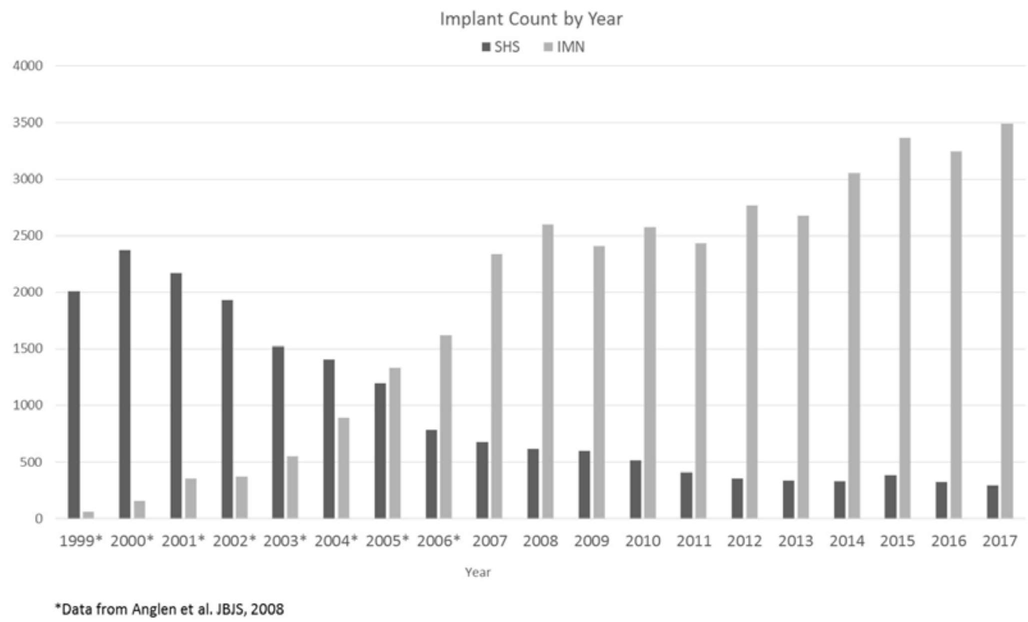
Lauren Casnovsky, MD; *Melissa White, BA; Harsh Parikh, MPH; Ann Van Heest, MD; Brian Cunningham, MD*

Purpose: The purpose of this study is to report the trend of implant utilization for intertrochanteric (IT) fracture fixation from 1999 to 2017 and develop an economic model to estimate total implant costs.

Methods: The American Board of Orthopaedic Surgery (ABOS) Part II database was used to identify all IT fractures (31A) over an 18-year period (1999-2017). The cases were categorized by intramedullary nail (IMN) or sliding hip screw (SHS) fixation on the basis of surgeon-reported CPT codes. Implant utilization was analyzed and cost modeled over time.

Results: Of the 54,487 cases accumulated into the ABOS Part II database, 18,208 cases (33.4%) were identified as SHS and 36,279 (66.6%) were identified as IMN. In 1999, the utilization of the 2 implants was 97.1% SHS and 2.9% IMN. In 2017, the utilization of the 2 implants diverged to 7.6% SHS and 92.4% IMN. Utilizing 1999 ABOS data as a baseline, implant selection in 2017 alone resulted in an increase of $7.5 million. This extrapolates to $793 million when observing for the total number of IT hip fractures.

Conclusion: Early-career orthopaedic surgeons now exclusively utilize a costlier implant for IT fractures despite no evidence for improved outcomes. If this trend continues into their careers, it continues to further bias implant selection to low-value interventions. This may represent a lack of insight into the current literature or implant cost.



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Subtrochanteric Femur Fractures Treated With Reconstruction Nails Have a Lower Reoperation Rate Compared to Cephalomedullary Nail Fixation: Matched Cohort Study of 232 Patients

Austin Heare, MD; *Brian Cunningham, MD; Harsh Parikh, MPH; David Shearer, MD, MPH; William Obremskey, MD, MPH; H Claude Sagi, MD; Robert O'Toole, MD*

Purpose: The optimal screw configuration in the proximal femur for the treatment of subtrochanteric femur fractures has not been studied clinically. The purpose of this study was to compare the rate of reoperation in subtrochanteric femur fractures treated with reconstruction nails (RNs) versus cephalomedullary nails (CMNs).

Methods: Utilizing the data collected from 6 Level I trauma centers, a retrospective matched cohort study assessed the reoperation rates for subtrochanteric femur fractures (32A-32C) treated with either RNs or CMNs. Cohorts were matched by age, to the nearest 5-year interval, and postoperative weight-bearing status. Primary outcome was reoperation specifically for: implant failure, malunion, and nonunion. Patients were followed to radiographic union. Statistical analysis consisted of intergroup comparative tests and relative-risk logistic regression.

Results: A total of 232 patients met inclusion criteria, 116 for both RN and CMN. A total of 17 patients (17.3%) required reoperation, 13 (11.2%) for the CMN group and 4 (3.4%) for the RN group (P = 0.01). CMNs had a 2.17 (2.01, 2.30) (P = 0.01) times higher risk of reoperation when compared to the RNs after adjustment for patient and fracture characteristics.

Conclusion: This study showed a significantly higher reoperation rate in subtrochanteric femur fractures treated with single-screw CMNs compared to dual-screw RNs.

Table 1. Study population characteristics stratified by nail type, August 2008 and November 2015 (N=232)

	Cephalomedullary (n=116)			**Reconstructive** (n=116)			**p-value**
Age	45.0 ± 21.7 [41.0, 49.0]			45.3 ± 22.0 [41.1, 49.5]			0.99[1]
BMI	24.5 ± 5.0 [23.1, 26.0]			28.4 ± 7.0 [25.7, 31.0]			**0.01[1]**
Gender [M/F]	85 (73.3%)	31 (26.7%)		81 (69.8%)	35 (10.2%)		0.56[2]
Study Site I / II / III	32 (27.6%)	5 (4.3%)	14 (12.1%)	12 (10.3%)	21 (18.1%)	19 (16.4%)	**<0.01[2]**
Study Site IV / V / VI	12 (10.3%)	38 (32.8%)	15 (12.9%)	5 (4.3%)	55 (47.4%)	4 (3.5%)	
AO/OTA [32A/32B/32C]	56 (48.3%)	32 (27.6%)	28 (24.1%)	52 (44.8%)	34 (29.3%)	30 (25.9%)	0.76[2]
Winquist-Hansen 0 / 1 / 2	20 (17.5%)	19 (16.7%)	35 (30.7%)	21 (18.3%)	30 (26.1%)	25 (21.7%)	0.38[2]
Winquist-Hansen 3 / 4	15 (13.2%)	25 (21.9%)		16 (13.9%)	23 (20.0%)		
Reduction Type [Open/Perc/Closed]	42 (37.8%)	25 (22.5%)	44 (39.6%)	19 (20.0%)	37 (39.0%)	39 (41.0%)	**<0.01[2]**
MOI [High/Low]	83 (71.6%)	33 (28.4%)		85 (73.3%)	31 (26.7%)		0.80[2]
Weight-Bearing [WBAT/NLWB]	64 (55.2%)	52 (44.8%)		64 (55.2%)	52 (44.8%)		1.00[2]
Length of Stay (LoS)	8.6 ± 13.4 [6.1, 11.0]			9.2 ± 11.8 [7.0, 11.4]			0.70[1]
Re-Operation	13 (11.2%)			4 (3.4%)			**0.04[2]**

A summary of study sample (N=232) characteristics. Continuous variable summary statistics will be reported in mean ± SD [95% CI] format. Parenthesis percentages are representative of their proportion within their respective treatment arm.
[1]Resulting two-sample Welch t-test p-value.
[2]Resulting chi-squared p-value for categorical analysis.

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

Does Screw Location Affect the Risk of Subtrochanteric Femur Fracture After Femoral Neck Fixation?

Erica Crump, MD; *Michael Quacinella, DO; Bradley Deafenbaugh, MD*

Purpose: Case reports in the literature suggest that there is an increased risk of subtrochanteric femur fracture after femoral neck fixation with cannulated screws when the lowest screw is placed below the level of the lesser trochanter. However, there is a paucity of biomechanical data in the literature supporting this observation. This study provides a model to investigate this question in a controlled manner.

Methods: Osteoporotic Sawbones femora were instrumented with 3 cannulated screws in a triangular apex distal configuration with the distal-most screw either above, at, or below the level of the lesser trochanter (n = 10 per group). Specimens were loaded along the mechanical axis to failure. Ultimate load to failure and fracture pattern were compared among groups.

Results: There was a greater load to failure in specimens with the lowest screw at or above the level of the lesser trochanter in comparison to those with the lowest screw starting below the lesser trochanter ("at or above" 10,026 N vs "below" 8772 N; P = 0.0174). There was no significant difference in load to failure between fixation constructs with the screw at or above the level of the lesser trochanter. Catastrophic subtrochanteric femur fracture through the distal-most screw hole occurred only in the group with screw fixation below the level of the lesser trochanter (3/10 specimens); all other specimens failed through the femoral neck or in the intertrochanteric zone.

Conclusion: In an osteoporotic Sawbones model, subtrochanteric femur fracture after femoral neck fixation with cannulated screws is associated with placement of the distal-most screw below the level of the lesser trochanter. Additionally, there is a decreased load to failure in these specimens when compared to those with the distal-most screw positioned at or above the level of the lesser trochanter. To our knowledge, this is the first biomechanical study to date supporting this concept.

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Fascia Iliaca Block for Peritrochanteric Femur Fractures: Can It Reduce Immediate Postoperative Narcotic Usage?

Anshul Agarwala*, *MD; *Shane McGowan, MD; Matt Rae, MS; Christopher Roscher, MD; Chinenye Nwachuku, MD*

Purpose: The concept of regional blocks has been shown to be an effective adjunct or in some cases alternative to postoperative narcotics. The goal of this study is to evaluate the effectiveness of the fascia iliaca block (FIB) as a mode of pain control for peritrochanteric fracture care, specifically as a tool to help reduce the amount of narcotic medication required in the immediate postoperative period.

Methods: A prospective, double-blind, 2-branch study was conducted on 59 consecutive closed peritrochanteric fracture patients above the age of 18 years who underwent fixation for peritrochanteric femur fracture from August 2016 to February 2018 at a single center. One group received preoperative ropivacaine FIB, the other received saline. Patient data was reviewed for narcotic use at 1, 6, 12, and 24 hours postoperatively. Medication was administered in the postoperative period using a hospital-specific order set with parameters for patient-reported pain scale (0-10) taken every 4 hours by nursing staff.

Results: Of the 59 patients randomized, 17 were saline, 24 were ropivacaine, and 18 were enlisted but did not receive FIB due to anesthesia staffing limitations. Postoperative narcotic use was measured in standardized morphine equivalents. A repeated-measures analysis of variance with between-groups factor was conducted to determine the magnitude of change in postoperative narcotic usage over time. At 1 hour postoperatively, saline versus ropivacaine blockade showed a morphine equivalent median (and range) of 5.0 (0-12.5) versus 0(0-26.8); at 6 hours, 8.8 (0-17.5) versus 2.5 (0-35.1); at 12 hours, 10.0 (0-20.9) versus 2.5 (0-40.1); and at 24 hours, 10.0 (0-24.2) versus 5.5 (0-47.6). The cohort that did not receive a block showed morphine equivalent median and ranges of 0 (0-15.4), 5.2 (0-21.7), 6.6 (0-26.7), and 13.8 (0-38.4). Results revealed a statistically significant effect only for time, meaning the amount of narcotic usage increased from 1 hour to 24 hours postoperatively across all 3 groups ($P < 0.0001$). However, the magnitude of change between groups over time (measured by the group x time interaction) was not significant ($P = 0.15$), indicating that changes in narcotic use over time did not differ based on group assignment.

Conclusion: In our study, the use of FIB for peritrochanteric fractures did not demonstrate a difference in narcotic usage in the immediate postoperative period between ropivacaine and saline groups. However, there was a noted trend toward increased narcotic usage at 24 hours in the group that did not undergo the procedure.

Preoperative Optimization of Geriatric Hip Fractures Using a Detailed Multidisciplinary Protocol

Cesar Cereijo**, **DO; *Daniel Worrell, DO; Michael Okrent, ScD; Christopher Whinney, MD; Damien Billow, MD*

Purpose: This study was conducted to evaluate the potential benefits of instituting an interdisciplinary protocol to streamline preoperative optimization and secondarily improve outcomes in patients admitted for the management of hip fractures.

Methods: This is a single center, prospective cohort study including 26 patients in the pilot cohort and 43 patients in the pre-pilot cohort who were diagnosed with a hip fracture. Subjects in the pre-pilot cohort were collected between January and July of 2016. Subjects in the pilot cohort were collected between August 2016 and March 2017. The study included management of hip fractures (femoral neck, intertrochanteric, or subtrochanteric) in patients age 65 years and older. Exclusion criteria included patients with diagnosed pathologic fractures, previous surgery to the affected hip, or those who refused surgical treatment. Data collection included time to evaluation by internal medicine, cardiology, vascular medicine, and anesthesiology. Time from fracture diagnosis to definitive surgical fixation was also recorded. Outcomes assessed include in-hospital, 30 and 90-day mortality, adverse patient events (deep vein thrombosis, pulmonary embolism, pressure ulcer, and pneumonia), 30-day and 90-day readmissions, and post-surgical ICU admissions. The Charlson Comorbidity Index and American Society of Anesthesiologists score were used to quantify the medical complexity of these patients. This study was conducted in its entirety at a 1330-bed tertiary medical center.

Results: 90-day mortality rates were significantly decreased in the pilot cohort compared to the pre-pilot cohort from 27.9% to 3.9%. Post-surgical and 30-day readmission rates were significantly reduced in the pilot cohort. Subsequently, there was a 26.1% decrease in average direct cost to the hospital per hip fracture patient after implementation of the protocol between the pre-pilot ($16,775.65) and pilot ($12,397.22) groups.

Conclusion: The outcomes from this study demonstrate a profound positive effect on patient outcome as well as cost-effectiveness in a patient population with an average comorbidity index higher than similar studies. Previous data have demonstrated the importance of early definitive management in hip fracture care. This study, however, outlines the importance of have a detailed protocol in place to minimize the delay of surgical management. The cost benefits from this protocol model should not be understated as there is an ever-growing importance to minimize excessive expenses in the current medico-economic environment.

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Tranexamic Acid Feduces Hidden Blood Loss in the Treatment of Intertrochanteric Fractures With PFNA: A Single-Center Randomized Controlled Trial

Yuxuan Cong**, **MD; *Yan Zhuang, MD*

Purpose: Hidden blood loss is a major concern for patients undergoing hip surgery for intertrochanteric fracture. The objective of this study was to investigate whether tranexamic acid (TXA) could reduce postoperative hidden blood loss in patients undergoing hip surgery for intertrochanteric fracture.

Methods: A total of 77 patients with intertrochanteric fracture were enrolled in this randomized controlled study. Patients received either 200 mL (1 g) of TXA (n = 37) or normal saline (NS) (n = 40) IV before hip surgery using proximal femoral nail anti-rotation (PFNA). Hemoglobin and hematocrit levels were measured preoperatively and postoperatively at day 1 and 3. Visible and hidden blood loss volumes were calculated at postoperative day 3.

Results: On postoperative day 3, the transfusion rate was significantly lower in the TXA group compared to the NS group, although mean hemoglobin and hematocrit levels were not significantly different between the 2 groups. However, the estimated hidden blood loss volume (210.09 ± 202.14 mL vs 359.35 ± 290.12 mL; $P < 0.05$) and total blood loss volume (279.35 ± 209.11 mL vs 417.89 ± 289.56 mL; $P < 0.05$) were significantly less in the TXA group compared to the NS group, respectively.

Conclusion: TXA significantly reduced postoperative hidden blood loss in patients with intertrochanteric fracture who underwent PFNA.

Greater Trochanteric Fractures With Intertrochanteric Extension Identified on MRI: What Is the Rate of Displacement When Treated Nonoperatively?

***William Kent**, **MD;** Theresa Whitchurch, BA; Jameel Bardesi, MD; Brady Huang, MD*

Purpose: Fractures of the greater trochanter (GT) are routinely evaluated for intertrochanteric (IT) extension using MRI. Despite the ability of MRI to identify IT fracture extension, there is no consensus about which fractures require operative intervention. Previous studies have suggested GT fractures with IT extension >50% into the IT region might benefit from fixation. There is a paucity of literature examining displacement rates of those incomplete fractures treated nonoperatively. Current protocols at our institution are to treat GT fractures with <50% IT extension nonoperatively with initial protected weight bearing and close clinical and radiographic follow-up. For fractures with ≥50% extension into the IT region, stabilization via sliding hip screw or cephalomedullary nail is recommended. The purpose of this study was to evaluate the rate at which GT fractures with IT extension displaced, requiring operative fixation.

Methods: After IRB approval, all nonoperatively treated GT fractures (OTA/AO 31A1.1) with IT extension on MRI were identified at our institution using an imaging database between 2010 and 2017. Patients with initial radiographs demonstrating a GT fracture who obtained an MRI for evaluation of IT extension were included in the study. Patients who were lost to follow-up prior to radiographic evidence of healing or fracture displacement were excluded. Patient charts and imaging were reviewed for demographic data, treatment plan, percent extension into the IT region (as determined from coronal MRI images), and clinical and radiographic evidence of fracture healing. The primary outcome measures were fracture displacement requiring operation and nonunion.

Results: 17 patients met initial inclusion criteria, with 2 patients subsequently excluded due to no radiographic follow-up. Average age was 65 years old (range, 34-84). Of the 15 patients with follow-up, 0 had displacement of their IT fracture. None required operative intervention. All 15 patients healed their fractures. 14 of 15 (93%) had IT extension of 50% or less across the IT region. One patient had initial IT extension of 60% but refused surgery. This patient also healed without displacement.

Conclusion: None of the fractures in our study displaced or required surgery. All of the fractures healed. To our knowledge, this is the largest series of its kind. Although retrospective and a small number of patients, it seems fractures with less than 50% extension into the IT region have a low likelihood of future displacement and high union rates when treated nonoperatively.

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Ambulatory Ability and Need for Additional Care 1 Year After Hip Fracture

***Ariana Lott**, **MD;** Jack Haglin, BS; Rebekah Belayneh, MD; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: While much study is focused on short-term functional recovery following hip fracture, less research has been devoted to the long-term outcomes of these hip fracture patients. The purpose of this study was to examine the 1-year functional status of patients after hip fracture.

Methods: At a single Level I trauma center from October 2014 to September 2015, all hip fracture patients over the age of 55 years were enrolled in a prospective registry. At time of enrollment, patient demographics, injury characteristics, fracture treatment, and preinjury functional status were collected. At 1-year post index hospitalization, patients were called to answer questions about their current functional status including the following: return to functional baseline, requirement of new assistive device, ability to walk outside, requirement of help with activities of daily living (ADLs), need for a new home health aid, and EuroQol (EQ) visual analog scale (VAS). Analysis of variance and chi-square analyses were used to compare groups, with significance set at P <0.05.

Results: Of the 130 hip fracture patients, 66 (50.7%) had intertrochanteric fractures, 49 (37.7%) had femoral neck fractures, 12 (9.2%) had subtrochanteric fractures, and 3 (2.3%) were periprosthetic hip fractures. 19 patients (15%) had died within 1 year of admission. Follow-up data were collected on 71 patients. There was no difference in age, injury type, or treatment type between patients who were contacted and those who were lost to follow-up. Of the patients successfully contacted, 15 patients (21.1%) returned to their baseline level of function. The average reported percent return to functional baseline was 42.0 ± 39.9%. 33 (46.5%) of patients still required an assistive device acquired only after injury at 1 year post fracture. Of the patients who were community ambulators pre-surgery, only 58.1% of these patients had returned to walking outside. At 1 year, 31 (43.7%) required help with their ADLs and 19 (26.8%) required a new home health aide. The mean VAS of the cohort was 44.2 ± 35.9. There was no difference in each of the above-mentioned functional outcomes measures between type of hip fracture or type of treatment.

Conclusion: While much focus is placed on recovery in the initial months following hip fracture, the results of this study demonstrate the lasting effects of hip fractures in geriatric patients. Surgeons should use these results to communicate possible expectations for long-term functional outcomes and future health needs including home health aides and assistive devices.

Femoral Neck Fractures in Dialysis Patients: Is Fracture Fixation Justified?

Jason Lipof, MD; *Alexander Greenstein, MD; Michelle Lawson, BS; Gillian Soles, MD; John Ketz, MD; Catherine Humphrey, MD; Kyle Judd, MD, MS; John Gorczyca, MD*

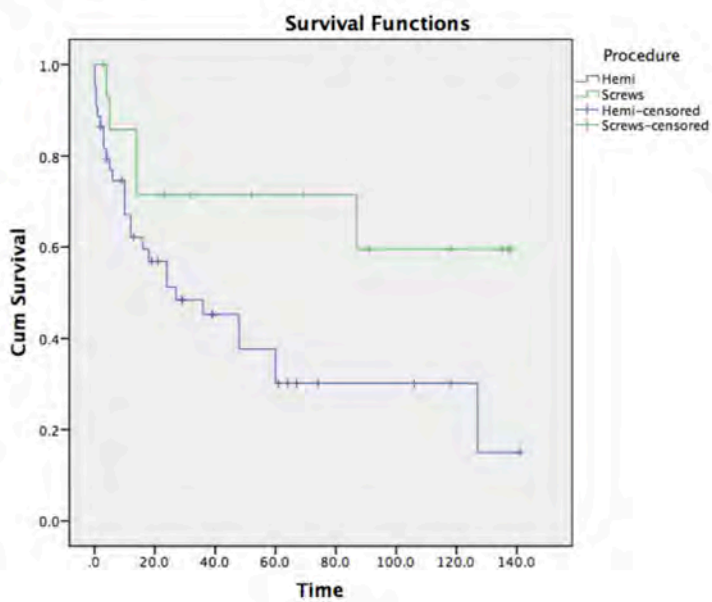
Purpose: Hemodialysis (HD) patients have a high risk of femoral neck fracture (FNF), and the morbidity and mortality are high. The role for internal fixation (IF) in HD patients with FNF is not well-defined. We hypothesize that IF for nondisplaced FNF will have a higher reoperation rate but a lower complication rate than hemiarthroplasty (Hemi) for displaced FNF.

Methods: Between January 2008 and October 2017, 59 HD patients with FNF (AO/OTA 31B-1 + 2) were identified by CPT codes (27235 + 27536) (15 IF, 44 Hemi). Charts were reviewed for age, sex, comorbidities, vitamin D, Ca++, albumin, TSH (thyroid-stimulating hormone), PTH (parathyroid hormone), fracture type, procedure(s), ASA (American Society of Anesthesiologists) class, follow-up, and mortality. We used log rank test, Fisher's exact test, and Cox regression analysis.

Results: The 1-year mortality was 13% with IF and 36% with Hemi (P <0.035). The complication rate (infection, periprosthetic fracture, mal/nonunion, reoperation) was 27% with IF and 9% with Hemi (P = 0.19). Medical comorbidities were associated with neither complication rate nor mortality. In both groups, higher albumin level had a lower risk of mortality (hazard ratio [HR] = 0.135 [0.04, 0.456], P = 0.001) while higher ASA class had a higher risk of mortality (HR = 6.402 [1.030, 39.811], P = 0.046).

Conclusion: HD patients with FNF have an alarming rate of mortality and complications that appear to be related more to the end-stage renal disease requiring HD than to any other medical comorbidity. IF patients have a lower mortality rate but a higher complication rate compared to HD patients. Lower albumin level and higher ASA were associated with higher mortality. This study questions the benefit of internal fixation of nondisplaced femoral neck fractures in hemodialysis patients.

Kaplan Meier Survival Analysis – Internal fixation (screws) vs Hemi (hemiarthroplaty) Time (months)



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POSTER ABSTRACTS

The Elixhauser Model Is Superior to the Charlson Comorbidity Index in Predicting Mortality and Complications in Proximal Femur Fractures

Paul Tornetta, III, MD; Nathan Orvets, MD; ***Jonathan Yin, MD;*** *Brian Silvia, MD, PhD*

Purpose: Risk adjustment with regard to safety and quality of care models has become more prevalent in clinical practice. There is currently no consensus model for orthopaedic hip fracture patients. Prior studies in other areas, such as cancer care, using national survey data note little predictive improvement when patient comorbidities are included beyond demographic information alone. The purpose of this study was to investigate the strength of 2 specific tools, the modified Elixhauser and Charlson comorbidity models compared to a base demographic model (age, sex, and year of operation) in predicting mortality and morbidity in elderly hip fracture patients at a single Level I trauma center.

Methods: Of 367 patients, 345 (258 F; 87 M) patients aged 80.7 ± 9 years who underwent surgery for 106 femoral neck (OTA 31-B), 191 intertrochanteric (OTA 31-A1 and 31-A2), and 48 subtrochanteric (OTA 31-A3) fractures had >90 day follow-up and formed the study cohort. Their comorbidities were scored according to the modified Elixhauser and Charlson comorbidity methods. Outcomes were (1) 90-day mortality and (2) adverse inpatient events (acute renal failure, cardiac, DVT/PE [deep vein thrombosis/pulmonary embolus], respiratory failure/pneumonia). Receiver operating characteristic (ROC) curves were generated using logistic regression for all models. The area under the receiver operating characteristic curve (AUC) was compared to establish the predictive performance of each model for both outcomes.

Results: The mean 90-day mortality and adverse event rates were 11% and 33.8%. The average Charlson and Elixhauser scores for those patients who survived 90 days versus those who did not were 2.2 versus 4.8 ($P < 0.001$) and 5.6 versus 16.4 ($P < 0.001$), respectively. The Elixhauser model was better at predicting 90-day mortality (AUC 0.87 ± 0.03) than the Charlson index (AUC 0.82 ± 0.04); $P < 0.041$. Both specific models performed substantially better than the base demographic model (AUC 0.66 ± 0.04); $P < 0.001$. The Elixhauser model (AUC 0.77 ± 0.03) also trended toward better performance than the Charlson index (AUC 0.73 ± 0.03) ($P < 0.15$) and was superior to the base model (AUC 0.59 ± 0.03) ($P < 0.001$) in predicting inpatient adverse events.

Conclusion: In our population of hip fracture patients, the modified Elixhauser method was more predictive of 90-day mortality than the Charlson Comorbidity Index. Both were substantially better than the demographic base model. This supports the use of a more complex comorbidity index to model risk adjustment in elderly patients with hip fractures for the purpose of quality assessment and counseling patients and their families.

Staged Intramedullary Nailing After External Fixation for the Femoral Shaft Fracture: Is It a Safe Procedure?

Joon-Woo Kim, MD, PhD; *Chang-Wug Oh, MD, PhD; Kyeong-Hyeon Park, MD; Il Seo, MD; Tae-Seong Kim, MD; Jeong Heo, MD; Sung-Hyuk Yoon, MD*

Purpose: Intramedullary (IM) nailing is the standard of treatment for the femoral shaft fracture. Sometimes, temporary external fixation is used before definitive nailing in case with open wounds or multiple injuries. However, staged IM nailing following external fixation is somewhat controversial, due to the infection risk. The purpose of the present study was to evaluate the incidence of infection and to identify its influencing factors after staged nailing of femoral shaft fracture.

Methods: A prospective analysis was performed on 43 patients who were available to follow-up for longer than 12 months from among those who underwent staged nailing after external fixation for femoral shaft fracture. The patients included 34 men and 9 women, with a mean age of 45.9 years. According to AO/OTA classification, 18 were type A, 15 were type B and 10 were type C fractures, including 9 open fractures (II: 4, IIIa: 3, IIIb: 2; Gustilo-Anderson criteria). 42 patients had fractures other than femoral shaft that required stabilization. 30 patients had non-orthopaedic injuries at head, chest, or abdomen. Fracture was stabilized with external fixation initially, and internal conversion with IM nail was done on an average of 18.3 days after patients' general condition and/or open wound improved. At the time of internal conversion, the external fixator pin site grades were 0 in 9 cases, 1 in 22 cases, and 2 in 12 cases, as described by Dahl. Results were assessed according to the achievement and time to osseous union and infections. Statistical analysis was performed to identify factors influencing results.

Results: Primary union was achieved by 36 of the 43 study subjects at an average of 19 weeks. Of 7 cases of nonunion, 2 had segmental bone loss at the index injury and healed after early autogenous bone grafting. Other 3 cases of aseptic nonunion were healed after exchange nailing. Septic nonunion developed in 2 cases, which were healed by reimplantation with external fixator and plate, respectively, after cure of infection. Nonunions were significant in open fractures ($P < 0.001$, Student t-test). There were 3 cases of deep infection (6.8%), which was significant in pin site grade 2 versus 0 or 1 ($P = 0.003$, Student t-test). The presence of open fracture and duration of external fixation were not related to the occurrence of infection.

Conclusion: Our findings demonstrate secondary nailing after external fixation for femoral shaft fracture showed low infection rate, considered to be a relatively safe procedure.

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Can the Use of Femoral Notch View Decrease Measurement Error of Distal Interlocking Screws After Retrograde Femoral Nailing?

David Zuelzer, MD; Jerad Allen, MD; ***Boshen Liu, MD;*** *Joseph Hsu, MD; Eric Swart, MD; Paul Matuszewski, MD*

Purpose: Prominent distal interlocking screws (DIS) after retrograde femoral nailing can lead to hardware irritation and secondary surgery. We sought to determine if different fluoroscopic views of the knee (anteroposterior [AP], notch, or tangential) could reduce the measurement error of screw placement during retrograde nailing.

Methods: Cadaveric lower limb specimens were used to simulate surgical procedures. 4 femoral nails were inserted in retrograde fashion (2 right, 2 left) utilizing standard technique. The DIS placed in each sample was either 2 mm short, flush, or 2 mm prominent to the medial femoral cortex. Standardized AP, notch, and tangential fluoroscopic views were obtained and compiled into an anonymous online survey and sent to 3 ACGME (Accreditation Council for Graduate Medical Education)-accredited residency programs. A total of 36 images were included in the survey. Respondents were asked to determine if the screw length on the survey was "too short", "correct length", or "too long." Correct length was described as the screw tip being flush with the medial cortex.

Results: The final cohort consisted of 106 respondents (62% resident and 38% faculty). 30% of faculty were trauma fellowship-trained. Overall, respondents chose the correct length 46.75%, 52.47%, 44.37% of the time using AP, femoral notch, and tangential views, respectively. The femoral notch view was the most accurate at identifying overall screw length discrepancies compared to the AP (odds ratio [OR]: 1.26; confidence interval [CI] 1.07-1.48; P <0.005), whereas the tangential view was the least (OR: 0.91; CI 0.77-1.07; P <0.248). A stratified comparison, with the AP as the reference, shows femoral notch view was best at identifying screws that are placed flush (OR: 1.76; CI 1.29-2.40; P <0.001), and tangential view was best at identifying screws that are placed too short (OR: 6.81; CI 4.6-10.08; P <0.001). There was no difference between the residents and faculty at detecting screw length discrepancy (faculty: 49%, residents: 48%; P <0.43). No significant difference in accuracy was found between trauma faculty and residents (faculty: 51%, residents: 48%; P <0.33).

Conclusion: Differentiating lengths of distal interlocking screws on traditional imaging (AP/notch/tangential) is poor, ranging from 44% to 52% accuracy. Femoral notch view increases the odds of correctly judging screw length by 76% when compared to AP imaging. Adding the femoral notch view into standard clinical practice can minimize measurement errors and help reduce unnecessary surgery for symptomatic hardware.

The Impact on Rates of Complications and Mortality of CT Scan in Detecting Concomitant Femoral Shaft and Neck Fractures

Qais Naziri, MD, MBA; ***Neil Shah, MD, MS;*** *Joshua Lavian, BS; Sergei Pushilin, MD; Gregory Penny, MD; Scott Pascal, MD; Barbara Freeman, MD; Niladri Basu, MD; Emmanuel Illical, MD; Kemjika Onuoha, MD; Bassel Diebo, MD*

Purpose: This study aimed to identify whether CT of suspected femoral shaft fracture (FSF) helped detect associated femoral neck fracture (FNF) and if detection of FNF had any impact on complications/mortality.

Methods: Patients with FSF (2009-2013) were retrospectively identified by ICD-9 codes in NY State's SPARCS (Statewide Planning and Research Cooperative System) database. Patients with ipsilateral FNF were also identified. Patients with both FSF and FNF and a CT were compared to those without a CT. Univariate analysis compared demographics, complications, subsequent procedure (open reduction and internal fixation [ORIF], total hip arthroplasty [THA], hemiarthroplasty, or other hip surgery), readmissions, and mortality. Multivariate binary logistic regression models identified independent predictors of femoral shaft and neck fractures (covariates: age, gender, race, Deyo score, and CT).

Results: 7104 patients had an FSF: 280 had concomitant FSF-FNF (FSF-FNF, 3.9%) and 6824 had only FSF. When compared to FSF-only, FSF-FNF patients were older and had significant differences in race and insurance status (P <0.019). FSF-FNF more often had ORIF, THA, and hemiarthroplasty and incurred higher total charges and hospital stays (P <0.001). No differences in mortality or gender were identified. 572 FSF patients had CT (8.0%) and 6541 had no CT (no-CT). No-CT patients were significantly older, had a higher Deyo index, and were more often female, white, and held private insurance (P <0.007). Patients with CT had higher rates of ORIF and nearly $10,000 more in mean total first visit charges (P <0.015). FSF-FNF was found in 6.6% of FSF with CT and 3.7% of no-CT FSF patients. FSF-FNF, when compared by CT or no-CT, had more no-CT white patients and higher rates of postoperative hip dislocation than in those with CT (P <0.007) but comparable complication and readmission rates. Regression models revealed that lack of CT was not an independent predictor of concomitant FSF-FNF. Age most strongly predicted any medical complication (odds ratio [OR] 1.023), while Deyo score was a significant independent predictor of readmission for any indication (OR 2.006) (P <0.001).

Conclusion: The concomitant incidence of femoral neck fractures with femoral shaft fractures combined with the potentially severe outcomes associated with a missed FNF warrant identification of methods to improve detection of FNF. This study found that CT did not improve ability to identify FNF, nor did it impact rates of complications or mortality.

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Comparison of Outcomes of Operative Fixation of Periprosthetic Distal Femur Fractures

***Walter Virkus**, MD;* *Yohan Jang, DO; Parker Rea, BS; Charles Lieder, DO; Landon Fine, DO; Greg Gaski, MD*

Purpose: Periprosthetic fractures (PPFs) adjacent to total knee arthroplasty (TKA) are increasingly common in the modern, active, aging population. The ideal treatment for PPFs is unclear, with studies showing mixed results with both plate and nail fixation. The purpose of this study was to compare outcomes between patients that underwent plating versus nailing of PPF adjacent to a TKA with unplanned surgery as the primary end point.

Methods: This is a retrospective cohort study of patients with PPF adjacent to a TKA treated by trauma-trained surgeons from 2013-2017. Patients were identified through a billing database and those with less than 6 months follow-up or treated with revision TKA were excluded. Treatment was surgeon preference of either retrograde intramedullary nail (RIMN) or locking plate fixation (open reduction and internal fixation [ORIF]). All RIMN cases used contemporary nails with multiplanar locking and modular fixed angle fixation. Patient comorbidities, surgical details, and radiographic and clinical follow-up was obtained from patient charts. Patients treated with RIMN were compared to ORIF. Patient-reported outcomes were obtained during office visits or telephone interview using PROMIS (Patient-Reported Outcomes Measurement Information System) Physical Function (PF) and Pain Interference (PI) domains. Visual analog scale (VAS, 0-10) was administered to quantify pain. Fracture union was determined by radiographic review. Malunion was defined as >54° malalignment in the coronal or sagittal plane.

Results: 116 patients with PPF were screened and 82 met inclusion criteria. Mean follow up was 27 months (range, 6-55 months; 85% >12-month follow-up). There was no difference between the RIMN group (n = 57) and ORIF group (n = 25) with respect to age, body mass index (BMI), ASA (American Society of Anesthesiologists), Charlson Comorbidity Index, hospital stay, discharge disposition, coronal plane malunion (14% vs 17%, P = 0.74), sagittal plane malunion (21% vs 22%, P = 1.00), nonunion (11% vs 16%, P = 0.48), or reoperation (18% vs 28%, P = 0.38). The ORIF group, compared to the RIMN group, had a significantly higher rate of deep infection (16% vs 2%, P = 0.03) and surgical time (128 vs 80 min, P <0.01). There was no difference in functional outcomes of RIMN versus ORIF (mean PF 33.4 vs 30.3, P = 0.22; mean PI 54.0 vs 53.8; P = 0.96). 53% of patients in RIMN group were made weight-bearing-as-tolerated as opposed to only 12% in ORIF group (P <0.01).

Conclusion: RIMN represents a potentially less invasive method of treating PPF around TKA compared to plating. Although this study is retrospective and the sample size is small, our results suggest RIMN may be associated with a reduced risk of infection and shorter surgical duration.

Predicting Complications After Hip Fractures: Comparison of Elixhauser Comorbidity Measure and Charlson Comorbidity Index

Chang-Yeon Kim*, *MD; *Lakshmanan Sivasundaram, MD; Nikunj Trivedi, MD; Nicholas Ahn, MD; Raymond Liu, MD; Heather Vallier, MD*

Purpose: An index that accurately predicts postoperative events would allow appropriate stratification of high-risk hip fracture patients. The Elixhauser Comorbidity Measure (ECM) and Charlson Comorbidity Index (CCI) are comorbidity measures for predicting postoperative outcomes. This study compares accuracy of ECM and CCI for predicting adverse events.

Methods: The National Inpatient Sample was queried for femoral neck or intertrochanteric fracture from 2002-2014. Logistic regression models with ECM or CCI were created to predict adverse events. A base model with patient demographics was evaluated. Predictions were validated with the C-statistic, which ranges from 0.5 to 1.

Results: 477,648 patients were included with complications: 2.5% mortality, 0.4% surgical, 3.3% cardiac, 4.2% pulmonary, 6.4% renal, and 1.2% thromboembolic. More ECM and CCI comorbidities correlated (P <0.0001) with adverse events. The model with demographics and ECM provided the best prediction, with C-statistic of 0.767 for inpatient mortality and 0.602 for surgical, 0.713 for cardiac, 0.754 for renal, 0.818 for pulmonary, and 0.615 for thromboembolic complications.

Conclusion: A predictive model using ECM outperforms CCI for predicting adverse events after hip fractures. Our results may assist value-based reimbursement methods to promote quality and reduce costs.

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Early Mortality Triples in Atypical Hip Fractures

Robert Walker*, *MD; *Lauren Nowak, PhD(c); Ryan DiGiovanni, MD; Melanie Macnevin; David Sanders, MD; Abdel-Rahman Lawendy, MD, PhD; Michael McKee, MD; Emil Schemitsch, MD*

Purpose: The purpose of this study was to compare atypical hip fractures with a matched cohort of standard hip fractures to evaluate the difference in outcomes.

Methods: Patients from the American College of Surgeons National Surgical Quality Improvement Program's (NSQIP) targeted hip fracture data file (containing a more comprehensive set of variables collected on 9390 specially targeted hip fracture patients, including the differentiation of atypical from standard hip fractures) were merged with the standard 2016 NSQIP data file. Atypical hip fracture patients aged 18 years and older in 2016 were identified via the targeted hip fracture data file and matched to 2 standard hip fracture controls by age, sex, and fracture location. Patient demographics, length of hospital stay, 30-day mortality, major and minor complications, and other hip-specific variables were identified from the database. Binary outcomes were compared using the McNemar test for paired groups, and continuous outcomes were compared using a paired t-test.

Results: 95 atypical hip fractures were identified, and compared to 190 age, sex, and fracture location-matched standard hip fracture controls. There was no significant difference in body mass index (BMI), race, American Society of Anesthesiologists (ASA) score, smoking status, timing of fixation, or functional status between the 2 groups ($P>0.05$). 30-day mortality was significantly higher in the atypical hip fracture group (atypical 7.36%, standard 2.11%; $P <0.001$). Length of stay (7.16 ± 6.04 days vs 7.61 ± 8.04 days), total operation time 86.73 ± 56.83 minutes vs 78.61 ± 47.01 minutes), transfusions 32.63% vs 36.32%), reintubation (2.10% vs 1.58%), deep vein thrombosis (1.05% each), cerebrovascular accident (0.00% vs 0.53%), and surgical site infection (0.0% vs 1.58%) were not significantly different between groups.

Conclusion: This is the first study, to our knowledge, that demonstrates an increase in the rate of mortality in atypical hip fractures. Comparing atypical hip fractures with a matched cohort of standard hip fractures revealed a significantly greater 30-day mortality rate with an odds ratio of 3.62 in atypical hip fractures (95% confidence interval 1.03-12.68). Prospective, clinical studies are recommended to further investigate these findings.

Comparing Complication Rates and Outcomes of Single-Shot Versus Continuous Fascia Iliaca Blocks for Pain Management of Geriatric Hip Fracture Patients

***Stephen Stephan*, MD;** *John Garlich, MD; Eytan Debbi, MD, PhD; Dheeraj Yalamanchili, MD; Samuel Stephenson, MD, PhD; Landon Polakof, MD; Mark Vrahas, MD; Charles Moon, MD; Carol Lin, MD; Milton Little, MD*

Purpose: Fascia iliaca blocks (FIBs) are a promising method to reduce acute pain in geriatric hip fractures. The FIB selectively targets the obturator, lateral femoral cutaneous, and femoral nerves at the level of the inguinal canal, and can be administered via a single-shot (SB) or continuous block (CB) via nerve catheter. Unlike SB, which studies have shown can safely be administered by residents, CB requires specialized training in regional anesthesia. We hypothesized that continuous FIB will lead to decreased narcotic use, improved pain control, and decreased delirium and would impact time to mobilization.

Methods: This is a retrospective review of a prospectively collected hip fracture database involving patients >60 years old at a Level I trauma center from March 2017 to November 2017. Patients were administered either an SB or CB FIB by the regional anesthesia team preoperatively. Patients were then placed onto a standardized oral pain regimen, treated operatively for hip fracture management, and mobilized as tolerated. Opioid usage, length of stay (LOS), time to ambulation, and incidence of delirium between the SB and CB groups were evaluated.

Results: 84 (47.5%) of 177 patients who presented with a hip fracture to our institution received a preoperative FIB and were included in the study. The mean age was 83.6 years ± 8.7. 50 (59.5%) received an SB while 34 (40.5%) received a CB. 22% of patients in the SB group developed delirium compared to 23.5% in the CB group (P = 0.869). The mean LOS was 5.27 and 5.25 days, respectively, for the SB and CB groups (P = 0.961). The mean time to ambulation was 40.23 and 41.29 hours for the SB and CB groups, respectively (P = 0.897). Preoperatively, total morphine equivalent dose (MED) consumption per day was 35.9 ± 34.1 mg/day for SB and 36.7 ± 33.7 mg/day for CB groups (P = 0.915). MED usage on postoperative days 0, 1, 2, and 3 were all not significantly different between the 2 groups (P = 0.209, 0.749, 0.824, 0.323).

Conclusion: This is the first study directly comparing SB to CB in hip fracture patients. There was not a significant difference between single-shot (SB) versus continuous block (CB) application with regard to opioid usage, LOS, time to ambulation, and the incidence of delirium. At institutions where CB is not available, SB may be administered by residents while providing equivalent pain control and outcomes. Further investigation into the applicability of these interventions is necessary.

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The Incidence of Anterior Femoral Notching in a Cohort of Periprosthetic Supracondylar Distal Femur Fractures

Theodore Schoenfeldt, BS; Theodore Guild, BA; Jeffrey Earhart, MD; ***Nelson Nwumeh, BA***

Purpose: Biomechanical studies show that anterior femoral notching significantly lessens the load to failure with torsional loading, but clinical studies of prospectively-followed total knee arthroplasty (TKA) patients have failed to correlate anterior femoral notching with fracture. This may be due to overall low fracture rates. This study identifies a large cohort of patients with periprosthetic supracondylar distal femur fractures to retrospectively identify the incidence of anterior femoral notching in this patient population.

Methods: This is an IRB-approved retrospective review of periprosthetic supracondylar distal femur fractures treated between 2007 and 2016. Patients were identified by CPT code, after which all imaging was reviewed by a fellowship-trained orthopaedic traumatologist. Prefracture lateral knee radiographs, when available, were also evaluated for anterior cortical notching and graded by the Tayside classification. In cases where no prefracture films were available, intraoperative and/or postoperative lateral films were evaluated. If these were insufficient, the patient was recorded as having no notching.

Results: In total, 87 periprosthetic femur fractures following TKA were identified over the 10-year period. Imaging review identified 68/87 (78%) supracondylar distal femur fractures and 40/68 (59%) had prefracture imaging available. 21 femurs (30.9%) demonstrated notching of the anterior cortex: 8 Tayside grade I, 8 grade II, 6 grade III, and 0 grade IV. All patients underwent operative treatment with open reduction and internal fixation (39), intramedullary nail (21), or distal femoral replacement arthroplasty (8).

Conclusion: While the overall incidence of periprosthetic fracture is reported to be low, this study demonstrates that anterior cortical notching does exist in a large percentage of patients with known periprosthetic supracondylar distal femur fracture. Although we cannot definitively conclude that a causal relationship exists, these data suggest that femoral notching may play an important role in periprosthetic supracondylar femur fractures. With an aging population and increasing number of knee arthroplasties done per year, further biomechanical and clinical study of this possible relationship is warranted.

Less Timely Femoral Fracture Stabilization In Level II Trauma Centers

Nishant Gohel, BS; ***James Goulet, MD;*** *Bryant Oliphant, MD, MBA; Riley Frenette, BA; Mark Hake, MD; Aaron Perdue, MD*

Purpose: Timeliness of femoral fracture surgery adjusted for injury severity is highly associated with mortality. Identifying negative outliers with prolonged times to surgery offers opportunities for improvement.

Methods: Variation in timeliness of care for femoral shaft fractures between 29 Level I and Level II trauma centers was studied using the Michigan Trauma Quality Improvement Program. A multicenter, retrospective analysis was performed for patients with femoral shaft fractures stabilized surgically between January 2011 and May 2017. Negative binomial regression was used to examine time to surgery. Risk-adjusted logistic regression models were run to adjust for uncontrollable variables known to be associated with delay.

Results: Of 2070 patients, 844 (40.8%) received treatment at a Level I trauma center and 1226 (59.2%) at a Level II center. Patients taken to Level II hospitals had no significant difference in ISS (odds ratio [OR] 0.97, 95% confidence interval [CI] 0.93-1.00) but had significantly lower New Injury Severity Scores (NISS) (OR 0.95, 95% CI 0.91-0.99). Adjusting for ISS and NISS, Level II trauma centers demonstrated longer times to surgery (OR 1.05, 95% CI 1.01-1.09, P = 0.023) in spite of lower trauma complexity in the smaller centers.

Conclusion: High variability between centers offers opportunities for center-specific quality improvement. Lower complexity is this study was not correlated with more timely fixation

Open Reduction Results in Similar Union and Complication Rates as Compared to Closed Reduction and Intramedullary Fixation of Femoral Shaft Fractures

***Zachary Telgheder*, MD;** *Matthew Sullivan, MD; Matthew Albanese, MD; David Bloom, BA; Swamy Kurra, MD*

Purpose: Intramedullary rod fixation is a common technique for treatment of femoral shaft fractures. Both open and closed reduction techniques have been described. The purpose of this study was to assess union rates, complication rates, and intraoperative parameters among patients treated with open versus closed reduction and intramedullary nailing of closed femoral shaft fractures.

Methods: Patients undergoing intramedullary fixation of femoral shaft fractures between January 2012 and June 2017 were retrospectively studied. Subjects were excluded if the fracture was pathologic, open, or if radiographic follow-up was less than 6 months. 107 patients met criteria for analysis. Those undergoing open reduction prior to intramedullary nailing were identified as the open reduction group, and those undergoing closed reduction were identified as the closed reduction group. The primary outcome analyzed was union rate as determined by the treating surgeon. Secondary outcomes were time to radiographic union; complications necessitating return to the operating room, including nonunion, infection, revision fixation, and treatment of malunion; and operative times.

Results: Mean follow-up in the open reduction group was 14 months (range, 6-38 months); mean follow-up in the closed reduction group was 14 months (range, 6-48 months). 34.6% (37 of 107 patients) underwent open reduction and intramedullary nailing, and 65.4% (70 of 107) underwent closed reduction. Patients in the open reduction group demonstrated similar rates of union (89.1%; 33/37) compared to those in the closed reduction group (65/70; 92.9%, P = 0.378). Patients in the open reduction group who demonstrated union did so in a mean of 6.2 months (range, 3-11 months), while patients in the closed reduction group did so in a mean of 5.4 months (range, 2-11 months) (P = 0.13). Six patients (15.8%) in the open reduction group demonstrated a postoperative complication requiring return to the operating room. Six patients (8.6%) in the closed reduction group required return to the operating room (P = 0.182). Patients in the open reduction group demonstrated longer mean operative times (1.8 hours) compared to the closed reduction group (1.3 hours) (P = 0.007).

Conclusion: Open reduction and intramedullary nailing results in similar rates of union, time to radiographic union, and rates of complications necessitating return to the operating room when compared to closed reduction and intramedullary nailing and represents an effective treatment option for closed femoral shaft fractures.

A Machine Learning Approach to Predicting Inpatient Mortality After Hip Fractures
Chang-Yeon Kim*, *MD; *Bilal Zonjy, MD; Lakshmanan Sivasundaram, MD; Nikunj Trivedi, MD; Raymond Liu, MD; Heather Vallier, MD*

Purpose: Hip fractures are increasing in incidence. Machine learning, training computers to predict outcomes, may be a novel strategy to address higher-dimensional, non-linear relationships in large datasets. We designed a machine learning approach to predict inpatient mortality after hip fracture.

Methods: Data for patients admitted for hip fractures between 2007 and 2014 were extracted from the National Inpatient Sample (NIS). Along with patient demographics, Clinical Classification Software variables (CCS variables, 14,000 ICD-9 diagnosis codes grouped into 285 mutually exclusive, nonhierarchical categories) were used as predictive features. Three machine learning algorithms, random forest (aggregated decision tree), penalized logistic regression, and logistic regression, were used to train computers to predict postoperative inpatient mortality. Model validation was performed and quantified with the C-statistic, which ranges from 0.5-1. A machine learning-based web application to predict mortality was developed using the best performing classifier.

Results: The random forest algorithm achieved the best predictive discrimination (C-statistic 0.9370; confidence interval [CI] 0.927-0.946) for random forest; 0.936 (CI 0.926-0.945) for penalized logistic regression; and 0.921 (CI 0.913-0.93) for logistic regression. Overall sensitivity was 0.771 (CI 0.738-0.803) for random forest, 0.709 (CI 0.681-0.738) for penalized logistic regression, and 0.577 (CI 0.539-0.614) for logistic regression. Overall specificity was 0.923 (CI 0.925-0.930) for random forest, 0.949 (CI 0.946-0.951) for penalized logistic regression, and 0.966 (CI 0.963-0.968) for logistic regression. Median risk predicted by the random forest model was 0.25 in the non-mortality cohort and 0.7 in the mortality cohort (P <0.0001). Random forest also ranked the predictive features based on importance, with respiratory failure, age, acute renal failure, cardiac arrest, and nonoperative management as the top 5 contributors to mortality. The random forest model was exported to an online machine-learning calculator to predict postoperative mortality: https://predictors.herokuapp.com/hip_fracture

Conclusion: We optimized a machine learning approach to predictive modeling after hip fracture, from algorithm testing to an application with a user-centered interface. We believe such strategies will be informative in future works for predictive modeling in orthopaedic surgery.

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Effect of Associated Upper Extremity Injuries on Older Patients With Hip Fractures

Jordan Hall, BS; *Kurtis Carlock, BS; Isabella Bianco, BA; Jessica Mandel, BA; Kenneth Egol, MD; Sanjit Konda, MD*

Purpose: This study was conducted to assess how the presence of an associated upper extremity (UE) injury, in particular distal radius fractures (DRFs) and proximal humerus fractures (PHFs), affects the hospitalization, cost, and recovery for older patients who suffer traumatic hip fractures.

Methods: Patients >55 years old who sustained a hip fracture secondary to trauma with an associated DRF or PHF and presented to 1 of 2 academic medical centers between 2014 and 2017 were prospectively enrolled. Each patient's demographics, injury severity, and functional status were recorded. Additional metrics, eg, length of stay, procedure type, inpatient cost, readmissions, and mortality within 1 year, were collected. Patients were compared to a randomly selected, age- and Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA)-matched (a previously validated inpatient mortality risk score for older patients) cohort of isolated hip fractures from a larger internal database in a 3-controls-to-1-patient manner. Chi-square, Fisher's exact, and Student's t-tests were used to compare means and proportions, with $P < 0.05$ considered significant for all tests.

Results: 38 patients were enrolled who sustained either a DRF (19) or PHF (19) in addition to a hip fracture. Regarding treatment of the associated injury, 7 DRF patients (36.8%) received operative management for the wrist fracture and 12 (63.2%) received closed reduction, whereas 4 PHF patients (21.1%) underwent surgical fixation of the PHF while the remaining 15 (78.9%) received closed reduction. Average length of stay was 6.7 and 6.8 days for the DRF and PHF patients, respectively. Minor and major complication rates were 26.3% and 15.7%, respectively, for the DRF patients and 21.1% and 18.4%, respectively, for the PHF patients. Zero of DRF patients and 1 (5.3%) of the PHF were readmitted within 90 days. Mean total cost of inpatient care was $22,451 and $21,304 for the DRF and PHF patients, respectively. No significant differences were noted in length of stay, major or minor complication rates, total inpatient cost, or 1-year mortality in comparison to control patients. The only significant difference demonstrated across all comparisons was the emergency department subcategory cost between DRF patients and controls. One (5.3%) of the DRF patients and 2 (10.5%) of the PHF patients died within 1 year compared to 2 (3.5%) and 4 (7.0%) patients in their respective control groups.

Conclusion: An associated upper extremity fracture in addition to a hip fracture was not found to significantly affect the perioperative hospital course or short- and long-term outcomes for patients when compared against those with isolated hip fractures.

POSTER ABSTRACTS

Accurate Prediction of Antegrade or Retrograde Femoral Intramedullary Implant Length From Patient Height: A Review of 608 Cases

***Jeff Pearson**, MD; Jonathan Quade, MD*

Purpose: The aim of this study was to determine if patient height correlates with implant length selection of antegrade or retrograde femoral intramedullary implants.

Methods: This was an IRB-approved retrospective chart review of 608 operatively treated femoral shaft fractures at a Level I trauma center from 2011 to 2017. Patient height (PH) was recorded in cm as well as femoral intramedullary implant length. Implant length, PH, and technique (antegrade or retrograde) were recorded. Spearman and Pearson correlation coefficients were utilized for statistical analysis of implant length and patient height. A P value <0.05 was considered significant.

Results: 608 operatively treated fractures were reviewed: 350 antegrade, 258 retrograde. Pearson correlation coefficients for antegrade implants were 0.676 with P <0.01, retrograde implants 0.628 with P <0.01. Two separate equations were determined to accurately predict P <0.01 femur nail implant length based on PH. Antegrade equation: = 97.14033 + (1.76*(PHcm)). Retrograde equation: = 58.74479 + (1.89317*(PHcm)).

Conclusion: Femur nail implant length can be accurately predicted based on patient height and technique utilizing the above equations. This is the first study utilizing a large number of femora to establish simple equations to aid with several issues. These equations serve as a simple templating tool. There is nothing in the literature that describes an accurate prediction model. Templating allows a check for the intraoperative measuring that would prevent an implant of incorrect length being implanted and discarded. This also allows for immediate implant availability as the implant representative can have a small selection nails in the operating room, decreasing time spent waiting on implant retrieval. Another application is in the case of bilateral comminuted femur fractures to accurately estimate limb length. A fourth application is in remote environments where surgical planning is critical for determining implant needs.

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Risk Factors for Increased Shortening After Nailing of Intertrochanteric Femur Fractures

Michael Ricci; Anna Miller, MD; Christopher McAndrew, MD, MS; ***William Ricci**, MD*

Purpose: This study was conducted to determine factors associated with increased shortening after cephalomedullary nailing of 2- and 3-part intertrochanteric femur fractures.

Methods: 153 patients between 50 and 100 years of age with intertrochanteric fractures (OTA 31A) treated with a trochanteric-entry cephalomedullary nail were studied retrospectively. 4-part, reverse obliquity, and subtrochanteric fractures were excluded. Mean age was 77 years (range, 50-100), there were 109 females (71%), 91 2-part (60%), and 62 3-part (40%) fractures. 81 were treated with an InterTan (Smith & Nephew) and 72 with a TFN (49 TFN-Blade, 23 TFN-Screw) (Synthes). Shortening was measured as previously described. Age, gender, fracture pattern, implant, and tip-apex-distance (TAD) were tested for association with fracture collapse. Correlation between age and TAD, and collapse was assessed using a Spearman correlation analysis. Comparison between gender, fracture pattern, and implant type (InterTAN or TFN) and shortening was with Mann-Whitney U test. Comparison between InterTAN, TFN-Blade, and TFN-Screw was with Kruskal Wallis and Mann-Whitney U tests.

Results: The only factor associated with shortening was implant type: TFNs shortened 2x more (7.5 mm, standard deviation [SD] 5.7, range -1.4 to 30.7) than InterTANs (3.4 mm, SD 3.9, range -1.7 to 20.1) ($P < 0.001$). Age (correlation coefficient [CC] 0.104, $P = 0.201$) and TAD (CC = -0.134, $P = 0.100$) did not correlate with shortening. There was no difference in shortening between males and females ($P = 0.765$). Including the entire cohort, there was no difference in collapse between 2- and 3-part fractures ($P = 0.570$). A subset analysis showed that the TFN-Blade shortened more (8.6 mm) than both the TFN-Screw (5.3 mm, $P < 0.008$) and InterTAN (3.4 mm, $P < 0.001$). A 4x higher proportion of TFN-Blades (30%) had shortening >10 mm than InterTANs (7%).

Conclusion: In active patients, fracture shortening has recently been associated with poor outcome after nailing of intertrochanteric femur fractures. This study identified implant type as a significant modifiable risk factor for shortening after nailing of 2- and 3-part fractures. The TFN-Blade was associated with the greatest, the TFN-Screw intermediate, and the InterTAN the least amount of shortening.

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

Utility of a Risk Stratification Tool for Geriatric and Middle-Aged Orthopaedic Trauma Patients to Predict 90-Day Readmissions

Sanjit Konda, MD; *Jordan Hall, BS; Jessica Mandel, BA; Kurtis Carlock, BS; Thomas Lyons, MD; Kenneth Egol, MD*

Purpose: This study aims to assess whether risk stratification by the Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA) could predict unplanned 90-day readmissions for older orthopaedic trauma patients. This risk assessment tool has demonstrated previous utility in predicting mortality risk within this population.

Methods: Patients >55 years old who sustained traumatic injuries and received orthopaedic or trauma consultations at 2 academic medical centers from 2014 to 2017 were included. Each patient's demographics, injury severity, and functional status were utilized to calculate a STTGMA score at time of admission. Patients were stratified by their calculated risk of inpatient mortality into minimal, low, moderate, and high-risk cohort groups of <0.24%, 0.24-1.1%, 1.1-7%, and >7%, respectively. Information regarding length of stay, inpatient complications, discharge disposition, and 90-day readmissions were additionally recorded. Multivariate logistic analysis was performed with occurrence of unplanned 90-day readmissions as the dependent variable. An AUROC (area under the receiver operating characteristic curve) was calculated to assess the predictive capacity of STTGMA risk stratification on 90-day readmissions. Chi-square and analysis of variance tests were used to compare means of dichotomous and continuous variables, respectively. A P value of <0.05 was considered significant for all statistical tests.

Results: A total of 3394 patients were prospectively enrolled. The mean age of the cohort at time of injury was 74.0 ± 11.9 years and differed significantly among risk cohorts (P <0.0005). The minimal, low, moderate, and high-risk cohorts were comprised of 1634 (48.1%), 1058 (31.2%), 521 (15.4%), and 181 (5.3%) patients, respectively. A total of 181 unplanned 90-day readmissions were observed, yielding an overall rate of 5.3%. Presence of inpatient complications, non-home discharges, and length of stay significantly differed and increased across risk groupings (P <0.0005). Controlling for the aforementioned factors, multivariate analysis revealed that risk stratification by STTGMA was an independent predictor of 90-day readmissions (B: 0.30, 95% confidence interval [CI]: 0.045-0.044, P <0.0001). AUROC for STTGMA risk stratification on predicting 90-day readmissions was 0.709 (95% CI: 0.670-0.748).

Conclusion: Risk stratification by STTGMA accurately categorizes differences in meaningful outcome metrics for older orthopaedic trauma patients. The tool possesses utility for early identification of high-risk patients to aid physicians in providing improved quality care pathways.

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Driving Under the Influence: Who Provides the Intervention?

Jonathan Dubin, MD; ***Emily Boschert*****, *BA;*** *Nyaluma Wagala, BA; Mark Bernhardt, MD*

Purpose: Driving under the influence (DUI) of alcohol and/or illicit drugs is a major cause of morbidity and mortality in the United States, despite it being theoretically preventable. Substantial evidence supports physician discussions and use of "teachable moments" for tobacco cessation, yet little data are available concerning substance abuse (SA) cessation, especially in the setting of traumatic injuries resulting from detrimental behaviors such as DUI. The purpose of this study is to investigate the interventions offered to DUI trauma patients requiring orthopaedic surgical intervention.

Methods: A retrospective chart review was conducted targeting all motor vehicle accident trauma patients requiring orthopaedic surgical intervention from January 1, 2013 to December 31, 2016 at a Level I urban trauma center. Inclusion criteria were: intoxicated drivers of vehicles with positive urine drug screen and/or blood alcohol levels at the time of injury, and required surgical intervention from orthopaedics. Excluded were: passengers, those who expired prior to discharge, and those who sustained a head injury that prevented meaningful intervention. Counseling by a physician, nurse, social worker, or referral to expert program were all considered "intervention".

Results: A total of 79 charts met criteria and were included in the study: 41 tested positive for alcohol, 23 for illicit drugs, and 15 for both. Average age was 37 ± 13.5 years, with a male:female ratio of 65:14. Of these 79, only 53% (42) were offered any SA intervention, and of those, only 57% (24) accepted, leaving a total of 30% of patients actually receiving any SA intervention during the hospital stay. Surprisingly, only 3 patients received any counseling from a physician during the admission, with social workers providing the intervention for the rest. 5 patients were also referred to an expert program. We found no significant differences according to gender, age, admitting, or discharge service with regard to whether a patient was offered intervention or agreed to accept it. There was a trend toward patients who switched services during admission to be less likely to accept intervention when offered (42% vs 70%; P = 0.069). Lastly, orthopedic surgeons provided no counseling duringa admission, and for only 3 patients (4%) by the 3-month follow-up.

Conclusion: Smoking cessation discussions are commonplace for orthopaedic surgeons and their patients. Intervention for drug and alcohol abuse, however, remains rare. Overall rates of intervention for patients requiring orthopaedic surgery after DUI is alarmingly low. Further research is required to understand why and how to improve.

Predictors of Symptomatic Implant Removal After Open Reduction and Internal Fixation of Tibial Plateau Fractures: A Cohort Study of 220 Patients

Christopher Stewart, BA; Nathan O'Hara, MPH; Daniel Mascarenhas, BS; Ted Manson, MD; Bradley Reahl, BS; Daniel Connelly, BS; Gerard Slobogean, MD, MPH; ***Robert O'Toole**, MD*

Purpose: Removal of painful implants after open reduction and internal fixation (ORIF) of tibial plateau fractures is performed in up to 18% of patients, yet little is known regarding risk factors for this return to the operating room. We hypothesized that radiographic details of the fixation and demographic parameters could predict a higher rate of symptomatic removal.

Methods: Tibial plateau fracture patients treated with ORIF from 2007 to 2017 at a single urban academic Level I trauma center were included in the study. Indication for implant removal was localized pain over the implant and not due to another indication such as infection or nonunion. The records and radiographs were reviewed to look for radiographic, demographic, and injury characteristics that were hypothesized to increase risk of implant removal. Of the 220 patients included in the final analysis, 82 required implant removal and 138 served as controls with at least 1 year of follow-up without implant removal or a plan for implant removal at latest follow-up. Backward stepwise elimination based on a minimum Akaike information criterion was performed to select predictors of removal included in a final multivariable logistic regression model.

Results: Based on our multivariable model, implant removal was associated with decreased age (odds ratio [OR]: 1.3 per 10 years, P = 0.03), lower body mass index (OR: 1.3 per 5 kg/m^2, P = 0.02), closed fractures (OR: 4.9, P < 0.01), and with each unit decrease in ISS (OR: 1.05, P <0.01). Associations that approached statistical significance were observed with additional protruding screws (OR: 1.1, P = 0.12) and a decreased distance from implant (mm) to the joint (OR: 1.08, P = 0.09). The model discriminated fractures requiring implant removal with moderate accuracy (area under the curve = 0.71).

Conclusion: In contrast to previous data presented in retrograde nailing of femoral shaft fractures, we were not able to identify a strong radiographic predictor of implant removal although several potentially modifiable factors did emerge. However, a marginal association between additional protruding screws and a decreased distance from implant to joint was observed with an increased likelihood of implant removal. These data may help inform patients and hint at steps in crafting fixation that might reduce the likelihood of returning to the operating room.

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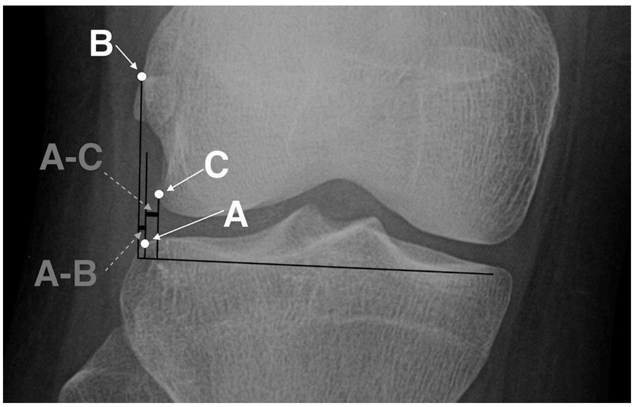
Restoring Condylar Width: Radiographic Relationship Between the Lateral Tibial Plateau and Lateral Femoral Condyle in Normal Adult Knees

Nima Kabirian, MD; *Daniel Jiang, BS; Mark Fleming, DO; Geoffrey Marecek, MD*

Purpose: Anatomic relationships used to determine if condylar width has been restored after surgery are not well described. We hypothesized that a constant radiographic relationship exists between the lateral tibial and femoral condyles.

Methods: Anteroposterior supine knee radiographs of 217 uninjured adults (18-65 years) including 109 unilateral and 108 bilateral knees with no or minimal osteoarthritis were included. The perpendicular distance between the lateral-most margins of the tibial plateau articular surface (A) and the lateral femoral epicondyle (B) and the lateral femoral condyle articular surface (C) was measured in millimeters. Medial and lateral measurements to point (A) were recorded as (-) and (+), respectively. First, the average of distances in all unilateral knees and randomly selected right or left knees from the bilateral group (n = 217) was calculated and compared between sexes. Next, A-B and A-C distances were compared between right and left knees in the bilateral group (n= 108) to find any significant difference.

Results: The average A-B was 0.60 ± 2.40 mm (mean ± standard deviation); range, -4.82 to +6.49. The mean A-C was -3.96 ± 2.07 mm (-8.51 to +3.98). No differences between sexes were found for A-B and A-C. Similarly, no difference was found between A-B and A-C between right (1.08 ± 2.31 and -3.90 ± 1.73) and left knees (0.90 ± 2.38 and -4.31 ± 1.7).



Conclusion: The lateral femoral epicondyle is aligned with the lateral tibial articular margin. The relationship between the lateral tibial plateau, lateral femoral epicondyle, and lateral femoral articular surface is constant from side to side; templating off of contralateral uninjured radiographs may be beneficial in fracture surgery.

Immediate Weight-Bearing After Plate Fixation of Fractures of the Tibial Plateau
(IOTA - UK best poster submission)
Mike Williamson, MBS; Efthymios Iliopoulos, MD; Aanchal Jain, MBBS; Wessam Ebied, MD;
***Alex Trompeter**, FRCS*

Purpose: Proximal articular fractures of the tibia are commonly stabilized with internal fixation using plates and screws. There is a lack of evidence and conflicting guidelines as to the most suitable postoperative rehabilitation and weight-bearing status. Many orthopaedic surgeons traditionally do not allow their patients to weight-bear for the first 6 weeks after surgery, fearing loss of fracture reduction and articular collapse. The aim of this study is to investigate whether the postoperative weight-bearing status is associated with loss of reduction or articular collapse.

Methods: We retrospectively analyzed data from our prospectively collected major trauma center database. All tibial plateau fractures that required open reduction and internal fixation with plate and screws were included. The immediate postoperative weight-bearing status of these patients was recorded and divided into 2 study groups. Group I consisted of those patients who were either non-weight-bearing or touch-weight-bearing for the first 6 postoperative weeks. Group II consisted of patients who were instructed to weight-bear fully (as tolerated) immediately after the operation. Radiographs were taken day 1 post-operation, at 6 weeks, and at 3 months and analyzed for fracture displacement and joint depression or loss of fixation.

Results: A total of 90 patients were included in the study. Group I (non-weight-bearing or touch-weight-bearing) consisted of 60 patients (67%), mean age 41.8 ± 15.2 years (range, 19-82). Group II (full weight-bearing as tolerated) consisted of 30 patients (33%), mean age 51.6 ± 17.4 years (range, 22-91). The follow-up radiographs demonstrated no failure of fixation in either study group. One patient from the weight-bearing group had >1 mm joint depression (4 mm) identified at the first follow-up, which did not progress or worsen by the second.

Conclusion: There is little consensus on the optimum weight-bearing status immediately post-plating of tibial plateau fractures. This study has aimed to answer this question by showing that immediate postoperative full weight-bearing does not affect the fixation or cause articular collapse up to 3 months after surgery. We propose that patients should be encouraged to weight-bear immediately post-operation. This will enable patients to benefit from the positive effects on fracture healing of early weight-bearing post-surgery and avoid the complications of non-weight-bearing without loss of fixation or articular collapse.

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Lateral Plateau Fractures With Depression: Does Fragment Height Matter?

***Garin Hecht**, MD;* *Sara Gruner, MD; Trevor Shelton, MD, MS; Daphne Beingessner, MD; David Barei, MD*

Purpose: We sought to measure the subchondral height of depressed articular fragments of lateral tibial plateau fractures and determine if screws placed though anterolateral proximal tibial plates support these fragments.

Methods: Images from 95 patients with Schatzker 2 or 3 tibial plateau fractures (AO/OTA 41B2.1, 41B3.1) were reviewed retrospectively. Depressed articular fragments >5 x 5 mm were identified on axial CT. The profile of each fragment on the best coronal or sagittal reconstruction view was used to measure fragment height. Up to 3 fragments per patient were measured for an average height. An intraclass correlation coefficient (ICC) showed good reliability between 2 observers (ICC = 0.770). AP fluoroscopic images were used to measure the distance from the articular surface to the most proximal screw in an anterolateral plate, with a 3.5-mm screw measured for calibration (Figure 1).

Results: Subchondral height of depressed articular fragments was 6.6 ± 1.5 mm (range, 3.8-12.5 mm). There were no differences in fragment height distributions when comparing age, gender, mechanism (high vs low-energy), Schatzker classification, and amount of articular depression. The average distance from the joint line to the "rafter screws" through the plate was 9.0 ± 2.4 mm (range, 4.2-15.6 mm), which is significantly larger than the fragment height (P ≤0.001).

Conclusion: Depressed articular fragments in lateral tibial plateau fractures average <7 mm in height. When reduced, the majority of these fragments are not directly supported by rafter screws through a commonly used anterolateral plate.

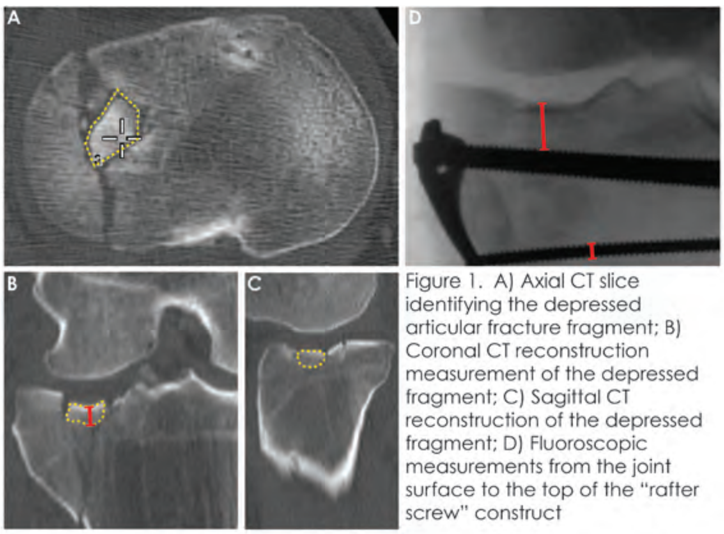

Figure 1. A) Axial CT slice identifying the depressed articular fracture fragment; B) Coronal CT reconstruction measurement of the depressed fragment; C) Sagittal CT reconstruction of the depressed fragment; D) Fluoroscopic measurements from the joint surface to the top of the "rafter screw" construct

Functional Outcome After Permissive Weight Bearing in Surgically Treated Trauma Patients With Tibial Plateau Fractures: A Retrospective Cohort Study

***Pishtiwan Kalmet*, MD;** *Yvette van Horn, MD; Sebastian Sanduleanu, MD; Henk Seelen, PhD; Peter Brink, MD, PhD; Martijn Poeze, MD, PhD*

Purpose: A Dutch survey among orthopaedic surgeons and trauma surgeons showed that almost 90% of the surgeons do not follow protocols regarding the weigh- bearing aftercare for tibial plateau fractures. Clinical studies comparing permissive weight bearing (PWB) versus restricted weight bearing (RWB) after surgically treated tibial plateau fractures are scarce. The aim of this study was to inventory potential differences in functional outcome and number of complications in patients with surgically treated tibial plateau fractures who followed a PWB regime, relative to those who followed an RWB regime.

Methods: This retrospective cohort study included surgically treated trauma patients with tibial plateau fractures, who underwent rehabilitation according to PWB or RWB between 2005 and 2015. Data such as demographics, functional outcome, and patient outcome were collected.

Results: This cohort study included 91 patients (31 and 60 patients in the PWB and RWB groups, respectively). No differences in age or gender were found between the groups. No significant differences were found in Short Form 12 (SF-12) and the visual analog scale (VAS) data between the PWB group and RWB group. Time to full weight bearing was significantly shorter in the PWB than in the RWB group, ie, 14.7 versus 20.7 weeks (P = 0.02). No significant differences were found regarding postoperative complications between the PWB and the RWB groups, ie, 6.5% versus 10.0%, respectively.

Conclusion: Permissive weight bearing after surgically treated tibial plateau fractures leads to a significantly reduced time to full weight bearing with no significant differences in complication rates.

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Safety and Efficacy of the Synthes 4.5-mm Variable Angle Locking Compression Distal Femur Plate

Boris Zelle*, *MD; *Khang Dang, MD; Connor Armstrong, BS; Ravi Karia, MD*

Purpose: Locked plate fixation remains the standard treatment for distal femur fractures. Recent reports have suggested early failure rates associated with the use of the Synthes 4.5-mm Variable Angle Locking Compression Distal Femur Plate. The purpose of this study is to examine the safety and efficacy of this plating system.

Methods: This is a retrospective case series that was performed at an urban university-based Level I trauma center and urban Level III trauma center. Patients 18 years of age and older who underwent plate fixation of their acute distal femoral fracture (OTA/AO 33A1 - 33C3) using the Synthes 4.5-mm Variable Angle Locking Compression Distal Femur Plate were included in this investigation. Patients with fracture from neoplastic disease were excluded. The primary outcome measure was mechanical hardware failure. Secondary outcome measures included reoperation to achieve fracture healing, malunion, and medical and surgical complications.

Results: A total of 74 patients (77 fractures) were included in this study. 32 out of 77 fractures presented as open fractures (41.6%). The median follow-up time was 52 weeks (range, 12-222 weeks). Mechanical failures were observed in 7 out of 77 fractures (9.1%). This included 5 plate failures at the level of the fracture site and 2 patients with screw failure at the plate/screw interface. A reoperation to achieve fracture healing was required in 17 patients,15 of which were open fractures with a median bone defect of 81.5 mm (range, 28.3-143.5).

Conclusion: In contrast to previous reports, our study suggests that the Synthes 4.5-mm Variable Angle Locking Compression Distal Femur Plate is a safe and effective implant with a relatively low rate of early mechanical implant failure. The surgical outcomes associated with this plating system compare favorably with the outcomes of other plate fixation systems reported in the literature.

Is Bone-to-Bone Healing Really Better?
Outcomes After Surgical Repair of the Knee Extensor Mechanism
***Aaron Roberts**, MD;* *John Ketz, MD*

Purpose: The extensor mechanism comprises the quadriceps tendon, patella, and patellar tendon. Injuries to the extensor mechanism can occur through bone or tendon, and they require operative repair to restore functional integrity and strength. We sought to evaluate differences in clinical outcomes following extensor mechanism repairs. We hypothesized there would be equivalent outcomes between soft-tissue repairs and fracture fixation.

Methods: We performed a retrospective review of patients who had extensor mechanism injury from January 2012 to June 2016. Patients undergoing quadriceps or patellar tendon repair (TR) and patella fracture open reduction and internal fixation (ORIF) were identified. A third group of patients sustaining patellar pole fractures (PP) was also analyzed; these patients had significant bony avulsion injuries but were treated using traditional tendon repair methods. Patient demographics and medical comorbidities were recorded. Outcomes assessed were fixation failure and PROMIS (Patient-Reported Outcomes Measurement Information System) physical function (PF) and pain interference (PI) scores. Statistical analysis was conducted using Student's t-tests and Fisher exact tests. Significance was defined as $P < 0.05$.

Results: A total of 301 patients were identified. There were 181 tendon repairs and 92 patella fracture fixations. The TR group was predominantly male (91%), while the ORIF group was majority female (62%). There was an increased prevalence of diabetes and higher body mass index in the TR group, but there was no difference between the TR and ORIF groups for age, tobacco use, inflammatory arthritis, or renal disease. 8 repair failures (4%) occurred in the TR group versus 17 fixation failures (18%) in the ORIF group ($P = 0.003$); 7 patients (4%) in the TR group and 6 (7%) in the ORIF group underwent revision repair/fixation ($P = 0.3726$). There was no difference in PROMIS PF score (43.5 ± 7.3 and 42.0 ± 6.7, $P = 0.3583$) or PI score (54.4 ± 8.8 and 56.4 ± 6.9, $P = 0.2760$) between the TR and ORIF groups at final follow-up. 24 patients sustained patellar pole fractures. 3 failures (13%) occurred in the PP group, all treated nonoperatively. The PROMIS PF score was 38.6 and PI score was 60.6 in the PP group. 4 additional patients underwent partial patellectomy with complete bony fragment excision and direct repair of tendon to bone.

Conclusion: There is a relatively high rate of failures following extensor mechanism repair, but not all require operative intervention. There were no differences in clinical outcomes after tendon repair (tendon-to-tendon or tendon-to-bone) compared to fracture fixation (bone-to-bone). A subset of patients with patellar pole fractures trended toward worse clinical outcomes.

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Pediatric Elbow Dislocations With a Concomitant Lateral Condylar Humerus Fracture

***Ryan Fairchild**, MD;* *Brandon Ramo, MD; Marilyn Elliott, BS; Shawn Funk, MD; Robert Wimberly, MD; Anthony Riccio, MD*

Purpose: This study was conducted to assess functional and radiographic outcomes of children with lateral condylar humerus fractures associated with an elbow dislocation.

Methods: An IRB-approved, retrospective review of all patients who sustained an operative lateral condylar humerus fracture (LCHF) was performed at a single Level I pediatric trauma center from 2008 to 2014. Medical records were reviewed for demographic data, operative time, complications, and referral to occupational therapy (OT) for elbow stiffness. Radiographs were analyzed to identify concomitant elbow dislocation, avascular necrosis, and magnitude of lateral spur formation. Patients were stratified into fractures sustained with and without an associated elbow dislocation, and outcomes were compared between these 2 cohorts.

Results: 311 patients met inclusion criteria, of whom 11 (3.5%) had a concomitant elbow dislocation. There was no difference in age at presentation (6.3 vs 4.9 years, P = 0.076) and time to final follow-up (106 vs 104 days, P = 0.63) between patients with and without a dislocation. The presence of concomitant dislocation did not increase operative time, perioperative complications, delay in union, or rate of avascular necrosis. The dislocation group demonstrated greater initial fracture displacement (13.6 mm vs 7.4 mm, P = 0.001) and magnitudes of lateral spur formation at final follow-up (120% vs 115% increase in ICW [intercondylar width], P = 0.034). 6 patients (55%) in the dislocation group required referral to OT for elbow stiffness compared to 59 (20%) without dislocation (P = 0.013). At time of final follow-up, all patients had been released to full activity and all patients who completed OT achieved a functional range of motion.

Conclusion: Children with an LCHF and an associated elbow dislocation can be expected to have significantly higher rates of elbow stiffness requiring occupational therapy referral than patients without a concomitant dislocation. While a greater magnitude of lateral spur formation can be expected as well, the clinical significance of this is likely negligible.

Compartment Syndrome in Pediatric Monteggia Fractures and Equivalents

John Kopriva, BS; John Awowale, MD; ***Paul Whiting, MD;*** *Andrew Livermore, MD; Alexander Siy, BS; Kenneth Noonan, MD*

Purpose: Diagnosing compartment syndrome (CS) requires providers to have appropriate clinical suspicion. In the current literature, CS is not commonly associated with Monteggia fractures (MFs) or Monteggia equivalents (MEs). The aim of this study was twofold: (1) to determine the incidence of CS among patients with MF/ME, comparing this to the incidence of CS in Type 3 supracondylar humerus (T3-SCH) fractures; and (2) to determine which patients with MF/ME are at a higher risk for CS.

Methods: A retrospective review was performed on children ages 2-12 years with MF/ME requiring operative management at a single academic institution over a 14-year period (January 1, 2003 to May 29, 2017). These injuries were characterized using the Bado classification. Similarly, all patients with T3-SCH fractures operatively managed over the same time period were identified. Medical record review of both groups identified which patients developed CS. Further review included demographic, procedural, and radiographic information. Statistical analysis compared the rates of CS in both groups and determined risk factors associated with developing CS.

Results: The rate of CS in operatively managed MF/ME was 9/61 (14.8%), which was significantly greater than the rate of CS in T3-SCH fractures (2/230 [0.9%]; P = 0.001). Among the 9 MF/ME cases with CS, 5 were diagnosed prior to surgical stabilization, and 4 were diagnosed intraoperatively post-fixation. Comparing MF/ME with CS to those without; there was no difference in gender (P = 0.7), Bado type (P = 1.0), or fracture pattern (MF vs ME) (P = 0.7). Patients with CS tended to be older (8.0 years compared to 6.9 years) (P = 0.082). Patients with CS had a higher incidence of preoperative vascular (22.2%) or neurologic (33.3%) deficits than those without CS (0 and 7.7%; P = 0.02 and P = 0.06, respectively). Children managed with intramedullary (IM) fixation of the radius had higher rates of CS (P = 0.013).

Conclusion: Patients with MF/ME had a significantly increased rate of CS compared to patients with T3-SCH fractures (an injury classically associated with CS). With no predisposition based on Bado classification or Monteggia equivalent status, all forms of MF/ME appear to have increased risk for CS. Older patients and those with preoperative neurovascular deficits are at higher risk for CS. Intraoperatively, we detected CS after fixation in 4 patients, many of whom required management with a radial IM rod. Careful assessment of the forearm, even after fixation, is required to detect CS in pediatric patients with Monteggia fractures or Monteggia equivalents.

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Minimally Invasive Plate Osteosynthesis of High-Energy Pediatric Tibia Fractures

Michael Murphy*, *BS; *Kyle Lynch, BS; Joseph Cohen, MD; Hobie Summers, MD; Michael Stover, MD; William Lack, MD*

Purpose: Pediatric tibia shaft fractures are commonly managed nonoperatively. However, surgery may be preferred for select high-nergy injuries to obtain and maintain acceptable reduction, minimize risk of soft-issue complications, and aid in mobilization of polytrauma patients. Options include external fixation and elastic nailing, each with its own risks and benefits. Plate osteosynthesis is an alternative treatment, but with limited outcome data in this population. Our purpose was to report on the largest series of minimally invasive plate osteosynthesis employed in skeletally immature patients with high-nergy injuries.

Methods: We retrospectively identified high-nergy tibia shaft fractures in skeletally immature patients treated with plate osteosynthesis at a Level I trauma center between 2006 and 2017. We reviewed the electronic medical record for patient, injury, and treatment factors. We recorded complications (infection, neurovascular injury, compartment syndrome, malalignment, nonunion, and limb length discrepancy) and subsequent surgeries. We assessed the relationships between age, implant selection, and implant removal using chi-square and t-test analyses.

Results: We identified 28 fractures in 26 patients (20 male and 6 female). Medial plate fixation was universally performed and was minimally invasive in all cases. Median age was 13 years (range, 4 to 15). OTA classification included 42-A1 (n = 3), A2 (n = 5), A3 (n = 10), B1 (n = 1), B2 (n = 3), B3 (n = 2), C2 (n = 2), and C3 (n = 2). There were 9 open fractures, including Gustilo-Anderson type I (n = 1), type II (n = 2), and type III (n = 6). Median follow-up was 8.5 months, median time to full weight-bearing was 2 months, and median time to union was 3 months. Plates varied in stock (2.7, 3.5 and 4.5-mm) and length (6 to 20 holes). Age was not significantly associated with plate stock (P = 0.19. There was plate-associated tenderness in 2 patients, 1 superficial infection, and one 15-mm leg length discrepancy. One patient underwent fasciotomy in the index surgery for compartment syndrome secondary to the initial trauma. Implant removal was performed for 15 fractures and was more likely in younger patients (mean age 10.9 years vs 12.8 years, P = 0.04), but was not associated with plate stock (P = 0.97). No neurovascular injury or loss of reduction occurred. There were no cases of rotational deformity and angulation was universally < 5° in the coronal plane and <10° in the sagittal plane.

Conclusion: Minimally invasive medial plate osteosynthesis of high-energy pediatric tibia shaft fractures may be performed with a low complication rate and should be considered in this select patient population.

Minimally Displaced Pediatric Lateral Condyle Fractures:
Is There Harm in Delayed Surgery?

Dustin Greenhill, MD; *Shawn Funk, MD; Marilyn Elliott, BS; Chan-Hee Jo, PhD; Brandon Ramo, MD*

Purpose: Either casting or surgery (to prevent displacement and delayed surgery) are recommended for pediatric lateral condyle fractures with ≤2 mm lateral displacement and extension to epiphyseal articular cartilage (stage 2, Song et al.). This study compares casting only, acute prophylactic in situ pinning, and surgery if casting fails due to displacement.

Methods: 738 fractures at a Level I trauma center between 2008 and 2014 were reviewed. Song stage 2 fractures (OTA/AO 13-E/2.1) followed to union were included. Inadequate radiographs were excluded. Displacement was defined as Song stage increase to >2 (unstable fracture). Patients were grouped per treatment: (1) cast only, (2) in situ pinning, or (3) closed or open reduction and percutaneous pinning (CRPP or ORPP) after displacement during attempted cast treatment.

Results: 139 fractures were included and 45 (32%) underwent surgery. Among 114 fractures intended for casting (groups 1 and 3) only 20 (18%) displaced and needed surgery. This implies 82% of fractures pinned in situ may have remained stable in a cast. On average, displaced fractures were noted 6.5 days (range, 2-13) after presentation and required 1 extra clinic visit and week of immobilization without increased complications. Surgeons chose ORPP more often for displaced fractures.

Conclusion: Our data estimate 82% of Song stage 2 fractures never meaningfully displace in a cast. Meaningful displacements occur in <2 weeks. Benefits of prophylactic pinning include 1 less radiograph and clinic visit in exchange for a clinically insignificant lateral cortex reduction and inherent surgical risks. Compliance, surgical scheduling, and a higher rate of open reduction after displacement may affect treatment decisions.

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Intraoperative Complications and Failures of Flexible Nail Fixation in Pediatric Forearm Fractures

Amr Abdelgawad, MD, MBA; *Ahmed Thabet Hagag, MD; Zainab Alam, BA; Ahmed Elabd, MD; Ehab Saleh, MD*

Purpose: Flexible intramedullary (IM) nailing for forearm fractures in pediatric patients is becoming increasingly popular. However, there are instances in which the IM nailing will either fail to obtain reduction or intraoperative complications will develop. The purpose of this study was to identify the characteristics of these failures/complications and possible risk factors.

Methods: Between 2009 and 2018, retrospective chart review at a Level I pediatric trauma facility was performed. 37 pediatric patients with forearm fractures who underwent surgery for fixation of the fracture-with the intent of using IM flexible nail by the 2 senior surgeons were included. The mean age at the time of surgery was 11 years (range, 7-16). One patient underwent 2 procedures due to re-fracture, making the total number of procedures 38. 5 of the fractures were open type I and 1 fracture was open type II.

Results: 26 procedures were successful. 12 cases had intraoperative failure or complications. Failures were considered to abort nail fixation procedure and replace it with plate fixation in either bones or have to augment fixation. There were 8 failures (6 had to abort and 2 needed augmentation). Four others had intraoperative complications. In 2 cases, the nail passed only a few centimeters beyond the fracture, 1 case had a broken instrument, and 1 case had residual displacement after complete nail passage. These complications did not change the course of treatment. The incidence of failure and complication in distally located radial fractures was 47.4% and in proximal/midshaft fractures together was 15.8% (midshaft 14.3%, proximal 20%).

Conclusion: Flexible IM nailing for pediatric forearm fracture, despite being a popular treatment option, may have more failure than the reported incidence. The surgeon performing the procedure should be ready to either add another fixation option or use a different fixation technique, especially in distally located fractures.

Metaphyseal Fracture Displacement Is Predictive of Intra-Articular Diastasis in Adolescent Triplane Ankle Fractures

Jose Romero*, *MD; *Surya Mundluru, MD; Dustin Greenhill, MD; Marilyn Elliott, BS; Robert Wimberly, MD; Anthony Riccio, MD*

Purpose: The accurate determination of intra-articular displacement in adolescent triplane fractures using plain radiography is difficult and correlates poorly with advanced imaging modalities. The purpose of this study is to determine the utility of a novel and simple plain radiographic measurement as a predictor of intra-articular displacement.

Methods: An IRB-approved, retrospective review of all adolescents who sustained a triplane ankle fracture was performed at a single Level I pediatric trauma center from 2003-2013. Plain radiographs (XR) and computed tomography (CT) scans obtained at initial presentation were independently reviewed by 3 orthopaedic surgeons. Maximum articular diastasis and step-off were measured using digital calipers on AP, mortise, and lateral XR as well as on axial, coronal, and sagittal CT scans. In addition, maximal metaphyseal fracture displacement was recorded on lateral XR. Articular displacement and step-off were compared between the 2 imaging modalities using Student's t-test. Pearson and Spearman coefficients were used to identify correlations between XR and CT measurements.

Results: 87 triplane ankle fractures were identified with both XR and CT scans prior to treatment. XR underestimated fracture diastasis by 233% in the sagittal plane (1 mm and 3.3 mm on sagittal CT; $P < 0.05$). XR underestimated diastasis by 24% in the coronal plane (2.3 mm on AP XR vs 2.9 mm on coronal CT; $P < 0.05$). XR underestimated articular step-off by 184% in the coronal plane and 177% in the sagittal plane ($P < 0.05$). Axial CT demonstrated a significantly greater amount of articular diastasis (4.2 mm; range, 0-19 mm) when compared to coronal (2.9 mm; range, 0-18.7 mm) and sagittal (3.3 mm; range, 0-11 mm) cuts ($P < 0.05$). 65 patients had metaphyseal fracture displacement ≥1 mm on lateral XR, of whom 61 had an articular gap of >2.5 mm on CT (positive predictive value of 94%).

Conclusion: Surgeons underestimate articular displacement of triplane fractures on XR with the greatest discrepancy in the interpretation of sagittal plane displacement. Metaphyseal displacement is easily measured on XR and correlates with articular displacement. Metaphyseal displacement ≥1 mm is strongly predictive of articular diastasis above what is commonly considered the threshold for operative intervention. This finding should therefore raise suspicion for significant articular displacement that may not be appreciated on XR and, when identified, should prompt consideration of CT before proceeding with nonoperative management.

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Sacroiliac Periosteal Avulsion Is an Indication of Posterior Pelvic Fracture Instability in Children

Chase Dean, MD; *Ryan Calkins, BS; Anastasiya Trizno, BS; Jason Stoneback, MD*

Purpose: Pediatric pelvic injuries are rare but are associated with high morbidity and mortality. While the necessity for operative treatment of unstable pediatric pelvic fractures has become increasingly apparent, the current instability assessment criteria remain subjective. The purpose of this study was to ascertain whether a sacroiliac periosteal avulsion (SIPA) injury was associated with unstable pelvic fracture patterns, Tile/AO Types 61-B and 61-C, in children.

Methods: Following IRB approval, all pediatric patients presenting with pelvic fractures to a Level I trauma center between January 2005 and June 2016 were retrospectively reviewed. Avulsion and acetabular fractures were excluded and only patients with pelvic CT scans were included in the study. All pelvic radiographs and CT scans were reviewed by a single fellowship-trained orthopaedic surgeon to identify the presence of an SIPA and classify injury patterns using Tile/AO guidelines. Gender, age at injury, triradiate cartilage status, mechanism of injury, and treatment type were also collected.

Results: Of the 147 included patients, 61-A2 was the most prevalent injury pattern (n = 90), followed by 61-B2, -C1, -C2, -A1, -B3, and -B1 (n = 21, n = 20, n = 7, n = 5, n = 4, and n = 1, respectively). The most frequently documented mechanisms of injury were motor vehicle crashes (n = 63). The mean age at injury was 9.8 ± 4.8 with more males sustaining pelvic injuries (n = 77). Triradiate cartilage was open in 78 patients (53%) at presentation. 24 patients were treated operatively, with open reduction and internal fixation (ORIF) most commonly involved (n = 15). SIPA was identified in 29 patients (mean age at injury: 12.2 ± 3.5, 8 immature pelves, 16 males), 83% of whom sustained unstable pelvic fractures (B2, n = 10; B3, n = 1; C1, n = 12; C2, n = 2). 11 of the 29 SIPA patients were treated operatively. The fixation method was ORIF in 6 patients, closed reduction and percutaneous fixation in 2, external fixation with percutaneous fixation in 2, and external fixation with subsequent internal fixation in 1. Incidence of SIPA was associated with unstable fracture types (Types 61-B and -C by Tile/AO) and closed triradiate cartilage, and not associated with gender.

Conclusion: Pelvic fractures with corresponding periosteal avulsion injuries of the sacroiliac joint are associated with greater instability in the pediatric pelvis. When SIPAs are present, operative management of these fractures should be considered.

Are Routine Postoperative CT Scans Warranted for All Patients After Operative Fixation of Pelvic Ring Injuries?

***Kevin Cronin**, MD; Christopher Hayes, MD; David Zuelzer, MD; Lindsay Hockensmith, BS; Cale Jacobs, PhD; Eric Moghadamian, MD*

Purpose: Postoperative CT after percutaneous fixation of unstable pelvic ring injuries is routinely used to confirm appropriate placement of hardware; however, the utility of such imaging has yet to be determined. The purpose of this study is to determine the frequency at which routine postoperative CT directly alters the plan of care. We hypothesize that routine postoperative CT would not change management for the large majority of patients.

Methods: An IRB-approved, retrospective chart review was performed to identify skeletally mature patients with operatively treated pelvic ring injuries between 2011 and 2015 at a single, Level I trauma center by fellowship-trained orthopaedic trauma surgeons. Patient demographics and reason for revision surgery were recorded. Pre- and postoperative radiographs and CT scans were reviewed to identify pelvic dysmorphism. Fisher exact test was used to determine if the frequency of CT altering care statistically differed for any specific patient population.

Results: 363 patients underwent operative fixation of unstable pelvic ring injuries during the study period. A postoperative CT scan was obtained in 331 patients (91%) with fixation constructs consisting of 282 (85%) combined anterior and posterior, 46 (14%) posterior only, and 3 (1%) anterior only. A dysmorphic pelvis was identified in 154 patients (43%). Two patients (0.55%) returned to the operating room on the basis of postoperative CT scans due to malpositioned screws. Both were identified as having a dysmorphic pelvis and no patients with normal pelvic anatomy underwent revision surgery for malpositioned screws. The frequency that CT identified malpositioned screws requiring revision surgery did not differ between those with and without dysmorphism (2/154, 1.3% vs 0/177, 0%; P = 0.22).

Conclusion: In our series, no patients without dysmorphism were found to have misplaced screws requiring return to the operating room. However, 2 patients with pelvic dysmorphism underwent revision after postoperative CT scan demonstrated a significantly malpositioned screw. While there potentially remains a role for postoperative CT scans in the appropriately selected patient, in the hands of experienced orthopaedic trauma surgeons, patients without dysmorphism and adequate intraoperative fluoroscopy may not require routine postoperative 3-dimensional imaging.

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Use of Closed Suction Drainage in Acetabular Fracture Surgery Is an Independent Risk Factor for Allogeneic Blood Transfusion

***Adam Boissonneault**, MD;* *Christopher Staley, BA; Madeline Roorbach, BA; Amalie Erwood, BS; Michael Maceroli, MD; Mara Schenker, MD*

Purpose: Our objective was to determine whether closed suction drains after a Kocher-Langenbeck surgical approach for treatment of acetabular fractures is associated with increased rates of allogeneic blood transfusion.

Methods: The study group consisted of 181 consecutive patients who presented to a single American College of Surgeons-verified Level I trauma center over a 4-year period. All patients underwent open reduction and internal fixation (ORIF) of an acetabular fracture using a Kocher-Langenbeck (K-L) approach. Patients who underwent a K-L approach for a combined acetabular and pelvic ring injury were excluded. The primary outcome measures were rate and volume of blood transfusion. The secondary outcome was surgical site infection rates.

Results: Of the 181 patients, 148 (82%) were treated with drains. Use of closed suction drainage was associated with increased rates of blood transfusion compared to the no drain control group (P = 0.005). Of the 33 patients who did not receive a drain, only 1 required a transfusion. After controlling for admission hemoglobin and hematocrit, logistic regression analyses revealed that patients with a drain were over 9 times as likely to require a blood transfusion (P = 0.038; odds ratio 9.1 [95% confidence interval: 1.1-72.3]). An increased number of total drains placed (range, 0-4) was also associated with increased rates of blood transfusion (P = 0.002). The mean total drain output was 670 mL for those that required a blood transfusion compared to 327 mL for those who did not (P <0.001). Use of a drain was also associated with an increased number of total packed red blood cell (PRBC) units transfused (P = 0.008), and an increased number of total drains used correlated to a significant increase in total PRBCs transfused (P = 0.050). Finally, the mean total drain output had a direct correlation to the mean total blood units transfused (r = 0.20, P = 0.020). There were 4 total surgical site infections and all occurred in patients with drains (P = 0.340).

Conclusion: Placement of closed suction drains for treatment of acetabular fractures using a K-L approach is associated with increased rates of blood transfusion. Additionally, there was no significant difference in surgical site infection rates in this study. Given the well-described increased cost and complications associated with blood transfusion, these data suggest a more prudent approach to drain placement for acetabular surgery is warranted.

Early Allogeneic Blood Transfusion Is an Independent Risk Factor for Development of Acute Respiratory Distress Syndrome in Patients With Pelvic Trauma

Adam Boissonneault*, *MD; *Christopher Staley, BA; Madeline Roorbach, BA; Amalie Erwood, BS; Richard Johnson, MD; Michael Maceroli, MD; Mara Schenker, MD*

Purpose: Our objective was to determine whether early allogeneic blood transfusion is associated with the development of acute respiratory distress syndrome (ARDS) in patients with pelvic ring and acetabular fractures.

Methods: The current study reports on 374 consecutive patients that presented to a single American College of Surgeons-verified Level I trauma center for treatment of pelvic ring, acetabular, or combined injury fractures. The primary outcome measure was development of ARDS during hospital admission. Predictor variables included all admission laboratory values, ISS, Abbreviated Injury Scale (AIS), ventilator dependency, and early blood transfusion. Blood transfusion data refer to packed red blood cells (PRBCs) and included those administered in the trauma bay and preoperative period; they exclude all data related to postoperative blood transfusion.

Results: Of the 374 patients in this study, 101 (27%) received early allogeneic blood transfusion, 42 (11%) were ventilator-dependent at time of surgery, and 19 (5%) developed ARDS. Patients who received early blood transfusion were almost 17 times as likely to develop ARDS (odds ratio [OR] 16.9, 95% confidence interval [CI] 4.8-59.5; P <0.001). The mean (standard deviation) volume of PRBCs transfused was 5.6 (1.6) units for those who developed ARDS compared to 1.1 (3.3) for those who did not. Being ventilator-dependent at time of operation was associated with development of ARDS (P <0.001). After controlling for the requirement of a ventilator, ISS, and chest injury, patients who received early blood transfusion were still over 5 times as likely to develop ARDS (OR 5.7, 95% CI 1.4-23.9; P = 0.017). Finally, admission laboratory data were also associated with development of ARDS, including mean lower albumin (P <0.001), mean lower hemoglobin (P <0.001), mean lower base excess (P <0.001), and mean increased glucose (P = 0.004). After controlling for all admission laboratory values, early blood transfusion continued to be a significant predictor of development of ARDS (OR 9.0, 95% CI 2.3-34.0; P = 0.001).

Conclusion: Our study suggests early allogeneic blood transfusion is an independent risk factor for development of ARDS in patients with pelvic trauma. These data emphasize the importance of judicious transfusion criteria in the acute setting.

Postoperative Allogeneic Blood Transfusion in Patients With Pelvic and Acetabular Trauma: Are We Actually Treating an Unresolved Traumatic Coagulopathy?

Adam Boissonneault*, *MD; *Christopher Staley, BA; Richard Johnson, MD; Michael Maceroli, MD; Mara Schenker, MD*

Purpose: Our objective was to determine if presentation coagulopathy and acidosis are associated with postoperative allogeneic blood transfusion rates in patients with pelvic and acetabular trauma.

Methods: Our study reports on 374 consecutive patients that presented to a single Level I trauma center with operative acetabular and pelvic fractures. Presentation coagulopathy and acidosis were defined as admission International Normalized Ratio (INR) ≥1.2 and base excess less than -5.0, respectively. The primary outcome was the requirement for a postoperative blood transfusion. Covariates included in our multivariate logistic regression model included age, modified frailty index (mFI) score, fresh frozen plasma (FFP) transfusion (in total units, over entire hospital stay), preoperative blood transfusion (in total units packed red blood cells [PRBCs]), admission hemoglobin (Hb), postoperative Hb, and surgical estimated blood loss (EBL).

Results: Of the 374 patients, 118 (32%) received a postoperative blood transfusion. Even after controlling for age, mFI, FFP transfusion, preoperative PRBC transfusion, admission Hb, postoperative Hb, and surgical EBL, patients who presented with the combination of both acidosis and coagulopathy were still 5 times as likely to receive a postoperative blood transfusion (odds ratio [OR] 5.0, 95% confidence interval [CI] 1.1-23.1; P = 0.040). Patients who presented with acidosis and coagulopathy received a mean 2.7 units PRBCs postoperatively compared to 0.9 units PRBCs for those who presented with admission INR and base excess values within normal limits. Admission INR values were directly correlated with total number of units PRBCs transfused postoperatively (r = 0.15, P = 0.005) and admission base excess values were inversely correlated with total numbers of PRBCs transfused (r = -0.23, P <0.001).

Conclusion: Our study demonstrates that presentation acidosis and coagulopathy is an independent risk factor for postoperative blood transfusion. Although patients are resuscitated with crystalloid fluids and blood products prior to surgery, such interventions may only replete circulatory volume and fail to fully address an underlying traumatic coagulopathy. More sophisticated resuscitation methods such as viscoelastic hemostatic assays (VHA)-guided therapy may more appropriately address coagulopathies and reduce rates of blood transfusions and their associated costs and complications.

WITHDRAWN

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Does Removing Iliosacral Screws Improve Sacroiliac Joint Pain and Outcomes?

Reza Firoozabadi*, *MD; *Boris Kovalenko, MD; Paul Toogood, MD*

Purpose: Unstable pelvic ring injuries are routinely treated with screws across the sacroiliac joint. Controversy exists with regard to removal of iliosacral (IS) screws. The primary author does not routinely remove IS screws after operative management of pelvic ring injuries. IS screws are only removed if the patient is symptomatic and has no radiographic evidence of nonunion. The most common symptom noted is pain over the posterior aspect of the sacroiliac joint with activity. The primary aim of this study was to determine if screw removal improved posterior pelvic pain and Short Musculoskeletal Function Assessment (SMFA) scores.

Methods: Patients who had symptomatic IS hardware removed over a 3-year period were included. Patients were excluded if screw removal was performed for non-pain-related reasons and if chart review was not able to identify pain levels and SMFA scores. Patients were also excluded if they did not have at least 2 follow-up visits after hardware removal. Medical records were reviewed for demographic information. Preoperative and postoperative imaging and operative reports were reviewed for type and number of IS screws utilized.

Results: During this period, 39 patients had posterior pelvic ring hardware removal. Nine patients were excluded because the primary reason for removal was not related to pain (3 for revision surgery after transfer from outside hospital, 2 patients for loose screws, 4 pediatric patients). This left a cohort of 30 patients, of whom 5 were excluded due to missing SMFA data. Mean age was 31 years (range, 13-58), mean number of days from date of initial surgery and hardware removal was 1102 (range, 242-5221), and mean number of days from screw removal and last follow-up was 367. 28% of patients required narcotics due to posterior pelvic pain prior to removal, compared to 8% of patients post removal.88% of patients said that they had improvement in pain after screw removal and that they are happy with the decision to have surgery. Preoperative SMFA Function score was a mean of 70 (range, 34-114; standard deviation [SD] 27), and post screw removal mean score was 61 (range, 34-105; SD 25). Preoperative SMFA Bother mean score was 29 (range, 12-46; SD 12), and post screw removal mean score was 23 (range, 12-37; SD 9.7). No complications were noted for the screw removal procedure.

Conclusion: This study suggests that removal of iliosacral screws in symptomatic patients may improve pain at the sacroiliac joint and decrease narcotic requirements. Larger studies need to be performed to verify our findings.

The Incidence of Injury to the Contralateral Sacroiliac Joint in Patients Treated Operatively for Unilateral Lateral Compression Pelvic Ring Injuries

***David Donohue**, MD; H Claude Sagi, MD*

Purpose: Accurate radiographic evaluation of patients presenting with high-energy pelvic ring injuries can be confounded by the presence of pelvic sheets/binders or the concavity of the gantry in the CT scanner. Both result in internal rotation to the pelvis and thus reduce anterior-posterior (AP) pelvic ring injuries. The purpose of this study is to describe the incidence of occult injury to the contralateral sacroiliac (SI) joint in patients presenting with unilateral lateral compression (LC) pelvic ring injuries.

Methods: A prospectively collected fracture database as well as billing records were reviewed. All skeletally mature patients with unilateral, LC pelvic ring injuries (AO/OTA 61-B2, 61-C1) and bilateral injuries (AO/OTA 61-B3.2 and 61-C2) treated operatively (CPT 27216) between January 1, 2013 and January 1, 2018 were included (n = 251). Preoperative CT scans, radiology reports, and operative reports were reviewed. An occult SI joint injury was considered present if the operative report indicated instability of the contralateral hemipelvis during examination under anesthesia (EUA), the postoperative diagnosis was distinct from the preoperative diagnosis indicating intraoperative identification of instability, or if the attending radiologist report indicated the contralateral SI joint was normal on the injury CT scan. Patient demographics, mechanism of injury, and posterior pelvic ring fracture pattern were recorded.

Results: 20 patients were found to have occult SI joint instability (8%)--12 males and 8 females with an average age of 32 years (range, 18-61). All were the result of high-energy trauma, most commonly motor vehicle collision (8/20) and pedestrians struck by a vehicle (4/20). All patients had a complete LC injury to the contralateral posterior pelvic ring. 45% (9/20) had a complete zone 2 sacral fracture, and 40% (8/20) had an intra-articular fracture of the ilium.

Conclusion: In patients with LC pelvic ring injury following high-energy trauma, there is an 8% incidence of occult injury to the contralateral SI joint. Proper evaluation of intraoperative imaging and evaluation under anesthesia are necessary to ensure such injuries are not overlooked.

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Percutaneous Superior Pubic Ramus Screws Are Associated With Low Failure Rates

***Boshen Liu**, **MD;** Alesha Scott, DO; Colin Cooper, MD; Brandon Scott, MD; Paul Matuszewski, MD; Raymond Wright, MD*

Purpose: Percutaneous superior pubic ramus screws are commonly utilized in the fixation of pelvic ring fractures. Prior reports have demonstrated a high failure rate (15%) associated with the use of this technique, with factors such as age, gender, and technique (retrograde vs antegrade), and fracture location predictors of failure. We hypothesized that the failure rate of these screws is less than previously reported and that parasymphyseal fractures are most likely to displace.

Methods: 355 patients with pelvic ring fractures who underwent percutaneous superior ramus screw fixation at a single Level I trauma center were retrospectively reviewed. The final cohort consisted of 274 patients with 382 superior ramus fractures treated with percutaneous screw fixation. Injury, immediate postoperative, and routine follow-up radiographs were assessed for fixation and reduction maintenance, which was defined as <2 mm of displacement compared to postoperative radiographs. Patient demographics, fracture morphology, fixation technique, loss of reduction, and failure were recorded. Logistic regression was utilize to assess the primary outcome, loss of reduction.

Results: Of the 274 patients who had adequate follow-up, the average age was 44 years (95% confidence interval [CI], 41-46). 142 superior ramus fractures were treated with antegrade screw fixation, and 187 were treated with retrograde screw fixation. 9 patients (2.92%) had loss of reduction or fixation failure. Increasing age was predictive of loss of reduction (P <0.05, odds ratio [OR] 1.03; 95% CI 1.0-1.06). Fracture location (parasymphyseal, mid-ramus, pubic root), retrograde trajectory, presence of inferior rami fracture, bilateral rami fractures, crescent fracture, and sacroiliac joint disruption were not associated with loss of reduction (P >0.05). In those that failed, 8 patients had unilateral rami fixation, 1 patient had bilateral rami fixation, and 8/9 failures were retrograde screws/parasymphyseal, but this was not significant (P >0.05). The most common cause for failure was errant screw insertion leading to incomplete osseous containment of the screw.

Conclusion: This series represents the largest to date assessing the use of intramedullary superior ramus screws in the fixation of pelvic ring fractures. Superior ramus screws are associated with a low failure rate (2.92%), which is significantly lower than previously reported (P <0.05). In our cohort, only increasing age was a predictor of failure. With proper technique, superior ramus screws can be utilized successfully in the treatment of pelvic ring injury.

Intraoperative CT for Percutaneous Fixation of the Pelvis: A Retrospective Case Series
***Gregory Altman**, **MD;** Michael Maher, MD; Jeffrey Sewecke, DO; Daniel Altman, MD*

Purpose: Intraoperative fluoroscopy is the standard technique for percutaneous fixation of pelvis fractures. This technique requires the use of multiple fluoroscopic views, repeated sequential imaging during the procedure, and may be demanding for successful placement. Imaging can be obstructed by bowel gas, patient habitus, and minor variations in sequential views. Improvement in technique with advanced imaging is a current area of inquiry. In this case series, we present the utility of intraoperative CT in the percutaneous placement of pelvis fixation.

Methods: In this series, 22 patients were treated with percutaneous pelvis fixation using both standard fluoroscopy and intraoperative CT using the Medtronic O-arm imaging system. Initial guide pin placement was performed using fluoroscopy. Once hardware was placed, intraoperative CT was used to confirm satisfactory position and reduction. Modifications were made if necessary and additional time required for the use of intraoperative CT noted. 14 of the 22 patients underwent additional postoperative CT and were used to compare radiation exposure and accuracy of intraoperative CT.

Results: 4 patients (18%) underwent hardware modification after review of intraoperative CT. In 2 cases, the S1 iliosacral screw was prominent and shorted to an acceptable length. In a third case, the hardware was incompletely compressed and iliosacral reduction was improved with correction. In the fourth case, excessive compression caused a malreduction through sacral comminution, leading to open reduction. The presence of sacral dysmorphism was evident in 7 patients (32%) within this series and in 3 of the 4 cases that underwent hardware modification. On average, the use of intraoperative CT added 24.4 minutes in operative time with each use. 14 patients underwent additional postoperative CT, but these studies did not provide further significant information. The average radiation dosage for intraoperative CT and standard dedicated pelvis CT was 255.36 mGy-cm and 365.33 mGy-cm, respectively.

Conclusion: The utility of intraoperative CT for placement of percutaneous pelvic fixation was supported in this retrospective case series. Intraoperative CT may be particularly useful in cases of sacral dysmorphism or in cases in which standard fluoroscopy is limited. Intraoperative CT may also negate the need for postoperative CT and repeated visits to the operating room for hardware modification. The average effective dose of radiation was lower in intraoperative CT compared to a standard pelvis CT.

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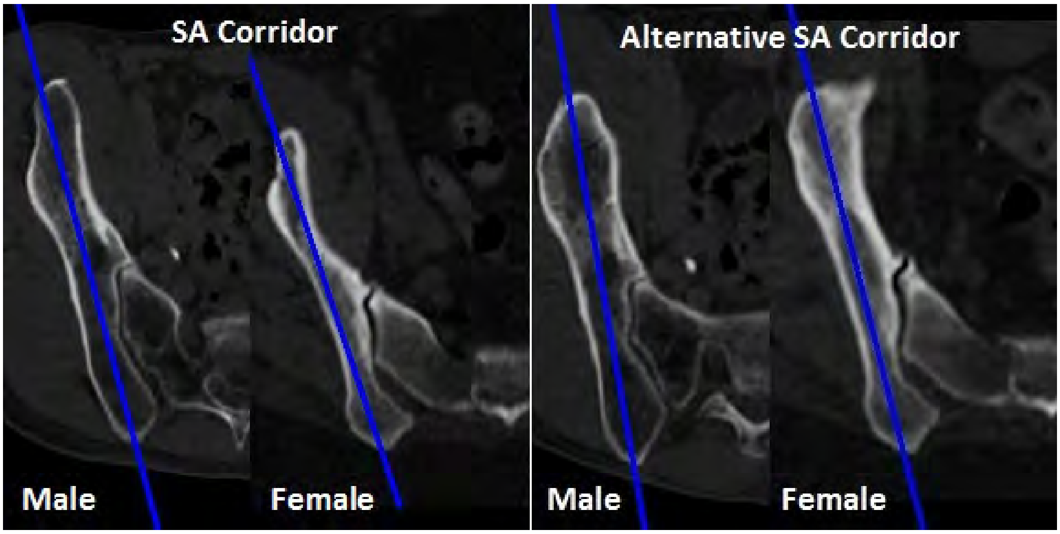
The Supra-Acetabular Osseous Corridor: Anatomy and Alternatives

Miqi Wang, MD; *Robert Jacobs, MD; Craig Bartlett, MD; Patrick Schottel, MD*

Purpose: The supra-acetabular (SA) corridor extends from the anterior inferior iliac spine to the posterior superior iliac spine and can safely accommodate implants to stabilize fractures of the pelvis. This study seeks to define the dimensions, common constriction points, and any alternative trajectories that would maximize the corridor diameter.

Methods: CT of 100 male and 100 female hemipelves without osseous trauma were evaluated using Philips Brilliance. The SA corridor boundaries were determined through manual best-fit analysis. The largest intercortical cylinder within the pathway was created and measured. Alternative trajectories were tested within the SA boundaries to determine if another orientation existed that maximized the diameter of the intercortical cylinder.

Results: The traditional SA corridor had a mean diameter of 8.3 mm in men and 6.2 mm in women. This difference in diameter (P <0.001) is due to a more S-shaped ilium in women. A larger alternative SA corridor was found that had a less limited path through the ilium and measured 11.3 mm in men and 9.9 mm in women. These dimensions are significantly different compared to those of the traditional SA corridor in both men and women (P <0.001).



Conclusion: In men, the SA corridor allows for the safe passage of most hardware used in pelvic fractures. However, in women, the SA corridor is restricted by a more S-shaped ilium. An alternative SA corridor was found that has a significantly larger mean diameter in both sexes. Ultimately, the trajectory of hardware will be dictated by the clinical scenario. When multiple implants are needed, especially in women, we recommend considering the alternative SA corridor.

Accuracy of Radiographic Displacement Measurement in Pelvic Ring Injury

***Sohaib Hashmi*, MD;** *Bennet Butler, MD; Kelly Wun, BS; Hobie Summers, MD; Michael Stover, MD*

Purpose: Pelvic ring injury outcomes studies rely on radiographic assessment. To date, no study investigates the accuracy of radiographic measurement. The aim of this study is to assess the accuracy and interobserver reliability of pelvic ring displacement measurement techniques. We hypothesize radiographic measurement methods do not accurately quantify pelvic ring displacement.

Methods: 12 pelvic ring models were suspended in a novel device allowing for exact displacements of the hemi-pelvis in the axial, sagittal, and/or coronal planes. 10 orthopaedic traumatologists measured radiographic pelvic ring displacements using anteroposterior, inlet, outlet radiographs and axial CT images. Observers completed a survey of demographic and treatment strategies. Radiographic measurements were analyzed for accuracy, coefficient of variance (CV), and alpha and kappa statistic to measure observer agreement. Absolute displacement measurements were scored with Matta and Tornetta grading system for alpha and kappa correlation evaluation.

Results: Mean age of observers was 47.5 years (range, 36-59) with mean 15.3 years (range, 4-27) of pelvic fracture surgery experience. 20% of surgeons primarily use open reduction and internal fixation technique, 40% reported using primarily closed reduction and percutaneous fixation, and 40% use a combination of open and closed techniques in treatment of pelvic ring injury. Hemi-pelvis displacement of 1 cm in coronal, axial, or sagittal planes had average radiographic measurement error of 32.5% (1.8%-100%, CV 50.97), 77.6% (15%-100%, CV 169.46), and 37.9% (0.17%-74.5%, CV 47.7) in each respective plane. Displacement of 2 cm of the hemi-pelvis resulted in average measurement error of overestimation in the coronal plane by 104% (85%-169%, CV 25.4), 75% in the axial plane (2.3%-100%, CV 162), and 59% in the sagittal plane (30%-100%, CV 51.3). Displacement of 5.4 cm in the coronal plane yielded the most accurate radiographic measurement, with average error 9.7% (1.7%-19.1%, CV 6.57). Krippendorff's alpha coefficient, a measure of interrater reliability, for radiographic measurement techniques by observers showed poor agreement with 0.336. The Conger's kappa coefficient also demonstrated poor agreement with 0.338.

Conclusion: Radiographic displacement measurement of pelvic ring injuries has significant inaccuracy among various measurement methods. Coronal and sagittal plane radiographic displacement measurements are more accurate compared to axial plane measurement. Radiographic displacement measurement techniques show poor interrater agreement.

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Prevalence, Recovery Patterns, and Quality of Life After Acetabular Fractures: The Brabant Injury Outcome Surveillance (BIOS) Study

***Lars Brouwers*, PhD;** *Koen Lansink, MD, PhD; Leonie de Munter, MSc; Mariska de Jongh, PhD*

Purpose: Overall, improved understanding of the full spectrum of the societal impact and burden of acetabular injury is needed. The main purpose of this study was to provide insight into prevalence and recovery patterns of short-term and long-term health-related quality of life (HRQoL) after acetabular injury.

Methods: This is a prospective, observational, multicenter, follow-up cohort study in which HRQoL and functional outcome after acetabular trauma was assessed during 12 months follow-up within injured adult patients admitted to 1 of 10 hospitals in the county Noord-Brabant, the Netherlands. Data were collected by self-reported questionnaires at 1 week (including preinjury assessment), and 1, 3, 6, and 12 months after injury. EuroQoL-5 Dimensions (EQ-5D), visual analog scale (VAS), and the Merle d'Aubigne Hip (MAH) score were used to examine the HRQoL and functional outcome. Subsets were created based on Judet-Letournel classification. Differences in HRQoL between the subsets on different timepoints were assessed using multivariable linear regression.

Results: 61 acetabular fractures were identified between 2015 and 2016; 27 elementary fractures and 34 associated fractures according to the Judet-Letournel classification; 81% male, mean age 59 years, mean ISS 7.6. A primary operation was performed in 42% and after 1 year 12% of the patients had undergone a total hip arthroplasty. Overall, patients with associated fractures obtained lower scores on the MAH score and EQ-5D at all measurements when compared with patients with elementary fractures. Although most recovery was seen in the first 3 months, both groups of patients did not reach their preinjury level 1 year after trauma. When compared with patients with elementary fractures, patients with associated acetabular fractures obtained lower scores 1, 3, 6, and 12 months after injury, corrected for confounding, on the MAH score, respectively; beta: 1.7, 1.5, 1.4, and 0.7 ($P < 0.001$). Patients with associated acetabular fractures obtained lower scores 1, 3, 6, and 12 months after injury, corrected for confounding, on the VAS and EQ-5D index score, respectively; beta: 9.0, 6.2, 6.9, and 4.3 ($P < 0.001$) and beta: 0.15, 0.12, 0.17, and 0.17 ($P < 0.001$).

Conclusion: Patients with acetabular fractures experience a significant reduction of their HRQoL and functional outcome within 1 year after injury. Patients with associated acetabular fractures have worse outcomes when compared with elementary fractures. Physicians should concentrate on the recovery of patients with acetabular fractures, especially in the first year after injury.

Survivorship of the Hip After Acetabulum Fracture

Gordon Preston, DO; *Koan Heindel, DO; Isabella Heimke; J. Collin Krebs, BS; Nicholas Scarcella, MD; Heather Vallier, MD*

Purpose: Acetabulum fractures comprise 3% of all fractures seen by orthopaedic traumatologists with treatment goals of preserving the native functional hip joint and optimizing mobility and function. The aim of this study was to determine the rate of failure of the hip joint after acetabulum fracture and to determine risk factors.

Methods: Review of 1105 skeletally-mature patients treated at 1 Level I trauma center for acetabulum fracture between 1998 and 2016 identified 962 patients with complete records. Patient, injury, and treatment factors were assessed regarding possible association with failure of the hip joint, defined as end-stage posttraumatic arthrosis (PTOA) or patient receiving total hip arthroplasty (THA) for pain relief.

Results: Mean age was 46 years (range, 17-94), with 695 males (72%), and 28% of all patients sustaining an isolated injury. Most common fracture patterns included posterior wall (289 [30%]), transverse posterior wall (162 [17%]), and associated both-column fractures (124 [13%]), accounting for 60%. All fractures united primarily: 676 (70%) operative (open reduction and internal fixation [ORIF]) and 286 nonoperative. 63 (6.5%) of 962 patients underwent THA after healing their acetabular fracture: 57 (90%) with initial operative treatment and 6 nonoperative. One other patient was treated with acute THA and was excluded from study. Mean follow-up was 20 months, and median time to THA was 12 months. Age, fracture type, ORIF, marginal impaction, and hip dislocations were significant predictors of hip joint failure. After multivariable analysis, mean injured age of THA patients was 53 versus 43 years (P <0.001). T-type fractures were most likely to fail (18%, P = 0.003), with odds ratio (OR) 4.52 (95% confidence interval [CI] 2.050-9.963). Marginal impaction was associated with failure in 16% (P <0.001) and OR 2.7 (1.447-5.164). Posterior hip dislocation was associated with failure in 9.7% (P <0.001) and OR 1.73 (0.922-3.229, P = 0.088).

Conclusion: The majority of patients retained their native hip at most recent follow-up. Median time to conversion to THA was 12 months. Most who had THA had initial surgical care of their fracture, likely reflecting increased fracture displacement and complexity. Older age, T-type fracture pattern, marginal impaction, and hip dislocations are all significant predictors of hip joint failure following acetabular fracture.

Effects of Obesity on Results and Outcomes Following Acetabulum Fracture

Sahini Pothireddy, BS; *Isabella Heimke; J. Collin Krebs, BS; Nicholas Scarcella, MD; Gordon Preston, DO; Heather Vallier, MD*

Purpose: Obesity is a growing public health issue. Regarding the trauma population, obesity has been shown to result in longer surgeries and prolonged hospital stays, and to be associated with more complications. The purposes of the study were to determine the impact of obesity on early and late complications and hospital course after acetabulum fracture and to identify effect on functional outcomes.

Methods: The registry of an urban Level I trauma center had 770 adult patients with acetabulum fracture between 1997-2016 and complete data. Obesity was defined as body mass index (BMI) >30. Functional outcomes were evaluated after minimum of 12 months with the Musculoskeletal Function Assessment (MFA) for 200 patients. Early complications included wound infection, thrombotic events, and iatrogenic nerve injury and late complications included posttraumatic arthrosis (PTA), osteonecrosis, and heterotopic ossification.

Results: 770 patients with mean age 46 years, 70% male, and mean BMI of 30 were studied. Obesity was noted in 317 patients (41%). Mean BMI of females was higher than males (32 vs 29, P <0.001). No differences were noted between obese and non-obese patients regarding age, mechanism, or fracture pattern. However, obese patients were more likely to be treated surgically (68% vs 58% of non-obese, P = 0.005). Early complications occurred more often in obese patients (13% vs 9.0%, P = 0.02), including more iatrogenic nerve injuries (6.0% vs 2.0%, P = 0.004). Obesity was also associated with late complications (34% vs 22%, P <0.0001), especially PTA (23% vs 11%, P <0.0001). Worse MFA scores were reported in obese patients (40 vs 31, P = 0.01) after mean follow-up of 54 months and adjustment for fracture pattern and type of treatment.

Conclusion: Obesity was more common in women than men, and independently had a negative impact on results and outcomes after acetabulum fracture. Patients with BMI >30 had more early and late complications and secondary operations. They also reported worse overall function, based on MFA scores.

Does Bone Density on CT Correlate With Fracture Characteristics and Conversion to Arthroplasty in Operatively Treated Elderly Acetabular Fractures?

Erik Lund**, **MD; *Jonathan Ford, PhD; Paul Hannon, BS; Stephanie Merimee, MD; Summer Decker, PhD; H. Mir, MD*

Purpose: Acetabular fractures in the elderly can be treated with a variety of methods, including open reduction and internal fixation (ORIF) and total hip arthroplasty (THA). A subset of patients requires late conversion to THA. Our objective was to determine if bone density (BD) as measured on preoperative CT correlates with fracture characteristics and predicts late conversion to THA after initial ORIF of elderly acetabular fractures.

Methods: We performed a retrospective review of patients from 2010-2017 presenting to a Level I trauma center with an acetabular fracture. We included patients >50 years old treated with ORIF, preoperative CT, and >6-month follow-up. BD was measured by 3 methods: (1) 3-dimensional volumetric measurement of periacetabular cancellous and cortical bone, (2) ovoid measurement on an axial slice cranial to the acetabulum, and (3) in the femoral neck. Statistical analysis included Pearson correlation and independent t-tests to compare the 3 methods against fracture pattern, loss of reduction, posttraumatic arthritis, reoperation, and THA. We stratified BD as normal, osteopenic, and osteoporotic based on previously defined CT criteria.

Results: 41 patients (average age 65 years) were included with an average 16-month follow-up (range, 6-72). Mortality rate was 12% (5/41). BD was classified as normal in 9/41 (22%), osteopenic in 21/41 (51%), and osteoporotic in 11/41 (27%). Lower BD correlated with older age (P <0.017). Patients with femoral head medialization had lower BD than those who did not (P = 0.01). In contrast, posterior wall fractures had higher BD than those who did not (P = 0.002), indicative of higher energy mechanism. 6 of 41 patients (14.6%) had late conversion to THA. BD did not correlate with conversion to THA (P = 0.669).

Conclusion: Patients with low BD as measured on preoperative CT were more likely to have femoral head medialization. However, BD did not correlate with late conversion to THA in this series. Further research is necessary to help predict which patients may require late conversion to THA and help guide initial management for elderly acetabular fractures.

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Identification of Subtle Residual Sacroiliac Joint Flexion in AO/OTA 61-C1.2 (APC3) Pelvic Injuries After Anterior Fixation

Zachary Working, MD; *Ashraf El Naga, MD; Paul Hoogervorst, MD; Riley Knox, BS; Meir Marmor, MD*

Purpose: Fixation of AO/OTA 61-C1.2 (APC [anterior-posterior compression] 3) pelvic fractures may entail provisional anterior fixation followed by reduction of the sacroiliac joint (SIJ) and posterior fixation. Differentiating SIJ widening from hemipelvis flexion or extension is difficult. We sought to identify a radiographic marker for posterior flexion or extension malreduction in the setting of a reduced anterior ring.

Methods: Anterior and posterior ligamentous structures were cut in 8 cadaveric pelves. The anterior ring was held reduced with Kirschner wires; flexion and extension deformities resulting in 1 cm displacement at the SIJ were created and a lateral compressive force applied. The SIJ was assessed using fluoroscopy. The direction of lateral and AP displacement relative to the contralateral joint was assessed via inlet while lateral and superior displacement was assessed using outlet views. Displacement direction was compared between flexion and extension models using Fisher's exact test.

Results: On outlet views, all flexed hemipelves showed caudal ileal translation at the superior SIJ, in contrast to all extended hemipelves showing cranial translation ($P < 0.0005$). There were no significant differences in lateral translation on outlet ($P = 1.0$) or inlet ($P = 0.077$) views nor AP translation on inlet views ($P = 0.199$) between the flexion and extension malreductions.

Conclusion: The direction of vertical displacement at the superior SIJ on the outlet view can differentiate between flexion and extension hemipelvis deformity in APC3 injuries with residual malreduction after provisional anterior fixation. This may require further reduction prior to lag screw compression.

Urethral Trauma Following Pelvic Fracture From Horseback Saddle-Horn Injury Versus Other Mechanisms of Pelvic Trauma

***Chad Service*, BS;** *Rachel Moses, MD; Sarah Majercik, MD; James Hotaling, MD; Sorena Keihani, MD; Sara Lenherr, MD; David Rothberg, MD; Jeremy Myers, MD*

Purpose: Saddle-horn injury occurs when horseback riders are thrown into the air by a bucking horse and subsequently land with their perineum striking the rigid saddle horn, often leading to pelvic ring disruption. We hypothesize there is a higher rate of urethral trauma in saddle-horn injury compared to pelvic fracture from other mechanisms.

Methods: A retrospective review was performed of male patients >18 years of age presenting to our Level I trauma center with pelvic ring fracture injuries between 2001 and 2016. Demographics, ISS, mechanism of injury (saddle horn vs other), presence of pubic symphysis diastasis, and lower genitourinary (GU) injuries (bladder and urethra) were identified in the trauma registry and confirmed through the clinical and radiographic medical record. Demographics, rates of pubic symphysis diastasis, and rates of urethral injury following horseback injury were then compared via t-test for continuous and chi-square for categorical variables to lower GU injury occurring by other mechanisms.

Results: 1195 males presented with pelvic ring fractures during a 15-year period with an average age of 43.5 years (standard deviation [SD] 18.7). Of these, 7% (87/1195) presented with any lower GU injury. Horseback saddle-horn injuries had a higher rate of lower GU injuries (20% [12/60] vs 7% [75/1135]; P = 0.001). In the 87 men with lower GU injuries, 54% (47/87) had urethral injury. In saddle-horn injury the rate of urethral injury was higher than in other mechanisms of pelvic fracture with lower GU injury (83% [10/12] vs 49% [37/75]; P = 0.03). Saddle-horn injuries with lower GU injuries had lower rates of major vascular injury than other mechanisms with lower GU injuries (0% [0/12] vs 44% [33/75]; P = 0.001) and lower ISS (16 vs 28, P = 0.002). Furthermore, rate of pubic symphysis diastasis was higher among saddle-horn injuries with lower GU injury versus other mechanisms (100% [12/12] vs 52% [39/75]; P = 0.001).

Conclusion: Lower GU injury (specifically urethral injury) and pubic symphysis diastasis were associated with saddle-horn injury compared to other mechanisms of pelvic ring disruption. While these patients are less globally injured and less likely to have major bleeding, clinicians should be aware of the risk of lower GU injury and take diagnostic measures to identify them.

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Predicting Early Failure of Percutaneous Superior Ramus Screws

Alvin Shieh*, *MD; *Christopher Hayes, MD; Trevor Shelton, MD, MS; Jonathan Eastman, MD*

Purpose: The most utilized system for describing anterior pelvic ring injury is the Nakatani classification. Prior studies have demonstrated a failure rate of up 15% when treated with percutaneous ramus screw placement. Interestingly, most failures were observed with zone 2 fractures treated with retrograde ramus screws. This dichotomy was thought to hinge around the ability of antegrade ramus screws to hold purchase in the good bone above the acetabulum. Many of these screw failures occurred with unicortical fixation within the metaphyseal bone at the acetabular junction. We sought to determine if fracture morphology and the use of longer osseous fixation pathways could alleviate this propensity for screw failure.

Methods: A retrospective review of all percutaneous superior ramus screws placed over the past 5 years for pelvic ring injuries was performed at our institution. All patients underwent surgery for an unstable pelvic ring injury demonstrated on dynamic stress views performed under anesthesia. All had fixation of both the anterior and posterior ring. Only patients with a minimum of 6 weeks radiographic or CT imaging were included. Failures were defined as screw cutout or interval fracture displacement greater than 5 mm. Statistical analyses were performed using Wilcoxon rank sums test and Fisher's exact test.

Results: There were a total of 7 failures out of 138 superior ramus screws (5.1%). Mean age of failures was 59 ± 20. Only 1 patient required revision screw fixation due to significant loss of reduction. Of the screws that failed, 5 were placed in a retrograde fashion, 5 had bicortical fixation, 5 were 4.5-mm screws, and 2 were 7.0-mm screws. Ramus fracture patterns included 4 oblique and 3 comminuted whereas none of the failures included transverse or segmental ramus fractures. Based on the Nakatani classification, 4 fractures were in zone 2, 2 were in zone 1, and 1 was in zone 3. 3 injuries were Young-Burgess lateral compression type 1, 3 had bilateral posterior ring injuries, and 1 had bilateral anterior ring fractures. Failure modes included 4 screws that cut out proximally, 2 screws that cut out distally, and 1 screw that bent at the fracture site.

Conclusion: The incidence of percutaneous superior ramus screw failure in our cohort was around 5% which is significantly lower than previously reported. No single fracture or fixation variable was found to be an independent predictor for superior ramus screw failure. Larger studies are indicated to more accurately determine risk factors for failure.

Safety of Medullary Superior Pubic Ramus Screws

James Learned, MD; *Clay Spitler, MD; Milton Little, MD; Jonah Hebert-Davies, MD; Milton Routt, MD; James Krieg, MD; Reza Firoozabadi, MD*

Purpose: Medullary superior pubic ramus (MSPR) screws allow for intramedullary stabilization of certain anterior pelvic ring injuries. Malpositioned implants can put the patient at risk for neurovascular injury and loss of reduction/fixation. Our purpose was to determine the incidence of unsafe trajectories when screws were placed using percutaneous fluoroscopically guided techniques.

Methods: This retrospective chart review included all patients treated with MSPR screws (antegrade and retrograde) by fellowship-trained orthopaedic trauma surgeons at a Level I trauma center from 2008-2012. Injury and postoperative CT scans, as well as intraoperative imaging, were reviewed for injury pattern and implant position; charts were reviewed for postoperative neurological deficits. Implants were considered "unsafe" if they either violated the innominate cortex or the tip protruded 20 mm or more beyond the far cortex.

Results: Patients were treated with cannulated and non-cannulated orthopaedic implants. 547 MSPR screws were placed in 378 patients (239 retrograde, 308 antegrade). 7 of 547 screws (1.3%) were unsafe radiographically. Of the 7 unsafe screws, 2 were retrograde and 5 were antegrade. 3 screws (2 antegrade and 1 retrograde) were long on postoperative CT; 4 screws (3 antegrade and 1 retrograde) extruded from the medullary canal along their path. Chart review of all unsafe screws revealed no patients with a documented postoperative nerve deficit or vascular injury. No patients were taken to the operating room for revision of fixation based on postoperative imaging assessment. There was no significant difference between the rates of unsafe screws in the antegrade and retrograde screw groups.

Conclusion: Percutaneous pelvic fixation of anterior pelvic ring injuries is common. Inappropriate positioning and inadequate imaging can affect the surgeon's ability to visualize the osseous landmarks and safely place screws. This study suggests that medullary superior pubic ramus screws can be safely placed by experienced surgeons.

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Perioperative Incidence and Locations of Deep Vein Thrombosis Following Different Isolated Lower Extremity Fractures

Hu Wang, MD; *Utku Kandemir, MD*

Purpose: This study was undertaken to determine perioperative incidence and locations of deep vein thrombosis (DVT) in injured and uninjured lower extremities following isolated lower extremity fractures (ILEFs).

Methods: This was a retrospective analysis of prospectively collected data in a consecutive patient series with ILEFs who had surgical treatment between September 2014 and September 2017. Patients underwent duplex ultrasonography (DUS) of bilateral lower extremities before and after surgery to evaluate for DVT, and were classified by location of DVT and fracture site. All patients received pharmacologic thromboprophylaxis during their hospital stay. Demographics, time to surgery, time of DUS examinations, and length of hospital stay were collected.

Results: 1825 patients were included in our study, and all patients underwent DUS of bilateral lower extremities a mean of 3.5 days (range, 0-18 days) after injury, and a mean of 3.6 days (range, 1-11 days) after surgery. Preoperative ultrasound detected DVT in 547 patients (30.0%), including 3.7% of patients with proximal DVT. 792 patients (43.4%) were found to have a DVT postoperatively, but only 6.2% of patients with proximal DVT. Proximal DVTs were detected postoperatively of the represented fractures; 14.5% were of the femoral shaft, 4.5% of the tibial plateau, 4.6% of the tibial shaft, 1.7% of the patellar, 6.5% of the hip, and 2.0% of the peri-ankle. Interestingly, the rate of DVT in the uninjured lower limb was significantly higher postoperatively compared to preoperatively (16.4% vs 4.9%), but only 0.2% of patients had proximal DVT.

Conclusion: While the perioperative incidence of overall DVT is high following ILEFs, the majority were distal DVTs. Femur shaft fractures were associated with the highest incidence for proximal DVT. The incidence was decreased in more distal fractures. The majority of patients diagnosed with DVT postoperatively had already had DVT before surgery. DVT can occur in both the injured and uninjured leg with obviously higher incidences in the injured leg, and proximal DVT in the uninjured leg is rare.

Psychological Developments 28 Years After Multiple Trauma

Sascha Halvachizadeh*, *MD; *Henrik Teuber, MD; Kai Sprengel, MD; Georg Osterhoff, MD; V. Neuhaus, PD, MD; Hans-Christoph Pape, MD; Roman Pfeifer, MD*

Purpose: The impact of polytrauma on long-term quality of life is poorly investigated. Potential effects are based on type and severity of the injury, but also on the psychological consequences of the trauma itself as well as long-term consequences. Trauma can decrease quality of life and increase socioeconomic burden. In this study, we examined other long-term psychological developments in multiply injured patients

Methods: More than 20 years after trauma, 637 patients enrolled in our polytrauma database who suffered trauma dating from January 1, 1973 to December 31, 1990 received a questionnaire that included self-assessment of posttraumatic psychological developments. This questionnaire included questions modified from or based on: Short Form-12 Health Survey (SF-12), diagnostic criteria of posttraumatic stress disorder (PTSD) from the Diagnostic and Statistical Manual of Mental Disorders (DSM IV) of the American Psychiatric Association (APA), HADS (Hospital Anxiety and Depression Scale), and the Clinical Anxiety Scale (CAS) as found in the Present State Examination, and an internally devised question set to evaluate potential positive psychological developments. Inclusion criteria were patients who were enrolled in the database and returned the questionnaire. Exclusion criteria were patients with severe head injuries or patients who could not fill out the questionnaire even with assistance.

Results: This study evaluated 337 completed questionnaires from 637 patients more than 20 years after trauma. Of these patients, 34.9% experienced or witnessed additional trauma, potentially amplifying psychological effects of the initial injury. 10 patients (3.0%) suffer from symptoms of PTSD. Further, 4.1% of patients reported symptoms of anxiety and nearly half (48.2%) show symptoms of depression. However, we also identified effects that were considered as positive by this population. The most common positive development was a sense of improved trust in others (42.0%) during times of need. Nearly one-third of patients (31.4%) accepted or learned to cope with personal shortcomings. More than half of patients (52.7%) developed a new appreciation for health and vitality. Nearly 1 in 5 patients (17.8%) developed faith or strengthened their religious beliefs.

Conclusion: Multiply injured patients risk developing multiple psychological effects including PTSD, anxiety, or depression. However, patients can also experience different psychological developments. As clinicians we must keep these effects in mind, offering psychiatric consultation where needed, while fostering and supporting potential positive developments.

Resource Utilization and Outcomes Among Fracture Patients With Substance Abuse and Psychiatric Comorbidities

***I. Leah Gitajn**, MD;* *David Jevsevar, MD, MBA; Michael Sparks, MD*

Purpose: The consequences of psychiatric illness and substance abuse transcend mental health care alone, resulting in worse outcomes in a range of fields. Despite this, there remains limited information among musculoskeletal trauma patients regarding implications on cost of care. The aim of the present study was to (1) describe the prevalence of substance abuse and psychiatric illness among fracture patients, (2) document differences in inpatient resource utilization among patients with substance abuse and/or psychiatric disorders, and (3) investigate association between unplanned readmission and substance abuse and/or psychiatric disorder.

Methods: 1734 patients <70 years of age with surgically treated extremity fractures from 2011-2017 were identified at a rural Level I trauma center. Records were reviewed for diagnoses of psychiatric and/or substance abuse disorders. Resource utilization during that admission was documented, including ICU stay, hospital length of stay (LOS), number of consulting services, and discharge disposition. Unplanned readmissions within the following year were identified from the medical record.

Results: In this cohort 21% of patients have substance abuse disorder and 39% of patients have psychiatric illness. Patients with substance abuse or psychiatric disorders required significantly more resources during admission including higher rate of ICU admission ($P < 0.001$), longer LOS (mean difference 4 days, $P < 0.001$), and more consulting services ($P < 0.001$). Readmission rate was significantly higher for patients with substance abuse disorder (40% vs 24%, $P < 0.001$) and psychiatric illness (43% vs 17%, $P < 0.001$). After controlling for age, gender, fracture location, number of procedures, number of fractures, and Charlson Comorbidity Index, independent predictors for readmission include substance abuse, anxiety disorder, depression, sleep disorder, and adjustment disorder. Treatment with methadone or suboxone was not associated with readmission.

Conclusion: The present data suggest that patients with substance abuse and/or psychiatric diagnoses have a higher rate of unplanned readmission and are high utilizers of hospital resources. However, participation in treatment with methadone or suboxone appears to mitigate the elevated risk for readmission, suggesting that treatment may be effective in reducing resource utilization. Interventions to better manage these issues are worthy of investigation in an effort to both improve outcome and also mitigate the elevated cost of care associated with this subset of patients.

Factors Influencing Discharge to Rehabilitation Facility Versus Home Following High-Energy Lower Extremity Trauma

***I. Leah Gitajn**, **MD;** Robert O'Toole, MD; The METRC; Renan Castillo, PhD; David Jevsevar, MD, MBA; Lisa Reider, PhD; University of Maryland at Baltimore School Medicine; Andrew Pollak, MD*

Purpose: The purpose of this study was to (1) evaluate the association between patient demographic, preinjury health, and injury characteristics with discharge to rehabilitation after high-energy lower extremity trauma; (2) assess whether discharge disposition is impacted by a financial relationship between treating center and rehabilitation facility; and (3) evaluate if there is heterogeneity in discharge disposition across clinical centers after controlling for patient, injury, and center-level characteristics.

Methods: The study included patients ages 18-80 years enrolled in 1 of 5 prospective multicenter studies between 2011 and 2017. Patients were treated for fractures of the femur, tibia, ankle, or foot. We evaluated characteristics hypothesized to affect discharge decision including demographics (gender, age, race, marital status), socioeconomic factors (education, occupation, health insurance), preinjury health (general/mental health, tobacco, alcohol, body mass index [BMI]), injury severity (Gustilo type, ICU admission), and financial relationship between treating center and rehabilitation facility. Analysis was conducted using a logistic regression model with hypothesized characteristics as covariates and clinical center treated as a random effect. Using this model and distribution of covariates, center-specific standardized estimates of the probability of discharge to rehabilitation were computed.

Results: Among 2628 patients treated at 1 of 55 centers across 13 states, 757 (28.8%) were discharged to rehabilitation and 1871 (71.2%) were discharged home. Older, female, unmarried, higher BMI, insured, alcohol abuse patients and those with an open injury and an ICU stay were more likely to be discharged to a rehabilitation facility. Patients treated at a center with a financial relationship had 1.5 (95% confidence interal [CI]: 0.9 to 2.4) higher adjusted odds of discharge to rehabilitation compared to those treated at a center without one. Even after accounting for patient-level factors and financial relationships, there was evidence of variation in discharge disposition across centers (likelihood ratio test: P <0.001).

Conclusion: Variation in discharge disposition may represent a potential for improvement in resource utilization and cost savings at some institutions. Further analysis is needed to ascertain whether patients do better if discharged to rehabilitation versus home. If there is value in these resources, it may support the additional cost.

POSTER ABSTRACTS

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Abdominopelvic Bleed Rate on Admission CT Correlates With Mortality and Transfusion Requirements in Trauma Patients With Pelvic Fractures

William Borror, MD; *Greg Gaski, MD; Scott Steenburg, MD*

Purpose: Early identification of trauma patients with pelvic fractures requiring transfusion and urgent intervention such as embolization and surgical stabilization is difficult. CT can be used to detect active bleeding in trauma patients. Semi-automated volume-measuring software allows the rate of active bleeding to be calculated when 2 imaging phases are acquired in the initial CT evaluation. We hypothesized that the total volumetric bleeding rate would be higher in pelvic fracture nonsurvivors versus survivors and that bleeding rate would correlate with transfusion requirements.

Methods: This was a retrospective cohort study at an academic Level I trauma center. The Trauma Registry was searched for patients with pelvic fractures and active bleeding detected on CT from 2013-2017. Patients who underwent dual-phase CT through the pelvis were included. Software that uses semi-automated technology (Philips Intellispace Portal) to generate 3-dimensional CT volumetric measurements was used to measure the size of active bleeding on both arterial and parenchymal phases. The active bleeding rate was calculated by dividing the change in active bleeding volume by the time between the 2 phases. Measurements were performed by a radiologist fellowship-trained in trauma/emergency radiology. Survivors (S) were compared to nonsurvivors (NS) with respect to volumetric bleed rate and blood transfusion.

Results: 23 S and 6 NS met inclusion criteria. There were no demographic differences between S and NS. The mean time between CT arterial and parenchymal phases was 49 seconds (range, 28-107 sec). Mean volumetric bleed rate in NS was much greater than S (40.7 cc/min vs 5.7 cc/min; P <0.01). 96% of S had a bleed rate <20 cc/min compared to 33% of NS. A bleed rate >20 cc/min was associated with a mortality rate of 80%; a rate of <20 cc/min was associated with a 92% survival rate. Mean hematoma volume was greater in NS compared to S (1854 cc vs 746 cc; P <0.01). Linear regression demonstrated a positive correlation between bleed rate and units of blood transfused ($r^2 = 0.34$).

Conclusion: This study describes a novel imaging method capable of early identification of pelvic fracture patients at risk of complications. An active bleeding rate >20 cc/min was associated with a high risk of mortality and a strong association was demonstrated between bleed rate and transfusion. The sample size presented is small and larger prospective studies are required for validation.

POSTER ABSTRACTS

Decreasing Lower Extremity Junctional Injury From Explosive Blast
Dana Covey, MD

Purpose: Junctional injuries are among the most lethal sustained in combat in Iraq and Afghanistan. They comprise wounds spanning the root of an extremity and the adjacent torso caused by passage of a missile, energized fragment, or blast. Control of proximal and distal hemorrhage may encompass anatomically distinct regions not amenable to tourniquet placement. This study reports results of a novel means of improved lower extremity junctional protection from life-threatening blast injuries.

Methods: 45 service members who sustained high lower limb amputations, with and without perineal injuries, were identified from an operative amputation registry in Helmand Province, Afghanistan, spanning a 12-month period. Mechanisms of injury included dismounted complex blast, and other explosive trauma. Group I (5 patients) used a 2-tiered (layered) proximal thigh/perineal protective undergarment (PUG), Group II (17 patients) used a 1-tier PUG, Group III (19 patients) wore no PUG, and 9 patients had unknown protection. The chi-square test was used to evaluate for statistical significance.

Results: In Group I, 20% of patients with high amputations who wore the 2-tiered PUG sustained perineal injuries. In Group II patients with the single-tier system, 58% sustained perineal injuries along with high amputations. Of the 19 patients who wore no PUG, 68% sustained perineal injuries with proximal amputations. Overall, these differences were statistically significant ($P < 0.025$).

Conclusion: Recent studies show that 15% to 28% of combat deaths in Iraq and Afghanistan were potentially survivable, and that over 80% of these deaths were due to hemorrhage. Furthermore, 70% of these hemorrhagic deaths had non-tourniquetable or non-compressible wounds. These data show that a tiered system of blast-resistive garments for personal junctional protection may decrease the morbidity and mortality of patients with lower extremity junctional trauma.

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When Do Depressive Symptoms Develop Following Trauma?

Sunny Gupta, MD; Sharareh Sharififar, PhD; Terrie Vasilopoulos, PhD; Heather Vincent, PhD; MaryBeth Horodyski, EdD; ***Jennifer Hagen**, **MD***

Purpose: Depressive, anxious, and chronic pain symptoms can manifest in up to 50% to 90% of musculoskeletal trauma patients. These symptoms are independent risk factors for poor functional outcomes. It is unclear when mental health symptoms actually begin appearing, or if there is a causal relationship to narcotic use. We hypothesize that psychologic symptoms begin immediately after the trauma, independent of narcotic use.

Methods: Musculoskeletal trauma patients (N = 96; 43.7 ± 16.5 years, 60.4% male) were prospectively enrolled in a longitudinal outcomes study at their index hospitalization. Exclusions were a preinjury diagnosis of depression or anxiety or psychotropic medication use. Beck Depression Inventory (BDI-II) and State-Trait Anxiety Inventory scores (STAI) were obtained during their index hospitalization, and at 2 weeks, 6 weeks, 3 months and 6 months. In-hospital narcotic use and outpatient narcotic prescriptions were obtained from the electronic medical record (EMR). Relationships between STAI scores, BDI-II scores, and narcotic quantity were examined in a linear regression model.

Results: Greater than 30% and 50% of patients had initial BDI-II and STAI scores consistent with moderate or severe depression (BDI-II scores ≥20 of 63 points) or with clinical anxiety (STAI ≥40 of 80 points), respectively. No patients with initial scores in the "severely depressed" category (BDI-II scores ≥29 points) remained there at either 3 or 6-month follow-up. Nearly 40% of patients with elevated initial BDI-II scores had elevated scores at 6 weeks. At the 6-month follow-up, over 30% of patients still had BDI-II scores consistent with depression. Those initially "severely depressed" required larger doses (mean morphine IV = 60.4 mg, 95% confidence interval [CI]:38.7-84.0) of narcotics on the day of discharge (P = 0.045) compared to those with mild-to-moderate or no symptoms. Only 10 of 96 patients received new or ongoing narcotics prescriptions from the orthopaedic clinic at 6 weeks; however, there was no correlation between ongoing narcotic requirements and BDI-II scores.

Conclusion: Over half of our patients had scores consistent with clinical depression or anxiety immediately following their injuries. Most patients with initially severe depression scores improved with time, but many patients persisted with altered mental health scores, even after cessation of narcotic use. This suggests that the depressive symptoms develop early, prior to discharge from the hospital, and regardless of narcotic use. While controlled intervention studies are needed, this argues for treatment of psychologic symptoms from the onset of the injury.

Traumatic Knee Dislocation: Series of 6 Case Reports
(IOTA - Mexico best poster submission)
Jose Lopez Gonzalez, MD; *Emilio Lora Fierro, MD; Edgardo Hernandez Sepulveda, MD*

Purpose: Traumatic knee dislocation represents 0.02% of all orthopaedic lesions, which makes it a rare injury for an orthopaedist. In most cases, it results in soft-tissue lesions causing a multidirectional inestability. The mechanism of injury is due to a high-energy trauma.

Methods: This is an observational study presenting the clinical findings in 6 patients with traumatic knee dislocation.

Results: Case report findings in 4 men and 2 women, age ranging from 22 to 65 years, 5 presenting anterior dislocation, and 1 posterolateral dislocation. Four of these injuries were due to mechanisms of high-energy trauma in motor-vehicle accidents; the rest were caused by a mechanisms of low-energy trauma.

Conclusion: In our series of 6 case reports, anterior type dislocations represent 83.3%. Neurological lesion was present in 16.6%, followed by vascular lesion with 33.3%. In these case reports, traumatic knee dislocations were due to motor-vehicle accidents in 66.6%.

Treatment of Proximal Humeral Fractures With Internal Fixation and Antiosteoporotic Drugs in Elderly Patients

Lisong Heng, MD

Purpose: We sought to evaluate the clinical efficacy of antiosteoporotic drugs (salmon calcitonin, alfacalcidol, and calcium tablet) for senile osteoporotic proximal humeral fractures after internal fixation.

Methods: 98 cases were randomly divided into 2 groups, the treatment group (50 cases) and the control group (48 cases). The treatment group was applied antiosteoporotic drugs after operation, while the control group was not.

Results: All patients were followed more than 12 months. The fracture healing time of treatment group was 12.8 ± 0.8 weeks, which was shorter than that of the control group (15.3 ± 0.5 weeks). The excellent and good rate of Neer shoulder score of treatment group was 92.0%, which was higher than the control group's 77.1%. The incidence of surgical complications of treatment group was 10.0%, which was less than the control group's 27.1%. There were significant differences ($P < 0.05$). In the treatment group, antiosteoporotic drugs were used postoperatively. In the proximal humerus of the healthy side , the BMD (bone mineral density) was significantly increased ($P < 0.05$).

Conclusion: Internal fixation combined with antiosteoporotic drugs can promote fracture healing, reduce the incidence of complications, increase BMD, and have satisfactory clinical effect for senile osteoporotic proximal humeral fracture.

Volumetric Changes of Grafted Bone in Induced-Membrane Technique Managing Critical Sized Defects of Long Bones

Jae-Woo Cho**, **MD; *Won-Tae Cho, MD; Jin-Kak Kim, MD; Gi-Ho Moon, MD; Beom-Soo Kim, MD; Do-Hyun Yeo, MD; Wonseok Choi, MD; Anseong Chang, MD; Jong-Keon Oh, MD, PhD*

Purpose: Little is known about the exact volumetric changes of grafted bone in induced-membrane technique. The purpose of the study was to report the volumetric changes of grafted bone in induced-membrane technique for critical sized segmental defects of long bone using serial CT scans.

Methods: We prospectively performed CT scans at the interval of 0 month (3-5 days after removal of hemovac drainage), 6 months, and 12 months in patients who underwent bone grafting as a final stage of induced-membrane technique for the treatment of critical sized segmental bone defect that resulted from posttraumatic osteomyelitis, infected nonunion, and open fracture from January 2013 to December 2016. Volumetric measurements of the amount of grafted bone were performed by 2 independent observers using 3-dimensional (3D) software (Mimics, Materialise NV). Patient demographics, microorganism, fixation construct, duration of membrane, details of bone grafting, and coverage of soft tissue were assessed.

Results: 31 patients (27 male, 4 female) with mean age 46 years were included in the study of whom 20 underwent autogenous cancellous bone grafting and 11 underwent mixed (autogenous bone with DBM [demineralized bone matrix) bone grafting at average 17 weeks after membrane formation. The critical sized segmental defect was located at 22 tibias and 9 femurs with 8.9-cm average defect size (range, 2.5-20.6). The average early volumetric change of grafted bone between 0 months and 6 months was 8.4 % resorption (range, 1.3-22.8). The average final volumetric change of grafted bone between 0 months and 12 months was 7.9% resorption (range, 2.1-37.5). The increment of volume was observed in 11 cases. There was significant difference in early resorption of grafted bone according to property of grafted bone (autogenous bone graft: 6.3%, mixed bone graft: 12.1%, $P < 0.05$). The increment of volume in grafted bone was significantly related with load-sharing fixation construct. ($P < 0.05$)

Conclusion: This study proved the reduced resorption rate of grafted bone in induced-membrane technique for the treatment of critical sized bone defect. Our data also indicated that property of grafted bone and fixation construct could affect the volumetric changes of grafted bone.

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Sacroiliac Implant Length and Loosening: CT Analysis of Radiographically Loose Components Compared to Controls

***Scott Mitchell*, MD;** *Allison Rixey, MD; William Cross, MD*

Purpose: The variation of sacroiliac arthrodesis implants available is vast. Hardware loosening in the setting of posttraumatic reconstruction of the pelvis is a common complication and little is known about its biomechanics. This study aims to understand the relationship of sacral bone density and implant length in order to improve the odds of achieving a stable construct.

Methods: From 2012 to 2016 all revision sacroiliac arthrodesis cases at a tertiary academic center were reviewed. Cases were selected if a radiologist found obvious implant loosening on preoperative radiographs or CT scans. Patient demographics, implant type, and implant length were recorded. A matched cohort of patients with CT scans of the pelvis who had not undergone bony pelvic or spine surgeries was analyzed as a control comparison.

Results: The softest bone was found to be in the 3rd zone (sacral ala), while the hardest bone was found to be in the sacral body (HU = 0 ± 37 vs 175 ± 42, P <0.0001). The records of 13 patients with symptomatic and radiographically loosened sacroiliac hardware were reviewed. Of the 33 loose implants analyzed, the average implant was 45 mm long, with 20.2 mm of fixation into the sacrum. 100% of the implants ended in the 5th zone or lateral, with the average implant falling into the 3rd zone.

Conclusion: Along the sacroiliac screw safe trajectory, the sacrum has distinct areas of bone density. Symptomatic patients with radiographically loosened hardware typically have implants that only have purchase in the soft lateral sacrum. Implants with sacral ala purchase and no sacral body purchase may fail due to poor local bone quality.

Identifying Predictors of Time to Soft-Tissue Reconstruction Following Open Tibia Fractures

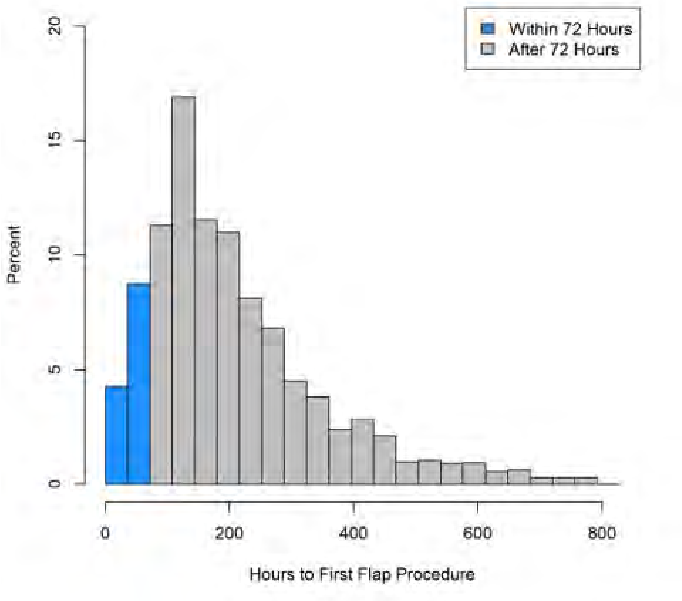
Lily Mundy, MD; Ronnie Shammas, BS; Tracy Truong, MS; Jeremy Weber, BS;
***A. Jordan Grier**, **MD;** Sarah Peskoe, PhD; Scott Hollenbeck, MD; Mark Gage, MD*

Purpose: Controversy remains regarding the optimal timing of soft-tissue coverage following severe lower extremity trauma. The purpose of this study was to identify nationwide practice patterns and factors associated with discrepancies in time to first flap surgery following open tibia fractures.

Methods: A retrospective analysis was performed on the National Trauma Data Bank from 2008-2015 to identify patients who presented with an open tibia fracture and underwent subsequent flap reconstruction. A lasso algorithm was performed, revealing those factors most significantly associated with differences in time to flap surgery.

Results: A total of 3297 patients were included in the analysis. Mean and median times to first flap surgery were 230.1 hours (standard deviation [SD] 246.7 hours) and 169.1 hours, respectively. Older age, non-white race, treatment in the South, and non-private insurance status were all independently associated with an increased time to flap surgery. In addition, more surgical debridements, higher injury severity or abbreviated injury score, and a nerve, vascular, or crush injury were independent predictors of increased time to flap surgery.

Conclusion: The majority of open tibia fractures requiring soft-tissue coverage undergo flap reconstruction after the historical 72-hour window. Specific sociodemographic and clinical factors were independently predictive of an increased time to flap surgery. These findings suggest that not all patients in the United States receive the same level of care in lower extremity trauma reconstruction, emphasizing the need to develop more explicit national standards.



POSTER ABSTRACTS

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Transfer of Vascularized Ulnar Nerve for the Reconstruction of Stepping Function of Paraplegia Patients by Using a Novel Nerve Anastomosis Technique

(IOTA - CAOS best poster submission)

Yan Wang, MD, PhD; *Shaocheng Zhang, MD*

Purpose: This study was undertaken to evaluate the feasibility and effectiveness of the vascularized ulnar nerve transfer for the reconstruction of stepping function of paraplegia patients with spinal cord injury (T2-T7).

Methods: 7 patients, aged 31 years on average, with spinal cord injury at T2-T7, were included in the study. The patients had received surgical decompression and their spinal injuries were still rated A on the Frankel scale after at least more than 1 year of rehabilitative treatment. The motor function of the hand was replaced by transferring pronator quadratus muscle branch of the anterior interosseous nerve after the ulnar nerve on the non-dominant side was amputated at the wrist incision. The ulnar nerve was transferred to inguinal region and anastomosed with part of the femoral nerve and obturator nerve. Functional rehabilitation training lasted for at least 1 year. The restoration of the muscle strength and stepping function were assessed.

Results: The functions of the transferred nerve recovered to varying degrees in all the seven patients. Six of them could stand, step forward, and walk with the help of brace and 2 crutches. The score of Spinal Cord Independence Measure (SCIM) was raised from preoperative 27-33 (mean: 29) to postoperative 45-62 (mean: 55). In all 7 subjects, the strength of intrinsic hand muscles was restored to grade 4 in 5 cases and grade 3 in 2 patients.

Conclusion: Although the technique to treat paraplegia is not all-inclusive, it could effectively restore the stepping-forward function and substantially improved the quality of life of paraplegia patients.

Primary Intramedullary Nailing of Open Tibia Fractures Due to Low-Velocity Gunshots: Does Operative Debridement Increase Infection? Rates?

Chester Donnally, III, MD; Charles Lawrie, MD; ***Jonathan Sheu*****,** ***BS;*** *Meredith Gunder, MD; Stephen Quinnan, MD*

Purpose: While gunshot-induced extremity fractures are typically not considered "open fractures," there is controversy regarding wound management in the setting of operative fixation to limit infection complications. Previous studies have evaluated the need for a formal irrigation and debridement (I&D) prior to intramedullary nailing (IMN) of gunshot-induced femur fractures but none have specifically evaluated tibias. By comparing primary IMN for tibial shaft fractures caused by low-velocity firearms additionally treated with a formal operative I&D compared to those without an I&D, we sought to identify if there are: (1) differences in treatment group infection rates, (2) particular fracture patterns more prone to infection, and (3) patient characteristics more prone to infections.

Methods: This was a retrospective cohort study at a single Level I trauma center of gunshot-induced tibial shaft fractures managed primarily with IMN. The following were studied: demographics, follow-up, fracture characteristics, injury management, and patient outcome. Fractures were categorized based on the OTA classification system for diaphyseal tibia/fibula fractures. All patients had IV antibiotics at presentation, and received 3 days of postoperative IV antibiotics per institutional protocol.

Results: In Group I, 6/23 patients (26.1%) developed superficial infections and 4/23 patients (17.4%) developed deep infections. In Group II, 0/16 patients (0%) developed superficial infections and 1 patient (6.25%) a deep infection, making the total infection rate 28.2% (11/39). Superficial infections were associated with intervention type while deep infections were not. Tobacco users and type 42-A fractures had significantly higher infection rates when treated with a formal I&D.

Conclusion: A formal debridement, followed by primary IMN in tibia fractures caused by low-velocity firearms, is associated with an increased risk of superficial infection that is well managed with antibiotics, but the incorporation of a debridement does not affect the rate of deep infection. A formal I&D during IMN fixation should be avoided in patients who are smokers and have type 42-A tibia fractures as these are factors associated with increased infection rates.

Tibial Fracture Healing Score: A Novel Tool to Predict Tibial Nonunion

***Yohan Jang**, DO;* *Greg Gaski, MD; Roman Natoli, MD; Walter Virkus, MD; Todd McKinley, MD*

Purpose: Predictive models recently developed to improve early diagnosis of nonunion in tibial fractures have relied on injury and/or patient characteristics, radiographic healing, and the presence of complications. The purpose of this study was to investigate the utility of a simple office-based tool in predicting the need for secondary intervention to obtain union in patients sustaining tibial fractures.

Methods: This is a prospective study of patients >18 years with isolated tibial shaft fractures (AO/OTA 41A, 42A-C, and 43A) treated with intramedullary nailing at a Level I trauma center from 2013 to 2017. Surgeon assessment of the following 3 clinical parameters was performed at routine office visits and scored as follows: (a) pain (none/mild/decreased = 1, no change/increased = 0), (b) function (minimal limp/able to perform a single leg stance = 1, significant limp/unable to perform single leg stance = 0), and (c) examination (no/minimal pain with manipulation = 1, pain with manipulation = 0). Radiographic healing was assessed by the adjusted radiographic union scale in tibial fractures (aRUST). The aRUST equals RUST divided by 4 to equally weight the clinical and radiographic components of the index. Tibial fracture healing score (TFHS) is the sum of 3 clinical scores (0-3) and aRUST (1-3) at 3 months postoperatively. Receiver operating characteristic curves were constructed to evaluate the accuracy of the TFHS and clinical scores without aRUST in predicting nonunion. Diagnosis of nonunion was defined by persistent pain and lack of radiographic healing >6 months post-injury. Demographics and injury characteristics were collected and compared using the Mann-Whitney U and Fisher exact tests between the union and nonunion group.

Results: 380 patients were screened, and 87 patients were included. Nonunion rate was 11%. Average time to second intervention was 8 months. There were no differences in demographics or injury characteristics except the nonunion group had more open fractures (P = 0.01). Clinical scores <2 yielded 91% sensitivity (95% confidence interval [CI] 0.84, 0.96), 90% specificity (95% CI 0.70, 1.00), 56% positive predictive value (PPV), and 99% negative predictive value (NPV), whereas TFHS <3 yielded 96% sensitivity (95% CI 0.92, 1.00), 90% specificity (95% CI 0.70, 1.00), 75% PPV, and 99% NPV in predicting need for secondary surgery to obtain union.

Conclusion: These results suggest that a simple office-based clinical tool may identify patients at high risk of nonunion. Patients with a TFHS <3 at the 3-month postoperative visit should be followed closely and may mitigate delay in surgical intervention. Further validation of this novel scoring system is warranted.

POSTER ABSTRACTS

Does Thoracic Trauma With Its Systemic Inflammatory Response Affect Tibia Fracture Healing?

Joanie Columbia**, **MD; *Heidi Israel, PhD; Lisa Cannada, MD*

Purpose: There is a known association between activation of the systemic inflammatory response system (SIRS) in the polytrauma patient. Studies in rat models have shown fracture healing is significantly impaired with concomitant thoracic trauma. The purpose of this study was to evaluate a cohort with blunt thoracic trauma and tibia fractures (TT) treated with an intramedullary nail (IMN) compared to patients without blunt thoracic trauma (C). We hypothesized there would be a delay in the healing of fractures when simultaneously incurring blunt thoracic trauma.

Methods: This study was a retrospective matched cohort of patients >18 years. Inclusion criteria were thoracic trauma and tibia fractures treated with an IMN. Blunt thoracic trauma was defined as patients with an Abbreviated Injury Scale for the chest of ≥2. Patients with open fractures, penetrating trauma, compartment syndrome, or inadequate follow-up were excluded. Demographic data, fracture details, operative treatment, and radiographic studies of the chest were reviewed. The primary outcome was time to healing. A fracture was considered healed as measured by Radiographic Union Score for Tibial fractures (RUST score) of ≥9 combined with the absence of pain at the fracture site. Chi-squared test was performed to detect significant differences between observed frequencies. An independent t-test was used to detect differences between independent variables and time to healing. Statistical significance was determined by a P value <0.05.

Results: There were 22 patients in the TT group with 44 age and sex-matched controls (C). The fractures were classified as OTA 42A (49), 42B (15) and 42C (2). The average follow up was 300 and 209 days for TT and C groups (NS). The time to fracture healing was 192 and 122 days for the TT and C groups (P <0.0001). Two patients among both groups experienced delayed union (3%) and 2 experienced nonunion (3%) (NS). Within the TT group, there was no difference in time to fracture healing for patients who required a ventilator versus those who did not.

Conclusion: There is a significantly longer time to tibial fracture healing in patients with thoracic trauma compared to controls. The reason is multifactorial, but lends support to the hypothesis that activation of the SIRS plays a role in time to fracture healing. To our knowledge, this is the first retrospective study to evaluate time to healing in tibial shaft fractures for patients with blunt thoracic trauma.

Does Suprapatellar Tibial Nailing Reduce Radiation Exposure and Operative Time?

Jerad Allen, MD; *David Hamilton, MD; Arun Aneja, MD, PhD; Raymond Wright, MD; Eric Moghadamian, MD; Paul Matuszewski, MD*

Purpose: Suprapatellar nailing (SPN) has gained significant popularity in the treatment of tibial shaft fractures. SPN has been shown to have decreased rates of knee pain and malunion. Proponents of SPN cite similar operative time and less radiation exposure due to the ease of positioning and imaging. However, little evidence exists to confirm this. The purpose of this study was to determine if SPN as compared to infrapatellar nailing (IPN) is associated with decreased operative time and radiation exposure. We hypothesized the SPN technique would have decreased operative time and less radiation exposure as compared to the IPN technique.

Methods: We retrospectively reviewed all adult tibial shaft fractures (OTA 41A, 42A-C, 43-A) treated with intramedullary nailing between 2012 and 2017 from a Level I teaching hospital. During this time our center transitioned from primarily IPN to SPN. Patients with >1 injury addressed during the operative procedure were excluded. Operative time and fluoroscopy time/radiation dose were set as primary endpoints. Patient demographics, presence of open fracture, and estimated blood loss (EBL) were included. Patients were grouped by SPN or IPN based on operative report. Fisher's exact test was utilized to assess categorical variables and a paired t-test was utilized to assess the primary outcome between the 2 groups. Linear regression was utilized to assess continuous variables.

Results: 235 fractures in 235 patients were included with 164 males and 71 females. Average age was 40.1 years (range, 24-57) and body mass index (BMI) 27.2 (range, 20-34.5). 60 patients were treated with SPN and 175 with IPN. There was no difference in age, BMI, EBL, or open fractures (P >0.05). By fracture classification, there was no difference in operative time, fluoroscopy time, or radiation dose (P >0.05). There was no difference in average operative time (SPN: 126 min [95% confidence interval (CI) 108.5-142.8] vs IPN: 130 min [95% CI 123.8-136.3], P = 0.64). Average fluoroscopy time and radiation dose were not significantly different (SPN: 166 se. [95% CI 131.5-200.9] vs IPN: 160 sec [95% CI 148.4-171.1], P = 0.73, SPN: 8.3 mGy [95% CI 6.1-10.4] vs IPN: 8.6 mGy [95% CI 7.6-9.4], P = 0.76).

Conclusion: This study demonstrates similar operative time, EBL, and radiation exposure in patients treated with intramedullary nail fixation of tibial shaft fractures via SPN and IPN techniques. While the outcomes of this study do not favor 1 technique over the other, our findings suggest that operative time and radiation exposure should not be a deciding factor in the choice of either technique for tibial fracture nailing.

POSTER ABSTRACTS

Semi-Extended Tibial Intramedullary Nailing in Open Fractures: A UK Major Trauma Center Experience

Nebu Jacob*, *MBBS; *Charlotte Richardson, MBBS; Michael Pearse, FRCS*

Purpose: Our purpose was to identify the incidence of knee sepsis in cases that underwent suprapatellar Intramedullary (IM) nailing of open fractures at a Level I trauma center in the UK. We wanted to highlight that a high incidence of intra-articular sepsis as a result of suprapatellar nailing of open tibial fractures has not materialized. Previous studies of knee sepsis following IM nailing have been performed by Halvorson et al. in 2012 and O'Toole et al. in 2010 in retrograde femoral nailing of open femoral fractures, which revealed 1 septic knee in a combined total of 128 cases. Mitchell et al. in 2017 showed they had no incidence of knee sepsis in 139 open tibial fractures managed with suprapatellar nailing.

Methods: This was a retrospective study reviewing notes to identify patients that underwent suprapatellar IM nailing of open tibial fractures with soft-tissue coverage at a single sitting over a 2-year period. This may have been done after application of monolateral external fixation device as a temporary stabilization technique for monitoring of soft tissues. Patients suitable for fixation with IM nailing were selected as a joint decision of the ortho-plastics teams. Patients were followed for a minimum of 1 month postoperatively. The study was performed at a Level I trauma center in the UK. Knee joint infection was defined as an infection requiring operative washout--open or arthroscopic of the knee.

Results: A total of 62 cases were identified that had suprapatellar IM nailing for open tibial fractures during the 2-year period included in the study who met the inclusion criteria. According to Gustilo Anderson classification, 23 (37%) were Grade I, 18 (29%) were Grade II, 6 (9.6%) were Grade 3a, and 15 (24%) were Grade 3b open fractures. The majority had debridement and direct closure of the wound (82%), with 6 requiring fasciocutaneous flaps, 2 requiring split skin grafting, 1 anterolateral thigh free flap, 1 rotational flap, and 1 gastrocnemius flap performed. There were no cases of knee sepsis in this study during the 30-day follow-up period.

Conclusion: Even though suprapatellar nailing is associated with a theoretically increased risk of knee sepsis, especially when treating open fractures, our study reveals a low risk of this, as long as a thorough debridement of the open wound was performed along with antibiotic management early on at presentation or at time of definitive closure and fixation. We found this to be a safe technique that aided reduction of very proximal and distal tibial fractures that had the benefit of the incision being in the quadriceps, remote to the site of usual skin compromise, thus aiding reconstruction.

Age-Related Variances in Patients With Tibial Plateau Fractures

***Lasun Oladeji*, MD, MS;** *John Worley, MD; Brett Crist, MD*

Purpose: Tibial plateau fractures account for approximately 8% of fractures in the elderly population. Treatment strategies in the elderly are similar to those for younger patients; however, practitioners must account for the elevated comorbidity burden in this population. To date, few studies have analyzed age-based outcomes in patients with tibial plateau fractures. Therefore, the purpose of this study was to determine age-related variances in demographics, fracture characteristics, mechanism of injury, and complications.

Methods: A 10-year retrospective review was conducted to identify patients who received treatment for a tibial plateau fracture. There were 351 patients (360 tibial plateau fractures) who were identified and subsequently stratified according to their age at time of injury. Patients were classified as elderly if they were 65 years of age or older at time of injury; all other patients were included in the control cohort. These 2 cohorts were analyzed using bivariate analysis to isolate for age-related variations with respect to risk factors, mechanism of injury, and complications.

Results: There were 351 patients (360 tibial plateau fractures) with a median follow-up of 1.84 ± 2.44 years who met inclusion criteria. Elderly women frequently presented with tibial plateau fractures (60.0% vs 43.4%, P = 0.06). Elderly patients were significantly more likely to present with diabetes (33.3% vs 16.1%, P = 0.01) or osteoporosis (14.3% vs 1.6%, P = 0.001). Younger patients were significantly more likely to require further surgery to address ligament (12.6 vs 0%, P = 0.008), meniscus (20.9 vs 7.1%), or cartilage pathology (13.6% vs 0%, P = 0.005). There was no difference in the arthroplasty conversion rate (4.8% elderly vs 7.9% control, P = 0.755).

Conclusion: Treatment of tibial plateau fractures in the elderly remains controversial. In this study, elderly patients presented with a greater comorbidity burden than their younger peers. However, despite the increased likelihood of comorbidities seen in this population, the findings of this study indicate that elderly patients respond just as well, if not better, than their younger counterparts following surgical management of tibial plateau fractures. Despite the recent interest in primary total knee arthroplasty for elderly patients with tibial plateau fractures, the results of this study suggest that these patients may respond well to open reduction and internal fixation.

Provisional Reduction Plates for Intramedullary Nailing of Open Tibia Fractures: We Don't Have to Take Them Out

Thomas Revak, DO; *Daemeon Nicolaou, MD; Tracy Watson, MD*

Purpose: A myriad of reduction techniques for tibia shaft fractures are available. Provisional plating is currently advocated as an adjuvant reduction tool for these fractures. Concerns of additional stripping, infection, and delayed healing have been postulated. Recent studies investigating reduction plating present cohorts where all plates are removed or left to the discretion of the surgeon. This study aims to identify a cohort of open tibia shaft fractures treated with intramedullary (IM) nail aided by permanent reduction plating. Our hypothesis is that definitive reduction plating in conjunction with IM nailing of open tibia fractures does not increase risk of nonunion or infection.

Methods: An IRB-approved retrospective study was performed using the trauma registry data from January 2015 to June 2017 at a Level I trauma center. All procedures were performed by fellowship-trained orthopaedic trauma surgeons according to protocol. Open tibia fractures were treated with nailing alone (IM) or nailing and permanent reduction plates (PP). Inclusion criteria required patients over 18 years of age treated for open AO/OTA 42 A-C shaft fractures, with 6-month follow-up or until healed. Exclusion criteria include pathologic fracture, >90 years of age, lack of follow-up, and proximal/distal joint involvement. Age, sex, laterality, mechanism of injury, open fracture grade, AO/OTA classification, and length of follow-up were recorded. Time to union (healing of 3 out of 4 cortices) and patients with documented or suspected infections were noted. Criteria for infection included patients treated with oral or IV antibiotics during follow-up or any additional procedures for infection.

Results: 267 patients underwent tibia IM nailing and 96 were identified as open fractures. 49 patients met inclusion criteria with 27 in the PP group and 22 in IM group. Statistical analysis revealed no difference between the 2 groups with regard to age, sex, open fracture grade, and AO/OTA classification with average follow-up of 8.58 and 11.63 months for PP and IM nailing, respectively. All fractures went on to union with 1 patient in each group requiring antibiotic/exchange nailing prior to union. Time to union was 5.67 months for PP group and 5.06 months for IM group ($P = 0.54$) with 2 infections in the PP group and 4 infections in IM group ($P > 0.05$).

Conclusion: Despite the small sample size, this study suggests that permanent provisional reduction plating, in the setting of open tibia fractures, does not delay fracture healing and has no increased risk of infection.

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The Red-Yellow-Green Report Card: Does Providing Direct Surgeon Feedback Influence Behavior and Decrease Implant Costs?

John Morellato*, *MBBS; *Mitchell Baker, BS; Marckenley Isaac, MS; Nathan O'Hara, MPH; Patrick Mixa, MD; Kanu Okike, MD, MPH; Christopher LeBrun, MD; Jason Nascone, MD; Ted Manson, MD; Gerard Slobogean, MD, MPH; Robert O'Toole, MD; Marcus Sciadini, MD; Andrew Pollak, MD*

Purpose: As hospitals look for ways to control expenses, orthopaedic surgeons have come under scrutiny due to relatively high implant costs. These costs have risen in the absence of evidence of improved outcomes. Our aim was to determine whether feedback of implant utilization costs to orthopaedic trauma surgeons resulted in a change in implant usage patterns.

Methods: A previously implemented "red-yellow-green" (RYG) implant selection tool at our institution classified 5 trauma implant constructs based on cost and categorized each construct as "Green" (preferred option, least expensive), "Yellow" (midrange), or "Red" (most expensive). The constructs included were: femoral intramedullary nail (IMN), tibial IMN, distal femoral and proximal tibial locking plate, and lower limb external fixator. The RYG cost chart showing all 5 constructs for the 4 available vendors was posted in each operating room. Baseline construct usage from the previous year was provided to 6 participating orthopaedic trauma surgeons. Individual surgeon usage was then tracked and a monthly feedback report was given. This report included their implant-specific and overall "Green" utilization percentage. The surgeons also received their overall ranking among the 6 participating surgeons. To determine the effect of the intervention on hospital expenditures, we calculated the amount spent by the hospital on the constructs in question per procedure in the 2 time periods.

Results: Over the 3-month study period, there were a total of 143 study cases. The overall "Green" utilization increased to 75% from the baseline of 53% ($P < 0.0001$). The average cost per implant for femoral nails, tibial nails, and external fixators was reduced by 4% each over the study period ($P < 0.0001$). In contrast, there was no change in the average cost per implant for femoral or tibial plates. Overall, there was a mean cost reduction of 3%; however, this was not significant ($P = 0.34$).

Conclusion: Through a simple intervention ,we were able to influence physician implant choice for nails and external fixators, which increased the utilization of preferred ("Green") implants. Surgeons appeared to be willing to change external fixators or nails more readily than plates based on cost consideration.

POSTER ABSTRACTS

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

Venous Thromboembolism Prophylaxis in Lower Extremity Orthopaedic Trauma: A Network Meta-Analysis

James Yan, MD; Aneesh Karir, BSc; ***Herman Johal****, MD, MPH*

Purpose: Venous thromboembolism (VTE) is a common and life-threatening complication among orthopaedic trauma patients. In lower extremity injuries, prolonged immobilization places patients at risk of deep venous thrombi (DVTs) and pulmonary embolisms (PEs). We performed a network meta-analysis using evidence from randomized controlled trials (RCTs) on the benefits and harms of VTE prophylaxis methods following trauma. Specifically, pharmacologic and non-pharmacologic interventions were assessed, including unfractionated heparin (UFH), low molecular-weight heparin (LMWH), factor Xa inhibitors, acetylsalicylic acid (ASA), direct-acting oral anticoagulants (DOACs), and mechanical compression devices.

Methods: The databases MEDLINE, MEDLINE In-Process & Other Non-Indexed Citations, Embase, and the Cochrane Library were searched. RCTs comparing VTE prophylaxis strategies following lower extremity fractures were included if they included adults (>18 years of age) with any lower extremity fracture, defined as a fracture of the pelvis, acetabulum, hip, femur, knee, tibia, ankle, or foot. Outcomes linked to benefits (reduction in VTE or mortality) and harms (wound or bleeding-related complications) were extracted. Subgroups included duration of prophylaxis (standard, <2 weeks vs extended, >2 weeks) and fracture location (proximal to knee vs distal).

Results: 28 RCTs were included. For prevention of PEs, symptomatic DVTs, major bleeding events, and mortality in distal injuries, no one strategy was significantly superior to another, including no treatment. For prevention of PEs, reoperation, and mortality in proximal injuries, no one strategy was significantly superior to another, including no treatment. For prevention of symptomatic DVTs in proximal injuries, extended factor Xa inhibitors were superior to standard LMWH (odds ratio [OR] 17.32, 95% confidence interval [CI] 1.13-772.47) and standard UFH (OR 29.51, 95% CI 1.31-1711.96), but not no treatment (OR 11.09, 95% CI 0.45-672.41). For prevention of major bleeding events in proximal injuries, standard UFH was superior to extended factor Xa inhibitors (OR 44.07, 95% CI 1.55-3395.58), but not no treatment (OR 8.65, 95% CI 0.18-679.59).

Conclusion: Focusing on clinically important outcomes, and placing emphasis on mortality benefit, prevention of symptomatic DVTs, and major bleeding, no treatment appears to be equally effective as treatment with any of the thromboprophylaxis strategies for distal lower extremity fractures; standard LMWH, DOACs, ASA, and extended-duration factor Xa inhibitors are all reasonable options for thromboprophylaxis of proximal lower extremity fractures.

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Bacterial DNA Screening to Determine Infection Risk in Patients With Closed Fractures Undergoing ORIF

Brian Campfield, MD; Andrew Garrone, BS; James Cook, PhD, DVM; ***Brett Crist**, **MD***

Purpose: This study was undertaken to prospectively screen patients for type and amount of bacteria present during the key stages of closed fracture open reduction and internal fixation (ORIF) in order to characterize potential predisposing factors for infection.

Methods: After IRB approval, patients scheduled for ORIF of closed fractures of the distal radius or ankle were enrolled. All components of perioperative management and surgical treatment followed standard of care. Sterile swabs were used to obtain samples for quantitative microbial cultures and bacterial DNA polymerase chain reaction (PCR) testing immediately upon surgical exposure of the fracture and immediately following final fixation prior to closure. Clinical and radiographic healing and all complications were documented. If operative debridement for infection occurred, samples were obtained for standard aerobic and anaerobic quantitative microbial cultures. Microbial culture results were recorded based on bacterial species producing growth at each sampling point. PCR was used to identify (species) and quantify (#rRNA sequences) bacterial DNA retrieved at each sampling point.

Results: 20 patients with closed fractures (n = 10 distal radius, n = 10 ankle) met inclusion criteria and completed the study protocol. Microbial culture from intraoperative swabs produced growth of coagulase-negative Staphylococcus in 2 cases (1 ankle, 1 radius), both of which healed without complications. All intraoperative samples for all patients contained quantifiable amounts of bacterial DNA of multiple species with PCR. Staphylococcus, Proprionibacteriacea, Streptococcus, and Corynebacterium species were most common. One ankle fracture experienced wound dehiscence prior to fracture healing and operative debridement cultures grew Enterobacter cloacae. This patient had no microbial growth from ORIF intraoperative swabs and did not have a predominant species of bacterial DNA present.

Conclusion: Quantifiable amounts of bacterial DNA of multiple species are present in closed radial and ankle fractures undergoing ORIF with Staphylococcus, Proprionibacteriacea, Streptococcus, and Corynebacterium species predominating. However, neither intraoperative screening of patients for bacterial DNA nor microbial culture from the fracture site was effective for determining risk of infection or other fracture-associated complications in this study. These data suggest that factors other than bacterial load present at the time of ORIF are responsible for complications associated with surgical treatment of closed fractures.

Δ Cerebral Fat Emboli in Standard Reaming Versus RIA Reaming in Femur Fractures

***Basem Attum**, **MD, MS;** Andres Rodriguez-Buitrago, MD; Vamshi Gajari, MBBS; Adam Lee, MD; William Obremskey, MD, MPH*

Purpose: We hypothesized that the number of cerebral fat emboli (CFE) will be greater with standard reaming compared to the reamer-irrigator-aspirator (RIA) system.

Methods: Patients with femur shaft fracture treated with an intramedullary nail were identified and randomized to standard reaming or RIA. Transcranial Doppler ultrasound was used to quantify the number of fat emboli before, during, and after reaming. Patient demographics were recorded and statistical analysis was performed.

Results: 26 patients met our inclusion criteria. 12 (46.2%) and 14 (53.8%) were randomized to standard reaming and RIA groups, respectively. 2 of 12 patients in the standard reaming group and 4 of 14 patients in the RIA group had presence of CFE during reaming, respectively. 1 patient (3.8%) in the RIA group had the presence of clinical CFE syndrome. The mean number of fat emboli during reaming in the standard reaming group and RIA group was 1.7 (standard deviation [SD] 4.4) and 23.0 (SD 83.8) ($P = 0.39$), respectively.

Conclusion: No difference in frequency of fat emboli was seen between standard reaming and RIA. The use of the RIA did not significantly reduce the number of CFE during reaming. A sample size of approximately 8000 patients would be needed to confirm our results.

Δ OTA Grant

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Predicting Functional Outcomes Following Nonunion Repair: Development of a Scoring Tool

***Sanjit Konda**, MD;* *Kurtis Carlock, BS; Kyle Hildebrandt, BS; Kenneth Egol, MD*

Purpose: The ability to predict which patients are at risk of poor functional outcome following fracture nonunion repair may help identify those who could benefit from aggressive intervention. This study sought to develop a score that can be used preoperatively to identify patients at risk of poor functional outcome following fracture nonunion surgery.

Methods: 410 operatively repaired fracture nonunions were prospectively followed. Data collected included demographics, injury information, and surgical management. Functional outcomes were assessed using the Short Musculoskeletal Function Assessment (SMFA) prior to nonunion surgery and at routine intervals postoperatively. Poor outcome was defined as an SMFA function index greater than 10 points above the mean at 12 months postoperatively. From 16 variables, stepwise logistic regression was used to generate a predictive model to identify patients at risk of having a poor outcome (Functional Outcome of Nonunion at One Year [FONY] score).

Results: Of the 410 patients followed, 303 (73.9%) had complete data with minimum 12-month follow-up. Significant predictors of poor outcome were lower extremity nonunion (odds ratio [OR] = 3.100; P = 0.004), female sex (OR = 2.208; P = 0.013), tobacco use (OR = 3.090; P = 0.001), Workers' Compensation insurance (OR = 5.204; P < 0.0005), radiographic bone loss (OR = 3.209; P = 0.001), and preoperative SMFA function index (OR = 1.023; P = 0.002). The FONY score model was significant and a good predictor of poor functional outcome (chi-square (6) = 76.49, P < 0.001; Nagelkerke R^2 = .32; AUROC [area under the receiver operating characteristic curve] = .81). At a FONY score below 25% (low risk), 11% of patients had a poor outcome. At a FONY score between 25% and 50% (intermediate risk), 38% of patients had a poor outcome. At a FONY score above 50% (high risk), 69% of patients had a poor outcome.

Conclusion: The FONY score is an accurate predictor of poor functional outcome following operative nonunion repair.

Fracture Blister Fluid: Is It Sterile or Infected?

David Hak, MD; *Cyril Mauffrey, MD*

Purpose: The purpose of this study was to determine whether the fluid in clear and blood-filled fracture blisters is sterile or infected. Operative treatment of fractures in the presence of fracture blisters remains controversial as there is concern regarding wound healing complications, especially in the presence of blood-filled blisters that some authors have associated with a greater infection risk.

Methods: We aspirated 24 fracture blisters present at the time of surgical treatment in 23 patients. The skin was prepped with betadine prior to aspiration. The fluid was analyzed by Gram stain and routine culture. Patient demographics, fracture classification, mechanism of injury, surgical treatment, and subsequent complications were recorded.

Results: 12 fractures were due to a high-energy mechanism, while 11 were low-energy injuries. There were 14 ankle fractures, 4 tibial shaft fractures, 3 pilon fractures, and 2 midfoot dislocations. The blisters were blood-filled in 12 cases, and clear in 12 cases. Gram stains were negative in all cases. Rare polymorphonuclear leukocytes were seen in 15 cases, few in 3 cases, and moderate in 2 cases. Cultures were positive in 6 aspirates, 3 from blood-filled blisters and 3 from clear fluid-filled blisters. Two clear blisters grew coagulase negative Staphylococcus and 1 grew a gram-negative rod. The 3 blood-filled blisters showed polymicrobial growth including *Staphylococcus aureus*, coagulase negative Staphylococcus, bacillus, and *Capnocytophaga*. Three patients developed postoperative wound infections. Two of these patients had blood-filled blisters with positive culture results, and 1 had a clear blister with negative culture results.

Conclusion: Both clear and blood-filled blister fluid may be colonized with bacteria. Caution should be exercised when operating in the presence of fracture blisters. Both clear and blood-filled fracture blisters should be of concern regarding the potential risk for subsequent wound infection.

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The Safety and Efficacy of Virtual Fracture Clinics in a Major Tertiary Trauma Hospital

Bernarda Cavka; ***Emily Cross;*** *Andrew Oppy, MBBS; Tom Treseder, MBBS; Andrew Bucknill, MBBS; George Plunkett, MBBS*

Purpose: Virtual fracture clinics (VFCs) were implemented in a major tertiary trauma hospital in March 2017 to provide patients with stable self-limiting fractures and uncomplicated acute musculoskeletal (MSK) injuries the option of receiving their management plan via a virtual (telephone) consultation in place of traditional clinic attendance. This study aimed to assess the efficacy and safety of the new model of care, and the patient experience.

Methods: Participants comprised patients with MSK injuries who were referred by the emergency department (ED) to orthopaedics between March 2017 and January 2018. Four days per week orthopaedic consultants reviewed the clinical assessment and digital imaging of ED referrals, identifying patients who could be managed without attending an in-person clinic consultation. The consultant provided a diagnosis and management plan that was communicated to patients via a telephone call from an advanced practice physiotherapist. Patients were excluded if they were non-English-speaking, pregnant, had an open fracture, neurovascular compromise ,or compartment syndrome, or if injuries were sustained from high-velocity trauma. Patient experience surveys were administered via e-mail to patients who were managed virtually.

Results: To date 1203 ED referrals have been reviewed in the VFC. 62% of patients (N = 746) required an in-person consultation, 35.2% (N = 424) were managed virtually, 1.8% (N = 22) of referrals were forwarded to another hospital, 0.7% (N = 8) were redirected to another specialty, and 0.2% of patients (N = 3) were listed for surgery. Only a small proportion of referrals (6.8%, N = 82) were excluded from virtual management primarily due to high-velocity trauma (2.5%, N = 30) and limited command of the English language (2.0%, N = 24). Of the 424 patients managed virtually, only 1.2% (N = 5) re-presented to the ED within 30 days of their initial ED presentation for the same MSK complaint. No adverse events were reported. Patient experience survey results (N = 64) indicate high patient satisfaction, with 78.8% of respondents stating they would recommend the VFC to a relative or friend.

Conclusion: Based on our experience, VFCs provide patients with acute MSK injuries a safe and appropriate alternative model of care without compromising safety and the patient experience. VFCs increase the capacity of the hospital outpatient clinics through elimination of unnecessary referrals that can be managed by health-care professionals in the community setting.

A Pilot Randomized Controlled Trial of a Hybrid Web-Based and In-Person Self-Management Intervention Aimed at Preventing Acute to Chronic Pain Transition After Major Lower Extremity Trauma (iPACT-E-Trauma)

Mélanie Bérubé, PhD(c); *Céline Gélinas, PhD, RN; Nancy Feeley, PhD, RN; Geraldine Martorella, PhD, RN; José Côté, PhD, RN; George-Yves Laflamme, MD; Manon Choinière, PhD, PsyD*

Purpose: Patients with lower extremity trauma (ET) are known to be at risk for chronic pain. We developed a hybrid web-based and in-person self-management intervention to prevent the transition from acute to chronic pain (CP) in this population (iPACT-E-Trauma). The objectives of this study were to assess the research methods associated with the testing of iPACT-E-Trauma and evaluate its potential effects at 3 and 6 months post-injury.

Methods: Using a randomized controlled design with 2 parallel groups, this study was conducted at a Level I trauma center. 56 adults with major lower ET were randomized in an experimental (iPACT-E-Trauma) and a control (pamphlet) group. A form was used to assess the feasibility of key methodological research parameters. The potential efficacy of iPACT-E-Trauma was evaluated by measuring pain intensity and pain interference with activities (primary outcomes), as well as risk and protective factors for CP (secondary outcomes). Complementary global health outcomes were also evaluated. Descriptive analyses were performed and a linear mixed model for repeated measures was used to evaluate iPACT-E-Trauma potential efficacy.

Results: The research methods were found to be feasible with regard to many parameters, including the ease of screening potential participants, the high percentage of eligible patients who took part in the study (85%), and the low attrition in both groups (≤14%). Some challenges were identified, such as the low rate of screened patients who were eligible to participate (37%) as well as the time required to recruit participants (9 months). Low mean scores on pain intensity and pain interference with activities (<4/10) were observed in both groups at 3 and 6 months post-injury. The experimental group perceived greater positive change in their condition compared to the control group 3 months post-injury. Similarly, health status physical scores were higher in the experimental group at 3 and 6 months post-injury, but not significantly different from those of the control group. Recognized psychological risk factors for CP were mainly absent at baseline in all participants, suggesting that they were at low risk for CP.

Conclusion: This study provided support for the feasibility of the research methods to be utilized for a larger clinical trial to test the efficacy of CP preventive interventions in the trauma context.

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Interfacility Transfer Is a Risk Factor for Venous Thromboembolism (VTE) in Lower Extremity Fracture Patients

***Alexander Crespo**, MD;* *Evan Boyd, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: Follow orthopaedic trauma, venous thromboembolism (VTE) is a commonly encountered perioperative complication with modifiable risk factors. The risk for developing VTE is increased with insufficient thromboprophylaxis and/or prolonged time to treatment. The purpose of this study is to compare the incidence of VTE among patients with pelvic and/or lower extremity fractures directly admitted to our institution versus those transferred from an outside hospital for definitive management.

Methods: We performed a retrospective case-control study of 637 admitted patients who received care for a lower extremity fracture at our institution between 2010 and 2017. Cohorts were separated based on those who were directly admitted (DA) to our institution versus those transferred (TR) from an outside facility. Comprehensive chart review was performed to determine initiation of VTE prophylaxis while at an outside institution. The incidence of VTE following admission was determined for each population.

Results: The interfacility transfer (TR) group was comprised of 126 patients and the direct admission (DA) group was comprised of 564 patients. TR patients had a significantly higher incidence of VTE compared to the DA group: 9.5% versus 0.7%, respectively ($P < 0.001$). Time to surgery was also longer in the TR group compared to the DA group: 3.05 ± 3.00 days versus 2.16 ± 2.42 days, respectively ($P = 0.005$). Demographics for TR and DA did not significantly differ with regard to age, gender, length of stay, or ASA (American Society of Anesthesiologists) score. In the TR group, no complete and explicit documentation regarding thromboprophylaxis administration while at the outside facility was found.

Conclusion: Patients undergoing interfacility transfer for definitive management of pelvic and lower extremity fractures are at significantly increased risk for the development of VTE. To our knowledge, this study is the first to investigate the incidence of VTE among patients transferred between separate institutions. The increased incidence of VTE among transfer patients suggests a role for stringent screening practices (ie, bilateral lower extremity duplex vs examination of the pelvis) and increased vigilance in this population. Transferring facilities should be urged to provide explicit documentation regarding VTE prophylaxis measures that have been initiated prior to transfer. These interventions may lead to a reciprocal decrease in perioperative morbidity and mortality.

Admission Hyperglycemia Is a Risk Factor for Deep Surgical Site Infection in Orthopaedic Trauma Patients

Braden Anderson, BS; Brent Wise, MD; Manjari Joshi, MD; Renan Castillo, PhD; Robert O'Toole, MD; ***Justin Richards****, MD*

Purpose: The association between hyperglycemia at hospital admission and infectious outcomes has not been carefully examined in orthopaedic trauma surgery. We hypothesized that there would be no association with admission hyperglycemia and deep surgical site infection (SSI) in orthopaedic trauma patients.

Methods: We performed a secondary analysis on a dataset used to create a risk model of SSI. The dataset was created with all patients with a deep infection and a random sample of non-infected adult patients requiring operative management for acute orthopaedic injuries between January 1, 2006 and December 31, 2015 at a single academic medical center. Patients were excluded for a history of diabetes, corticosteroid use, or admission to the intensive care unit. Hyperglycemia was defined as an admission blood glucose ≥200 mg/dL. The primary outcome was 90-day deep SSI meeting CDC (Centers for Disease Control and Prevention) criteria. A multivariable logistic regression model was used to calculate the odds ratio (OR) for the risk of SSI in patients with admission hyperglycemia, after controlling for significant confounding variables that had been previously identified. The final study population consisted of 465 patients: 128 with deep SSI and 337 without infection.

Results: Admission hyperglycemia was significantly associated with deep SSI (8/14, 57.1% vs 120/451, 26.6%; P = 0.012). Male gender (100/329, 30.4 % vs 28/136, 20.6%; P = 0.03), previous drug or alcohol abuse (17/42, 40.5% vs 26.2%; P = 0.049), flap coverage (11/19, 57.9% vs 26.4%; P = 0.003), and fracture region (upper extremity: 18/116, 15.5%; pelvis/hip: 11/40, 27.5%; femur: 14/60, 23.3%; tibia/ankle: 69/191, 36.1%; foot: 16/58, 27.6%; P = 0.003) were also associated with infection. Age, race, smoking status, body mass index, and the American Society of Anesthesiologists physical classification score were examined. The multivariable logistic regression model demonstrated that admission hyperglycemia was an independent risk factor for deep SSI (OR: 4.5, 95% confidence interval [CI] 1.4-13.9, P = 0.03), after controlling for male gender (OR: 1.76, 95% CI 1.1-2.9), prior drug or alcohol abuse (OR: 1.8, 95% CI 0.9-3.6), flap coverage (OR: 3.6, 95% CI 1.3-9.9), and fracture region (upper extremity OR: reference; pelvis/hip OR: 2.6, 95% CI 1.1-6.3; femur OR: 1.9, 95% CI 0.85-4.3; tibia/ankle OR: 3.4, 95% CI 1.9-6.2; foot OR: 2.0, 95% CI 0.92-4.5).

Conclusion: Admission hyperglycemia was a significant independent risk factor for 90-day deep SSI and may serve as an important marker for infection risk in orthopaedic trauma patients without a history of diabetes.

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Secondary Transfer From the C-Arm Drape Is a Source of Contamination During Intraoperative Fluoroscopy

David Zuelzer*, *MD; *Jerad Allen, MD; Joseph Hsu, MD; Paul Matuszewski, MD*

Purpose: Fluoroscopy is used commonly used intraoperatively. However, little is known regarding the efficacy of preventing contamination using draping techniques. The purpose of this study was to determine if contamination occurs by secondary transfer from the un-draped portion of the C-arm with current draping techniques.

Methods: We simulated an operating room case by draping a Sawbones femur wrapped with black cloth. An OEC C-arm was utilized (GE Healthcare) with standardized C-arm draping techniques. We used a simulated contaminant, a commercially available fluorescent powder (GlitterBug, Brevis Corporation) that phosphoresces under ultraviolet light. GlitterBug powder was placed on undraped portion of the C-arm prior to draping, as well as the non-sterile edge of drapes 10 cm below the sterile field. A 24-in black light (American DJ) was hung above the operative field. In a darkened room a Canon EOS 40D camera on a tripod set in manual grayscale mode, 200 ISO, and 5-second shutter was used to obtain images. We then simulated typical C-arm movements by cycling through lateral to AP imaging. For analysis, the long axis of the operative field was divided into thirds, with 1 area being adjacent to the surgeon, another adjacent to the C-arm, and the other in the middle. An image was taken before (control) and after 5, 10, and 15 cycles of lateral to AP imaging. ImageJ software (National Institutes of Health) was used to quantify the change in light intensity at each time point over each area. Intensity was recorded as a percentage of change from the control. The procedure was repeated 5 times with new drapes and femurs.

Results: Contamination of the surgical field was observed in all areas in all cases after 15 cycles, with the area adjacent to the C-arm being most pronounced. Only the area adjacent to the C-arm demonstrated a linear increase in intensity with increased cycles (R^2 = .297, P = 0.036), with the mean increase in intensity 5% after 15 cycles (95% confidence interval [CI] 1.97-7.86). The remaining areas (closest to surgeon and middle of field) showed an increase as well but were not statistically significant (P >0.05).

Conclusion: Our results confirm that secondary contamination of the surgical field from the C-arm occurs. The area most prone to contamination is the area adjacent to the fluoroscopy unit, usually opposite the surgeon.

Risk Factors for Long-Term Opioid Use After Ankle Fracture Surgery: A Cox Regression Analysis and Prospective Follow-up

Chang-Yeon Kim**, **MD; *Richard Lee, BS; Ann Drake, BS; Lakshmanan Sivasundaram, MD; Jonathan Copp, MD; Megan Audet, BA; Heather Vallier, MD*

Purpose: Opioid pain medications are commonly used after ankle fracture surgery. However, prescription of opioids for persistent pain is controversial and under scrutiny. The aims of this study were to identify risk factors for prolonged opioid use after ankle fracture surgery and to investigate effects of such use on functional outcomes.

Methods: Postoperative prescription records from weeks 2-16 of patients who underwent ankle fracture (44A, 44B, 44C) fixation over 10 years at a Level I trauma center were reviewed. Demographic and injury characteristics were evaluated. Outcomes were assessed using the Short Musculoskeletal Function Assessment (SMFA) and the Foot Function Index (FFI), after minimum 1 year. Multivariate Cox regression analysis was performed to analyze factors associated with opioid use during the 16-week interval. Multiple linear regression was used to investigate whether functional outcomes were independently correlated with the time at which patients stopped using opioid medication.

Results: A total of 726 patients with mean age 44 years (standard deviation [SD] 17) and mean body mass index (BMI) 31.2 (SD 9.1) were included. Reported tobacco/alcohol/drug use was 47.0%, 50.9%, and 10.3%, respectively. At least 1 medical comorbidity was present in 44.2%. Mean ASA (American Society of Anesthesiologists) score was 2.23. Proportion of patients using opioids decreased during each 2-week interval from 83.5% at week 2, to 3.9% at week 16. Multivariate Cox regression showed age >60 years (P = 0.002, hazard ratio [HR] 0.66, 95% confidence interval [CI] 0.51-0.86) was negatively correlated with opioid use, while ASA score (P = 0.033, HR 1.22, 95% CI 1.01-1.36) and tobacco use (P = 0.012, HR 1.27, 95% CI 1.05-1.53) were positively correlated with opioid use. Multiple linear regression analysis, after adjusting for demographic and injury, showed that time of last opioid prescription was significantly associated with worse outcome, including FFI (P = 0.019, B = 1.09, 95% CI 0.18-2.0), SMFA Dysfunction (P = 0.012, B = 1.03, 95% CI 0.22-1.83), and SMFA Bothersome (P <0.016, B = 1.14, 95% CI 0.21-2.07) scores.

Conclusion: In a multivariate Cox regression model, tobacco use and higher ASA score were risk factors for prolonged opioid use, while age >60 years was associated with less opioid use after ankle fracture. Prospective follow-up with FFI and SMFA scores demonstrated that prolonged use of opioids after surgery was independently associated with worse functional outcome.

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Evaluation of Lateral C-Arm Drape Contamination During Lower Extremity Fracture Surgery: A Prospective Pilot Study

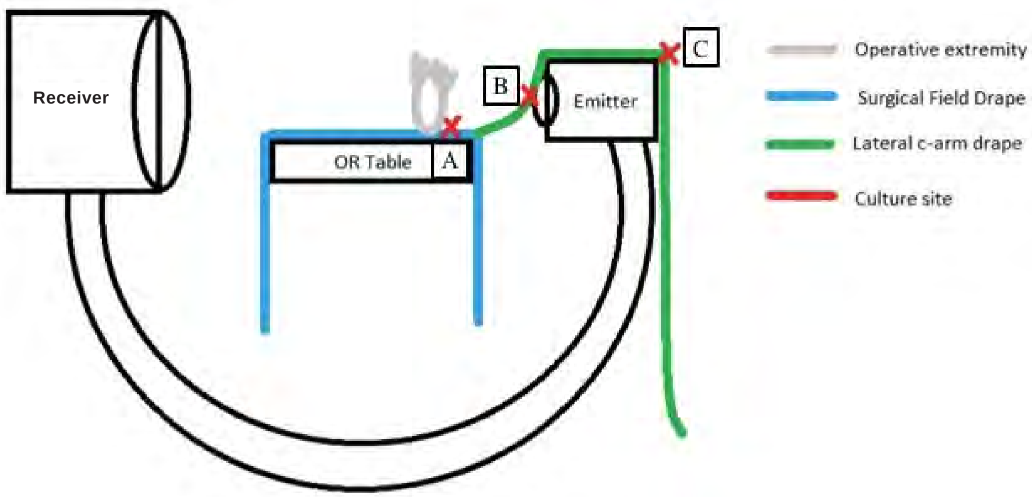
Erin Haggerty, MD; *David Hampton, MD; Bettina Ayers, BA; Milton Little, MD; Charles Moon, MD; Donald Wiss, MD; Carol Lin, MD*

Purpose: Lateral fluoroscopy (C-arm) views are critical for orthopaedic trauma, but the rate of bacterial contamination of the lateral C-arm tube drape and its role in surgical site infections (SSIs) has not been studied. We hypothesized that higher rates of contamination would be associated with duration of drape use and the number of lateral images. We also evaluated the impact of contaminated drapes on SSI.

Methods: We prospectively evaluated 30 patients with closed lower extremity fractures undergoing fixation. The clip drape technique was employed in which 1 sterile ¾-sheet drape was applied to the operative table to cover the emitter when in the lateral position. The same drape was used throughout the case. 3 defined locations on the C-arm drape and surgical field (see image) were cultured at initiation, every 5th lateral, and conclusion of its use. Swab samples were assessed for bacterial growth yielding positive drape swabs (PDS) or negative drape swabs (NDS). A t-test was applied for statistical comparison with $P < 0.05$ considered significant. The rate of 30-day SSI was recorded.

Results: Only 3/216 culture swabs (1.4%) were PDS during the 30 procedures, 2 from area A and 1 from area B. All 3 were obtained at the conclusion of drape use. There was no association between duration of drape use (64.6 minutes in PDS vs 87.7 in NDS), or drape manipulations (8.0 in the 3 PDS vs 10.7 in the remaining 27 NDS). There were no SSIs.

Conclusion: The clip drape technique for lateral fluoroscopy appears to be effective in maintaining surgical field sterility even with prolonged use. A single lateral drape may be used throughout surgery, which has potential cost savings.



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

Overlapping Surgery: Are the Outcomes of Internal Fixation for Intertrochanteric Fractures Affected?

Juan Vargas-Hernandez, MD; *Jonathan Barlow, MD; William Cross, MD; Andrew Sems, MD; Brandon Yuan, MD*

Purpose: Although overlapping surgery has occurred for several decades, media scrutiny of the practice has increased recently, highlighting concerns about the possibility of adverse outcomes during overlapping procedures. However, there is little evidence to support or reject this theory. The purpose of this study is to determine if overlapping surgery affects the outcomes of internal fixation for intertrochanteric fractures.

Methods: With previous IRB approval, we conducted a retrospective chart review of an institutional database. Patients with an OTA/AO classification code 31-A treated with internal fixation between January 1, 2005 and December 31, 2016 were included. At our institution, concurrent surgery, defined as the critical portions of 2 procedures occurring simultaneously, is only permitted in cases of an emergency and is rare. However, overlapping surgery, defined as 2 procedures occurring simultaneously but without the critical portions overlapping, is permitted. Of the 1674 patients included in the study, 58% (n = 970) underwent overlapping and 42% (n = 704) non-overlapping surgery. Patient demographic characteristics, ASA (American Society of Anesthesiologists) scores, and smoking status were collected. Reoperation due to any cause and mortality were the principal outcomes. Survivorship was analyzed by Kaplan-Meier methodology and log rank test. JMP statistics software was utilized.

Results: Survivorship free of reoperation at 1 year was 94% and 96% for overlapping and non-overlapping procedures, respectively (P = 0.28). Survivorship free of death at 1 year was 78% and 74% for overlapping and non-overlapping procedures, respectively (P = 0.0495). After adjusting for age, sex, smoking status, and ASA scores, overlapping surgery demonstrated a relative risk of reoperation of 0.78 (95% confidence interval [CI] 0.53-1.17) and a relative risk of mortality of 0.82 (95% CI 0.72-0.95) when compared to non-overlapping surgery.

Conclusion: Overlapping surgery did not have a significant effect on reoperation rates after internal fixation for intertrochanteric femur fractures and was associated with a lower mortality rate even when adjusting for ASA score. Further analysis as to the root causes of this finding are necessary. Although overlapping surgery has the potential to improve the efficiency of each individual surgeon, further studies are required to analyze its economic and clinical consequences. The possibility of overlapping surgery must be part of the informed consent process for surgery.

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Characterization of Vitamin D Deficiency and Use of a Standardized Supplementation Protocol in Orthopaedic Trauma Patients

Joseph Jacobson**, **MD; *Serena Harris, PharmD; Todd Walroth, PharmD; Evan Zahn, PharmD; Allison Boyd, PharmD; Brian Mullis, MD*

Purpose: Vitamin D deficiency has been associated with unwanted outcomes in hospitalized trauma patients such as a longer length of stay, increased infection rates, and higher rates of fracture nonunion. The primary objective of this study was to determine the prevalence of vitamin D deficiency among trauma patients with fractures and to assess the incidence of fracture nonunion in those treated with a standardized vitamin D protocol.

Methods: Through a retrospective chart review, rates of nonunion were compared between populations pre- and post-implementation of a standardized vitamin D supplementation protocol (patients with any fracture except those of the hands, feet, or head). All adult patients with a tibia and/or fibula fracture who underwent any form of operative intervention were identified via ICD-10 codes. Exclusion criteria included patients who were pregnant or incarcerated, patients receiving vitamin D supplementation prior to admission, and history of bone disease. A total of 152 patients were included in the pre-protocol (July 1, 2013-June 30, 2015) and 218 in the post-protocol (July 1, 2015-June 30, 2017) groups.

Results: Groups were well-matched at baseline for age, weight, and number of risk factors for nonunion (eg, smoking, diabetes, etc). Statistically significant differences were noted in the number of Caucasian patients (66% vs 54%; $P = 0.018$) and median ISS (4 vs 8.5; $P = 0.003$) in the pre- versus post-protocol groups. In patients with an initial vitamin D level, 210 (98%) presented with vitamin D deficiency (defined as < 30 ng/mL). Patients in the post-protocol group had a median initial vitamin D level of 9.9 ng/mL with a median follow-up level of 31.8 ng/mL ($P = 0.001$). The median treatment duration was 7.5 weeks, which fits with the institution's replacement protocol. There were no cases of vitamin D toxicity or supratherapeutic levels. Overall percentage of patients with nonunion did not differ between the pre- versus post-protocol groups (11% vs 11%; $P = 0.958$).

Conclusion: The results of this study demonstrate the safe and effective use of a standardized protocol for vitamin D supplementation in trauma patients. Preliminary results indicate vitamin D supplementation did not impact nonunion rate. Limitations include significant differences in ISS and race between the 2 groups. Future directions include cohort matching of ISS, race, fracture location, and age to further assess vitamin D supplementation impact on nonunion rates.

Are Patients Equally Satisfied With Advanced Practice Providers Compared to Surgeons in a Pediatric Fracture Clinic?

Christine Ho, MD

Purpose: The Connect Provider Scorecard reports patient satisfaction scores to health-care professionals from the NRC. In our Level I pediatric trauma facility, advanced practice providers (APPs) with specialized training in pediatric orthopaedics practice independent fracture clinics. The purpose of this study was to compare Connect Scorecard patient satisfaction for APPs and pediatric orthopaedic surgeons (MDs).

Methods: Scorecard results from both APP (n = 12) and MD (n = 10) fracture clinics were compiled from August 2015 to August 2017. APPs had 17,402 fracture clinic visits with 4243 scorecards completed; MDs had 11,623 fracture clinic visits with 2282 scorecards. Scores were compared with t-test.

Results: Compared to MDs, APPs had higher mean scores in every category (Table 1). Statistically significantly higher APP scores were seen for 3 categories, including "Provider Communication Composite", a composite of scores from 4 categories, "Provider explained things understandably", "Provider listened carefully", "Provider showed respect for what patient said", and "Provider spent enough time with patient". APPs with >6 years of pediatric orthopaedic experience had higher scores in every category when compared to APPs with <6 years experience.

Conclusion: Patients are equally satisfied with well-trained APPs when compared to pediatric orthopaedic surgeons for their child's fracture care; APPs may have higher communication skills compared to pediatric orthopaedic surgeons.

	APP Mean score (range)	MD Mean score (range)	P-value
Provider Communication Composite*	92.1 (90.0-94.3)	89.4 (80.3-92.2)	0.022
Provider explained things understandably	92.5 (88.1-96.2)	91.1 (84.4-94.4)	0.238
Provider listened carefully	94.7 (91.7-98.0)	92.4 (84.4-98.0)	0.077
Easy to understand information about concerns	95.1 (92.3-97.2)	94.2 (86.4-96.8)	0.355
Provider knew medical history	87.3 (83.7-94.0)	85.9 (77.4-92.1)	0.415
Provider showed respect for what patient said	96.0 (93.0-98.0)	93.37 (86.3-96.8)	0.020
Provider spent enough time with patient	85.4 (80.4-90.0)	80.7 (66.1-89.6)	0.032
Rating of provider	87.4 (82.0-92.5)	85.4 (76.1-94.3)	0.275
Would recommend provider's office	93.2 (89.6-96.9)	91.9 (82.1-98.1)	0.344

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No Pain Relief Benefit to Operative Treatment of Clavicle Fractures: ORIF Patients Use Significantly Greater Opioids Than Those Treated Nonoperatively

David Rothberg, MD; *Andrew Stephens, BS; James Cardinal, BS; Justin Haller, MD; Thomas Higgins, MD*

Purpose: The operative treatment of midshaft clavicle fractures shows benefit in reducing risk of nonunion and malunion and faster return to work. Lower pain scores have also been promoted as an advantage relative to nonoperative treatment. Given this apparent indication for operation, and the role of prescription opiates in the national opioid crisis, we sought to determine if opioid consumption was lower for operatively treated clavicle fractures.

Methods: All midshaft clavicle fractures treated at a Level I trauma center were identified over a 5-year period (2012-2016). Demographics, fracture characteristics, surgical complications/outcomes, nonoperative outcomes, and all narcotics prescribed for 6 months post-injury were collected. Narcotic prescriptions, converted to morphine equivalents (MEs), were obtained through the state prescription drug monitoring program (PDMP). Patients were excluded if they did not have 3 months follow-up, were not present in the PDMP, or did not have an isolated injury.

Results: After exclusion, 110 operative and 48 nonoperative patients were included in analysis. Age, gender, previous alcohol, tobacco or drug use, and final recorded follow-up range of motion (ROM) were not different between groups. As expected, pretreatment fracture shortening (1.8 cm vs 0.7 cm, $P < 0.001$) and displacement (150% vs 70%, $P < 0.001$) were greater in the operative group. 100% of operatively treated fractures healed by 3 months versus 79.2% in the nonoperative group ($P < 0.001$). 51.8% (57/110) of operative patients received a postoperative nerve block for pain. Total MEs (604 vs 187, $P < 0.001$) and postoperative MEs (420 vs 187, $P < 0.001$) were greater for the operative group. No other variable recorded had an effect on MEs prescribed in either group. Patients who received nerve blocks trended toward a higher rate of MEs prescribed (1.2 more MEs, $P = 0.3$).

Conclusion: Despite many surgeons believing that operative treatment makes clavicle fractures less painful, those treated with open reduction and internal fixation (ORIF) required substantially more opiates (55 more 5-mg oxycodone pills per patient) than those treated nonoperatively. Interestingly, patients in the operative group who received a regional nerve block consumed even more opioids than those who were not blocked. While there may certainly be advantages to the increasing operative treatment of clavicle fractures, they must be weighed against the risks of a greater than doubling in opiate consumption.

A Comparison of a Multimodal Pain Control Using Liposomal Bupivacaine in an Orthopaedic Trauma Population

Katherine Li**, **MD; *R. Randall McKnight, MD; Ana Katsafanas, BS; Meghan Wally, MPH; Jarrod Dumpe, MD; Rachel Seymour, PhD; Joseph Hsu, MD*

Purpose: Narcotic abuse and overprescribing are currently a major focus for health-care professionals. In the last decade, there has been an increased interest in the orthopaedic community regarding pain control by targeting multiple areas of the pain pathway at the same time to bring the patient pain relief. This so-called multimodal pain control strategy uses multiple types of oral medication, regional anesthesia, and local injections that affect the pain pathway at different locations. Locally injected liposomal bupivacaine (Exparel) has shown promise in the arthroplasty literature to potentially affect narcotic consumption, patient mobilization, and length of hospital stay. This study was done to investigate if perioperative locally injected Exparel affected postoperative pain and mobility compared to a traditional pain regimen.

Methods: This is a retrospective chart review. Inclusion criteria was all patients age 18-85 years, admitted to an orthopaedic service for operative treatment of a high or low-energy traumatic injury from February 2016 to August 2016, and were treated by any of 4 orthopaedic traumatologists. Patients treated by 1 of the 4 traumatologists made up the intervention group (LA) and received a multimodal pain strategy including local injection of Exparel at the conclusion of their operation. All other patients were treated with a traditional pain regimen (TR). Patients who were not treated by 1 of the 4 traumatologists, had a Glasgow Coma Scale (GCS) of <8, or were not admitted to an orthopaedic service were excluded. Primary outcomes were visual analog scale (VAS) scores and oral morphine milligram equivalent (MME) usage. Secondary outcomes were length of hospital stay and time to mobilize with physical therapy.

Results: 144 total patients met inclusion criteria with 115 and 29 patients in the TR and LA groups, respectively. Mean age was 54.7 years with no differences between groups. There were no statistical differences in VAS or MME at 24 and 48 hours. There were no signiciant differences between groups in mean hospital length of stay, GCS on presentation, or ISS. TR patients mobilized with physical therapy at 3 days, while those in the LA group mobilized at 1.5 days (P = 0.059). Average charges billed were $67,863 and $71,722 for TR and LA patients, respectively.

Conclusion: In operative orthopaedic trauma patients, we found no differences in pain or MME usage at 24 and 48 hours. Exparel may have a benefit perioperatively in allowing earlier ambulation with physical therapy; however, additional studies are needed.

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Implementation of the PROMIS Toolbox Within an Orthopaedic Trauma Clinical Trials Consortium

Anthony Carlini, MS; Katherine Frey, MPH; Rachel Kirk, BS; Susan Collins, MSc; Robert O'Toole, MD; Kristin Archer, PhD; William Obremskey, MD, MPH; Julie Agel, MA; Conor Kleweno, MD; Saam Morshed, MD, PhD; Michael Weaver, MD; Thomas Higgins, MD; Kitty Chan, PhD; Albert Wu, PhD; ***Renan Castillo*****,** ***PhD;*** *The METRC*

Purpose: The Patient-Reported Outcomes Measurement Information System (PROMIS) has developed item banks, short forms, and computer-adaptive tests (CATs) to help standardize measurement for important patient-reported outcome (PRO) domains. These tools have the potential to revolutionize outcome measurement in clinical research through greater assessment precision while reducing response burden. Perceived implementation challenges include the need for CAT software, mobile technology, and Internet access. The goal of this study was to examine the feasibility of using PROMIS tools within a large, multicenter clinical trials consortium.

Methods: This was an observational study of PRO data collection for 1000 trauma patients at 43 Level I trauma centers, evaluated at 3, 6, and 12 months following an orthopaedic injury (including open and closed tibia, calcaneus, pilon, ankle and foot injuries, below-the-knee amputation). Data collection included 10 PROMIS domains (defined as traits or determinants of current or future health outcomes). These domains included: physical function, pain interference, anxiety, depression, ability to participate in social activities, psychosocial illness, general cognition, satisfaction with roles and activities, sleep disturbance, and emotional support. Participants completed CAT questionnaires using a tablet-based application, an online survey link, or by phone. Paper short-form surveys were available as a backup.

Results: A total of 2830 PRO assessments (a cumulative 24,740 domains) were completed across all study follow-ups. Among CAT assessments, 85% were recorded in person using the tablet application, 12% were completed using a survey link e-mailed to the participant, and 3% by phone. Across all time points, electronic data collection was used 98% of the time. The median time per full 10-domain CAT assessment was 12.3 minutes while the median number of items asked was 51.

Conclusion: It was feasible to use PROMIS tools in a large multicenter, trauma orthopaedics research setting with few barriers encountered. The ability to assess multiple PRO domains in the time typically required for a single legacy measure is appealing. This ability to ease patient burden and diminish time required from research staff in collecting outcomes data across a wide spectrum of domains is critically important to the successful completion of future large-scale trials.

PROMIS PF and SMFA Crosswalk: Accuracy Varies by Domain

Renan Castillo, PhD; *Anthony Carlini, MS; Katherine Frey, MPH; Robert O'Toole, MD; Kristin Archer, PhD; William Obremskey, MD, MPH; Julie Agel, MA; Conor Kleweno, MD; Saam Morshed, MD, PhD; Michael Weaver, MD; Thomas Higgins, MD; Susan Collins, MSc; Stephen Wegener, PhD; Albert Wu, PhD; Kitty Chan, PhD; The METRC*

Purpose: As part of the National Institutes of Health (NIH) Roadmap initiative, PROMIS (Patient-Reported Outcomes Measurement Information System) has developed item banks, short forms, and computer-adaptive tests (CATs) in order to standardize measurement for many health-related quality of life domains. The PROMIS Physical Function (PF) domain consists of a 121-item bank, and is increasingly being used by the orthopaedic research community. One of the most widely used measures of function in this setting is the 46-item Short Musculoskeletal Functional Assessment (SMFA), which assesses dysfunction, mobility, bother, and emotion. A critical tool for researchers transitioning from legacy measures to PROMIS is the availability of linking (also known as crosswalk) tables. While most of the PROMIS measures have published linking tables for many legacy measures, there is no crosswalk available for the PROMIS PF and the SMFA.

Methods: The study, conducted at 43 Level 1 trauma centers, enrolled 1000 patients participating in longitudinal trials, and collected 733 SMFA and PROMIS PF assessments at either 6 or 12 months post injury. Linking functions between SMFA domains and PROMIS PF were developed following the equipercentile matching methodology, but are not presented in this abstract due to space constraints. A minimally important clinical difference (MCID) for the SMFA of 7 was used based on prior literature.

Results: Overall, there was a high correlation between the PROMIS PF CAT and SMFA mobility and dysfunction domains: 0.79 and 0.81, respectively. Interestingly, the accuracy of the observed versus PF-predicted SMFA scores was poor. Only 55% and 44% of the predicted SMFA dysfunction and mobility scores, respectively, were within 1 MCID of the observed scores. While a ceiling effect was observable for the SMFA, this was not the main cause of the discrepancies between the instruments. As expected, accuracy was even lower for other SMFA domains not focused on physical function.

Conclusion: SMFA versus PROMIS PF linking functions can be used to compare across studies and normative sets. However, the accuracy of the crosswalks suggests that the PROMIS PF is not a perfect match for any of the SMFA domains, and that the predicted values should be used with significant caution. Additional PROMIS domains may be required to replace the SMFA, as reliable linking in several domains is not currently available.

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Radial Nerve Palsy Recovery Rate and Recovery After Fractures of the Humerus: A Systematic Review

John Mangan, MD; Jack Graham, BS; ***Asif Ilyas**, **MD***

Purpose: A prior systematic review by Shao et al. published in 2005, based on studies published between 1964 to 2004, identified an overall radial nerve palsy rate of 11.8% after fractures of the humeral shaft, with a spontaneous recovery rate of 70.7%, and purportedly no difference found between cases treated with early versus expectant treatment. However, the authors combined both nonsurgical and delayed surgical treatment into the "expectant" category to make this conclusion. Therefore, to better refine our current understanding of the radial nerve palsy rate and recovery potential simply with and without surgical exploration, an updated systematic review was undertaken focusing on modern technique and more contemporary outcomes.

Methods: A systematic review of all published literature was undertaken. An electronic database search was performed to identify publications that met specific inclusion criteria. We identified 23 articles published since 2000 or later that met our eligibility requirements. Data were carefully abstracted from these articles and analyzed independently as well as collectively with the results of the Shao et al. systematic review.

Results: The prevalence of primary radial nerve palsy was 12.3% (890/7262) after humeral shaft fractures. Patients treated nonoperatively had a rate of recovery of 77.2%. Patients who failed nonoperative management and underwent nerve exploration more than 8 weeks after their injury had a rate of recovery of 68.1%. In contrast, patients treated with early surgery, within 3 weeks of the injury, had a rate of recovery of 89.8% (P <0.001).

Conclusion: From published data from 2000 onward, patients who underwent early surgical exploration and fracture repair within 3 weeks of injury had a statistically higher likelihood of regaining radial nerve function than patients who underwent nonoperative management, with or without later surgical exploration. Based on this updated systematic review focusing on studies published in the last 15 years, we would recommend considering early surgical exploration for radial nerve palsy following fractures of the humeral shaft.

Low Complication Rates Among Geriatric Olecranon Fracture Patients Treated With Plate Fixation

Sean Campbell, MD; *Malcolm DeBaun, MD; Lawrence Goodnough, MD, PhD; Julius Bishop, MD; Michael Gardner, MD*

Purpose: A recent trial in the UK demonstrated no difference between tension band and plate fixation for geriatric olecranon fractures. A second study compared operative to non-operative treatment in patients age 75 years or older; the study was stopped early due to a high complication rate with operative treatment. This led the authors to recommend "non-operative management of displaced fractures of the olecranon in the elderly." Both studies were notable for higher complication rates than many surgeons would anticipate. The purpose of this study was to determine the complication rate among geriatric olecranon fractures treated surgically with plate fixation at a single Level I trauma center.

Methods: The medical records of all patients 75 years and older who were treated with plate fixation for an olecranon fracture over a 15-year period were reviewed. Variables recorded included demographic data, type of fixation used, complications, need for reoperation, and union at follow-up.

Results: 36 patients met inclusion criteria; mean follow-up was 10 months. 26 patients were treated with locked plating. 34 of the 36 patients went on to union prior to subsequent surgery (94%). The overall reoperation rate was 11% (4 of 36 patients). 3 patients required reoperation for infection or wound dehiscence; 1 patient elected to have a symptomatic implant removed. The 3 nonelective reoperations included (1) 1 patient had a deep infection and loss of reduction, and was treated with implant removal and triceps advancement; (2) 1 patient had a deep infection and was treated with implant removal, splinting, and went on to successful fracture union; and (3) 1 patient had wound dehiscence in the setting of a healed fracture, and was treated with implant removal and wound closure. The overall complication rate, including elective implant removal for prominence, was 13.8%.

Conclusion: The complication and reoperation rates following plate fixation of geriatric olecranon fractures was low. Loss of reduction was uncommon and most patients went on to uneventful fracture union. These outcomes are different from several recent publications reporting high complication rates and supporting nonoperative treatment. Our results support plate fixation of geriatric olecranon fractures as an alternative to nonoperative management.

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Olecranon Osteotomy Fixation Following Distal Humerus ORIF: Plate and Screws Versus Tension Band

***Jack Haglin**, **BS;** Ariana Lott, MD; Rebekah Belayneh, MD; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: A transolecranon approach allows for improved visualization and more accurate reduction of distal humerus fractures. This study compares 2 methods of olecranon repair following olecranon osteotomy in distal humerus fracture repair.

Methods: This was a retrospective review of distal humerus fractures treated via a transolecranon approach. In each case, the osteotomy was fixed with either tension band wiring (TBW) or plate fixation (PF). Measured outcomes included range of motion, osteotomy time to union, and development of complications (nonunion, infection, reoperation). Mayo Elbow Performance Index (MEPI) scores were obtained for all patients. Data were analyzed using independent samples t-tests, chi-squared tests, and Fisher exact tests.

Results: Of 217 distal humerus fractures from this period, we identified and included a total of 42 eligible patients with OTA type 13-C2 or 13-C3 fractures. Mean follow-up was 15 months (15.0 ± 5.6). 24 patients had fixation of the olecranon osteotomy with TBW, and 18 were fixed with PF. Groups did not differ with respect to any preoperative characteristic. Clinically there were no differences in osteotomy time to union, elbow arc of motion at any time point, or patient MEPI scores. Further, there were no differences in complications related to the osteotomy.

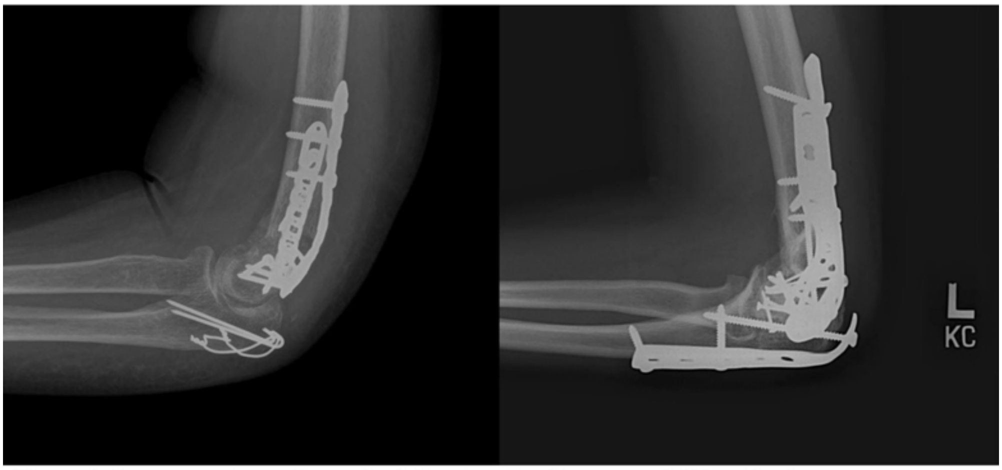

Figure 1. Post-operative radiographs following distal humerus ORIF with olecranon osteotomy fixed with TBW (left) and PF (right).

Conclusion: TBW and PF of olecranon osteotomies following open reduction and internal fixation (ORIF) of distal humerus fractures with a transolecranon approach had similar outcomes. Without differences between methods of olecranon fixation, the cost difference of each modality should be considered by orthopaedic surgeons when repairing the olecranon.

Identifying Risk Factors for Capsulectomy

Patrick Kelly, BA; *Raymond Pensy, MD; Nathan O'Hara, MPH; Ilaria Caturegli, BS*

Purpose: The purpose of this study is to identify risk factors for capsulectomy following an index elbow fracture operation. The null hypothesis is that there are no identifiable risk factors associated with operative treatment of elbow fractures resulting in the need for later capsulectomy.

Methods: A retrospective cohort study identified all patients in a 6-year span who underwent open reduction and internal fixation of the proximal ulna, coronoid, radial head, or distal humerus, or radial head arthroplasty. The primary outcome was a capsulectomy subsequent to an index elbow fracture operation. Demographic and clinical characteristics of the patients were included as possible risk factors. Backward step-wise elimination based on P <0.25 to enter and P >0.1 to leave was performed to select covariates for inclusion in a final multivariable logistic regression model.

Results: The final cohort included 322 patients with a mean age of 49.5 years (standard deviation [SD]: 18.2); 58% were male, and 36% sustained open fractures. 16% of the patients (n = 52) received capsulectomy following fixation. An increased time in a splint (odds ratio [OR]: 1.2 per week, 95% confidence interval [CI]: 1.1-1.3, P <0.01), a dislocation (OR: 2.1, 95% CI: 1.0-4.1, P = 0.04), and males (OR: 2.4, 95% CI: 1.2- 4.8, P = 0.02) were more likely to have a capsulectomy. The use of external fixation (OR: 2.3, 95% CI: 0.9-5.8, P = 0.09) and being non-compliant with the range of motion (ROM) protocol (OR: 3.4, 95% CI: 0.9-13.6, P = 0.08) were marginally associated with an increased likelihood of capsulectomy. Other plausible risk factors such as ipsilateral nerve involvement, an open fracture, head injury, spinal injury, weight-bearing status, and concurrent fractures were not found to be associated with the likelihood of a capsulectomy.

Conclusion: Each additional week in a splint was found to increase the likelihood of a capsulectomy by 16%. Patients who did not adhere to their prescribed ROM protocol were 3 times more likely to have a capsulectomy. The data suggest judicious splint utilization and re-enforcement of a directed and supervised rehabilitation program may mitigate the likelihood of a capsulectomy for elbow fracture patients.

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Reverse Total Shoulder Arthroplasty Improves Pain and Outcomes With Reduced Reoperations Compared to Hemiarthroplasty for Acute Geriatric Proximal Humerus Fractures: A Meta-Analysis

Daniel Austin**, **MD; *Michael Torchia, MD; Niki Cozzolino, BS; Lauren Jacobowitz, BS; John-Erik Bell, MD, MS*

Purpose: Previous meta-analyses comparing reverse total shoulder arthroplasty (RSA) to hemiarthroplasty (HA) for the treatment of acute geriatric proximal humerus fractures have been limited by small numbers of patients. A recent outpouring of new literature greatly expands the available data and warrants an updated meta-analysis.

Methods: We searched MEDLINE, Embase, and the Cochrane Database. We included all studies that directly compared RSA to HA for the treatment of acute proximal humerus fractures in adults with a mean age older than 65 years and at least 6 months of follow-up. We calculated mean differences (MD) for range of motion, standardized mean differences (SMD) for outcome scores and pain scores, and relative risk (RR) for dichotomous outcomes.

Results: 15 studies were included in our review, including 421 patients treated with RSA and 492 treated with HA. Compared to HA, the RSA group had improved pain scores (SMD = 0.74, P <0.001), outcome scores (SMD = 0.63, P <0.001), and forward flexion (MD = 24.3, P <0.001). Compared to RSA, the HA group had an increased risk of reoperation (RR = 2.8, P = 0.02) and a trend toward increased risk of tuberosity non- or malunion (P = 0.06). There were no differences between the groups with regard to external rotation (P = 0.31) or deep infection (P = 0.90).

Conclusion: Our data suggest that RSA should be strongly considered as a reconstructive option in patients with proximal humerus fractures over the age of 65 years. The aggregate of our findings suggests a clear role for RSA in this patient population.

Surgeon Experience, Sagittal Reduction, and Complications of Proximal Humerus Fractures

Tomas Liskutin, MD, MS; *Elizabeth Harkin, MD; Hobie Summers, MD; Joseph Cohen, MD; Mitchell Bernstein, MD; William Lack, MD*

Purpose: Debate remains regarding the role of various treatments for proximal humerus fractures. Complicating this, outcome studies of patients treated with open reduction and internal fixation (ORIF) typically do not account for quality of reduction or surgeon experience. Although coronal plane reduction has recently been associated with outcome, sagittal plane reduction remains unstudied. We hypothesized sagittal reduction quality would be associated with complications, and reductions would improve with experience.

Methods: We retrospectively identified 41 patients sustaining 42 AO/OTA C-type proximal humerus fractures treated with ORIF by a fellowship-trained orthopaedic trauma surgeon in the first 8 years of his career. A second traumatologist blinded to patient characteristics and outcome assessed injury and postoperative radiographs for medial hinge integrity and 5 measures of deformity (coronal head-shaft angle [Has], head-shaft displacement [HSd], greater tuberosity cranialization [GTc], and sagittal HSa and HSd). Major complications and the American Shoulder and Elbow Surgeons (ASES) Shoulder Score were assessed. Student t-test and chi-square analyses assessed reduction quality relative to complications, while analysis of variance assessed reduction precision over time.

Results: Outcome by ASES score was similar to previous reports (mean 73.6, standard deviation 22.5). Complications were assessed for cases having >6 months follow-up (n = 35, mean 48 months, range 7-128). The complication rate was 31.4%, including avascular necrosis (7), loss of reduction (2), posttraumatic arthritis (1), and impingement (1). Reoperation was required for 7 patients. Post-reduction sagittal Has <25° (P <0.01) and lack of medial hinge integrity (P <0.01) were significantly associated with complications. There were no differences in age, mechanism, or fracture classification as surgical experience grew. Post-reduction coronal HSa, sagittal HSa, and sagittal HSd improved significantly with surgeon experience (P <0.01, P <0.01, and P = 0.03, respectively) as did the likelihood of an overall anatomic reduction (P <0.01). Receiver operating characteristic curve analysis found a threshold for superior reduction quality after 23 cases (area under the curve = 0.873, P <0.01).

Conclusion: Sagittal reduction quality and medial hinge integrity were associated with complications. Additionally, reduction quality significantly improved with surgeon experience. Future studies of proximal humerus ORIF should include multiplanar assessments of reduction while accounting for surgeon experience.

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The Ultimate Fate of Radial Nerve Palsy Associated With Humeral Shaft Fractures and Nonunions

***Rebekah Belayneh*, MD;** *Ariana Lott, MD; Jack Haglin, BS; Sanjit Konda, MD; Philipp Leucht, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to comprehensively examine the incidence and resolution of radial nerve palsy (RNP) in operative and nonoperative humeral shaft fracture populations.

Methods: Nerve lesions were identified as complete (RNPc), which included motor and sensory loss, and incomplete (RNPi), which included sensory-only lesions. Charts were reviewed for treatment type, radial nerve status, RNP resolution time, and follow-up time. Descriptive statistics were used to document incidence of RNP and time to resolution. Independent samples t-test was used to determine significant differences between RNP resolution time in operative and nonoperative cohorts.

Results: 175 patients (77 operative and 98 nonoperative) with diaphyseal humeral shaft injury between 2007 and 2016 were identified and treated. 17 out of 77 patients (22.1%) treated operatively were diagnosed preoperatively with a radial nerve lesion. Two patients (2.6%) developed secondary RNPc postoperatively. 8 out of 98 patients (8.2%) presented with RNP post injury for nonoperatively treated humeral shaft fractures. All patients who presented with either RNPc, RNPi, or iatrogenic RNP had complete resolution of their RNP. There was no statistically significant difference found in recovery times when the following groups were compared: operative versus nonoperative RNPc patients, operative versus nonoperative RNPi patients, and RNPc versus RNPi patients.

Conclusion: All 27 patients (100%) presenting with or developing a radial nerve lesion in our study recovered. No patients required further surgery for their radial nerve lesions. Radial nerve exploration appears to facilitate a speedier resolution of RNP when directly compared to observation, although not statistically significant. These findings provide surgeons valuable information they can share with patients who sustain a radial nerve injury with an associated humerus shaft fracture or nonunion.

Minimally Invasive Plate Osteosynthesis (MIPO) of Humeral Shaft Fractures

Mustafa Mesriga, MD, MS; *Mahmoud Hadhoud, PhD*

Purpose: The aim of this study was to assess the clinical and functional outcomes and the complications in patients with humeral shaft fractures treated by using minimally invasive plate osteosynthesis (MIPO).

Methods: 30 patients with humeral shaft fracture were included in this study. The patients were admitted to the orthopaedic department of Menofia university hospital during the period from March 2012 to April 2016 with follow-up period 27 months (range, 18-36 months). The patients were placed supine on the operating table. A 3-cm proximal incision was made 6 cm distal to the acromion between the biceps and the deltoid muscle. A 3-cm distal incision was made at the lateral border of the biceps muscle 5 cm proximal to the flexion crease of the elbow. The biceps was retracted medially to expose the musculocutaneous nerve. The brachialis was split longitudinally. The musculocutaneous nerve was retracted with the medial half of the split brachialis, while the lateral half served as a cushion to protect the radial nerve. The plate was passed deep to the brachialis from the distal to the proximal incision.The plate position and reduction was visualized on the image intensifier. Varus or valgus angulation and rotations were corrected. The plate was temporarilyy fixed to the bone with Kirschner wires. After confirmation of the reduction alignment, screws were inserted to complete the fixation. We assessed operative time, intraoperative radiation exposure, union, postoperative complications, and shoulder and elbow function. Shoulder function was assessed by UCLA (University of California at Los Angeles) score; elbow function was assessed by MEPI (Mayo Elbow Performance Index).

Results: 30 patients with humeral shaft fracture were included in this study. Mean operation time was 80 minutes. Primary union was achieved in 28 patients. Mean time to union was 15.3 weeks. The intraoperative radiation time ranged between 60 and 90 seconds with a mean value of 72 seconds. There was 1 case of deep infection. There was 1 case of postoperative radial nerve palsy that improved clinically with follow-up without surgical intervention. The shoulder and elbow function was satisfactory. The mean elbow function by MEPI score was 90.3, the mean UCLA score for shoulder function was 32.2.

Conclusion: MIPO technique achieves good results in fractures of humeral shaft. It reduces the perioperative complications with a short operation time and minimal soft-tissue dissection. The radial nerve is not at risk as long as the forearm is kept in supination during the procedure, and no screws are inserted into that part of the humeral shaft where the radial nerve runs along the spiral groove.

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Superior Clavicle Plating Using Low-Profile Locking Plates Has Low Complication and Low Hardware Removal Rates

Jessica Mandel**, **BA; *Deirdre Regan, BA; Kyle Hildebrandt, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to describe 1 center's experience using superiorly applied low-profile locking plates for the operative fixation of displaced midshaft clavicle fractures.

Methods: 83 patients who presented with displaced, shortened midshaft clavicle fractures were treated operatively by 1 surgeon at our institution from August 2005 to July 2015. All patients received a specially contoured, low-profile, 2.7/3.5-mm locking plate applied in the superior position. Data were analyzed to evaluate time to union, final shoulder range of motion, incidence of hardware removal, and rate of postoperative complications. Frequencies and means were determined using SPSS version 23.

Results: 9 patients were lost to follow-up before fracture union was documented, leaving a final cohort of 74 patients. Our cohort was 66.2% male with an average age at initial injury of 36.5 ± 14.1 years. At a mean of 3.6 ± 1.9 months, 99% of patients had united their fracture. At an average of 7.37 months follow-up, mean range of shoulder motion was: 174° forward elevation, 173° abduction, 82° external rotation, and internal rotation to T7. Using the Short Musculoskeletal Function Assessment (SMFA), the mean functional outcome index score was 4.12, bothersome index was 1.94, activity index was 1.55, emotion index was 2.51, arm and hand index was 1.14, mobility index was 0.68, and total index was 1.56. 92% of patients had retained their hardware. There was 1 incidence of each of the following complications: infection, nonunion, hardware failure, and deep vein thrombosis.

Conclusion: Previous reports of high incidences of hardware irritation and need for removal were not seen with the use of newer low-profile plates. Superior clavicle plating using precontoured low-profile locking plates is a good treatment modality for displaced midshaft clavicle fractures. This method yields excellent clinical results with regards to time to union, shoulder range of motion, incidence of hardware removal, and the rate of postoperative complications. Patients considering operative fixation of displaced midshaft clavicle fractures should be counseled accordingly.

Time to Radiographic Union: A Predictor of Functional Outcomes in Proximal Humerus Fracture Repair?

Rebekah Belayneh, MD; *Jack Haglin, BS; Ariana Lott, MD; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to investigate the role time to radiographic union may play in long-term functional outcomes of proximal humerus fractures following surgical repair.

Methods: Patients with a surgically treated proximal humerus fracture and a minimum of 12 months of follow-up were reviewed at a single academic institution. Reduction of all fractures and positioning of the osteosyntheses were within acceptable limits. Radiographs were reviewed at each routine time point by the treating physician in concert with the radiologist to determine when the fractures were radiographically healed. Prospectively collected patient-reported long-term functional outcome data were obtained from the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaires. Pearson correlation was performed to study the relationship between time of radiographic union and DASH score. Regression analysis was performed to look for associations between time of radiographic union and other factors.

Results: Complete data were available for 110 eligible patients. The mean time to radiographic union of the proximal humerus fractures in our cohort was 3.6 ± 2.6 months. Statistical analysis revealed that there was a positive correlation between time to radiographic union and DASH scores; the sooner the fracture healed radiographically (low time to radiographic union), the better the outcome (low DASH score) ($r = 0.288$). After controlling for age, body mass index (BMI), and Charlson Comorbidity Index (CCI), time to union still correlated positively and significantly with DASH scores ($r = 0.235$). Multiple linear regression showed that while age, BMI, CCI, and time to union collectively and statistically significantly predicted functional outcomes, time to union was the variable that carried the most weight ($\beta = 0.222$) and was the only statistically significant variable.

Conclusion: Quicker radiographic union is associated with improved long-term functional outcomes following proximal humerus fixation. Bone health strategies that promote faster bony healing may be beneficial not only in the short term but in the longer term as well.

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Does Altering Projection of the Fractured Clavicle Change Treatment Strategy?

Paul Hoogervorst, MD; *Anand Appalsamy, MD; Diederik Meijer, MD; Job Doornberg, MD, PhD; Albert van Kampen, MD, PhD; Gerjon Hannink, PhD*

Purpose: Shortening of the fractured clavicle is proposed and debated as an indicator for surgical intervention. There is no standardized or uniform method for imaging and measuring shortening. Different methods and techniques may can lead to different measured outcomes. However, the question remains whether a difference in measured shortening using a different technique has any short-term clinical relevance in terms of treatment strategy. The aim of this study was to investigate whether a different projection of the same midshaft clavicle fracture would lead to a different choice in treatment strategy.

Methods: 36 AO/OTA 15A.1-3 midshaft clavicle fractures were digitally reconstructed into radiographs in both a 15° caudo-cranial and a 15° cranio-caudal projection. The 72 projections were rated in random order by 23 orthopaedic trauma or upper extremity surgeons for necessitating either conservative or operative treatment.

Results: On average, the raters altered their treatment strategy with a different projection of the same midshaft clavicle fracture 12.2 times of the 36 cases (33.9%), ranging from 5 times (13.9%) to 19 times (52.8%). A statistically significant increase in choice for surgical treatment when using the 15° caudo-cranial projection was identified (P = 0.01).

Conclusion: This study reveals the influence the projection of the midshaft clavicle fracture has on the surgeon's decision of treatment strategy. The decision changed from operative to nonoperative or vice versa in 33.9% of the cases.

Symptomatic Implant Removal Following Mini-Fragment Plating for Olecranon Fractures

Sharon Babcock*, *MD; *Ryan Murphy, MD; Matthew Darlow, BS; Andrew Choo, MD; John Munz, MD; Joshua Gary, MD; Timothy Achor, MD*

Purpose: There are multiple factors associated with reoperation following internal fixation of olecranon fractures, yet symptomatic hardware repeatedly continues to be the largest contributor. A current prospective randomized trial comparing fixation constructs revealed greater than 20% hardware removal rate for fractures treated with plate osteosynthesis. The primary objective of this retrospective case series is to assess the reoperation rate, specifically for symptomatic hardware removal, in adult patients who underwent operative fixation of olecranon fractures treated with mini-fragment plate osteosynthesis over a 2-year period at a single Level I academic trauma institution.

Methods: All adult patients sustaining proximal ulna fractures (AO/OTA 2U1A, B, and C) that underwent fixation with mini-fragment plate osteosynthesis by an orthopaedic traumatologist at a single trauma center from October 2015 over a 2-year period were included. The mechanism of injury and open fractures were noted. The primary outcome of reoperation and reason for reoperation following mini-fragment plate osteosynthesis were documented.

Results: A total of 29 olecranon fractures were treated in 28 patients, with an average age of 43. 12 were involved in motor vehicle or motorcycle accidents, 2 were pedestrian struck, 3 sustained gunshot wounds, and 11 patients (including bilateral fractures in a single patient) sustained falls from standing or a height. There were 12 open fractures and 17 closed fractures. 4 patients underwent reoperation (13.8%). One patient had a planned external fixator removal and manipulation under anesthesia following a type 3C open fracture. The second patient had a superficial wound dehiscence. Two of the 4 patients (6.9%) underwent hardware removal, 1 for ectopic bone excision and contracture release in a polytraumatized patient with a severe head injury, and finally a single patient for symptomatic painful hardware (3.4%).

Conclusion: Mini-fragment plate fixation of olecranon fractures offers a reliable fixation construct, with a lower symptomatic hardware removal rate than conventional fixation methods of tension band wiring and precontoured locking plates.

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Early Results of the Anconeus Approach to the Elbow

Matthew Landrum, MD; Brian Sager, MD; Tyler Youngman, MD; ***Adam Green, MD;*** *Drew Sanders, MD; Ashoke Sathy, MD; Adam Starr, MD*

Purpose: Many approaches provide visualization and access to the elbow joint including the olecranon osteotomy, triceps splitting or sparing, triceps reflecting anconeus pedicle (TRAP) flap, Kocher, and EDC (extensor digitorum communis) splitting. The most widely known approach for access to the proximal radius and ulna via the lateral side of the elbow is the Kocher approach. Less commonly used, the anconeus approach was originally described by Pankovich in 1977. It offers improved visualization of the radial head compared to the Kocher approach and provides a superior view of the ulnohumeral articulation. It can be extensile with the potential to expose the entire proximal radius and ulna. The anconeus approach is technically easy to do and is well tolerated. We perform the approach without reflecting the triceps. The purpose of this study is to review outcomes of patients who underwent fracture fixation or arthroplasty using the anconeus approach and to re-present this useful approach to the orthopaedic trauma community.

Methods: A retrospective chart review was performed using ICD-9, ICD-10, and CPT codes of all patients undergoing open reduction and internal fixation (ORIF) or arthroplasty of radial head fractures, Monteggia fractures, coronoid fractures, or olecranon fractures between the years of 2008 and 2017 at a single institution by 2 surgeons. A total of 111 patients were identified. 50 of the 111 patients underwent surgery utilizing the anconeus approach. 5 patients were excluded for lack of follow-up. The remaining 45 charts were reviewed for outcome measures including estimated blood loss (EBL), final range of motion, and complications including infection, failure of fixation, heterotopic ossification (HO), nonunion, later conversion to arthroplasty, and removal of hardware.

Results: The mean EBL was 57.1 mL. Average follow-up was 31 weeks. The range of motion was recorded as flexion and extension with the averages being 105° (range, 45°-140°) and 19° (range, 0°-85°), respectively. The average arc of motion was 86° (0°-130°). The average pronation was 67° (0°-90°). The average supination was 64° (6°-90°). There were no early or late infections, failures of fixation, or nonunions. There were 8 cases of HO formation (19%). No cases of HO required excision and all occurred about the radial head prosthesis. There was 1 nonunion that required conversion to radial head arthroplasty, 1 conversion to total elbow arthroplasty, and 4 cases of removal of symptomatic hardware.

Conclusion: The anconeus approach provides improved visualization and access to the proximal radius and ulna with a low risk of complications and acceptable return of functional range of motion.

POSTER ABSTRACTS

Rapid Prototyping in Midshaft Clavicle Fracture Repair: A Clinical Study
(IOTA - Netherlands best poster submission)
Rens van der Linde, MD; *Rob van Doremalen, MSc; Jan Kootstra, MD; Svenhjalmar van Helden, MD, PhD; Edsko Hekman, MSc*

Purpose: Clavicle fractures are common injuries, often treated using plate fixation. Clavicle plates rarely fit properly, requiring perioperative alterations. The aim of this study was to test a method in which plates were bent preoperatively, enabling custom-fitted clavicle plates for every individual clavicle. We hypothesized this would shorten the process of perioperative plate handling, and reduce the number of complications and reoperation rate.

Methods: A non-blinded, prospective cohort study was performed. The control group received conventional treatment using standard precontoured clavicle plates. The intervention group was treated using customized plates, which were preoperatively adjusted with the use of reconstructed physical 3-dimensional models. Clinical records were examined in order to obtain patient characteristics and information about the course of treatment. Primary outcome was reduction in plate handling time. Secondary outcomes were complications and reoperation rate, both after ≥2 years.

Results: 7 patients were included in both the control and intervention groups. The process of peroperative plate alteration was reduced by 3:22 minutes (P = 0.430), although the overall average fracture repair time increased by 3:35 minutes (P = 0.450). One patient in the intervention group developed an infection, requiring reoperation. Furthermore, significantly more patients in the control group required a reoperation for plate removal because of implant-related complaints (P = 0.032).

Conclusion: Preoperative adjustments of clavicle plates can successfully be implemented in daily practice. However, it does not reduce overall operation time. A significant decrease in reoperations due to implant-related complications was observed in the intervention group.

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Does Cortical Scoring Work When There Is No Implant? An Assessment of Cortical Scoring in Nonoperatively Treated Humeral Fractures

Paul Tornetta, III, MD; ***Alex Gaukhman, MD;*** *Karina Lo, BS; Jody Litrenta, MD; Samir Mehta, MD; Robert Ostrum, MD; Emil Schemitsch, MD; William Ricci, MD; Robert O'Toole, MD; Stephen Kottmeier, MD; Daniel Horwitz, MD*

Purpose: Cortical scoring systems have demonstrated high observer reliability. Based on prior studies, observer agreement is better after fixation with nails than plates, and bone deficits decrease reliability. However, the use of cortical scoring in fractures without implants has not been clearly evaluated. The purpose of this study is to evaluate the agreement of the RUST (Radiographic Union Score for Tibial Fractures and modified RUST (mRUST) cortical scoring systems in a cohort of nonoperatively treated humeral shaft fractures and to determine the observer-based threshold score for radiographic union.

Methods: We used the radiographs from 113 sets of AP and lateral radiographs of 32 patients who were treated nonoperatively for their humeral shaft fractures (OTA 12-A, B, C). Radiographic sets spanned from 3 weeks to 99 weeks with a mean of 11 weeks to ensure a spectrum from minimal callus to remodeling. These were provided to the evaluators in a random order. 9 experienced orthopaedic trauma surgeons graded each set of radiographs using the mRUST system and graded each set of radiographs as healed or not healed. Absolute intraclass correlation coefficient (ICC) was calculated for the mRUST, the RUST, and for the assignment of union.

Results: Both the mRUST and RUST performed well. The ICC for the individual corticies ranged from 0.65 to 0.70 for the RUST (good) and 0.70 to 0.75 for the mRUST (good to excellent). The ICC for the summed cortical scores were 0.78 and 0.80, indicating excellent agreement. The ICC for the assessment of union was 0.63 (good). In defining the threshold score for radiographic union, 88% of observers graded union if the RUST was ≥9 and the mRUST was ≥13.

Conclusion: The use of cortical scoring systems are reliable for the assessment of radiographic progression of healing in humeral fractures treated nonoperatively, demonstrating excellent agreement. Thresholds of 9 for the RUST and 13 for the mRUST are the most reasonable for defining union, with 88% of observers calling these fractures healed in both cases.

Operative Fixation of Diaphyseal Forearm Fractures Using Mini-Fragment Plates: A Retrospective Review of Fracture Union Rates

***Elizabeth Newman**, MD; Shea Comadoll, BS; Chandler Cox, BS; Edgar Araiza, MD; Holly Pilson, MD; Jason Halvorson, MD; Eben Carroll, MD*

Purpose: Radius and ulna diaphyseal fractures are common adult forearm fractures. The majority of these fractures require surgical intervention with open reduction and plate and screw fixation. The gold standard treatment for adult radius and ulna diaphyseal fractures is fixation with 3.5-mm plates. At our institution we have transitioned to treating many forearm fractures with mini-fragment plates.

Methods: After IRB approval, we retrospectively reviewed all fractures of the radius and ulna fixed with mini-fragment plates over a 5-year period. Only patients 18 years old and older were included in the study. Patients with less than 6 months follow-up were excluded.

Results: A total of 74 radius and ulna fractures met inclusion criteria for the study. The average age of the patients was 42 years old. Most injuries were a result of high-energy trauma. Of the 76 fractures, 73 went on to union (96%). No instances of plate breakage, bending, or failure were noted. Average length of follow-up was 396 days. There were 2 patients with 3 fractures that developed nonunions (all 3 of these injures were open injures). Two were atrophic and 1 was a septic nonunion. In these patients, no hardware failure occurred.

Conclusion: The rate of nonunion in our series was comparable to rates published in the literature. More importantly we noted no instance of hardware failure in this small clinical series. Advantages of the mini-fragment technique include less soft-tissue dissection and implants with more fixation points per unit length of plate. Disadvantages include a slightly increased cost over more traditional implants.

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Outcomes and Complication Rates Following Reverse Shoulder Arthroplasty Treatment for Proximal Humerus Fracture

Santano Rosario, BA; *Alexis Rounds, BS; Paul Navo, MPH; Nicholas Trasolini, MD; Michael Stone, MD; Alexander Weber, MD; George Hatch, MD; Reza Omid, MD*

Purpose: Since the U.S. Food and Drug Administration approval of reverse total shoulder arthroplasty (rTSA) in 2004, the use of this procedure for complicated proximal humerus fractures has gradually increased. This study aims to assess the outcomes and complication rates following rTSA treatment for proximal humerus fractures.

Methods: California's Office of Statewide Planning and Health Development (OSHPD) database was analyzed from 2000 to 2014 for patients who underwent a rTSA as treatment for a proximal humerus fracture. A Kaplan-Meier 10-year survival analysis was performed with failure defined as revision arthroplasty. Patient outcomes and postoperative complication diagnoses were identified.

Results: 1219 patients (73.91% female, age 70.71 ± 13.85 years) diagnosed with proximal humerus fracture who underwent rTSA were identified over a 14-year period. Nearly 40% of patients underwent rTSA the same day as presentation and an additional 46% in the first 6 weeks. The annual amount of rTSAs performed has increased through the 15-year period, in particular between 2010 and 2014 (759% increase in annual totals). There were no cases of revision at 10 years of follow-up. Postoperative complication rates were 0.49% hemorrhage/hematoma, 0.16% infection, and 0.08% damage of another structure.

Conclusion: Reverse shoulder arthroplasty appears to be steadily becoming the preferred operative treatment method for proximal humerus fractures. The low complication rates highlight the low risk of the procedure. Further, the lack of revisions after 10 years illustrates the long-term success rate of the procedure. Future studies should investigate the risk factors predisposing patients to complications following reverse shoulder arthroplasties.

The Impact of Patient Activation on Disability and Patient Experience Following Upper Extremity Fractures

Prakash Jayakumar, MD, PhD; *Teun Teunis, MD, PhD; Sarah Lamb, PhD; Mark Williams, PhD; David Ring, MD; Stephen Gwilym, FRCS*

Purpose: To assess the relationship between patient activation (ie, the propensity to engage with one's health and health-care system) within a month of shoulder, elbow, or wrist fracture, and disability and patient experience at 6 to 9 months.

Methods: 744 adults sustaining upper extremity fractures attending fracture clinics between January 1, 2016 and August 31, 2016 completed outcome measures on a web-based program including measures of patient activation (Patient Activation Measure [PAM-13], Effective Consumer Scale [ECS-17]) within a month of injury and disability (Quick Disabilities of the Arm, Shoulder and Hand [QuickDASH], Patient-Reported Outcomes Measurement Information System Upper Extremity Physical Function Computer Adaptive Test [PROMIS UE PF CAT]) at 6 to 9 months, as well as patient experience (Numerical Rating Scale [NRS] for satisfaction with clinical care [NRS-C] and NRS satisfaction with health services [NRS-S]) at 6 to 9 months, accounting for demographic, clinical, and psychosocial factors. Statistical analysis included bivariate analysis, collinearity assessment, factor analysis, and multivariable regression.

Results: In bivariate analysis, PAM-13 and ECS-17 had moderate-high correlations with PROMIS UE PF (PAM-13: $r = 0.55$; ECS-17: $r = 0.60$) and QuickDASH (PAM-13: $r = -0.65$; ECS-17: $r = -0.67$). PAM-13 and ECS-17 also demonstrated moderate correlations with NRS-C (PAM-13: $r = 0.53$; ECS-17: $r = 0.57$) and NRS-S (PAM-13: $r = 0.55$; ECS-17: $r = 0.58$); $P < 0.001$ for all displayed correlations. Factor sets included (1) psychosocial factors and patient engagement, (2) sociodemographics and patient engagement, (3) pathophysiology, and (4) social support. Factor set 1 accounted for most of the variation in disability (PROMIS UE PF, semi-partial $R^2 = 0.45$; QuickDASH, semi-partial $R^2 = 0.63$) and most of the variation in experience (NRS-C, semi-partial $R^2 = 0.56$; NRS-S, semi-partial $R^2 = 0.64$).

Conclusion: Individuals that are more engaged with their health and health-care systems earlier on achieve better future health-related and experiential outcomes following upper extremity fractures. However, one should also account for psychosocial factors, such as self-efficacy (ie, the confidence and ability to cope despite a painful injury), which may supersede activation in predicting outcomes. Incorporating these findings into a patient-centered approach to managing these patients and making treatment decisions may improve their longer-term outcomes and experiences.

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Influential Factors of Disability Following Elbow Fractures

Prakash Jayakumar, MD, PhD; *Teun Teunis, MD, PhD; Sarah Lamb, PhD; Mark Williams, PhD; Stephen Gwilym, FRCS; David Ring, MD*

Purpose: This study was undertaken to identify the influential factors predictive of medium-term disability following elbow fractures.

Methods: 183 adults sustaining elbow fractures attending fracture clinics between January 1, 2016 August 31, 2016 completed patient-reported outcome measures on a web-based program including measures of disability (Quick Disabilities of the Arm, Shoulder and Hand [QuickDASH], Oxford Elbow Score [OES], 3-Level EuroQol 5 Dimensions [EQ-5D-3L], Patient-Reported Outcomes Measurement Information System Upper Extremity Physical Function Computer Adaptive Test [PROMIS UE PF CAT]) at 6 to 9 months, along with psychosocial (PROMIS Pain Interference CAT, PROMIS Anxiety CAT, PROMIS Depression CAT, PROMIS Emotional / Instrumental Support CAT, Pain Catastrophizing Scale [PCS], Tampa Scale for Kinesiophobia [TSK-11], Pain Self-Efficacy Questionnaire [PSEQ-2]), demographic and clinical factors, and grip strength, assessed within a week (t = 0) and within 2 to 4 weeks (t = 1) after injury. Statistical analysis included bivariate analysis and multivariable regression.

Results: Kinesiophobia consistently explained a large proportion of the variation in disability at t = 0: QuickDASH partial R^2 = 0.08, P = 0.005; OES partial R^2 = 0.122, P <0.001; EQ-5D partial R^2 = 0.069, P = 0.001; PROMIS UE PF partial R^2 = 0.14, P = 0.005. At t = 1, pain self-efficacy (PSEQ-2); QuickDASH partial R^2 = 0.136, P = 0.004; OES partial R^2 = 0.195, P = 0.002; EQ-5D partial R^2 = 0.125, P <0.001; PROMIS UE PF partial R^2 = 0.123, P <0.001; and instrumental support: QuickDASH partial R^2 = 0.273, P <0.001; OES partial R^2 = 0.256, P <0.002; EQ-5D-3L partial R^2 = 0.166, P <0.001; and PROMIS UE Physical Function partial R^2 = 0.075, P = 0.001 were the strongest predictors. Pathophysiology, injury-related factors, and grip strength did not explain any of the variability in disability in multivariable analysis.

Conclusion: Fear of movement or further injury is the dominant psychological predictor of future disability within a week of sustaining an elbow fracture while confidence and coping with the injury, along with practical support provided family and friends, are the strongest predictors after a few weeks of recovery. Incorporating this information into patient-centered management pathways in trauma care may enhance treatment decision-making, improve longer-term patient outcomes, and promote the integration of psychosocial support (eg, behavioral therapy, practical support) during recovery.

Opioid Use Predicts Higher Rates of Nonunion After Proximal Humerus Fractures

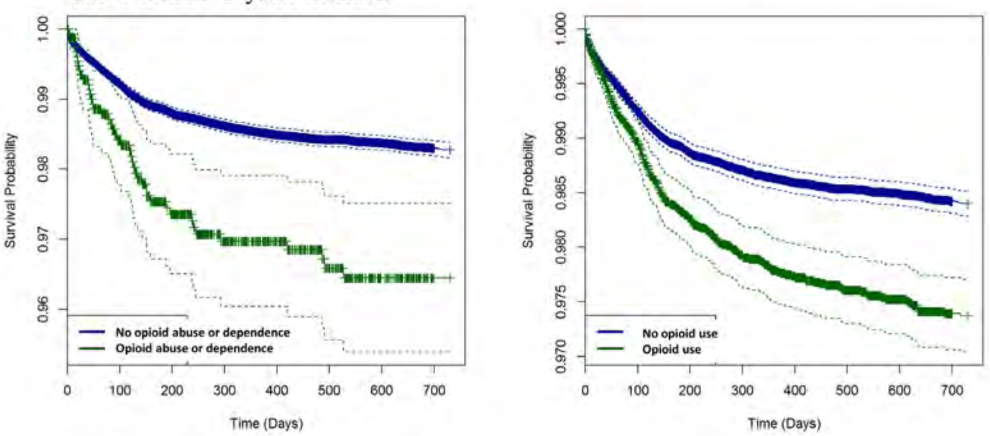
Derek Berglund, MD; *Rushabh Vakharia, MD; Christopher Wang, DO; Dragomir Mijic, DO; Daniel Tarazona, MD; Jonathan Levy, MD*

Purpose: Animal models have suggested that opioids negatively impact fracture healing. However, little is known about how opioid use in the general population affects fracture union. The purpose of this study was to determine the effects of opioid use or previous opioid dependence or abuse on nonunion after proximal humerus fractures.

Methods: Patients sustaining proximal humerus fractures from 2007-2016 were identified within the Humana claims database using ICD-9 or ICD-10 diagnosis codes. Patients were stratified based on presence or absence of diagnosed opioid dependence or abuse prior to fracture. Rates of nonunion after fracture and survivorship to union were analyzed. Secondary analysis was performed for patients using opioids within 30 days of fracture.

Results: 78,216 patients with proximal humerus fractures were identified. 1642 patients (2.1%) had a previous opioid dependence/abuse diagnosis and 11,898 patients (15.2%) filled an opioid prescription within 30 days of fracture. Among opioid abusers, 2.7% of fractures resulted in nonunion within the study period versus 1.4% among non-abusers (P <0.001, odds ratio [OR] = 1.82, 95% confidence interval [CI] = 1.36-2.40). 2.2% of patients using opioids prior to fracture did not heal compared to 1.3% in opioid-free patients (P <0.001, OR = 1.69, 95% CI = 1.47-1.94). Survivorship to union is shown in Figure 1.

Figure 1: 2-year survivorship to union of proximal humerus fractures in patients with vs without diagnosed opioid dependence/abuse and patients with vs without opioid use within 30 days of fracture.



Conclusion: Proximal humerus fractures in patients with a history of opioid dependence/abuse or who are using opioids prior to fracture are nearly twice as likely to result in nonunion.

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Healing the Index Humeral Nonunion Surgery:
117 Cases Treated With Plate Osteosynthesis and Graft Augmentation

Donald Wiss, MD; ***John Garlich, MD;*** *Julie Agel, MA*

Purpose: Nonunion (NU) of the humeral shaft is disabling. We sought to (1) evaluate the effect of plate type and type of biologic augmentation on successful healing, and (2) determine risk factors for recalcitrant nonunions (RNUs).

Methods: We retrospectively reviewed a prospectively collected database of 117 aseptic humeral shaft NUs treated by a single surgeon with plate osteosynthesis and biologic augmentation either with bone morphogenetic protein (BMP) or iliac crest bone graft (ICBG). Biologic augmentation was reserved for oligo- or atrophic NUs. The minimum follow-up was 1 year. We compared healing rates of the NU surgery by plate type (conventional vs locking) and graft choice (BMP vs ICBG). Using logistic and multivariate regression models and chi-squared tests we determined risk factors for developing an RNU.

Results: Of the 117 NUs, treatment for the initial fracture was nonoperative in 51% and operative in 49%. In the operative group, 50% were initially treated with a plate, 35% with a nail, and 15% by other methods. 90.6% of NUs treated with surgery eventually healed: 98 healed after the index NU surgery and 19 developed an RNU. Of the 19 RNUs, 11 remained ununited at last follow-up. There was no statistically significant association between plate type (conventional and locking) and healing rate (P = 0.52). Graft augmentation was used in oligo- and atrophic NUs (n = 91); there was no significant association between graft type (BMP-2 or 7 and ICBG) and healing rates (P = 0.517). Compared to nonoperative treatment, initial operative treatment of the humerus fracture was more likely to develop an RNU (P = 0.03). Initial plate fixation of the acute fracture was the only independent predictor of developing an RNU with an odds ratio of 4.16 (confidence interval [CI], 1.2-14.2) compared to initial nonoperative treatment. Compared to nonoperative treatment, initial fracture treatment with a nail or other methods did not increase the odds of developing an RNU.

Conclusion: We present the largest series to date describing the treatment and outcomes of humeral shaft NUs. Plate osteosynthesis with biologic augmentation in select patients can yield high union rates. Within this cohort, patients were more likely to develop an RNU if the method of treatment for their initial injury was plate osteosynthesis.

Older Age Does Not Affect Outcome in Operatively Managed Fractures of the Upper Extremity

Rebekah Belayneh, MD; *David Kugelman, BS; Abdullah Qatu, BS; Sanjit Konda, MD; Kenneth Egol, MD*

Purpose: The purpose of this study is to investigate and compare the clinical and functional outcomes of elderly patients with surgically managed upper extremity fractures to the outcomes of younger patients with similar injuries treated at the same institution.

Methods: An IRB-approved database was queried for patients who sustained proximal humerus and distal radius fractures treated operatively and had at least 12 months of follow-up. All patients were prospectively followed and assessed for clinical and functional outcomes at the latest follow-up visit using the Disabilities of the Arm, Shoulder and Hand (DASH) survey along with ranges of motion of the injured extremity. Functional and clinical outcomes were compared between the 2 groups to assess for differences using independent t-tests for dichotomous variables.

Results: A total of 405 patients met inclusion criteria. Out of 405 patients, 164 sustained proximal humerus fractures, 211 sustained distal radius fractures, and 30 sustained clavicle fractures. The elderly cohort, made up of patients 60 years of age and older, had 200 fractures of the upper extremity. The non-elderly cohort consisted of 205 fractures of the upper extremity. The average patient age in the elderly cohort was 70 years (range, 60-88), and the non-elderly cohort was 44 years (range, 19-59). Long-term follow-up was obtained for all 405 patients (mean: 16 months; range, 12-72 months). There was a greater percentage of females comprising the elderly cohort (82% vs 57%). No significant differences in the functional and clinical outcomes were found between the 2 groups.

Conclusion: Age alone does not seem to affect clinical and functional outcomes following open reduction and internal fixation of an upper extremity fracture. Elderly patients who underwent operative fixation of upper extremity fractures have similar long-term functional and clinical outcomes compared to those of younger patients.

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Open Reduction and Internal Fixation of Isolated Diaphyseal Humeral Shaft Fractures After Failed Conservative Bracing Versus Immediate Fixation: A Case-Control Series

Jonathan Quade, MD; ***Charles Reeder**, **BS;*** *Gerald McGwin, PhD*

Purpose: We evaluated the definitive surgical treatment and clinical efficacy of simple, non-pathological diaphyseal fractures of the humerus that failed initial conservative bracing. The intent is to reveal statistically significant distinctions that would encourage or dissuade immediate surgery over conservative bracing.

Methods: This IRB-approved study is a retrospective case-control chart review conducted at a single academic Level I institution. Study participation required a non-pathological, isolated diaphyseal humerus fracture requiring open reduction and internal fixation (ORIF) after attempted and failed nonoperative treatment. 35 patients met these criteria from 2008-2014, and were matched to 39 randomly selected control patients who qualified for conservative bracing but instead opted for immediate ORIF. The groups were matched for age, gender, 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 significant difference between the 2 groups with respect to length of surgery (P = 0.328), hospital admission time (P = 0.737), total treatment time (P = 0.248), referral to pain management (P = 0.512), or radial nerve palsy (P = 0.459). Statistically significant parameters included the number of clinic visits prior to surgery (averaging 4.06 in the delayed group vs 1.38 in the control; P <0.001) and time between injury and surgery (59.4 days vs 4.1 days in the control; P <0.001).

Conclusion: This study demonstrates the surgery for humeral nonunions is not significantly different from immediate surgery. The significant findings in this study are related to overall treatment time including office visits and days of conservative treatment. These factors are related specifically to social situations and show a statistically significant acceleration in treatment time for the operatively treated group, allowing the patient to return to work, activities, and functional capacity sooner compared to attempting nonoperative treatment. This study clearly demonstrates that the added indication for surgery on an isolated humeral shaft should include work status and need for timely return from injury.

Dorsal Tangential View Provides a Reliable Assessment of Distal Radioulnar Joint Reduction in the Neutral, Pronated, and Supinated Positions

Matthew Jordan, MD; ***Ashraf El Naga**, **MD;*** *Scott Mitchell, MD; Brian Adams, MD; David Netscher, MD*

Purpose: Assessment of distal radioulnar joint (DRUJ) alignment is often based on lateral radiographs whose interpretation is dependent upon precise forearm positioning. Although more reliable, axial wrist CT scans are not readily available intraoperatively or in clinic. The dorsal tangential view (DTV) is an axial view of the dorsal wrist that is currently used for assessment of dorsal screw penetration during radius fixation. The purpose of this study was to determine if the DTV can also reliably assess DRUJ alignment and if reliability is affected by forearm rotation.

Methods: Four transhumeral cadaveric specimens were used to simulate an unstable DRUJ. The supporting structures of the DRUJ were sectioned. DTV images were obtained with a mini C-arm with the DRUJ held under direct visualization in 5 positions: dorsally dislocated, dorsally subluxed, reduced, volarly subluxed, and volarly dislocated. In each position, DTV images were taken with the forearm in neutral rotation, full pronation, and full supination for a total of 60 images. Three observers (2 trauma-trained, 1 hand-trained) assessed DRUJ position. Sensitivity and specificity were calculated. The weighted kappa statistic was used to assess inter- and intraobserver reliability overall and in each forearm position.

Results: Sensitivity for detecting a DRUJ subluxation or dislocation was 95.7%. Specificity was 89.7%. The weighted kappa for interobserver reliability between paired observers were 0.948 (95% confidence interval [CI] 0.889-1.000), 0.912 (95% CI 0.838-0.986), and 0.929 (95% CI 0.860-0.997) with a mean kappa of 0.930. The mean kappa for interobserver reliability was 0.926, 0.931, and 0.930 for the forearm in neutral, supinated, and pronated positions, respectively. The weighted kappa values for intraobserver reliability were 0.965 (95% CI 0.918- 1.000), 0.964 (95% CI 0.916-1.000), and 0.965 (95% CI 0.916-1.000) for the 3 observers with a mean kappa of 0.965. The mean kappa for intraobserver reliability were 1.000, 0.967, and 0.930 with the forearm in neutral, supinated, and pronated positions, respectively. The DTV demonstrates excellent inter- and intraobserver agreement overall and with the forearm in neutral, supinated, and pronated positions.

Conclusion: The DTV is a reliable way of evaluating the position of the DRUJ and is not dependent on forearm rotation. Surgeons may consider this view for verification of the DRUJ position in the operating room or in clinic.

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Frailty, as Measured by the 5-Item Modified Frailty Index, Predicts Readmission, Reoperation, and Hospital Length of Stay in Elderly Patients Undergoing Surgical Management of Distal Radius Fractures

Jacob Wilson*, *MD; *Russell Holzgrefe, MD; Christopher Staley, BA; Mara Schenker, MD; Clifton Meals, MD*

Purpose: Compared to cast treatment, surgery may expose elderly patients with distal radius fractures to undue risk. Surgical intervention in this cohort may offer less benefit than previously thought and appropriate patient selection is imperative. The modified frailty index (mFI) has been used to predict complications after other orthopaedic surgeries. We hypothesized that this index would predict complications, readmission, reoperation, and increased length of stay in elderly patients with distal radius fractures undergoing open reduction and internal fixation (ORIF).

Methods: This is a retrospective review of the prospectively collected ACS-NSQIP (American College of Surgeons National Surgical Quality Improvement Program) database, including patients >50 years old who underwent ORIF of a distal radius fracture. A 5-item mFI score was calculated for each patient. Postoperative complications, readmission and reoperation rates, as well as length of stay (LOS) were recorded. Bivariate and multivariate statistical analysis was then performed.

Results: 6494 patients were identified (mean age = 65 years). When compared to patients with mFI = 0, patients with mFI ≥2 were nearly 2.5 times as likely to incur a postoperative complication (1.7% to 7.4%; P <0.001). Specifically, the rate of Clavien-Dindo IV, wound, cardiac, and renal complications were increased significantly in patients with mFI ≥2 (P <0.001, P = 0.024, P = 0.01, and P = 0.001, respectively). Additionally, as mFI increased from 0 to ≥2, 30-day reoperation rate increased from 0.8% to 2.4%, 30-day readmission from 0.8% to 4.6%, and LOS from 0.5 days to 1.44 days (P <0.001). Frailty was associated with increased incidence of complications, readmission, and reoperation even when controlling for demographic data, LOS, and operative time. Age alone was not significantly associated with postoperative complications, readmission, or reoperation.

Conclusion: Frail state is highly predictive of postoperative complications, readmission, reoperation, and increased LOS following ORIF of distal radius fractures. Our data suggest that a simple frailty evaluation can help inform surgical decision making in elderly patients with distal radius fractures.

Radiographic Healing and Functional Outcomes of Untreated Ulnar Styloid Fractures Following Volar Plate Fixation of Distal Radius Fractures: A Prospective Analysis

*Michael Okoli, MD; **Asif Ilyas**, MD*

Purpose: Ulnar styloid fractures (USFs) are common concomitant injuries associated with distal radius fractures (DRFs). Recent studies have found conflicting evidence on whether these fractures treated or untreated affect pain and functional outcomes. The purpose of this study was to prospectively evaluate pain and functional outcomes of consecutively untreated USFs in surgically repaired DRFs. We hypothesized that the presence of and treatment of USFs would have no effect on outcomes or reoperations.

Methods: A prospective study at a single institution of consecutive DRFs treated surgically with volar locked plating was undertaken. Patients were scrutinized for the type of USF, and their ultimate effect on the Quick Disabilities of the Arm, Shoulder and Hand (q-DASH, and abbreviated version of the DASH questionnaire) score and the Patient Rated Wrist Evaluation (PRWE) scores. Outcome measures were collected at 2 weeks, 3 months, and 1 year postoperatively.

Results: There was an incidence of 48% (146/306) of surgically treated DRFs with an associated distal ulna fracture. By location, there were 65.8% tip, 27.4% base, and 6.8% neck USFs. Only tip and base fractures were subsequently analyzed. However, there was no statistically significant difference in q-DASH scores irrespective of type at any time point postoperatively. Similarly, no significant difference in PRWE scores was seen irrespective of type at any time point postoperatively. By 1 year postoperatively, there were 53.8% nonunited USFs. Nonunions occurred in 58.8% of tip, 42.9% of base, and 50% of neck USFs. Again, tip and base USF nonunions compared to united USFs also showed no difference in q-DASH and PRWE scores. Lastly, there was no difference in reoperation rate for any reason between patients with versus without an associated USF by final follow-up.

Conclusion: Ulnar styloid fractures are a common concomitant injury occurring in nearly half of distal radius fractures treated surgically, and the majority go on to nonunions. Our prospective cohort analysis showed that neither the presence, type, nor bony union status of a concomitant USF has any significant effect on patient outcomes or reoperations. Our study confirms our hypothesis that USF of the tip and neck should be left untreated.

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How Well Do Injury-Specific and Generic Functional Outcome Measures in Distal Radius Fractures Detect Change Over Time?

***Amar Cheema**, **MD;** Peter O'Brien, MD, FRCPC; Henry Broekhuyse, MD; Pierre Guy, MD; Jeffrey Pike, MD; Kelly Lefaivre, MD, FRCPC*

Purpose: Distal radius fracture treatments have been compared in numerous papers. Outcome measures are now commonly used to determine which of those treatments are most successful. Most of these measures are reliable and validated. However, the degree of responsiveness has not been adequately addressed. These outcome measures have demonstrated the ability to detect change, but how well they can over time has not been investigated. Further, whether injury-specific or generic functional outcome measures can better detect change for a given injury has also not been addressed. We aimed to identify which of the most commonly used outcome measures in the literature for distal radius fractures was most responsive. Secondarily, we identified whether the differing responsiveness reflected a minimal clinically important difference (MCID) as well as floor and ceiling effects.

Methods: 236 patients over the age of 50 years with distal radius fractures (AO/OTA classification 23-A, B, and C) were prospectively enrolled at a single Level I trauma center. Functional outcome measures were collected at baseline, 6 months, and 1 year. Outcome measures used were the physical component of the 36-Item Short Form Health Survey (SF-36), Disabilities of the Arm, Shoulder and Hand (DASH), and the Patient Rated Wrist Evaluation (PRWE). Their ability to detect change, or responsiveness, was evaluated by calculating the standard response means at each time point. The proportion of patients meeting an MCID for each measure, as determined statistically, was also calculated. Floor and ceiling effects were collected at each time point.

Results: The DASH was best at detecting change between 0 and 6 months (P <0.0001), the PRWE was best between 6 and 12 months (P <0.0001), and both were better than the SF-36. The proportion of patients meeting an MCID between 0 and 6 months was greater in the PRWE and DASH, but it did not meet statistical significance (P = 0.23). The PRWE had a significant ceiling effect at baseline (72.31%) and 1 year (17.46%), while the DASH does so only at baseline (50.76%).

Conclusion: Of the outcome measures investigated, our data support the use of the injury-specific DASH and PRWE over the SF-36 in assessing distal radius outcomes as they are better at detecting changes over time. The DASH is best at detecting initial improvement as opposed to the PRWE, which captures late improvement. However, the DASH has no ceiling effect post-injury unlike the PRWE and has a lower floor effect at all time points.

Risk Factors Associated With Distal Radius Implant Removal: A Retrospective Analysis of 1041 Cases

***Mitchell Baker*, BS;** *Ugochukwu Udogwu, BA; Marckenley Isaac, MS; Daniel Connelly, BS; D. Marinos, BS; Nathan O'Hara, MPH; Gerard Slobogean, MD, MPH; Robert O'Toole, MD; W Eglseder, MD; Raymond Pensy, MD*

Purpose: With continued advances in distal radius fracture fixation, contemporary rates of and risk for implant removal are not well defined. The purpose of this study was to identify factors associated with unplanned implant removal in a large cohort of surgically treated distal radius fracture patients.

Methods: A review of 1041 acute distal radius fracture cases requiring operative fixation at our medical system locations from 2007 to 2015 were included in this retrospective study. 131 fractures were treated with dorsal plate fixation, 787 with palmar plate fixation, and 123 with both dorsal and palmar plate fixation. Demographic, clinical, and treatment characteristics were included as candidate predictors in an initial Cox proportional hazards model that was reduced using forward stepwise elimination based on a minimum Bayesian information criterion to identify factors associated with the primary outcome variable of symptomatic implant removal.

Results: Of the 1041 cases included in the analysis, the mean patient age was 48 years (standard deviation [SD] 17) and 55% were male. Overall, the 1-year implant removal rate was 5.4% and the 5-year implant removal rate was 7.8%. Dorsal plating and patient age remained as the only significant factors associated with implant removal in the reduced model. Patients with dorsal plating were twice as likely to have their implants removed (hazard ratio [HR]: 2.1, 95% confidence interval [CI]: 1.1-3.6, P <0.01). Increased age was protective against implant removal (HR: 0.8 per decade, 95% CI: 0.7-0.9, P <0.01). 1-year implant removal rates for patients with dorsal plates were 8.9% compared to 4.0% in patients without dorsal plates (P <0.01). 5-year implant removal rates were 12.1% in patients with dorsal plates compared to 6.4% in patients treated with other techniques (P <0.01). Palmar plating was not associated with distal radius fracture implant removal.

Conclusion: Our approach to distal radius fracture fixation results in dorsal implant removal rates lower than previous reports, yet remain double that of palmar fixation. Our data indicate that dorsal implant fixation appears to have an acceptable removal rate and remains a valuable component of fixation strategies.

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Effects of Centralized Microvascular Outreach on Quality of Patient Care

***Christopher Chen**, **MD;** Drew Newhoff, MD; Kyros Ipaktchi, MD; Dawn Goral, BS*

Purpose: Decentralization of digit replantation from high-volume hospitals has been correlated to decreased success of digital replantation. These findings suggest that certain digital injuries should be transferred to specialty centers for higher level of care. However, such practice may lead to inappropriate referrals, longer transfer times, overburdening of operating room resources, and poor patient follow-up. The purpose of this study was to compare patient care from before and after the designation of our institution as a 24/7 replantation center. We hypothesize that there will be a significant increase in referrals that do not require microvascular intervention, increased time to surgery, and shorter duration of follow-up.

Methods: Patients transferred to our institution between January 2009 and December 2015 for microvascular evaluation were divided into 2 groups: before and after May 2012, when our institution transitioned from part-time to 24/7 microvascular coverage. Retrospective chart review was performed to collect data on transport distance, time from injury to operative theater, use of microcopic technique, and duration of postoperative follow-up. Data were analyzed with a Student t-Test, with significance set at $P < 0.05$.

Results: 166 versus 350 patients were transferred to our institution for microvascular intervention before and after 24/7 microvascular coverage. There was no significant difference in the proportion of these patients who required microscopic exploration or repair (28.3% vs 28.6%). For these patients, there was no significant difference in time from injury to time of operation (9 hours 59 min vs 8 hours 56 min, $P = 0.72$). Finally, there was no significant difference in mean follow-up after surgery (4.35 months vs 6.20 months, $P = 0.75$).

Conclusion: Our data demonstrate that despite the increased volume of transfers following our designation as a 24/7 replant center, patients received comparable care with regard to timing to operating room and duration of postoperative follow-up. This study supports the use of centralized specialty centers for treatment of digital amputation or injuries requiring microscopic revascularization. Moving forward, technological advances in telemedicine may be useful in improving the quality of patient transfers to prevent overburdening of specialized centers.

Influential Factors of Disability Following Distal Radius Fractures

Prakash Jayakumar*, *MD, PhD; *Teun Teunis, MD, PhD; Sarah Lamb, PhD; Mark Williams, PhD; David Ring, MD; Stephen Gwilym, FRCS*

Purpose: This study was conducted to identify the influential factors predictive of medium-term disability following distal radius fractures.

Methods: 384 adults sustaining wrist fractures attending fracture clinics between January 1, 2016 and August 31, 2016 completed patient-reported outcome measures (PROMs) on an web-based program including measures of disability (Quick Disabilities of the Arm, Shoulder and Hand [QuickDASH], Patient Rated Wrist Evaluation [PRWE], 3-Level EuroQol 5 Dimensions [EQ-5D], Patient-Reported Outcomes Measurement Information System Upper Extremity Physical Function Computer Adaptive Test [PROMIS UE]) at 6 to 9 months, along with demographic, clinical and psychosocial factors (PROMIS Pain Interference CAT, PROMIS Anxiety CAT, PROMIS Depression CAT, PROMIS Emotional/Instrumental Support CAT, Pain Catastrophizing Scale [PCS], Tampa Scale for Kinesiophobia [TSK-11], Pain Self-Efficacy Questionnaire [PSEQ-2]) assessed within a week (t = 0) and 2 to 4 weeks (t = 1) after injury. Statistical analysis included bivariate analysis and multivariable regression.

Results: Pain self-efficacy consistently explained a large proportion of the variation in disability at t=0: QuickDASH partial $R^2 = 0.23$, $P < 0.001$; PRWE partial $R^2 = 0.13$, $P < 0.001$; EQ-5D partial $R^2 = 0.16$, $P < 0.001$; along with anti-depressant use: QuickDASH partial $R^2 = 0.44$, $P < 0.001$; PRWE partial $R^2 = 0.47$, $P < 0.001$; EQ-5D partial $R^2 = 0.31$, $P < 0.001$; PROMIS UE PF partial $R^2 = 0.14$, $P < 0.001$. At t=1, pain self-efficacy was again the strongest predictor: QuickDASH partial $R^2 = 0.39$, $P < 0.001$; PRWE partial $R^2 = 0.30$, $P < 0.001$; EQ-5D partial $R^2 = 0.30$, $P < 0.001$; PROMIS UE PF partial $R^2 = 0.52$, $P < 0.001$; along with anti-depressant use: QuickDASH partial $R^2 = 0.18$, $P < 0.001$; PRWE partial $R^2 = 0.26$, $P < 0.001$; EQ-5D partial $R^2 = 0.12$, $P < 0.001$. Other factors explaining a substantial proportion of variance included being retired, unemployed, on Workers' Compensation, having a prior arm fracture, and using opioids, but these were not consistent across PROMs.

Conclusion: Self-efficacy, the confidence in one's ability to cope despite pain, along with anti-depressant use, were the dominant predictors of future disability following a distal radius fracture, both within a week and a month following injury. Incorporating this information into patient-centered management of these injuries may enable better treatment choices, generate new treatment modalities such as behavioral therapies in trauma care, and improve patient-reported outcomes.

POSTER ABSTRACTS

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Volar Plating in Distal Radius Fractures: A Prospective Clinical Study on Efficacy of Dorsal Tangential Views (AKA Lleyton Hewitt View) to Avoid Dorsal Screw Penetration

Minke Bergsma, MD; *Job Doornberg, MD, PhD; David Worsley, FRCS; Ruurd Jaarsma, MD, PhD*

Purpose: Delayed ruptures of the extensor tendons secondary to the use of volar locking plates for distal radial fractures is an avoidable iatrogenic complication. Although common practice in South Australia, the efficacy of dorsal tangential views (DTVs) has not been evaluated accurately. The purpose of this prospective cohort study is to evaluate the efficacy of DTVs.

Methods: At 1 Level I trauma center, we prospectively included 42 females and 13 males with an average age of 59 years (range, 56 to 89 years) undergoing volar plating for 19 extra-articular (AO Type A), 22 simple articular (AO Type B), and 14 complex articular fractures (AO type C). Variable-angle locking compression plates (VA-LCP, Synthes) with 4 distal holes were used in 43 cases, and 5 distal holes in 12 cases , including 7 volar rim plates. All DTVs--including fluoroscopy views that included protruding screws--were saved to our digital archiving system.

Results: Efficacy (defined as change of screws) of DTVs after volar plating of distal radius fractures is 29%. DTVs revealed dorsal cortex protrusion in 12 of 55 included fractures (22%) with an average screw length of 20.8 mm (range, 24 to 12 mm) changed to 18.1 mm (range, 22 to 10 mm): 7 radial styloid screws, 2 second from radial, 2 second from ulnar, and 1 ulnar-sided screw was changed. Treating surgeons decided to change to longer screws in 4 cases with lengths from 17.3 mm (range, 20 to 14 mm) to 20 mm (range 22 to 16 mm). One patient had an extensor pollicis longus (EPL) rupture, which may have been caused by either a protruding screw that was not identified on DTV, or the fracture spica obscuring the obtained view as identified on CT.

Conclusion: The results are consistent with previously preclinical work: obtaining the DTVs is efficient in addition to AP and lateral views as it reveals dorsally protruding screws in over 35%, and leads to change in practice in order to avoid iatrogenic extensor tendon rupture after volar plating for distal radius fractures.

Drainless Closure With Preoperative Tranexamic Acid in Decreasing Blood Loss in Surgical Treatment of Fractures of the Hip Region

Sathis Chandran, MS

Purpose: Fractures of the hip region are very common in the elderly population. All of these cases are routinely treated by surgery. A common practice is to use suction drains in fracture surgery to decrease the incidence of postoperative blood collection. Tranexamic acid reduces blood loss during surgery and postoperative period. In Kannur medical college, there are many surgeons doing hip fracture surgery in which some surgeons use tranexamic acid preoperatively and some of them do not use them. Also, some of them routinely use closed suction drains after surgery, while some of them do not. A study was undertaken to study and compare the blood loss in these groups.

Methods: All patients who underwent hip fracture surgery in Kannur medical college from January 2012 to December 2014 were included in the study. Total number of cases was 212: tranexamic acid group (no suction drain), 107; only suction drain, 62; and no drain and no preoperative tranexamic acid, 43. The patients underwent appropriate preoperative investigations and consultations to assess fitness to undergo surgery. Preoperative hemoglobin (Hb) % and PCV (packed cell volume) were noted. All cases were done under epidural/spinal anesthesia. In the tranexamic acid group, IV injection of tranexamic acid 1000 mg was given 10 minutes before incision and injection of tranexamic acid 500 mg repeated after 6 hours in the postoperative period. Postoperative Hb % was compared with preoperative value. The fall in Hb % was compared with other 2 groups.

Results: Mean preoperative Hb % was 12.2 g/dL. Mean postoperative Hb % in the tranexamic acid group was 11.23 g/dL, compared to mean postoperative Hb % with only suction drain of 10.10 g/dL, and mean postoperative Hb % with no suction/no tranexamic acid of 10.75 g/dL.

Conclusion: Hip fracture is the most common semi-emergency procedure done in Kannur medical college. Some blood loss is inevitable since tourniquets canot be applied to hips. These elderly patients with poor blood reserve cannot afford much blood loss.Tranexamic acid administration definitely reduces blood loss during and in the postoperative period as compared to the groups without tranexamic acid. Use of suction drain results in increased blood loss due to constant sucking of the blood from the operative site. Suction drains may also act as a portal for bacteria to enter the wound. As is evident in this study, if injection of tranexamic acid is used, there is definite decrease in postoperative blood oozing and therefore no need for any suction drain. There was no instance of any serious hematoma collection in the tranexamic acid/no suction drain group. Postoperative Hb % was less decreased in this group compared to other groups. This study suggests that IV tranexamic acid combined with drainless closure is safe and effective in reducing blood loss during hip fracture surgery.

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Fracture Pattern of Greater Trochanter in Femoral Trochanteric Fracture: Evaluation With 3D-CT

Etsuo Shoda*, *MD; *Shimpei Kitada, MD; Takahiro Niikura, MD; Atsushi Sakurai, MD; Takeharu Sasaki, MD*

Purpose: Femoral trochanteric fracture is sometimes very difficult to recognize exact fracture pattern, especially greater trochanter, in plain radiographs. In this study, fracture pattern of greater trochanter was evaluated with 3-dimensional (3D)-CT.

Methods: 250 femoral trochanteric fractures (46 men, 204 women; over 65 years old) treated in 4 hospitals (April 2014 to August 2015) were evaluated with 3D-CT.

Results: Fracture patterns of greater trochanter are following 5 patterns (Figure 1): (1) no fragment, G(-); (2) small fragment in the tip, G(S); (3) big oblique fragment not including lesser trochanter, G(B); (4) large oblique fragment including lesser trochanter, G-L; and (5) whole greater trochanter is 1 big fragment, G(W). G(-) was 63 cases, G(S) 30 cases, G(B) 39cases, G-L 85 cases, and G(W) 33 cases. G-L is most frequent in 3D-CT.

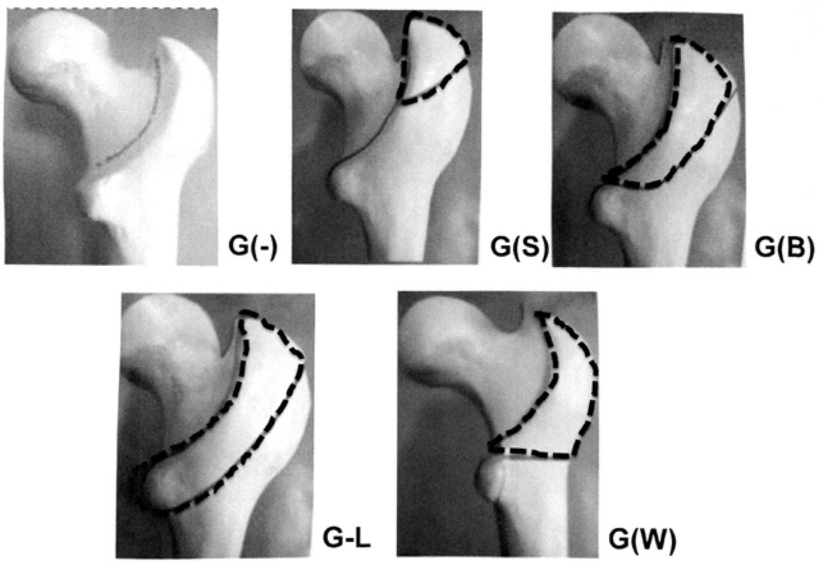

Figure 1. Fracture pattern of greater trochanter (posterior)

Conclusion: The case without posteromedial bone support is recognized as unstable. G-L has no posteromedial support because lesser trochanter is included in the large fragment. So this G-L type should be divided into unstable fracture. However, 47 cases of 85 cases (55%) of this type were classified as stable fracture in AO/OTA classification. This shows it is very difficult to recognize this fragment in plain radiographs. 3D-CT shows the fracture line very clearly, making it easy to understand the fracture pattern of the greater trochanter.

Implementation of New Standard Operating Procedures:
What Are the Benefits for Geriatric Trauma Patients With Multiple Injuries?

Lorenz Peterer, MD; ***Kai Jensen, MD;*** *Georg Osterhoff, MD; Ladislav Mica, MD; H.-P. Simmen, MD; Hans-Christoph Pape, MD; Kai Sprengel, MD*

Purpose: The demographic changes toward aging of the population imposes a challenge to trauma centers, as geriatric trauma patients require specific procedures. This study investigated whether the integration of new standard operating procedures (SOPs) for the resuscitation room (ER) has an impact on the clinical course in geriatric patients. The new SOPs were designed for severely injured adult trauma patients, based on the Advanced Trauma Life Support (ATLS) and imply early whole-body CT, damage control surgery, and the use of goal-directed coagulation management. We investigated whether there were changes in the in-hospital mortality and infection rate after the implementation of new SOPs.

Methods: In this single-center cohort study, we included all patients ≥65 years of age with an ISS ≥9 who were admitted to our hospital primarily via ER. A historic cohort was compared to a cohort after the implementation of the new SOPs. Pearson's chi-square, Fisher's exact, and Mann-Whitney U tests were used to compare the treatments. Binary logistic regression analysis was conducted to measure the strengths of associations and to identify possible risk factors.

Results: We enrolled 311 patients who met the inclusion criteria between 2000 and 2006 (group PreSOP) and 2010 to 2012 (group SOP). In group SOP, the mortality rate was significant lower (64.1% vs 44.4%; standardized mortality ratio 0.90 vs 0.70, P = 0.001) whereas the rate of infections (21.4% vs 21.9%) was comparable and not significant different with group PreSOP. Traumatic brain injuries were the leading cause of death in both time periods (60.2% vs 72.5%). However, the rate of exsanguinating patients decreased from 26.5% to 7.5%. This benefit was seen only for severely injured patients (ISS ≥16), but not for moderately injured patients (ISS 9-15).

Conclusion: Our findings suggest that the implementation of new SOPs comprising early whole-body CT, damage control surgery, and the use of goal-directed coagulation management significantly reduced the mortality rate in severely injured geriatric trauma patients, whereas moderately injured patients seemed not to obtain the same benefit and with no influence on the infection rate. Further research is needed to improve the outcomes for this fast-growing population.

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Posterior Plate Fixation for Unstable Pelvic Ring Fractures

***Masahiro Shirahama**, MD, PhD;* *Shingo Okazaki, MD; Yuka Sugiura, MD*

Purpose: We reviewed clinical results with a minimally invasive method and using a newly developed plate for unstable pelvic ring fractures, especially vertically unstable sacral fractures.

Methods: Between January 2002 and June 2017, 60 patients with vertically unstable sacral fractures were treated with a minimally invasive method and using an M-shaped transiliac plate (Best Medical Co) that was developed by the author. This plate is anatomically designed for posterior pelvic ring, and achieved rigid fixation when fitted in the bilateral iliac spines. From 2014, we changed the plate design, and added locking screw system. This gull-wing locking plate (Omic Co) has achieved more invasive and rigid. Patients included 32 male and 28 female, with the mean age of 46.2 years (range, 15-82). According to the AO classification, 37 patients had a C1 injury, 14 had a C2 fracture, and 9 patients sustained a C3 injury of the pelvic ring. The plate was inserted under the paravertebral muscles through bilateral 5-cm longitudinal incisions just cranial to the posterior superior iliac spines. Functional outcome was assessed using the Majeed functional evaluation and radiography. Minimum follow-up was 1 year.

Results: All patients were not fixed anterior of the pelvic ring. The average surgical time was 90 minutes (range, 45-150), and intraoperative blood loss was 259.8 mL (range, 35-1055). Postoperative functional results were excellent and good in 49 patients (81.7 %), and fair in 9 cases due to infection or sciatic nerve paralysis. Poor results were 2 cases of infection, and 1 case of nonunion. 8 patients had complicated wound-healing delays, but there was no residual pain or redisplacement.

Conclusion: Using an M-shaped transiliac plate and gull-wing locking plate can achieve significant outcome and rigid fixation with minimal invasion for vertically unstable sacral fractures.

Is 24/7 Specialized Trauma Care a Lifesaver?

***Roos Havermans**, MD;* *Mariska de Jongh, PhD; Koen Lansink, MD, PhD*

Purpose: The implementation of the trauma centers has led to a significant reduction in mortality and length of hospital stay. The trauma care should be optimized in order to reach even higher survival rates. The aim of the present cohort study was to evaluate the trauma care in a Level I trauma center after the implementation of a 24/7 in-hospital coverage of the trauma surgeon, intensivist, anesthesiologist, and emergency physician. Besides, the in-hospital infrastructure related to the trauma care has been optimized. The purpose is to reach improved survival rates for the trauma patients after the optimizations.

Methods: A cohort study was performed. All adult trauma patients admitted to our trauma center directly during the years 2010 through 2012 (period I) and 2014 through 2016 (period II) were included and analyzed. Data were obtained directly from the trauma registry database and the hospital records. Logistic and linear regression was used, adjusted for demographics and characteristics of trauma. The primary end point is mortality, divided into mortality at the trauma room, mortality within 48 hours, and in-hospital mortality. Secondary end points are emergency room time (ER time), time until CT, hospital length of stay (H-LOS), ICU length of stay (ICU-LOS), complications, emergency intervention, time until emergency intervention, and delayed diagnosis.

Results: A total of 3714 patients were included: 1290 in period I and 2424 in period II. Mean ISS decreased from 10.5 to 9.1. Mean Revised Trauma Score (RTS) increased from 11.3 to 11.6. In-hospital mortality adjusted for confounding factors showed a reduction in period II (odds ratio [OR]: 0.65; $P = 0.042$). ER time decreased with 30 minutes ($P < 0.001$) and time until CT decreased with 22 minutes ($P < 0.001$). The number of delayed diagnoses and complications were significantly lower in the second period, with an OR of, respectively, 0.2 and 0.4 ($P < 0.001$). H-LOS and ICU-LOS decreased significantly, respectively, -0.9 day ($P = 0.032$) and -1.8 days ($P = 0.022$).

Conclusion: The 24/7 in-hospital coverage of the senior clinicians saves live with the improved survival rates. Moreover, the clinical outcomes for the trauma patients improved and the length of hospital stay decreased. Therefore, the 24/7 in-hospital coverage of senior clinicians and optimization of the in-hospital infrastructure related to the trauma care are recommended for other Level I trauma centers to improve the survival rates.

POSTER ABSTRACTS

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Clinical and Radiographic Predictors of Acute Compartment Syndrome in Tibial Shaft Fractures

Lydia Wuarin, MD; *Amanda Gonzalez, MD; Patrick Belinga, MD; Pierre Hoffmeyer, MD; Robin Peter, MD; Axel Gamulin, MD*

Purpose: The aim of this study was to retrospectively evaluate the relationship between epidemiological, clinical, and radiographic factors of patients with tibial shaft fractures and the development of acute compartment syndrome (ACS).

Methods: 270 consecutive adult patients sustaining 273 tibial shaft fractures between January 2005 and December 2009 were included in this retrospective cohort study. The outcome measure was ACS, which was clinically diagnosed. Patient-related (age, sex), fracture-related (high- vs low-energy injury, monotrauma vs polytrauma, closed vs open fracture), and radiological parameters (AO/OTA classification, presence or absence of a noncontiguous tibial plateau or pilon fracture, distance from the center of the tibial fracture to the talar dome, distance between tibial and peroneal fracture if associated, and total angulation and total translation of main tibial fragments) were evaluated regarding their potential association with ACS. Logistic regression was used for the analysis, predictors significant at P <0.2 were included in the final model.

Results: ACS occurred in 31 (11.4%) of 273 tibial shaft fractures. In the univariate analysis, age <45 years, male gender, high-energy trauma, polytrauma, closed fracture, higher AO/OTA classification, and longer distance from the center of the tibial fracture to the talar dome (≥15 cm, meaning a more proximal fracture) were significantly associated with an increased rate of ACS. In the multivariate analysis, age <45 years, male gender, closed fracture, polytrauma, and a longer distance from the center of the tibial fracture to the talar dome remained statistically significant predictors (P <0.2).

Conclusion: One radiological parameter related to the occurrence of ACS has been highlighted in this study, namely a longer distance from the center of the tibial fracture to the talar dome, meaning a more proximal fracture. A potential explanation is that a fracture occurring at a location surrounded by a bulkier muscle mass (proximal diaphysis) may lead to more energy transmitted to the soft tissues, thus to the potential development of ACS. This observation may be useful when clinical findings are difficult to assess (doubtful clinical signs, obtunded, sedated or intubated patients). However, larger studies are mandatory to confirm and refine the prediction of ACS occurrence.

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

Cheng Ren*, *MD; *Zhong Li, MD; Kun Zhang, PhD; Qian Wang, MD; Kun Zhang, PhD*

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 in the treatment of intramedullary nailing for tibial fractures through a retrospective analysis.

Methods: 246 cases from January 2014 to May 2017 were divided into group A and group B according to the difference of the locking tools. The patients in group A were treated with traditional locking tools; the patients in group B were treated with the new type of ultradistal locking tools. Time consumption of operation, the number of intraoperative fluoroscopy, and one-time locking ratio in 2 groups were obsevved.

Results: The average time consumption of operation in the group A is 70.6 ± 4.2 minutes; the time in the group B is 59.8 ± 3.3 minutes. The comparison between the 2 groups was statistically significant (P = 0.021). The average number of intraoperative fluoroscopy in group A is 21 ± 4.2; the number in group B is 10 ± 4.1 The comparison between the 2 groups was statistically significant (P = 0.019). The average one-time locking ratio in group A was 86.54% and 95.36% in group B; the comparison between the 2 groups was significant (P = 0.003).

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

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Does the Time of the Day of Surgery Influence Perioperative Complications? A Nationwide Database Analysis In 31,692 Patients

Sascha Halvachizadeh, MD; *Hans-Christoph Pape, MD; V. Neuhaus, PD, MD*

Purpose: Emergency and surgery for acute injuries is often required to avoid excessive bleeding and prevent from infections in open fractures. However, it has previously been discussed that surgeon-related factors (eg, experience of the surgeon, teaching vs non-teaching hospital) might play a role in adverse outcomes for these surgeries. The purpose of this study was to evaluate whether the time of day for emergent surgery is associated with complications.

Methods: A prospective database (AQC, nationwide Swiss quality assurance project) was used to evaluate all trauma surgeries within 11 years in more than 70 Swiss surgical units. Inclusion criteria were all trauma coded diagnoses that were surgically treated in Swiss hospitals. Exclusion criteria were cases missing data for time of surgery. The time of surgery was stratified into morning (7 AM to noon), afternoon (1 PM to 6 PM), evening (7 PM to 11 PM) and night (midnight to 6 AM). The primary outcomes were intraoperative (eg, nerve, tendon, or vascular damage, iatrogenic fractures), postoperative (eg, bleeding, infection, impaired wound healing, incorrect axial, rotational, or length reduction), general complications (pulmonary, cardiovascular, gastrointestinal, renal, or neurological), and mortality. Co-factors included age, gender, ASA (American Society of Anesthesiologists) classification, type of surgery, experience of the surgeon, length of surgery, and length of stay. Variables were sought in bivariable and multivariate anylysis.

Results: Of 31,692 patients, 44% were operated in the morning, 40% in the afternoon, 14% in the evening, and 1.7% at night. The in-hospital mortality rate was significantly higher after nightly (2.4%) as well as afternoon surgery (1.7%). The time of surgery had no significant influence on intra- (0.5%) or postoperative complication rates (3.4%) in multivariable analysis, but a significant influence on general complications (7.9%). Afternoon and night surgery were significant predictors for general complications. Age, gender, higher ASA classification, and emergency procedures were typical risk factors for mortality and complications in this cohort.

Conclusion: Emergency procedures performed at night and in the afternoon appear to be associated with an increased incidence of adverse outcomes. Further studies should evaluate whether this is relevant for certain diagnoses and/or procedures

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Chandra, Tulika King George's Medical University, Lucknow, Uttar Pradesh, India	Paper #72
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Chang, Anseong Guro Hospital, Korea University Medical Center, Guro-gu, Seoul, Republic of Korea	Poster #106
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Chen, Christopher University of Colorado, Aurora, Colorado, USA	Poster #165
Chen, Eric Boston University Medical Center, Boston, Massachusetts, USA	Paper #123
Chen, Wei Hebei Third Hospital, Shijiazhuang, China	Basic Science Paper #7
Chesser, Tim Southmead Hospital, North Bristol NHS Trust (British Orthopaedic Trauma Society), Bristol, United Kingdom	International Symposium; Breakout Sessions

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Flecher, Xavier Marseille University, Marseille, France	International Paper #62
Fleming, Mark LAC+USC Medical Center, Los Angeles, California, USA	Poster #63
Fontalis, Andreas St George's Hospital, London, United Kingdom	International Paper #63
Ford, Jonathan University of South Florida, Tampa, Florida, USA	Poster #92
Fowler, T. Ty Orthopedic ONE, Columbus, Ohio, USA	Poster #30
Fowler, Tim North Bristol NHS Trust, Bristol, Avon, United Kingdom	Paper #76
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Frank, Johannes J University Hospital Frankfurt, Frankfurt, Germany	International Paper #62
Fredericks, Douglas C University of Iowa, Coralville, Iowa, USA	Basic Science Paper #12
Freeman, Barbara J. Kings County Hospital Center, Brooklyn, New York, USA	Poster #48
Frenette, Riley University of Michigan, Ann Arbor, Michigan, USA	Poster #54
Frey, Katherine Baltimore, Maryland, USA	Posters #135, 136
Friess, Darin Oregon Health and Science University, Portland, Oregon, USA	Breakout Session
Fukui, Tomoaki Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan	Poster #1
Fuller, Garth Cedars Sinai Medical Center, Los Angeles, California, USA	Paper #122
Funk, Shawn Texas Scottish Rite Hospital for Children, Dallas, Texas, USA	Posters #69, 72

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Lee, Richard MetroHealth System, Cleveland, Ohio, USA	Poster #128
Lee, Sang Yang Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan	Poster #1
Lee, Sooyeon New York University School of Medicine, New York, New York, USA	Basic Science Paper #16
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Leighton, Ross K Nova Scotia Health Authority, Halifax, Nova Scotia, Canada	International Symposium; Paper #104; Poster #28
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Lightdale-Miric, Nina Children's Orthopaedic Center, Children's Hospital Los Angeles, Los Angeles, California, USA	Paper #84
Lin, Carol A Cedars-Sinai Medical Center, Los Angeles, California, USA	Paper #122; Posters #33, 34, 52, 129

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Liporace, Frank A Jersey City Medical Center, Jersey City, New Jersey, USA	Paper #69; Breakout Sessions
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Liskutin, Tomas Loyola University Medical Center, Maywood, Illinois, USA	Poster #142
Litrenta, Jody Boston University Medical Center, Boston, Massachusetts, USA	Poster #151
Little, Milton TM Cedars-Sinai Medical Center, Los Angeles, California, USA	Paper #122; Posters #33, 34, 52, 96, 129; Breakout Session
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Liu, Max Bolun Institute for Global Orthopaedics and Traumatology, San Francisco, California, USA	Paper #75
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Livermore, Andrew University of Wisconsin, Madison, Wisconsin, USA	Paper #85; Poster #70
Lo, Karina Cooper University Hospital, Camden, New Jersey, USA	Poster #151
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Lopez Gonzalez, Jose Alberto Hospital Civil de Culiacan, Culiacan, Sinaloa, Mexico	Poster #104
Lora Fierro, Emilio Heraclio Hospital Civil de Culiacan, Culiacan, Sinaloa, Mexico	Poster #104
Lord, Elizabeth UCLA Medical Center and Orthopaedic Hospital, Santa Monica, California, USA	Paper #128
Lorich, Dean G Hospital for Special Surgery, New York City, New York, USA	Paper #90

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Weber, Timothy G OrthoIndy, Indianapolis, Indiana, USA	Paper #69
Wegener, Stephen Baltimore, Maryland, USA	Poster #136
Weil, Simon St George's Hospital, London, United Kingdom	International Papers #38, 63
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Weinlein, John Charles Campbell Clinic, Memphis, Tennessee, Memphis, Tennessee, USA	Paper #108
Weldy, John University of Mississippi Medical Center, Jackson, Mississippi, USA	Poster #16
Wellman, David Stephenson Hospital for Special Surgery, New York City, New York, USA	Paper #90
Wen, Shiming Department of Orthopedic Trauma,HongHui Hospital,Xian Jiaotong University Health Science Center, Xi'an, Shannxi, China	International Papers #31, 46
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Whitaker, John University of Louisville, Louisville, Kentucky, USA	Paper #67
Whitchurch, Theresa UC San Diego, San Diego, California, USA	Poster #42
White, Fletcher	Basic Science Paper #13
White, Melissa University of Minnesota & Regions Hospital, St. Paul, Minnesota, USA	Poster #36
White, Timothy O Edinburgh,	Breakout Session
Whitehouse, Michael University of Bristol, Bristol, Avon, United Kingdom	Paper #76
Whiting, Paul Spencer University of Wisconsin, Madison, Wisconsin, USA	International Paper #57; Papers #85, 114; Poster #70; Breakout Session
Whittaker, Mathew UC San Diego, San Diego, California, USA	Basic Science Paper #27

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Ramon B. Gustilo, MD, Founding President	
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Charles C. Edwards, MD	1987-88
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Bruce D. Browner, MD	1989-90
Joseph Schatzker, MD	1990-91
Richard F. Kyle, MD	1991-92
Robert A. Winquist, MD	1992-93
Peter G. Trafton, MD	1993-94
Kenneth D. Johnson, MD	1994-95
Alan M. Levine, MD	1995-96
Lawrence B. Bone, MD	1996-97
James F. Kellam, MD	1997-98
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Andrew R. Burgess, MD	1999-00
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ANNUAL MEETINGS

September 14 - 15, 1985	New York, New York, USA
November 20 - 22, 1986	San Francisco, California, USA
November 19 - 21, 1987	Baltimore, Maryland, USA
October 27 - 29, 1988	Dallas, Texas, USA
October 19 - 21, 1989	Philadelphia, Pennsylvania, USA
November 7 - 10, 1990	Toronto, Ontario, Canada
October 31 - November 2, 1991	Seattle, Washington, USA
October 1 - 3, 1992	Minneapolis, Minnesota, USA
September 23 - 25, 1993	New Orleans, Louisiana, USA
September 22 - 24, 1994	Los Angeles, California, USA
September 29 - October 1, 1995	Tampa, Florida, USA
September 27 - 29, 1996	Boston, Massachusetts, USA
October 17 - 19, 1997	Louisville, Kentucky, USA
October 8 - 10, 1998	Vancouver, British Columbia, Canada
October 22 - 24, 1999	Charlotte, North Carolina, USA
October 12 - 14, 2000	San Antonio, Texas, USA
October 18 - 20, 2001	San Diego, California, USA
October 11 - 13, 2002	Toronto, Ontario, Canada
October 9 - 11, 2003	Salt Lake City, Utah, USA
October 8 - 10, 2004	Hollywood, Florida, USA
October 20 - 22, 2005	Ottawa, Ontario, Canada
October 5 - 7, 2006	Phoenix, Arizona, USA
October 18 - 20, 2007	Boston, Massachusetts, USA
October 15 - 18, 2008	Denver, Colorado, USA
October 7 - 10, 2009	San Diego, California, USA
October 13 - 16, 2010	Baltimore, Maryland, USA
October 12 - 15, 2011	San Antonio, Texas, USA
October 3 - 6, 2012	Minneapolis, Minnesota, USA
October 9 - 12, 2013	Phoenix, Arizona, USA
October 15 - 18, 2014	Tampa, Florida, USA
October 7 - 11, 2015	San Diego, California, USA
October 5 - 8, 2016	National Harbor, Maryland, USA
October 11 - 14, 2017	Vancouver, British Columbia, Canada
October 17 - 20, 2018	Kissimmee (Orlando Area), Florida, USA

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*Leadership terms transition at the October 18, 2018 Business Meeting.
Please visit the OTA website to view the October 2018 - October 2019 leadership listing.

MARCH 2017 - OCTOBER 2018 BOARD OF DIRECTORS, continued

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Chair (*ex officio*): Edward Harvey

Basic Science Sub-Committee
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James Kellam (Presidential Consultant)
J Lawrence Marsh (Presidential Consultant)
MAJ Daniel Stinner (Presidential Consultant)

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Usha Mani
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Eben Carroll
Utku Kandemir
Theodore Toan Le
Samir Mehta
Hassan Mir
Brian Mullis

Ex-Officio Members
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Paul Tornetta, III, MD & J. Tracy Watson, MD: AAOS/OTA Course Directors
Lisa K. Cannada, MD: Core Curriculum Phase 3 Project Director
Carla S. Smith, MD: Fall Resident Comprehensive Course Chair
Michael P. Leslie, DO: Fall Resident Comprehensive Course Co-Chair
Roy Sanders, MD: JOT Editor
Thomas A. DeCoster, MD: OKO
Daniel J. Coll, MHS, PA-C: PA Member

*Committee terms transition at the October 18, 2018 Business Meeting.
Please visit the OTA website to view the October 2018 - October 2019 committee lists.

Ex-Officio Members, continued
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Cory A. Collinge, MD: Resident Advanced Trauma Techniques Course Co-Chair
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Gudrun Mirick
Arvind Nana
Clay Spitler
Michael Zlowodzki

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Michael Prayson
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EBQVS Liaison (*ex officio*): Arvind Nana
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Pat Yoon
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Presidential Consultant (*ex officio*):
Lewis Zirkle

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Ney Amaral
Fernando DeLaHuerta
Theodore Toan Le
Amir Matityahu
Cyril Mauffrey
Hans-Christoph Pape
Resident Member (*ex officio*): Sara Putnam
Presidential Consultant (*ex officio*): Toney Russell

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Milan Sen
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Lt. COL Christopher LeBrun (USAF)
LCDR Christopher Smith (USN)
Max Talbot (Canadian Armed Forces)
MAJ Eric Verweibe (USA)
Resident Member (*ex officio*): Pooria Hosseini

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Hassan Mir – Member Rep
Lisa Taitsman – BOS Match Oversight Committee OTA Rep
Kathleen Caswell – Executive Director Representative

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Mohit Bhandari
Mitch Harris
Research Chair (*ex officio*):
Mike Archdeacon
Governance Council Chair (*ex officio*):
Ted Miclau
BSFF Chair (*ex officio*): Ed Harvey
Fund Development Chair (*ex officio*):
Dan Horwitz

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Harneeth Uppal
Anna Miller
Rafael Neiman
Matt Karam
Rahul Vaidya
Kyle Jeray
Mark Hake
Matthew Avery

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Executive Director
847-430-5131

Bonnie Emberton
Fund Development Manager
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Jennifer Gangler
Exhibits Coordinator
847-430-5132

Darlene Meyer
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Christine Schreiber
IT & Meetings Project Manager
847-430-5139

Barbara Shozda
Managing Director
847-430-5137

Aimee Spellman
Meetings and Programing Manager
847-430-5136

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web: www.ota.org

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2018-2019 Academic Year Fellowship Program Awards:

Allegheny General Hospital – Pittsburgh, PA
Gregory Altman, MD, Director

Carolinas Medical Center Department of Orthopaedic Surgery – Charlotte, NC
Madhav Karunakar, MD, Director

Cedars Sinai Orthopaedic Trauma Fellowship – Los Angeles, CA
Donald Wiss, MD, Director

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Rakesh Mashru, MD, Director

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Rachel Reilly, MD, Director

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Lawrence X. Webb, MD, Director

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Michael Weaver, MD, Director

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David L. Helfet, MD, Director

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Anthony T. Sorkin, MD, Director

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George Haidukewych, MD, Director

OrthoIndy Trauma Fellowship – Indianapolis, IN
Timothy Weber, MD, Director

Regions Orthopaedic/ University of Minnesota Orthopaedic Trauma Fellowship – St. Paul, MN
Peter A. Cole, MD, Director

Reno Orthopaedic Clinic Trauma Fellowship – Reno, NV
Timothy Bray, MD, Director

Saint Louis University, Orthopaedic Traumatology Fellowship – St. Louis, MO
David Karges, MD, Director

COTA

CENTER FOR ORTHOPAEDIC TRAUMA ADVANCEMENT ACKNOWLEDGMENTS

COTA 2018-2019 Academic Year Fellowship Program Awards, continued:

Stanford Orthopaedic Trauma – Redwood City, CA
Michael Bellino, MD, Director

Tampa General Hospital – Tampa, FL
Roy Sanders, MD, Director

The Regents of the University of California – Sacramento, CA
Mark A. Lee, MD, Director

The University of Texas Health Science Center at Houston – Houston, TX
Timothy S Achor, MD, Director

UCSD Orthopaedic Trauma Fellowship – San Diego, CA
Alexandra Schwartz, MD, Director

UCSF SFGH Orthopaedic Trauma Institute – San Francisco, CA
Theodore Miclau, MD, Director

University of Maryland / Shock Trauma – Baltimore, MD
Robert V. O'Toole, MD, Director

University of MissouriTrauma Fellowship Program – Columbia, MO
Brett D. Crist, MD, Director

University of Washington Orthopaedics Trauma / Harborview – Seattle, WA
David P. Barei, MD, Director

Vanderbilt Orthopaedic Trauma – Nashville, TN
Cory Collinge, MD, Director

Wake Forest University School of Medicine Trauma Fellowship – Winston Salem, NC
Eben A. Carroll, MD, Director

WellSpan York Hospital Orthopaedic Trauma Fellowship – York, PA
Thomas DiPasquale, DO, Director

Funded by the generous medical education contributions from:

Smith & Nephew, Stryker, DePuy Synthes, Medtronic & Zimmer Biomet

CONGRATULATIONS

2017-2018 OTA Fellowship Graduating Class:

Atif Ahmed, MD, DDS and **Rebecca Rajfer, MD**
Allegheny Health Network, Pittsburgh, PA
Gregory T. Altman, MD, Director

Brad Askam, MD, **Andrew Chen, MD, MPH** and **John Hwang, MD**
Carolinas Medical Center, Charlotte, NC
Madhav Karunakar, MD, Director

Gable Moffitt, MD
Case Western Reserve Medical School, MetroHealth Medical Center, Cleveland, OH
John H. Wilber, MD, Director

Adam Neustein, MD
Cedars Sinai Medical Center, Los Angeles, CA
Donald A. Wiss, MD, Director

James Ostrander, MD
Cooper University Hospital, Camden, NJ
Rakesh Mashru, MD, Director

Keivan Abtahi, DO
Duke University Medical Center, Durham, NC
Rachel Reilly, MD, Director

Giselle Hernandez, MD
Georgia Orthopaedic Trauma Institute, Navicent Health, Macon, GA
Lawrence X. Webb, MD, Director

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Grant Medical Center, Columbus, OH
Benjamin C. Taylor, MD, Director

Andre Shaffer, MD and **Arvind Von Keudell, MD**
Harvard Orthopaedic Trauma, Massachusetts GH
Brigham and Women's Hospital, Boston, MA
Michael Weaver, MD, Director

Jessica Bear, MD, **Owen Diamond, MD** and **Natalie Rollick, MD**
Hospital for Special Surgery, New York, NY
David L. Helfet, MD, Director

2017-2018 OTA Fellowship Graduating Class, continued

Johnathan Thompson, DO
Hughston Orthopaedic Trauma Service, Columbus, GA
John C.P. Floyd, MD, FACS, Director

Carrie Heincelman, MD and **Yohan Jang, DO**
IU Methodist Orthopaedic Trauma Fellowship, Indianapolis, IN
Anthony T. Sorkin, MD, Director

Hugo Centomo, MD, PhD
LAC & USC Orthopaedic Trauma Fellowship, Los Angeles, CA
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Orlando Regional Medical Center, Orlando, FL
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J. Spence Reid, MD, Director

James Richman, MD
Rutgers, New Jersey Medical School, Newark, NJ
Mark R. Adams, MD, Director

Kandice Beenken, DO
San Diego Trauma Fellowship, San Diego, CA
Jeffrey M. Smith, MD, Director

Cody Pehrson, MD
Sonoran Orthopaedic Trauma Surgeons, Scottsdale, AZ
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Renee Genova, MD, BS
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David Karges, MD, Director

2017-2018 OTA Fellowship Graduating Class, continued

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Stanford University, Redwood City, CA
Michael J. Bellino, MD , Director

Daniel Kaplan, DO, PT
Swedish Medical Center Orthopaedic Trauma Fellowship
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Roy Sanders, MD, Director

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Christopher Stadler, MD
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Alexandra K. Schwartz, MD, Director

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University of Louisville, Louisville, KY
David Seligson, MD, Director

Christopher Domes, MD, ATC, **Matthew Hogue, MD**, **Aaron Johnson, MD, MS**,
Christopher Lee, BS, MD and **John Morellato, MD**
University of Maryland, R. Adams Cowley Shock Trauma Center, Baltimore, MD
Robert V. O'Toole, MD, Director

2017-2018 OTA Fellowship Graduating Class, continued

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Gregory Zych, MD, Director

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Richard Kyle, MD, Director

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Paul Henkel, DO and **Keerat Singh, MD**
University of Missouri, Columbia, MO
Brett D. Crist, MD, Director

Kyle Lybrand, MD
University of Nevada School of Medicine,
Reno Orthopaedic Trauma Fellowship, Reno, NV
Timothy Bray, MD, Director

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University of New Mexico Hospital, Albuquerque, NM
Thomas A. DeCoster, MD, Director

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University of Oklahoma, Tulsa, OK
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2017-2018 OTA Fellowship Graduating Class, continued

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Yale University Orthopaedic Traumatology Fellowship
Michael Baumgaertner, MD, Director

Chris Han, MD
York Hospital, York, PA
Thomas DiPasquale, DO, Director

AWARDS

OTA HUMANITARIAN SCHOLARS

The OTA has established a new 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 2018 scholarship recipients:

Billy Thomson Haonga, MD - *Dar es Salaam, Tanzania* - (Paper #75)
Kisitu Kyengera, MBBS - *Mbarara, Uganda* - (Paper #34)

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 2018 scholarship recipient: ***Darko Talevski, MD*** - *Skopje, Macedonia*

JOHN BORDER, MD, MEMORIAL LECTURE

Supported in part by AO/North America and OTA

This lectureship was established to honor the memory of Dr. John Border. John Border was instrumental in the development of modern trauma care and in particular, modern orthopaedic trauma care. He was the pioneer in the concept of total care and the implications of the orthopaedic injuries on the total management of the trauma patient. He was also a surgeon scientist, using both his clinical observations and basic science research to further his patient care in Orthopaedic Trauma.

2017 – Observations in Innovation
Roy Sanders, 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.

2017 – Operative Versus Nonoperative Treatment of Acute Displaced Distal Clavicle Fractures: A Multicenter Randomized Controlled Trial
(COTS) Canadian Orthopaedic Trauma Society; ***Jeremy Alan Hall, MD****;*
Niloofar Dehghan, MD; Emil H. Schemitsch, MD; Aaron Nauth, MD; Robert Korley, MDCM; Robert G. McCormack, MD; Pierre Guy, MD; Steven Ray Papp, MD; Michael D. McKee, MD
**of papers that granted first right of refusal to the Journal of Orthopaedic Trauma*

2018 OTA AFA COMMUNITY SURGEON ACHIEVEMENT AWARD* RECIPIENT

**Orthopaedic Trauma Association (OTA) and American Fracture Association (AFA) co-founded this annual award in 2017.*

2018 – Peter Althausen, MD, MBA

OTA MEMORIAL AWARD (Resident Research Award)

2017 – A Prospective Randomized Control Trial Comparing Immediate Weight Bearing Versus Touch-Down Weight Bearing in Extra-Articular Distal Femur Fractures
Daniel Allen Bravin, MD*; David F. Hubbard, MD; Lindsey Bravin, MD; John C. France, MD; Michelle A. Bramer, MD*

OTA 2018 MEMBER FULL AWARDED GRANTS

(January 1, 2018 - December 31, 2019 Grant Cycle)

Title: **Use of a Self-Directed Exercise Program (SDEP) Following Selected Lower Extremity Fractures: A Randomized Clinical Trial**
Principal Investigator: **Rachel Seymour, PhD**
Co-Principal Investigator: **Michael Bosse, MD**
Awarded Funds: **$79,078** Funded by: **OTA/Smith & Nephew**

Title: **The Impact of Residual Deformities on Outcome after Calcaneus Fractures**
Principal Investigator: **Andrew Dodd, MD**
Co-Principal Investigator: **Jeremy Kubik, MD**
Awarded Funds: **$34,950** Funded by: **OTA**

Title: **A Prospective Randomized Trial of Nonoperative versus Operative Management of Patella Fractures in the Elderly**
Principal Investigator: **Aaron Nauth, MD**
Co-Principal Investigator: **Emil Schemitsch, MD**
Awarded Funds: **$79,320** Funded by: **OTA**

Title: **Reversing the Negative Effects of Fluoxetine on Fracture Healing**
Principal Investigator: **Philipp Leucht, MD**
Co-Principal Investigator: **Rivka Ihejirika, MD**
Awarded Funds: **$50,000** Funded by: **OTA**

Title: **The Use of Autologous Endothelial Progenitor Cells (EPCs) for Fracture Healing in a Large Animal Model: A Comparison with Iliac Crest Bone Grafting**
Principal Investigator: **Aaron Nauth, MD**
Co-Principal Investigator: **Emil Schemitsch, MD**
Awarded Funds: **$50,000** Funded by: **OTA**

Title: **Biomechanical Optimization of the Far Cortical Locking Technique**
Principal Investigator: **Emil H Schemitsch, MD**
Co-Principal Investigator: **Radovan Zdero, PhD**
Awarded Funds: **$50,000** Funded by: **OTA**

Title: **Perioperative Screening and Nutritional Supplementation in Orthopaedic Trauma Patients**
Principal Investigator: **Nathan R Hendrickson MD, MS**
Co-Principal Investigators: **Michael Willey, MD**, **J. Lawrence Marsh, MD**, **Luis Garcia, MD**, **Matthew Karam, MD**, **Natalie Glass, PhD**
Awarded Funds: **$75,984** Funded by: **AAOS/OTA**

Title: **Effect of Silver or Bleach Irrigation Solution on Prevention of Infection Following Open Tibia Fractures: A Randomized Controlled Trial**
Principal Investigator: **Samuel Hailu, MD**
Awarded Funds: **$50,000** Funded by: **OTA/Citieffe/Smith & Nephew International**

TOTAL OTA MEMBER GRANTS AWARDED: **$469,332**

OTA 2018 RESIDENT AWARDED GRANTS

(January 1, 2018 - December 31, 2018 and June 1, 2018 - May 31, 2019 Grant Cycle)

Grant Title: **Engineered Approaches for Muscle Repair to Promote Concurrent Bone Regeneration**
Principal Investigator: **Augustine Mark Saiz, Jr., MD**
Co-Investigator: **Kent Leach, MD, Mark Lee, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/DePuy**

Grant Title: **Identifying Optimal Soft Tissue Coverage for Masquelet Bone Grafting Technique**
Principal Investigator: **Karan Shaileshkumar Patel, MD**
Co-Investigator: **Philipp Leucht, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/FOT**

Grant Title: **Effect of Peri-articular Hardware on Peak Contact Pressures across the Knee Joint**
Principal Investigator: **Michelle Gosselin, BS, MD**
Co-Investigator: **Anna Miller, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/DePuy**

Grant Title: **The Effect of Marijuana Smoke Inhalation on Fracture Healing**
Principal Investigator: **Bennet Arthur Butler, MD**
Co-Investigator: **Michael Stover, MD**
Amount Funded: **$16,650** Grant Funded by: **OTA/FOT**

Grant Title: **A Biomechanical Study Comparing Dual Mini Fragment Plating of Clavicle Fractures with Superior Pre-contoured Plating**
Principal Investigator: **Daryl Brian Dillman, MD, MPH**
Co-Investigator: **Andrew Trenholm, MD**
Amount Funded: **$8,711** Grant Funded by: **OTA/FOT**

Grant Title: **Heterotopic Ossification in a Murine Model of Lower Extremity Blast Injury**
Principal Investigator: **Peter Mittwede, MD, PhD**
Co-Investigators: **Gele Moloney, MD**, **Patrick Maher, MD**, **Peter Alexander, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/Zimmer-Biomet**

Grant Title: **Effects of Perioperative Handling on the Viability and Osteogenic Potential of Bone Graft and Bone Marrow Aspirate**
Principal Investigator: **Karan Shaileshkumar Patel, MD**
Co-Investigator: **Philipp Leucht, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA/Zimmer-Biomet**

Grant Title: **Targeting Fracture Healing with Boron Derivative Implants**
Principal Investigator: **Susan Mengxiao Ge, MD, C.M.**
Co-Investigators: **Edward Harvey, MD**, **Geraldine Merle, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA**

Grant Title: **Does Soft Tissue Perfusion Improve from Time of Injury to Delayed Fixation in High Risk Tibial Plafond Fractures?**
Principal Investigator: **Aresh Sepehri, BSc MD**
Co-Investigators: **Gerard Slobogean, MD**, **Raymond Pensy, MD**, **Robert O'Toole, MD**
Amount Funded: **$ 20,000** Grant Funded by: **OTA/Zimmer-Biomet**

Grant Title: **Bone Morphogenetic Protein vs Platelet-Derived Growth Factor for the Enhancement of Fracture Healing: a Comparison Using Clinically Relevant Carriers in a Small Animal Model**
Principal Investigator: **Hilary Anna Felice, MD, MSc**
Co-Investigator: **Aaron Nauth, MD**
Amount Funded: **$20,000** Grant Funded by: **OTA**

TOTAL RESIDENT GRANTS AWARDED: **$185,361**

INFORMATION

IS WI-FI AVAILABLE?

Yes, in the Gaylord Convention Center

Wi-Fi Login: **OTA2018**

Password: **OTAwifibyGlobus**

WHERE CAN I DOWNLOAD THE OTA ANNUAL MEETING APP?

iTunes and Google Play store

Search: **2018 OTA Annual Meeting**

HOW DO I GET MY CME'S?

- Download the 2018 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, October 17- Saturday, October 20

6:00 am - 5:00 pm

Sun Registration 1 - a small private room located to the left of Sun A, just outside the ballrooms of the convention center. The key to this room is available at the OTA Information Desk. A comfortable chair, power outlet, and refrigerator are available in the room.

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 34th 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.

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **20** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ACCREDITATION – CME INFORMATION

The Basic Science Focus Forum and International Trauma Care Forum have been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and the Orthopaedic Trauma Association. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates the live activity of the Basic Science Focus Forum for a maximum of **10.5** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The American Academy of Orthopaedic Surgeons designates the live activity of the International Trauma Care Forum for a maximum of **10.25** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The 34th Annual Meeting of the Orthopaedic Trauma Association has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and Orthopaedic Trauma Association. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of **20** ***AMA PRA Category 1 Credits***™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

FDA STATEMENT

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 34th 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 34th Annual Meeting are printed in **boldface**.

As an accredited provider of continuing medical education CME, the Academy and OTA are required by the Accreditation Council for Continuing Medical Education (ACCME) to obtain and share with participants of an OTA CME activity any potential conflicts of interest by faculty, program developers and CME planners.

The ACCME Standards of Commercial Support, Standard 2 states the requirements:

2.1 The provider must be able to show that everyone who is in a position to control the content of an education activity has disclosed all relevant financial relationships with any commercial interest to the provider. 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 AAOS disclosure policy requires that faculty submit all financial relationships occurring within the past 12 months that create a potential conflict.

Each participant in the Annual Meeting has been asked to disclose if he or she has received something of value from a commercial company or institution, which relates directly or indirectly to the subject of their presentations.

Authors who completed their financial disclosures have identified the options to disclose as follows:

- n. Respondent answered 'No' to all items indicating no conflicts;
- 1. Royalties from a company or supplier;
- 2. Speakers bureau/paid presentations for a company or supplier;
- 3A. Paid employee for a company or supplier;
- 3B. Paid consultant for a company or supplier;
- 3C. Unpaid consultant for a company or supplier;
- 4. Stock or stock options in a company or supplier;
- 5. Research support from a company or supplier as a PI;
- 6. Other financial or material support from a company or supplier;
- 7. Royalties, financial or material support from publishers;
- 8. Medical/orthopaedic publications editorial/governing board;
- 9. Board member/committee appointments for a society.

An indication of the participant's disclosure appears after his/her name in the alphabetical listing along with the commercial company or institution that provided the support.

The Academy and OTA do not view the existence of these disclosed interests or commitments as necessarily implying bias or decreasing the value of the author's participation in the meeting.

Δ Indicates presentation was funded by a grant from the Orthopaedic Trauma Association.

Cameras or video cameras may not be used in any portion of the meeting.

OTA MANDATORY DISCLOSURE POLICY FOR GOVERNANCE GROUPS AND CONTINUING MEDICAL EDUCATION CONTRIBUTORS

PHILOSOPHY

In order to promote transparency and confidence in the educational programs and in the decisions of the Orthopaedic Trauma Association (hereinafter collectively referred to as "OTA"), the OTA Board of Directors has adopted this mandatory disclosure policy.

The actions and expressions of Fellows, Members, and Others providing education of the highest quality, or in shaping OTA policy, must be as free of outside influence as possible, and any relevant potentially conflicting interests or commercial relationships must be disclosed. Because the OTA depends upon voluntary service by Fellows, Members, and Others to conduct its educational programs and achieve its organizational goals, this disclosure policy has been designed to be realistic and workable.

The OTA does not view the existence of these interests or relationships as necessarily implying bias or decreasing the value of your participation in the OTA.

OBLIGATION TO DISCLOSE

Each participant in an OTA CME program or author of enduring materials, and members of the OTA Board of Directors, Committees, Project Teams or other official OTA groups (collectively "OTA governance groups"), has the obligation to disclose all potentially conflicting interests. Disclosure information is to be submitted through the AAOS on-line Disclosure Program (or other disclosure form provided and approved by the OTA Participants are responsible for the accuracy and completeness of their information. In addition, participants who disclose via the AAOS on-line Disclosure Program have an obligation to review and update their personal information in the AAOS Orthopaedic Disclosure Program at least semiannually (usually April and October). It is recommended that participants note any changes to the AAOS Orthopaedic Disclosure Program as soon as possible after they occur.

Failure of a required participant to disclose will result in the participant being asked not to participate in the OTA CME program and OTA governance groups.

A list of all participants in OTA CME programs and OTA governance groups, along with their disclosures, will be included in all meeting materials.

Participants in OTA governance groups have an obligation to indicate any potential conflicts they may have during discussions affecting their personal interests during the meeting of the OTA governance group. At each meeting of the OTA governance group, members of the group will be reminded that full disclosure must be made of any potential conflict of interest when a matter involving that interest is discussed.

The chair of the governance group shall also have the prerogative of requesting a participant to provide further information or an explanation if the chair identifies a potential conflict of interest regarding that participant. Based on the information provided in the OTA Orthopaedic Disclosure Program and/or upon a further review, the chair of the OTA governance group may determine that the participant shall:

Disclose the conflict and continue to participate fully in the OTA governance group's deliberations

Disclose the conflict, but abstain from discussing and voting on the matter; or

Disclose the conflict and leave the room until the matter has been fully discussed and acted upon.

If one of the latter two actions is taken, it should be reflected in the minutes of the OTA governance group's meeting.

Adopted: February 2011
Revised: March 2014

Orthopaedic Trauma Association
ANTITRUST POLICY
(Adopted July 2012)

Discussions at OTA meetings often cover a broad range of topics pertinent to the interests or concerns of orthopaedic surgeons. As a general rule, except as noted below, discussions at OTA meetings can address virtually any topic without raising antitrust concerns if the discussions are kept scrupulously free of even the suggestion of private regulation of the profession. However, a number of topics that might be (and have been) discussed at OTA meetings may raise significant complex antitrust concerns. These include:

- Membership admissions, rejections, restrictions, and terminations;
- Method of provision and sale of OTA products and services to non-members;
- Restrictions in the selection and requirements for exhibitors at the OTA Annual Meeting or in CME activities;
- Establishment of the professional compliance program and adoption of Standards of Professionalism;
- Collecting and distributing certain orthopaedic practice information, particularly involving practice charges and costs;
- Obtaining and distributing orthopaedic industry price and cost information;
- Professional certification programs;
- Group buying and selling; and
- Inclusions or exclusion of other medical societies in organizational activities or offerings.

When these and related topics are discussed, the convener or members of the OTA group should seek counsel from Legal Counsel.

OTA urges its Board, committees and other groups not to participate in discussions that may give the appearance of or constitute an agreement that would violate the antitrust laws.

Notwithstanding this reliance, it is the responsibility of each OTA Board or committee member to avoid raising improper subjects for discussion. This reminder has been prepared to ensure that OTA members and other participants in OTA meetings are aware of this obligation.

The "Do Not's" and "Do's" presented below highlight only the most basic antitrust principles. OTA members and others participating in OTA meetings should consult with the OTA Presidential Line and/or General Counsel in all cases involving specific questions, interpretations or advice regarding antitrust matters.

Do Nots

1. Do not, in fact or appearance, discuss or exchange information regarding:
   a. Individual company prices, price changes, price differentials, mark-ups, discounts, allowances, credit terms, etc. or any other data that may bear on price, such as costs, production, capacity, inventories, sales, etc.
   b. Raising, lowering or "stabilizing" orthopaedic prices or fees;
   c. What constitutes a fair profit or margin level;
   d. The availability of products or services;
   e. The allocation of markets, territories or patients.

2. Do not suggest or imply that OTA members should or should not deal with certain other persons or firms.
3. Do not foster unfair practices regarding advertising, standardization, certification or accreditation.
4. Do not discuss or exchange information regarding the above matters during social gatherings, incidental to OTA-sponsored meetings.
5. Do not make oral or written statements on important issues on behalf of OTA without appropriate authority to do so.

Do

1. Do adhere to prepared agenda for all OTA meetings. It is generally permissible for agendas to include discussions of such varied topics as professional economic trends, advances and problems in relevant technology or research, various aspects of the science and art of management, and relationships with local, state or federal governments.
2. Do object whenever meeting summaries do not accurately reflect the matters that occurred.
3. Do consult with OTA counsel on all antitrust questions relating to discussions at OTA meetings.
4. Do object to and do not participate in any discussions or meeting activities that you believe violate the antitrust laws; dissociate yourself from any such discussions or activities and leave any meeting in which they continue.

Special Guidelines for Collecting and Distributing Information

The collection and distribution of information regarding business practices is a traditional function of associations and is well-recognized under the law as appropriate, legal and consistent with the antitrust laws. However, if conducted improperly, such information gathering and distributing activities might be viewed as facilitating an express or implied agreement among association members to adhere to the same business practices. For this reason, special general guidelines have developed over time regarding association's reporting on information collected from and disseminated to members. Any exceptions to these general guidelines should be made only after discussion with the Office of General Counsel. These general guidelines include:

1. Member participation in the statistical reporting program is voluntary. The statistical reporting program should be conducted without coercion or penalty. Non-members should be allowed to participate in the statistical reporting program if eligible; however, if there is a fee involved, they may be charged a reasonably higher fee than members.
2. Information should be collected via a written instrument that clearly sets forth what is being requested.
3. The data that is collected should be about past transactions or activities; particularly if the survey deals with prices and price terms (including charges, costs, wages, benefits, discounts, etc,), it should be historic, i.e., more than three months old.

4. The data should be collected by either the OTA or an independent third party not connected with any one member.
5. Data on individual orthopaedic surgeons should be kept confidential.
6. There should be a sufficient number of participants to prevent specific responses or data from being attributable to any one respondent. As a general rule, there should be at least five respondents reporting data upon which any statistic or item is based, and no individual's data should represent more than 25% on a weighted average of that statistic or item.
7. Composite/aggregate data should be available to all participants – both members and nonmembers. The data may be categorized, e.g., geographically, and ranges and averages may be used. No member should be given access to the raw data. Disclosure of individual data could serve to promote uniformity and reduce competition.
8. As a general rule, there should be no discussion or agreement as to how members should adjust, plan or carry out their practices based on the results of the survey. Each member should analyze the data and make business decisions independently.

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.

INDUSTRY SESSIONS

Session	Title	Faculty
IS01 Stryker Wednesday, 6:00 - 9:00 PM *(Emerald Plaza)*	Nailing Redefined. Experience It	
IS02 Medtronic Wednesday, 6:00 - 8:30 PM *(Miami 1-3)*	Navigated Pelvic Trauma and Sacroiliac Joint Fusion	*Holly Pilson, MD*
IS04 DePuy Synthes Thursday, 11:15 AM - 1:00 PM *(Naples 1-3)*	Pelvic and Acetabular Fractures: New Reduction and Adjunct Fixation Techniques using Continuous Compression Implants	*Patrick Wiater, MD; Kevin Grant, MD*
IS05 DePuy Synthes Thursday, 11:15 AM - 1:00 PM *(Captiva 1-2)*	Improving Outcomes and Post-Operative Pain Management for Geriatric Hip Fractures	*Jennifer Bruggers, MD; Michael O'Boyle, MD*
IS06 DePuy Synthes Thursday, 11:15 AM - 1:00 PM *(Daytona 1-2)*	Overcoming Challenges and Avoiding Pitfalls of Periprosthetic Femur: A Case-Based, Panel Discussion	*Eben Carroll, MD; George Haidykewych, MD; Cory Collinge, MD; Frank Liporace, MD*
IS07 Stryker Thursday, 11:15 AM - 1:00 PM *(Sun 3-4)*	An introduction and hands-on review of the T2 Alpha Intramedullary Nailing System.	*Joshua Langford, MD - Orlando Regional Medical Center*
IS08 Zimmer Biomet Thursday, 11:15 AM - 1:00 PM *(Osceola 2)*	Innovative Concepts Hip Fracture Management Topic 1: THP™ Hip Fracture Plating System Overview & Clinical Experience Topic 2: Etex® BSM Clinical Experience	*James Nepola, MD; Geoffrey Marecek, MD*
IS09 Smith & Nephew Thursday, 11:15 AM - 1:00 PM *(Miami 1-3)*	Current Strategies for Proximal Humerus Fractures	*Chip Ogburn, MD*
IS10 Nuvasive Specialized Orthopedics Thursday, 11:15 AM - 1:00 PM *(Osceola 1)*	Treating Complex Trauma with a Remote Controlled Intramedullary Device	*J. Tracy Watson, MD; Matthew Gardner, MD; Stephen M. Quinnan, MD; John Wyrick, MD*
IS11 Ziehm Imaging Thursday, 11:15 AM - 1:00 PM *(Sun 2)*	The Revolution In 3D Imaging	*Milton "Chip" Routt, MD*
IS12 Orthofix Thursday, 11:15 AM - 1:00 PM *(Sun 5)*	Current Concepts in Trauma Solutions. Fractures about the Hip, Shoulder and Lower Limbs	*Davide Blonna, MD; Wade Gordon, MD; Kenneth Koval, MD*

INDUSTRY SESSIONS, continued

Session	Title	Faculty
IS13 SI-BONE Thursday, 11:15 AM - 1:00 PM *(Sun 1)*	Trauma and The SI Joint: Didactic and Hands-On Lab	*Craig S. Bartlett, MD; Bharat Desai, MD; John David Black, MD; W. Carlton Reckling, MD*
IS17 ACell Thursday, 11:15 AM - 1:00 PM *(St. George #114)*	A Novel Regenerative Medicine Technology To Integrate Advanced Wound Management Into Your Orthopaedic Trauma Protocols	
IS18 DePuy Synthes Friday, 12:35 - 1:25 PM *(Exhibit Hall – Product Theater)*	A Novel Approach to Fixating Difficult Fracture Patterns Utilizing Nitinol Continuous Compression Implants	*Patrick Wiater, MD*
IS15 DePuy Synthes Friday, 6:30 - 8:00 PM *(St. George #114)*	Femoral Neck Fractures – Repair vs Replace and early clinical cases using the DePuy Synthes Femoral Neck System (FNS)	*Christopher Finkemeier, MD; Steven Haman, MD*
IS16 DePuy Synthes Friday, 6:30 - 8:00 PM *(St. George #112)*	Advances in Deformity Correction and Trauma Applications of Circular Ring Fixators utilizing MAX-FRAME™ Multi-Axial Correction System	*Spence Reid, MD; Justin Kane, MD*

PRODUCT THEATER

(Exhibit Hall – Product Theater)

DePuy Synthes Friday, 12:35 - 1:25 PM	A Novel Approach to Fixating Difficult Fracture Patterns Utilizing Nitinol Continuous Compression Implants	*Patrick Wiater, MD*

OTA GRATEFULLY ACKNOWLEDGES THE FOLLOWING EXHIBITORS FOR THEIR SUPPORT OF THE 34TH ANNUAL MEETING:

Booth #	Company Names	City, State
516	**aap Implantate AG**	Berlin, Germany
1009	**ACell**	Columbia, MD
517	**Acumed, LLC**	Hillsboro, OR
623	**Advanced Orthopaedic Solutions**	Torrance, CA
1024	**American Geriatrics Society CoCare: Ortho**	New York, NY
419	**AOTrauma North America**	Wayne, PA
817	**Arthrex, Inc.**	Naples, FL
1022	**ARZZT**	The Woodlands, TX
622	**Austin Medical Ventures**	Germantown, TN
629	**BIC Tool Co., Ltd.**	Hiezu-son, Saihaku-gun, Japan
1015	**Biedermann Motech**	Miami, FL
408	**BioAccess Inc**	Baltimore, MD
504	**Biocomposites**	Wilmington, NC
422	**(Bloccs) Precision Dippings Manufacturing Ltd**	Yate, England
913	**Bone Foam Inc.**	Corcoran, MN
1013	**Bone Solutions Inc.**	Colleyville, TX
512	**BONESUPPORT**	Cambridge, MA
924	**CarboFix Orthopedics, Inc**	Ocean Isle Beach, NC
727	**CITIEFFE inc.**	Bologna, Italy
404	**Conventus Orthopaedics, Inc.**	Maple Grove, MN
705	**Depuy Synthes**	West Chester, PA
405	**DJO Global**	Vista, CA
315	**DNE, LLC**	Slatington, PA
724	**EDGe Surgical, Inc.**	Chicago, IL
923	**Envision Physician Services**	Dallas, TX
409	**Gauthier Biomedical Inc.**	Grafton, WI
917/Office A	**Globus Medical Inc.**	Audubon, PA
524	**HansBiomed USA**	Englewood Cliffs, NJ
627	**Histogenics**	Waltham, MA
319	**IlluminOss Medical**	East Providence, RI
1007	**Innomed, Inc.**	Savannah, GA
825	**Invibio Biomaterials Solutions**	West Conshohocken, PA
506	**ITS**	Maitland, FL
813	**KCI, an Acelity Company**	San Antonio, TX
317	**LinkBio Corp**	Rockaway, NJ
418	**LNK Services, LLC**	Helena, AL
526	**McGinley Orthopedics**	Casper, WY

EXHIBITORS LISTING, continued

Booth #	Company Names	City, State
824	**Medartis**	Exton, PA
407	**MedTech International Group**	Houston, TX
323	**Medtronic**	Minneapolis, MN
729	**mymedicalimages.com, LLC**	Boca Raton, FL
502/Office B	**NuVasive Specialized Orthopedics, Inc.**	Aliso Viejo, CA
929	**ODi (Orthopedic Designs Inc.)**	Tampa, FL
928	**OHK Medical Devices Inc.**	Grandville, MI
309	**Orthofix**	Lewisville, KY
305	**Orthomed inc.**	Tigard, OR
514	**OrthoXel**	Cork, Ireland
513	**OsteoCentric Technologies**	Austin, TX
403	**Pacific Instruments**	Honolulu, HI
823	**PFS Med, Inc**	Springfield, OR
1011	**PolyNovo North America**	Wilmington, DE
829	**Puracyn Plus by Innovacyn**	Rialto, CA
427	**Sawbones Worldwide a division of Pacific Research Laboratories Inc**	Vashon, WA
728	**Sectra NA Inc.**	Shelton, CT
828	**Shukla Medical**	St. Petersburg, FL
412	**SI-BONE, Inc.**	Santa Clara, CA
927	**Skeletal Dynamics**	Miami, FL
805	**Smith and Nephew**	Cordova, TN
523	**Stabiliz Ortho**	Voorhees, NJ
922	**Starr Frame LLC**	Richardson, TX
625	**Structure Medical**	Mooresvile, NC
505	**Stryker**	Mahwah, NJ
725	**Sygenx, Inc.**	Houston, TX
527	**Synergy Surgicalists**	Bozeman, MT
508	**Synovis MCA**	Birmingham, AL
624	**TDM Co., Ltd**	Gwang-ju, Korea
925	**TeamHealth**	Knoxville, TN
723	**The Orthopaedic Implant Company**	Reno, NV
416	**TriMed, Inc.**	Santa Clarita, CA
525	**Vidant Health**	Greenville, NC
413	**Wolters Kluwer**	Philadelphia, PA
303	**Wright Medical**	Bloomington, MN
313	**X-Bolt**	Dublin, Ireland
423	**Ziehm Imaging**	Orlando, FL
307	**ZipLine Medical, Inc.**	Campbell, CA
615	**Zimmer Biomet**	Warsaw, IN