



# David Geffen School of Medicine

OREF CALIFORNIA REGION  
RESIDENT RESEARCH SYMPOSIUM  
Friday, September 25, 2020

University of California, Los Angeles (UCLA)  
Virtual Resident Research Symposium

Hosted by:

**Francis J. Hornicek, MD, PhD**

Professor and Chair, Department of Orthopedic Surgery  
Helga and Walter Oppenheimer Endowed Chair in Orthopaedic Oncology  
David Geffen School of Medicine at UCLA

and

**Nelson F. SooHoo, MD**

Professor and Residency Program Director  
University of California, Los Angeles

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### About OREF:

The Orthopaedic Research and Education Foundation (OREF) was founded in 1955 to ensure an expanding base of knowledge and effective, evidence-based treatment protocols for orthopaedic surgeons to continually improve patient care. Since its founding, OREF has funded nearly \$150 million in research and educational grants and awards that benefit all of orthopaedics. For more information about OREF grants and awards, please visit [www.oref.org](http://www.oref.org). Follow OREF on its Facebook page (OREFtoday) and on Twitter (@OREFtoday).

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**OREF CALIFORNIA REGION  
RESIDENT RESEARCH SYMPOSIUM  
SUMMARY AGENDA**  
Friday, September 25, 2020

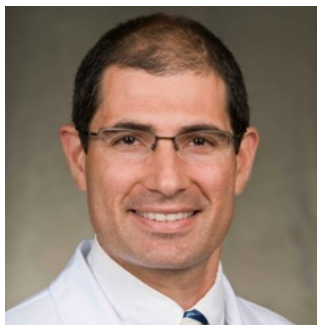
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8:00 a.m. – 8:05 a.m.	<b>Welcome and Introductions</b> Francis J. Hornicek, MD, PhD Professor and Chair, Department of Orthopaedic Surgery Helga and Walter Oppenheimer Endowed Chair in Orthopaedic Oncology David Geffen School of Medicine at UCLA
8:05 a.m. – 8:08 a.m.	<b>OREF Welcome</b> Lee Grossman Chief Executive Officer Orthopaedic Research and Education Foundation
8:08 a.m. – 8:42 a.m.	<b>Session I – Resident Research Presentations &amp; Discussion</b> <b>Moderator: Raffi S. Avedian, MD</b>
8:42 a.m. – 9:16 a.m.	<b>Session II – Resident Research Presentations &amp; Discussion</b> <b>Moderator: Nicholas Bernthal, MD</b>
9:16 a.m. – 9:50 a.m.	<b>Session III – Resident Research Presentations &amp; Discussion</b> <b>Moderator: Adam Lee, MD</b>
9:50 a.m. – 10:00 a.m.	<b>Break</b>
10:00 a.m. – 10:34 a.m..	<b>Session IV – Resident Research Presentations &amp; Discussion</b> <b>Moderator: Carol A. Lin, MD</b>
10:34 a.m. – 11:04 a.m.	<b>Session V – Resident Research Presentations &amp; Discussion</b> <b>Moderator: Nelson F. SooHoo, MD</b>
11:04 a.m. – 11:44 a.m.	<b>Keynote Address</b> <i>Building A Model for Global Orthopaedic Surgical Research–The UCSF Experience</i> Saam Morshed, MD, MPH, PhD Associate Professor of Orthopaedic Surgery, Epidemiology and Biostatistics University of California, San Francisco
11:44 a.m. – 12:00 p.m.	<b>Awards Presentation and Closing Remarks</b>

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## KEYNOTE SPEAKER

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**Saam Morshed, MD, MPH, PhD**

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Associate Professor of Orthopaedic Surgery,  
Epidemiology and Biostatistics  
University of California, San Francisco

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Dr. Morshed is an Associate Professor of Orthopaedic Surgery, Epidemiology and Biostatistics at the University of California, San Francisco (UCSF). He completed both medical school and orthopaedic residency at (UCSF). As an Orthopaedic Research and Education Foundation Clinical Research Training Fellow, he received a Master's of Public Health and PhD in Epidemiology from the University of California Berkeley. Prior to returning to UCSF to join the faculty in the Department of Orthopaedic Surgery, he completed subspecialty training in orthopaedic trauma at Harborview Medical Center in Seattle. His clinical practice is focused on skeletal trauma, surgery of the pelvis and acetabulum, and problem fractures including mal-unions and non-unions. He serves as Co-director of the UCSF orthopaedic trauma fellowship.

Dr. Morshed is Director of the Clinical Research Center at the UCSF/Zuckerberg San Francisco General Hospital Orthopaedic Trauma Institute. His research interests include treatment of major extremity trauma and he leads several multicenter clinical trials as a Major Extremity Trauma and Rehabilitation Consortium principal investigator. Dr. Morshed has served or led numerous professional society committees for the American Academy of Orthopaedic Surgeons, Orthopaedic Research Society, and currently chairs the Strategic Research Initiatives Committee for the Orthopaedic Trauma Association. Dr. Morshed is Co-Director of the Global Research Initiative of the Institute for Global Orthopaedics and Traumatology (IGOT) at UCSF which coordinates sustainable and equity-based education and research programs with partnering institutions in the developing world.

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## **Judges**

Raffi S. Avedian, MD  
Stanford University

Nicholas Bernthal, MD  
University of California, Los Angeles

Adam Lee, MD  
Creighton University School of Medicine

Carol A. Lin, MD  
Cedars- Sinai

Saam Morshed, MD, MPH, PhD  
University of California, San Francisco

Nelson F. SooHoo, MD  
University of California, Los Angeles

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8:00 a.m. – 8:05 a.m.	<b>Welcome and Introductions</b> Francis J. Hornicek, MD, PhD Professor and Chair, Department of Orthopaedic Surgery Helga and Walter Oppenheimer Endowed Chair in Orthopaedic Oncology David Geffen School of Medicine at UCLA
8:05 a.m. – 8:08 a.m.	<b>OREF Welcome</b> Lee Grossman Chief Executive Officer Orthopaedic Research and Education Foundation
	<b>Session I – Presentations and Discussion</b> <b>Moderator: Raffi S. Avedian, MD</b>
8:08 a.m. – 8:12 a.m.	<i>Stem Tip Location Represents a Potentially Modifiable Risk Factor for Aseptic Loosening following Cemented Distal Femoral Replacement</i> Danielle Greig, MD, University of California, Los Angeles
8:12 a.m. – 8:16 a.m.	<i>Human Rotator Cuff Tears have an Endogenous, Inducible Stem Cell Source Capable of Improving Muscle Quality and Function after Rotator Cuff Repair</i> Obiajulu Agha, MD, University of California, San Francisco
8:16 a.m. – 8:20 a.m.	<i>Intramedullary Fixation of Both Bone Forearm Fractures in Children and Adolescents: Healing Correlates with Development of the Olecranon Apophysis</i> Joshua Spiers, MD, Loma Linda University
8:20 a.m. – 8:24 a.m.	<i>One-Stage Durable Functional Prosthetic Spacers are an Option for Treating Periprosthetic Joint Infection after TKA</i> Liam Bosch, MD, Stanford University
8:24 a.m. – 8:28 a.m.	<i>Combined Motor and Sensory Neuromonitoring for Cervical Spondylotic Myelopathy Surgery Causes Confusion: A Level-1 Diagnostic Study</i> Kristen Combs, MD, Harbor – UCLA Medical Center
8:28 a.m. – 8:32 a.m.	<i>Rapid Improvers and Resistant Responders after Shoulder Arthroplasty: Analysis of Patient Recovery Trajectories Using Latent Class Growth Modeling</i> William Rubenstein, MD, University of California, San Francisco
8:32 a.m. – 8:42 a.m.	<b>Question and Answers</b>

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**Session II – Presentations and Discussion**

**Moderator: Nicholas Bernthal, MD**

- 8:42 a.m. – 8:46 a.m.      *Patient Reported Outcomes after Surgical Fixation of Acute Posterior Sternoclavicular Physeal Fractures and Dislocation in Children*  
Alejandro Cazzulino, MD, University of California, San Francisco
- 8:46 a.m. – 8:50 a.m.      *Association Between Rotator Cuff Tears and Superior Migration of the Humeral Head in Rotator Cuff Arthropathy: A Magnetic Resonance Imaging-Based Anatomical Study*  
Matthew Siow, MD, University of California, San Diego
- 8:50 a.m. – 8:54 a.m.      *Opioid Use in Revision Total Hip Arthroplasty*  
Christopher Holland, MD, University of California, Davis
- 8:54 a.m. – 8:58 a.m.      *Lumbar Sagittal Mismatch Deformity Negatively Affects Total Knee Arthroplasty Outcomes*  
William L. Sheppard, Jr., MD, University of California, Los Angeles
- 8:58 a.m. – 9:02 a.m.      *Inhibition of Angiotensin Converting Enzyme Impairs Anti-Staphylococcal Immune Function in a Preclinical Model of Implant Infection*  
Rishi Trikha, MD, University of California, Los Angeles
- 9:02 a.m. – 9:06 a.m.      *Complications After Radial Head Replacement: Mid-to Long-term Follow Up*  
Matthew Cherches, MD, University of California, San Francisco
- 9:06 a.m. – 9:16 a.m.      **Question and Answer**

**Session III – Resident Research Presentations & Discussion**

**Moderator: Adam Lee, MD**

- 9:16 a.m. – 9:20 a.m.      *Compressive Osseointegration Device for Management of Non-Oncologic Salvage Arthroplasty*  
Scott Galey, MD, University of California, Los Angeles
- 9:20 a.m. – 9:24 a.m.      *Risk Factors for Conversion of Hip Arthroscopy to Total Hip Arthroplasty: A Large Closed Cohort Study*  
Sachin Allahabadi, MD, University of California, San Francisco
- 9:24 a.m. – 9:28 a.m.      *Mean 6 Year Clinical Outcomes, Survivorship, and Return to Sports After Arthroscopic Capsular Repair with Suture Anchors for Adolescent Multidirectional Shoulder Instability*  
Brendon C. Mitchell, MD, University of California, San Diego
- 9:28 a.m. – 9:32 a.m.      *Does Conflict of Interest Affect the Reported Fusion Rates with Bone Graft Extenders?*  
Garwin Chin, MD, University of California, Irvine
- 9:32 a.m. – 9:36 a.m.      *An Externally Validated Machine Learning Algorithm for Prediction of Ninety-Day and One-Year Mortality After Surgery for Spinal Metastasis*  
Akash A. Shah, MD, University of California, Los Angeles

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- 9:36 a.m. – 9:40 a.m.      *The Effect of Hepatitis C Infection on Shoulder Arthroplasty Complication Rates in US Veterans*  
Favian Su, MD, University of California, San Francisco
- 9:40 a.m. – 9:50 a.m.      **Question and Answers**
- 9:50 a.m. – 10:00 a.m.      **Break**
- Session IV – Presentations and Discussion**  
**Moderator: Carol A. Lin, MD**
- 10:00 a.m. – 10:04 a.m.      *Clinical and Functional Outcomes of Patients Who Undergo Knee Fusion versus Amputation for Periprosthetic Joint Infection*  
Christopher Hart, MD, University of California, Los Angeles
- 10:04 a.m. – 10:08 a.m.      *Interobserver Reliability of Classification Systems for Injury Severity and Radiographic Complications after Radial Head Arthroplasty*  
Gopal Lalchandani, MD, University of California, San Francisco
- 10:08 a.m. – 10:12 a.m.      *Outcomes of Patients Undergoing Conversion of Knee Arthrodesis for Prosthetic Joint Infection to Second Stage Endoprosthetic Reconstruction*  
Sai Devana, MD, University of California, Los Angeles
- 10:12 a.m. – 10:16 a.m.      *Fragility of Statistically Significant Findings from Randomized Clinical Trials of Surgical Treatment of Humeral Shaft Fractures: A Systematic Review*  
Stephen Craig Morris, MD, Loma Linda University
- 10:16 a.m. – 10:20 a.m.      *Motivations and Impact of International Rotations in Low- and Middle-income Countries for Orthopaedic Surgery Residents: Are We on The Same Page?*  
Heather Roberts, MD, University of California, San Francisco
- 10:20 a.m. – 10:24 a.m.      *Graft Failure in Adolescent Patients Undergoing Adult-Type ACL Reconstruction with Bone Patellar Tendon Bone or Hamstring Autograft*  
Ashish Mittal, MD, San Francisco Orthopaedic Residency Program,  
St. Mary's Medical Center
- 10:24 a.m. – 10:34 a.m.      **Question and Answers**

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**Session V – Presentations and Discussion**

**Moderator: Nelson F. SooHoo, MD**

- 10:34 a.m. – 10:38 a.m.     *Novel Antibody Disrupts Biofilm Bacteria in a Mouse Model of Spinal Implant Infection*  
Zachary Burke, MD, University of California, Los Angeles
- 10:38 a.m. – 10:42 a.m.     *Primed Cellular Immunotherapy to Prevent or Treat Spine Implant Infection*  
Peter Hsiue, MD, David Geffen School of Medicine at UCLA
- 10:42 a.m. – 10:46 a.m.     *Outcomes of Acute but Not Delayed Reverse Total Shoulder Arthroplasty for Proximal Humerus Fracture Are Equal to Those for Rotator Cuff Arthropathy*  
Erika Roddy, MD, University of California, San Francisco
- 10:46 a.m. – 10:50 a.m.     *Rates and Predictors of Operative Management of Proximal Humerus Fractures in Adolescents*  
Arin Kim, MD, University of California, San Francisco
- 10:50 a.m. – 10:54 a.m.     *Altered Cortical Activation After Anterior Cruciate Ligament Reconstruction During Single-Leg Balance Task*  
Max Jiganti, MD, Good Samaritan Regional Medical Center
- 10:54 a.m. – 11:04 a.m.     **Question and Answers**
- 11:04 a.m. – 11:44 a.m.     **Keynote Address**  
*Building a Model for Global Orthopaedic Surgical Research – The UCSF Experience*  
Saam Morshed, MD, MPH, PhD  
Associate Professor of Orthopaedic Surgery,  
Epidemiology and Biostatistics  
University of California, San Francisco
- 11:44 a.m. – 12:00 p.m.     **Awards Presentation and Closing Remarks**

## Stem Tip Location Represents a Potentially Modifiable Risk Factor for Aseptic Loosening following Cemented Distal Femoral Replacement

Danielle Greig, MD  
University of California, Los Angeles

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**Purpose:** To describe the incidence of AL of cemented stem DFRs and to identify modifiable risk factors for its development.

**Significance:** As indications for distal femoral replacement (DFR) expand and patient survival improves, aseptic loosening (AL) has become a leading cause of implant failure.

**Methods:** A retrospective review was performed of 245 consecutive primary, cemented stem DFRs. Radiographs were reviewed to identify stem tip location. A multivariate analysis was performed to identify risk factors for AL.

**Results:** AL was the most common cause of implant failure (incidence: 11.8%). Younger age ( $p=0.002$ ), male sex ( $p=0.01$ ), longer resection length ( $p=0.03$ ), and non-modular implants ( $p=0.001$ ) were all significantly associated with AL. When controlling for these factors, stem tip location in metaphyseal bone was independently associated with AL ( $p=0.04$ ). 36% of implants that loosened had a stem tip located in the metaphysis, versus 8% of implants that did not fail. 30-year survival to AL was lower for implants with a metaphyseal stem tip compared with implants with a diaphyseal stem tip (22.7% vs 47.6%;  $p=0.11$ ).

**Conclusion:** Independent of resection length, stem extension into metaphyseal bone was associated with diminished survival to AL. This finding should be considered when planning endoprosthetic reconstruction, as it may be modifiable in some patients.

# Human Rotator Cuff Tears have an Endogenous, Inducible Stem Cell Source Capable of Improving Muscle Quality and Function after Rotator Cuff Repair

Obiajulu Agha, MD

University of California, San Francisco

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**Purpose:** We hypothesize that there are resident Fibro-adipogenic progenitors (FAPs) present in injured human rotator cuff (RC) muscle, and that patients with smaller tears would have higher numbers of FAPs than found in larger tears.

**Significance:** The muscle quality of the RC, measured by atrophy and fatty infiltration (FI), is a key determinant of outcomes in RC injury and repair. FAPs have been shown to be the main contributors of FI and fibrosis in animal RC injury models.<sup>[1][2]</sup>

**Methods:** Supraspinatus biopsies were obtained for analysis as were deltoid biopsies to serve as controls from 20 patients undergoing RC surgical repair. Muscle FI and fibrosis were quantified using histologic staining. FAPs and Satellite cells (SCs) from different tear sizes were quantified using FACS. FAPs were analyzed for gene expression as well as fibrogenic and adipogenic differentiation profiles.

**Results:** Histologic analysis confirmed the presence of more fat and fibrosis in full thickness tears (FTT). There were more FAPs in FTT compared to partial thickness tears ( $9.43 \pm 4.25\%$  vs.  $3.84\% \pm 2.54\%$ ,  $p < 0.01$ ), of which showed more adipogenic and fibrogenic potential. FTT were divided by tear size, with larger tears found to have significantly more FAPs than smaller tears. FAPs also displayed the ability for induction to beige adipocytes (BAT) with increased pro-myogenic gene expression of IGF-1 and follistatin.

**Conclusion:** Endogenous FAPs are present within the human RC and likely are the source of FI and fibrosis. These FAPs increase in larger tears but are capable of adopting a pro-myogenic BAT phenotype that could be utilized to improve RC muscle quality.

## **Intramedullary Fixation of Both Bone Forearm Fractures in Children and Adolescents: Healing Correlates with Development of the Olecranon Apophysis**

**Joshua Spiers, MD**  
Loma Linda University

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**Purpose:** To determine whether healing of both bone forearm (BBFA) fractures in pediatric patients treated with intramedullary fixation is associated with the stage of the olecranon apophysis development.

**Significance:** Describe a radiographic marker of skeletal maturation to guide choice of implant when performing surgical fixation of BBFA fractures.

**Methodology:** A retrospective review was performed to evaluate all pediatric patients who had BBFA fracture treated with intramedullary nail fixation. The stage of the olecranon apophysis development was assessed on the lateral radiograph. Data were statistically analyzed to assess the olecranon stage at which the increased rate of delayed union becomes more prevalent using the receiver operating characteristic (ROC) curve.

**Results:** 1398 patient records were reviewed with 63 patients meeting the inclusion criteria. Using a ROC curve, a cutoff of olecranon stage > 3 (stages 4 to 7) of the Diméglio modification of the Sauvegrain method was a significant predictor of the increased rate of delayed union time compared with olecranon stages 0 to 3 ( $P=0.004$ ).

**Conclusions:** There is an increased rate of delayed union for BBFA fractures treated with intramedullary nailing in children with more mature olecranon apophyses as compared with those with younger olecranon stages.

## One-Stage Durable Functional Prosthetic Spacers are an Option for Treating Periprosthetic Joint Infection after TKA

Liam Bosch, MD  
Stanford University

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**Purpose:** We hypothesized that single-stage durable functional prosthetic spacer (dFPS) revisions for knee periprosthetic joint infection (PJI) using primary total knee arthroplasty (TKA) components and high-dose antibiotic cement would result in similar eradication rates and functional scores compared to standard two-stage revision using all-cement spacers.

**Significance:** Previously reported single-stage revision methods for TKA-PJI have strict exclusion criteria and institutional barriers to implementation. An improved solution is needed.

**Methodology:** 20 TKAs with chronic PJI undergoing dFPS revision were retrospectively reviewed and compared to a matched cohort of 28 TKA-PJIs undergoing standard two-stage revision. Kaplan-Meier survivorship curves were constructed and a log-rank test was used to analyze the differences in survival probabilities between the two methods. Significance was  $p < 0.05$ .

**Results:** At final follow-up (dFPS mean 31 months vs two-stage 32 months,  $p = 0.856$ ), mean Knee Society Score was not different (dFPS  $89 \pm 10$  vs two-stage  $84 \pm 13$ ,  $p = 0.108$ ). Infection eradication rates were similar at final follow-up [dFPS 19 (95%) vs two-stage 26 (93%),  $p = 1.00$ ]. Survival probability (reoperation or re-infection) was similar at 50 months (dFPS 84% vs two-stage 87%,  $p = 1.00$ ).

**Conclusion:** Single-stage dFPS is non-inferior to two-stage re-implantation after TKA-PJI with similar rates of infection control, implant survival, and functional scores.

**Combined Motor and Sensory Neuromonitoring for Cervical  
Spondylotic Myelopathy Surgery Causes Confusion:  
A Level-1 Diagnostic Study**

**Kristen Combs, MD**  
Harbor – UCLA Medical Center

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**Purpose:** The purpose of this study was to evaluate the sensitivity and specificity of combined motor and sensory neuromonitoring for cervical spondylotic myelopathy, as well as the intra-operative value. Our hypothesis was that sensitivity and specificity would be very low and high respectively, and neuromonitoring would not have a significant value.

**Significance:** Major intraoperative neurologic events are important complications in spine surgery, especially for cervical spondylotic myelopathy.

**Methods:** Neuromonitoring somatosensory evoked and transcranial motor evoked potentials were analyzed for a consecutive series of 540 cervical spondylotic myelopathy patients over a 10-year period. Positive and negative alerts were compared against the patient's postoperative examination and the sensitivity and specificity for neuromonitoring were calculated.

**Results:** There were seven positive neuromonitoring alerts, all of which were motor evoked potentials (MEPs). All alerts were false positive. There were no false negative alerts, and all negatives were true negatives. The overall sensitivity was 0%, and the specificity was 98.7%.

**Conclusion:** Combined motor and sensory neuromonitoring for cervical spondylotic myelopathy added set-up time and cost, but no patient benefit for the avoidance of neurologic decline. Rather, the 1.3% of cases with intraoperative disagreement between motor and sensory evoked potentials created a confusing choice for the surgeon.

# **Rapid Improvers and Resistant Responders after Shoulder Arthroplasty: Analysis of Patient Recovery Trajectories Using Latent Class Growth Modeling**

**William Rubenstein, MD**

University of California, San Francisco

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**Purpose:** To classify total shoulder arthroplasty (TSA) patients into representative subgroups based on recovery trajectories.

**Significance:** The results of this study will help establish common recovery trajectories after TSA and identify differences among the patients in each group.

**Methods:** Data from a prospectively collected TSA database were utilized. Only primary, non-infected TSAs were included. Latent class analysis (LCA) - a multi-level model that can evaluate heterogeneity in outcome patterns - was used to sub-classify the patient cohort into differing recovery trajectories after surgery.

**Results:** Four recovery trajectories were identified. Resistant Responders had low baseline scores and poor final results, Steady Progressors had moderate baseline scores with moderate final results, Rapid Improvers had low baseline scores with excellent final results, and High Performers had high baseline scores with excellent final results. Resistant Responders had a significantly higher proportion of patients with cuff tear arthropathy and a higher likelihood of being younger while Rapid Improvers had a higher proportion of patients with osteoarthritis.

**Conclusions:** Typically, those with higher baseline scores demonstrated the best outcomes at two years. However, some Rapid Improvers, which included a higher proportion of patients with osteoarthritis, were able to achieve excellent results even with low ASES scores at baseline.

## Patient Reported Outcomes after Surgical Fixation of Acute Posterior Sternoclavicular Physeal Fractures and Dislocation in Children

Alejandro Cazzulino, MD  
University of California, San Francisco

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**Purpose:** This study describes the presentation of acute posterior sternoclavicular fracture-dislocations (SCFDs) and assesses patient reported functional outcomes following ORIF.

**Significance:** SCFDs are a rare but potentially lethal injury in pediatric patients given the proximity to vascular structures. The current literature surrounding the topic is limited to case reports and small series.

**Methodology:** This is a retrospective observational study of pediatric patients that had surgically managed acute posterior SCFD from 1990-2018 from a single institution. Demographic, clinical, and surgical details were obtained. Functional outcomes included QuickDash, VAS pain rating, SANE of shoulder function, and PROMIS Upper Extremity questionnaire.

**Results:** Thirty-seven patients were included. Average age at time of injury was  $15.2 \pm 2.1$  years and 89% were male with the majority of patients (87%) reporting sports-related injuries. Patient reported outcomes were obtained for 14 (37%) patients with a mean follow-up of 4.5 years. The mean QuickDash score was 5.1/100 with 0 being normal, and the mean VAS pain rating was 0.7/10. The mean SANE score was 96% with 100% being completely normal. The mean PROMIS score was 55 with 50 being the mean of the relevant reference population. Approximately 29% (4/14 patients) stated that their injury negatively affected their ability to participate in sports.

**Conclusions:** The current study corroborates past epidemiological studies, which shows that adolescent males playing sports sustain these injuries. Functional outcomes were satisfactory in this cohort, however, sports participation may be negatively affected. Future studies with larger cohorts and comparative groups are needed to better understand outcomes in this population.

**Association Between Rotator Cuff Tears and Superior Migration  
of the Humeral Head in Rotator Cuff Arthropathy:  
A Magnetic Resonance Imaging Based Anatomical Study**

**Matthew Siow, MD**

University of California, San Diego

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**Purpose:** To determine the relationship between severity of rotator cuff tears and AHI via a large sample of shoulder MRIs.

**Significance:** Acromiohumeral interval (AHI) is measured from radiographs and has been previously validated in various studies. Currently, the data is mixed regarding the specific rotator cuff pathology that contributes most to humeral head migration, indicative of more advanced rotator cuff arthropathy.

**Methodology:** Three orthopaedic surgeons and one musculoskeletal radiologist measured AHI on 257 3 Tesla (3T) shoulder MRIs performed between January 2010 and June 2019. Rotator cuff pathologies were recorded from imaging reports made by fellowship-trained musculoskeletal radiologists.

**Results:** 199 (77%) had a rotator cuff tear: 174 supraspinatus (67.7%), 119 infraspinatus (46.3%), 80 subscapularis (31.1%), and 3 teres minor (0.2%). Full thickness tears of the supraspinatus (7.1 mm), infraspinatus (5.3mm), or subscapularis (6.8 mm) were associated with decreased AHI ( $p < 0.001$ ). Having more torn tendons was associated with decreased AHI ( $\rho = -0.157$ ,  $p = 0.012$ ). Isolated infraspinatus tears had lowest AHI (7.7 mm), versus isolated supraspinatus (8.9 mm) or combination (8.2 mm) of tears, although not significant ( $p = 0.098$ ).

**Conclusion:** Our study demonstrates a correlation between a complete RTC and superior humeral migration. Infraspinatus may have the greatest effect on maintaining the native position of the humeral head.

## Opioid Use in Revision Total Hip Arthroplasty

Christopher Holland, MD  
University of California, Davis

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**Purpose:** To analyze opioid use during revision total hip arthroplasty(rTHA).

**Significance:** Opioid use after rTHA has not been well described in the literature.

**Methods:** Patients who underwent rTHA from 2010 to 2018 at our institution were identified and categorized as opioid tolerant if a prescription was present 3 months preoperatively. Patient demographics, opioid prescriptions and average morphine milligram equivalents (MME) were compared between opioid naïve and tolerant groups.

**Results:** Of 247 patients, 50% were in the tolerant group with average preoperative MME of 23.7mg/day. Age, surgery duration, BMI and discharge disposition were not significantly different between the two groups. Tolerant patients were significantly more likely to smoke and had higher ASA scores ( $p=0.031$ ,  $p=0.016$  respectively). Opioid tolerant patients received significantly higher daily MME at all time points from 3 to 24 months postoperatively( $p<0.001$ ). Tolerant patients were also more likely to have a prescription at 6, 12, and 24 months postoperatively compared to naïve patients ( $p<0.001$ ,  $p=0.002$ ,  $p<0.001$  respectively).

**Conclusion:** Patients who had been prescribed opioids in the 90 days preceding surgery had a higher daily average MME at all postoperative timepoints, were more likely to require a narcotic prescription after 6 months and demonstrated a higher risk of chronic opioid use after rTHA.

## Lumbar Sagittal Mismatch Deformity Negatively Affects Total Knee Arthroplasty Outcomes

William L. Sheppard, Jr., MD  
University of California, Los Angeles

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**Study Purpose:** To demonstrate how lumbar sagittal spine deformity decreases total knee arthroplasty outcomes.

**Significance:** There is currently no data regarding the potential relationships between pre-existing spinal deformity and clinical outcomes following total knee arthroplasty (TKA). We hypothesize the lumbar sagittal mismatch deformity (MD) will result in decreased functional outcomes after TKA.

**Methods:** This retrospective cohort comparison of 933 TKAs was performed between January 2017-2020. Exclusions were performed if pre-operative lumbar radiographs were unavailable/inadequate to measure sagittal spinal parameters of interest. Clinical outcomes were assessed in 94 TKAs, which were divided into two groups: those with MD, as defined by  $|\text{Pelvic-Incidence} - \text{Lumbar-Lordosis}| > 10^\circ$ , and those without MD.

**Results:** 53 TKAs met the MD criteria, while 41 did not have MD. There were no significant differences in demographics, pre-operative knee range/arc-of-motion, or opiate use between groups. MD TKAs were more likely to have manipulations-under-anesthesia (MUA) ( $p=0.026$ ), range-of-motion (ROM) $<0-120$  ( $p<0.001$ ), a decreased arc-of-motion (AOM) by  $16^\circ$  ( $p<0.001$ ), and a flexion contracture post-operatively ( $p=0.01$ ).

**Conclusions:** Pre-existing MD may adversely affect clinical results following TKA. Statistically and clinically significant decreases in post-operative ROM/AOM, increased likelihood of flexion contracture, and increased need for MUA were all noted in those with MD.

## **Inhibition of Angiotensin Converting Enzyme Impairs Anti-Staphylococcal Immune Function in a Preclinical Model of Implant Infection**

**Rishi Trikha, MD**

University of California, Los Angeles

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**Purpose:** Assess the purported immunomodulatory effect of RAS-modulation in a preclinical model of implant infection.

**Significance:** Evidence suggests the renin-angiotensin system (RAS) plays key immunomodulatory roles. In particular, angiotensin-converting enzyme (ACE) has been shown to play a role in antimicrobial host defense.

**Methods:** C57BL/6J mice received either an ACEi, an ARB or no treatment. Conditioned blood was utilized to quantify respiratory burst function as well as *Staphylococcal Xen36* burden *ex vivo*. *Staphylococcal* burden was then assessed *in vivo* using a validated mouse model of spinal implant infection.

**Results:** The ACEi group demonstrated a decreased ability to eradicate bacteria as significantly higher levels of colony forming units (CFU) and biofilm formation was appreciated *ex vivo* ( $p < 0.05$ ). Mice treated with an ACEi showed a higher infection burden *in vivo* at all times ( $p < 0.05$ ) and significantly higher CFUs of bacteria on both implant and paraspinal tissue ( $p < 0.05$ ). There was also significantly decreased infiltration and respiratory burst function of immune effector cells in the ACEi group ( $p < 0.05$ ).

**Conclusion:** ACEi, but not ARB, treatment resulted in increased *S. aureus* burden and impaired immune response in a preclinical model of implant infection. These results suggest that perioperative ACEi use may represent a previously unappreciated, modifiable risk factor for surgical site infection.

## Complications After Radial Head Replacement: Mid-to Long-term Follow Up

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**Purpose:** This study sought to evaluate radiographic complications after primary radial head arthroplasty (RHA) at mid-term follow-up.

**Significance:** Long-term radiographic problems including loosening, stress shielding, and radiocapitellar arthritis have been well described following RHA. However, no prior studies have examined radiographic complications at mid-term follow-up.

**Methods:** A retrospective review identified 63 patients who underwent RHA at two centers. Associated injuries, fracture pattern, implant design, radiolucency, stress shielding (SS), radiocapitellar arthritis (RCA), and heterotopic ossification (HO) were evaluated. Age-and-gender-controlled, multivariable logistic regression was used to assess the relationship between demographics and radiographic complications.

**Results:** Age, follow-up duration, fracture pattern, and associated injuries were not associated with SS, RCA, HO, or radiolucency ( $p > .05$ ). Male gender was associated with a lower degree of arthritis (estimate -0.40; 95% CI -0.72 - -0.08), but not with SS, HO, or radiolucency. Bipolar implants were associated with a lower degree of RCA (estimate -0.6; 95% CI -1.11 - -0.09), but implant type was not associated with SS, HO, or radiolucency.

**Conclusions:** Male gender and the use of bipolar implants may be protective factors against the development of radiographic RCA. These data also suggest radiographic complications occur at mid-term follow-up, as soon as six months post op.

## Compressive Osseointegration Device for Management of Non-Oncologic Salvage Arthroplasty

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**Purpose:** The survival of the Compress implant will be inferior in the multiply revised arthroplasty patient when compared to the oncologic limb salvage population.

**Significance:** By achieving implant fixation in short segments of bone, Compress implants offer an alternative fixation method for arthroplasty surgeons during revision surgery, but with unknown rates of failure.

**Methods:** Between June 2004 and December 2017, 66 consecutive revision TKAs and THAs using the femoral compress method were performed by 3 high-volume arthroplasty surgeons. This cohort was reviewed retrospectively. Patients were followed for a minimum of 6 months. Outcome measures included: implant failures, complications, and outcome scores.

**Results:** 44 revision TKAs in 40 patients and 22 revision THAs in 20 patients were reviewed. There were 31 male and 29 female patients, with a mean age of 61 years (22-86) and a mean follow-up of 2.3 years (0.5 to 9.5 years). The survivorship at final follow up was 53%. There were 31 (47%) implant failures requiring revision including: 13 (19.7%) periprosthetic fractures, 11 (16.7%) infections, and 7 (10.6%) instances of mechanical loosening

**Conclusion:** At early follow-up of complex arthroplasty, in which bone stock is unsupportive of long stems, CPS implants may represent an alternative to other salvage options with modest success rates.

## **Risk Factors for Conversion of Hip Arthroscopy to Total Hip Arthroplasty: A Large Closed Cohort Study**

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**Purpose:** To evaluate risk factors for conversion of hip arthroscopy to total hip arthroplasty (THA) within two years in a closed patient cohort.

**Significance:** Hip arthroscopy for femoroacetabular impingement and labral injury seeks to improve hip function and longevity; understanding risks of treatment failure may guide surgical decision-making.

**Methods:** We evaluated 1561 consecutive hip arthroscopies from 2008-2018 in a closed cohort system. Patients were included with minimum two-year follow-up or if they had THA within two years (the primary outcome) regardless of follow-up. Characteristics of patients with or without THA conversion were compared with multivariable logistic regression models and receiver-operating characteristic (ROC) curves.

**Results:** Median follow-up was 4.6 years (range: 0.6–11.6). The mean age was 37.2 years and 57% were female. 82 patients underwent THA within two years (5.3%, 95%CI: 4.3%-6.5%) after median 9 months (interquartile range: 5.9–14.4 months) following initial arthroscopy. Increasing age was highly predictive of early THA conversion (area under ROC=0.78,  $p<0.0001$ ).

**Conclusion:** In this large closed patient cohort with midterm follow-up, the risk of conversion to THA within two years after hip arthroscopy increased substantially with patient age at the time of the procedure. BMI, race, sex, and prior arthroscopy were not important independent predictors of conversion.

# **Mean 6 Year Clinical Outcomes, Survivorship, and Return to Sports After Arthroscopic Capsular Repair with Suture Anchors for Adolescent Multidirectional Shoulder Instability**

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**Background:** Multidirectional shoulder instability (MDI) refractory to rehabilitation can be treated with arthroscopic capsulolabral reconstruction with suture anchors.

**Purpose:** To identify risk factors for surgical failure by comparing anatomic, clinical, and demographic variables in adolescents who underwent surgical intervention for MDI.

**Methods:** All patients undergoing arthroscopic shoulder surgery at one institution between January 2009 and April 2017 were reviewed.

**Results:** Eighty adolescents (88 shoulders) were identified for having undergone surgical treatment of MDI. Forty-two (50 shoulders; 31 female, 19 male) were available at a minimum of 2-year follow-up. Mean follow-up was 6.3 years (range, 2.8-10.2 years). Thirteen (26.0%) shoulders experienced surgical failure defined by recurrence of subluxation and instability, all of which underwent re-operation. Time to re-operation occurred at a mean of 1.9 years (range, 0.8-3.2). Number of anchors used was not different between those that failed and those that did not fail. Patients reported a mean SANE score of 83.3, PASS score of 85.0, and QuickDASH score of 6.8. Return to prior level of sport (RTS) occurred in 56% of patients.

**Conclusion:** Adolescent MDI that is refractory to non-surgical management appears to have long-term outcomes after surgical intervention that are comparable to adolescent patients with unidirectional instability.

## Does Conflict of Interest Affect the Reported Fusion Rates with Bone Graft Extenders?

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**Purpose:** We hypothesize that spine fusion studies with conflict of interest (COI) have higher reported fusion rates.

**Significance:** Bone graft extenders are being used more in spine surgery as a substitute for iliac crest bone graft. But potential COI could impact how fusion rates are reported.

**Methodology:** Pubmed was searched for studies evaluating fusion rates when bone graft extenders including demineralized bone matrix, hydroxyapatite, and tricalcium sulfate are used with laminectomy bone. Studies were screened for one- or two-level fusions and degenerative spinal conditions.

**Results:** 1928 studies were evaluated, 86 were included in this study. There were 24 studies with potential COI and 62 studies without COI. The average fusion rate of all the studies was 84.63%. Fusion rates of studies with COI was 80.93% versus 86.06% without COI. Fusion rates with CT was 79.79% versus 87.94% without CT. Fusion rates with an independent reviewer was 82.61% versus 85.63% without an independent reviewer.

**Conclusions:** Reported fusion rates of bone graft extenders vary greatly. Reported fusion rates were lower in studies with a potential COI. The use of CT scans and independent reviewers may be a means of negating the potential risks of COI affecting the reporting of fusion rates.

# **An Externally Validated Machine Learning Algorithm for Prediction of Ninety-Day and One-Year Mortality After Surgery for Spinal Metastasis**

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**Purpose:** We aim to externally validate Skeletal Oncology Research Group (SORG) machine-learning algorithms for prediction of mortality at key post-operative time points after surgery for spinal metastasis.

**Significance:** Decompression and stabilization for spinal metastasis may be performed to relieve pain and preserve functional status. These benefits must be weighed against the risks of perioperative mortality. We previously developed SORG algorithms for survival prediction after surgery for spinal metastasis.

**Methods:** Patients  $\geq 18$  years at a single tertiary care center treated surgically for spinal metastasis between 2004-2020 were retrospectively identified. Baseline characteristics of the validation and derivation cohorts were compared. Discrimination, calibration, and decision curve analysis were employed to assess performance.

**Results:** 298 patients met inclusion criteria. Ninety-day mortality was 21.9%; one-year mortality was 52.6%. Baseline characteristics of the two cohorts differed significantly. The algorithms for ninety-day and one-year mortality were well-calibrated with excellent discrimination (AUC: 0.84 and 0.90, respectively). Use of the algorithms results in a greater balance of true positives than false positives.

**Conclusion:** We report successful external validation of SORG algorithms for prediction of post-operative ninety-day and one-year mortality for spinal metastasis. By providing key prognostic information, these tools may inform patient counseling and can be accessed at: <https://sorg-apps.shinyapps.io/spinemetssurvival/>.

## **The Effect of Hepatitis C Infection on Shoulder Arthroplasty Complication Rates in U.S. Veterans**

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**Purpose:** The purpose of our study was to determine if HCV infection is associated with increased complication rates after total shoulder arthroplasty (TSA) in US Veterans and to determine if preoperative HCV treatment with direct-acting antivirals (DAA) changes that risk.

**Significance:** To date, no study has evaluated the effect of HCV treatment on outcomes after TSA.

**Methods:** All US veterans who underwent TSA, including both anatomic and reverse, from 2014 to 2018 were retrospectively identified using the Veteran Affairs dataset. Patients with HCV were identified using ICD-9 and ICD-10 codes and were further classified into “treated” and “untreated” groups depending on whether they received DAA prior to TSA. Chi-square test were used to compare complication rates between patients with and without HCV and between HCV-treated and HCV-untreated patients.

**Results:** Out of 5418 TSA, 9.8% had HCV, 23.3% of whom were treated with DAAs pre-operatively. At 1-year, HCV-untreated patients had increased rate of myocardial infarction (14.3% vs 10.6%,  $p = 0.03$ ), pneumonia (4.7% vs 2.7%,  $p = 0.005$ ), sepsis (3.0% vs 1.4%,  $p = 0.02$ ), and acute kidney injury (6.4% vs 4.8%,  $p = 0.03$ ) compare to patients without HCV. There was no difference in the rates of implant infection or mechanical complication ( $p > 0.05$ ). No difference in complication rates were observed between HCV-treated and HCV-untreated groups ( $p > 0.05$ ).

**Conclusion:** US Veterans with HCV infection are at an increased risk of medical but not surgical complications after TSA when compared to patients without HCV. This study was likely underpowered to demonstrate a significant difference in complication rates between patients with HCV who were and were not treated with DAAs.

## **Clinical and Functional Outcomes of Patients Who Undergo Knee Fusion versus Amputation for Periprosthetic Joint Infection**

**Christopher Hart, MD**

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**Purpose:** Compare outcomes of patients who undergo knee fusion (FUS) versus amputation (AMP) for persistent or recurrent periprosthetic joint infection (PJI) following antibiotic spacer placement and/or failed two-stage reimplantation.

**Significance:** Little is known about the perioperative complications and functional outcomes of patients who have undergone FUS versus AMP for PJI.

**Methods:** Retrospective review of 93 patients who underwent FUS or AMP from 2011-2018 for recurrent or persistent PJI. Patient characteristics and Knee Society Scores (KSS) were recorded. Student's t-test and Fisher's exact test were used for comparison.

**Results:** 67 patients underwent FUS and 26 underwent AMP. Following FUS, the overall medical complication rate was 27%, 22% underwent at least one reoperation (most commonly for recurrent infection). Following AMP, the overall medical complication rate was 19%, 27% underwent at least one reoperation (most commonly for wound dehiscence). There was no significant difference in overall complications between the two groups ( $p=0.22$ ). KSS were higher in the FUS group (26 versus 17,  $p=0.005$ ). Only 38% of patients who underwent AMP ambulated with a prosthesis at final follow-up.

**Conclusion:** FUS and AMP for knee PJI have similar perioperative complication rates; however, FUS is associated with improved functional outcomes.

## Interobserver Reliability of Classification Systems for Injury Severity and Radiographic Complications after Radial Head Arthroplasty

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**Significance:** Although radiographic classifications are commonly used for injury severity (Mason Johnston) and radiographic complications after radial head arthroplasty (RHA) – including stress shielding (SS) (Chanlalit), heterotopic ossification (HO) (Brooker), and radiolucency (Popovic) – little is known about their interobserver reliability (IOR).

**Purpose:** The purpose of this study is to determine the (IOR) of these classification systems in patients after RHA.

**Methods:** Patients who underwent RHA between 2006 and 2019 with at least 6 months of radiographic follow-up were identified. Radiographic reviews were performed by two teams, each with one fellowship-trained surgeon and one orthopedic resident. Agreement was interpreted as slight (0-0.2), fair (0.21-0.4), moderate (0.41-0.6), substantial (0.61-0.8), and almost perfect (0.81-1).

**Results:** Sixty-two elbows amongst 63 patients were included. IOR for percent of Popovic zones with radiolucency was moderate. IOR for HO (binary Brooker) and SS (Chanlalit) was fair. IOR for injury severity (MJ) and radiolucency (Popovic, binary and nominal) were slight.

**Conclusion:** The IOR for commonly used classification systems to assess for injury severity and radiographic complications after RHA are only fair or slight. Further research is warranted on these classification systems to help improve communication of findings between physicians and researchers.

## **Outcomes of Patients Undergoing Conversion of Knee Arthrodesis for Prosthetic Joint Infection to Second Stage Endoprosthetic Reconstruction**

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**Purpose/Significance:** Reimplantation endoprosthetic reconstruction (REI) is an option in knee fusion (FUS) patients who are unsatisfied and have evidence of PJI clearance. We present a retrospective review of 56 patients who underwent REI following FUS.

**Methods:** From January 2010 to December 2019, 56 patients underwent conversion of FUS to REI. All patients were staged according to the McPherson Staging System. Infecting organism was obtained via pre-FUS aspiration. Knee Society Scores (KSS) were recorded pre-REI and at latest follow-up.

**Results:** Mean patient age was 67. The most common infecting organisms were *Staphylococcus epidermidis* (23.2%) and *Staphylococcus aureus* (23.2%, MSSA 14.3%, MRSA 8.9%). Mean time to REI was 220 days. There was an 8.9% in-house complication rate and 21.4% overall complication rate (excluding infection). 67% remain infection-free at 37 months mean follow-up. Clinical KSS improved 24 points and functional KSS 22 points on average. There was no statistically significant association between index organism or McPherson host type and REI failure.

**Discussion:** Approximately two-thirds of patients who underwent REI have remained infection free at mid-term follow-up with significant improvement in clinical and functional KSS.

# **Fragility of Statistically Significant Findings from Randomized Clinical Trials of Surgical Treatment of Humeral Shaft Fractures: A Systematic Review**

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**Purpose:** Evaluate the robustness of randomized controlled trials (RCTs) comparing treatment options for humeral shaft fractures.

**Significance:** There remains no consensus regarding the preferred surgical treatment. Applying the fragility index (FI) will aid in clinical decision.

**Methods:** We completed a systematic review of RCTs evaluating the surgical treatment of humeral shaft fractures. Inclusion criteria included: articles published in English; patients randomized and allotted in 1:1 ratio to 2 parallel arms; dichotomous outcome variables. The FI was calculated using the Fisher exact test for total complications, each complication individually, and secondary surgeries.

**Results:** Fifteen RCTs were included. Comparison groups were open reduction plate osteosynthesis (ORPO) with dynamic compression plate (DCP) or locking compression plate (LCP), intramedullary nail (IMN), and minimally invasive plate osteosynthesis (MIPO). Regarding total complications, only two studies had an FI > 0. The FI was > 0 in three RCTs regarding shoulder impingement, and in one RCT each regarding iatrogenic radial nerve palsy, malunion, elbow stiffness, and secondary surgeries. The FI was 0 in all RCTs regarding delayed union/nonunion and infection.

**Conclusion:** The FI shows that conclusions from RCTs regarding surgical treatment of humeral shaft fractures are fragile and do not demonstrate superiority of any particular technique.

**Motivations and Impact of International Rotations in  
Low- and Middle-income Countries for Orthopaedic Surgery Residents:  
Are We on The Same page?**

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**Purpose:** The purpose of this study was to explore North American orthopaedic resident motivations for participation in rotations in low- and middle-income countries (LMICs) and the perceived impact of these rotations among host surgeons and trainees. We hypothesized that there would be areas of low concordance between North American motivations and host-perceived impact.

**Significance:** Despite interest among North American orthopaedic residents to pursue rotations in resource-limited settings, little is known regarding resident motivations and impact on host surgeons.

**Methodology:** Surveys were distributed to North American orthopaedic surgeons and trainees who participated in international rotations during residency to assess motivations for participation and to orthopaedic surgeons at partnering LMIC institutions to assess impact of visiting trainees.

**Results:** Responses were received from 136 North Americans and 51 LMIC hosts. North American residents were motivated by a desire to increase surgical capacity. Host surgeons reported a greater impact from learning from residents than on surgical capacity. Negative aspects reported by hosts included selfishness, lack of reciprocity, racial discrimination, competition for surgical experience, and resource burdens.

**Conclusion:** The motivations and impact of orthopaedic resident rotations in LMICs need to be aligned. Host perceptions and bidirectional educational exchange should be incorporated into partnership guidelines.

## **Graft Failure in Adolescent Patients Undergoing Adult-Type ACL Reconstruction with Bone Patellar Tendon Bone or Hamstring Autograft**

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**Purpose:** We sought to evaluate graft rupture between bone-patellar tendon-bone (BTB) versus hamstring autograft in adolescent patients undergoing adult-type ACL reconstruction (ACL-R).

**Significance:** Adolescent patients are perhaps at the highest risk of failure following ACL-R due to demands on the reconstruction after surgery.

**Methods:** A retrospective review of patients under the age of 21 undergoing primary adult-type ACL-R using BTB or hamstring autograft from 2011-2019 was performed. Patient demographics, athletic participation, graft type and size, compliance, complications, and rates of revision were evaluated. Statistical analysis was done using Fisher's exact test with significance  $< 0.05$ .

**Results:** 269 patients with an average age of 16.5 years and follow-up of 2.1 years were included. The overall graft rupture rate was 4.8%. There was no difference in average age, sex, compliance, and participation in high risk sports between graft type groups. Graft size was larger with BTB autograft than hamstring autograft (9.0 vs. 8.3;  $p < .001$ ). There was no significant difference in the overall rate of re-operation (8.6% vs. 10.6%;  $p = 0.81$ ) or graft rupture (2.9% vs. 5.5%;  $p = 0.26$ ) with BTB and hamstring autografts respectively.

**Conclusion:** Rates of graft tear after adult type ACL-R did not differ with BTB versus hamstring autograft in adolescent patients.

## Novel Antibody Disrupts Biofilm Bacteria in a Mouse Model of Spinal Implant Infection

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**Purpose:** We hypothesize that a novel human monoclonal antibody against bacterial biofilm matrix will reduce bacterial burden in a mouse model of spinal implant infection.

**Significance:** Bacterial biofilms on implants are highly resistant to the host immune response and traditional antibiotic therapy. Spinal implant related infections are particularly difficult to manage as removal of implanted hardware may catastrophically destabilize the spine. Novel therapies to treat biofilm infections are needed to improve patient outcomes.

**Methodology:** TRL1068 is a human monoclonal antibody against a biofilm scaffolding protein that is conserved across both gram positive and gram negative species. The efficacy of TRL1068 was assessed in a mouse model of spinal implant infection. A stainless-steel pin is implanted in the L4 spinous process and inoculated with a bioluminescent strain of *S. aureus*. Bacterial burden is monitored *in vivo*. Mice were randomized to treatment on POD 4 and 7 with subcutaneous 15 mg/kg TRL1068, inactive antibody, or vehicle control. All treatment groups received BID vancomycin 120 mg/kg on POD 7-21. On POD 35 all animals were sacrificed. Implants and peri-implant tissue were harvested separately and sonicated for CFU analysis.

**Results:** Treatment with TRL1068 + vancomycin accelerated the decline of the bacterial burden compared to the inactive antibody + vancomycin or vancomycin alone. CFUs were enumerated from 22% (4/18) of implants in mice treated with the inactive antibody. In contrast, none of the mice treated with TRL1068 + vancomycin were found to have an infected implant: 0% (0/18).

**Conclusion:** Implant related infections remain a major burden for patients and health systems. The novel human monoclonal antibody TRL1068 may add a valuable therapy to the armamentarium of treatment options as biofilm disruption facilitates the clearance of otherwise recalcitrant bacterial reservoirs.

## Primed Cellular Immunotherapy to Prevent or Treat Spine Implant Infection

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**Purpose:** Evaluate the effect of autologous 'primed' macrophages in a mouse model of spine implant infection.

**Significance:** Recent breakthroughs have demonstrated that macrophages can be trained to recognize and respond to *Staphylococcus aureus* ex vivo and then re-introduced to augment protective immunity in a mouse model of skin infection. It is unclear whether similar effects will be seen in a mouse model of spine implant infection.

**Methods:** Bone marrow cells isolated from mouse femurs and tibias were differentiated in vitro into bone marrow-derived macrophages (BMDM) and 'primed' against heat-killed *S. aureus*. Efficacy of primed macrophages were evaluated using an established mouse model of spine implant infection. Bacterial burden was evaluated over a 24-day period in mice that received primed macrophage injection (MF) and compared to an infected control group.

**Results:** The MF cohort did not demonstrate any decrease in bacterial burden compared to the infected control group during the study period. Increasing the number of primed macrophages injected and changing the timing of injections did not result in reduced bacterial burden postoperatively.

**Conclusion:** Although primed cellular immunotherapy holds enormous clinical potential for spine and other orthopaedic implant infections, there are still numerous translational challenges that need to be overcome.

## Outcomes of Acute but Not Delayed Reverse Total Shoulder Arthroplasty for Proximal Humerus Fracture Are Equal to Those for Rotator Cuff Arthropathy

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**Purpose:** Patients undergoing reverse total shoulder arthroplasty (RTSA) for fracture or fracture sequelae have worse outcomes compared to patients undergoing RTSA for cuff tear arthropathy (CTA).

**Significance:** Recent results support the use of RTSA for the treatment of proximal humerus fractures in the elderly over hemiarthroplasty or open reduction internal fixation (ORIF). However, there are limited data on the outcomes of RTSA for fracture or fracture sequelae as compared to RTSA for CTA.

**Methods:** This was a retrospective analysis of all patients at a single institution between 2008-2019 who underwent primary RTSA for a diagnosis of acute fracture, fracture nonunion or malunion after a period of nonoperative treatment, failed hemiarthroplasty or ORIF for proximal humerus fracture, or CTA. The primary outcome was American Shoulder and Elbow Surgeons (ASES) score at most recent follow-up, with minimum 1-year follow-up. Analysis of variance and chi square tests were used for univariate analysis. Linear regression analysis was used to perform multivariate analysis. Prosthesis survival rates were calculated using Kaplan Meier survival analysis.

**Results:** 287 patients were included in the final cohort, including 62 with fracture and 225 with CTA. Sex, diagnosis, and undergoing a revision surgery were associated with worse ASES scores on univariate analysis ( $p < 0.05$ ). On multivariate analysis, there was no difference in ASES scores or range of motion between the acute fracture and RTSA cohorts ( $p > 0.05$ ). Outcomes of RTSA for malunion/nonunion and hemiarthroplasty/ORIF were significantly worse than those for acute fracture/CTA ( $p < 0.01$ ). Five-year prosthesis survival was 95% for CTA, 97% for acute fracture, 97% for malunion/nonunion, and 78% for failed prior surgery.

**Conclusion:** We found no significant differences in outcomes for RTSA for acute fracture compared to elective surgery for CTA. Notably, outcomes of delayed RTSA for fracture were significantly worse than those for acute treatment.

## **Rates and Predictors of Operative Management of Proximal Humerus Fractures in Adolescents**

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**Background:** To investigate trends in the treatment of proximal humerus fractures in adolescents and identify predictors of operative management.

**Significance:** Pediatric proximal humerus fractures are usually treated with nonoperative management but there is less consensus for adolescents.

**Methods:** This retrospective database study included patients between the ages of 10 to 18 who sustained a proximal humerus fracture between 2004 to 2019. Patients with open fractures were excluded from the analysis. Descriptive, univariate, and multivariate analyses were used to determine rates and trends of operative management of pediatric proximal humerus fractures.

**Results:** 17,515 proximal humerus fracture admissions were identified and 11.9% were treated operatively. The mean age of patients was 12.5 years and 37.5% of patients were female. The rates of surgery decreased from 15.1% in 2004-2008 to 8.9% in 2015-2019. There were increased odds of operative management with age, male gender, and residence in the South and decreased odds with urban residence ( $p < 0.01$ ).

**Conclusion:** From 2004 to 2019, there has been a significant decrease in the rate of operative management of adolescent proximal humerus fractures and predictors of operative management were identified. Further study is needed to identify differences in patient outcomes between operative and nonoperative management in adolescents.

## Altered Cortical Activation After Anterior Cruciate Ligament Reconstruction During Single-Leg Balance Task

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**Purpose/Significance:** Poor balance in anterior cruciate ligament reconstruction (ACLR) patients indicates neuromuscular control (NMC) deficits, which may be associated with altered cortical activation in the brain. This study examines cortical activation patterns in ACLR patients compared with healthy controls during a single-leg balance task with and without visual feedback.

**Methodology:** Thirteen ACLR patients (ACLR,  $23.38 \pm 3.38$  years) and thirteen healthy controls (CONT,  $23.54 \pm 3.48$  years) performed a single-leg balance task with both visual feedback (VF) and non-visual feedback (NVF) with continuous electroencephalograph (EEG) monitoring. Knee function was also evaluated through a subjective assessment survey.

**Results:** Frontal theta power was significantly higher with VF compared to NVF. Significant group by condition interaction effect for parietal alpha-2 revealed that the CONT group had increased activation with VF, whereas the ACLR group had increased activation with NVF. A negative correlation emerged between KOS-ADL in the ACLR group with parietal alpha-2 during NVF and occipital alpha-2 during VF.

**Conclusion:** ACLR patients had comparable single-leg balance to healthy controls, yet different cortical activation patterns emerged on EEG. ACLR patients with better knee function showed greater cortical activation in the somatosensory and visual cortices. Further research should consider these cortical changes in restoration of balance after ACLR.

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