# Calgary Orthopaedics 12<sup>th</sup> Annual Resident Research Day





University of Calgary

Thursday, April 3, 2025 0700 – 1800 hours

Please see Program for specific location of events



# Adjudicators: Dr. Ted Miclau, University of California, San Francisco Dr. Brent Edwards, University of Calgary Dr. Ryan Martin, University of Calgary Moderator: Dr. Prism Schneider, University of Calgary

**Residents:** R5s R3s R2s R4s R1s Dr. Laurel Collings Dr. Gurprit Girn Dr. Manjot Birk Dr. Stephanie Gibbon Dr. Alyssa Federico Dr. Erin Davison Dr. Anna-Lee Policicchio Dr. Timothy Lasswell Dr. Mallika Makkar Dr. Brett Lavender Dr. Jarrett Moore Dr. Brodie Ritchie Dr. Michael Leslie\* Dr. Reva Qiu Dr. Kaela Schill Dr. Laura Morrison Dr. Ethan Sanders Dr. Kaja Matovinovic Dr. Colin Rey Dr. Jared Topham Dr. Julian Rizos Dr. Gareth Ryan Dr. Ben Wajda \* Away on a pre-approved elective Dr. Logan Woods Dr. Meredith Stadnyk

#### PROGRAM:

Time	Descripti	on / Location	Individuals				
ACADEMIC SESSION							
0715-0830 hrs	Meet at H	otel Lobby at 0715 hrs and have breakfast at Charcut	Dr. P. Schneider				
	Roast Hou	ISE (within HOtel) (Reservation 0730 hrs under Prism Schneider – they don't ns prior to 0730 hrs but said it would be alright to show up at 0715 hrs)	Dr. T. Miclau				
0830-0900 hrs	Travel fro	m Restaurant/Hotel to Cumming School of Medicine	Dr. P. Schneider				
			Dr. T. Miclau				
0900-1100 hrs	Career Development Session – Room 1405B, HSC		All Orthopaedic Residents				
	Dr. Miclau - "Leadership 101: An Introduction"		Dr. T. Miclau				
			Dr. P. Schneider				
			Dr. R. Martin				
1100-1115 hrs	Group Pho	oto by Hippocrates Statue	All Orthopaedic Residents				
			Dr. T. Miclau				
			Dr. P. Schneider				
			Dr. R. Martin				
1115-1215 hrs	Lunch –	All Orthopaedic Residents	· · ·				
	HRIC Adjudicators: Dr. T. Miclau, Dr. B. Edwards, Dr. R. Martin, Dr. P. Schneider						
	Atrium	Sponsor Representatives: Bioventus Ms. L. Rygiel // ConMed Ms. S. Paulson // MD Management Ms.					
		E. Chiu and Ms. L. Cole // Solventum Ms. K. Foran // Stryker Mr. T. Duszynsk,i Mr. J. Innes and T.					
	Offereins // Tactile Orthopaedics Ms. A. Kraeling // Tribe Medical Arthrex Mr. R. Kennedy and						
		LaGrange // Zimmer Biomet West Mr. J Lingard					
1215-1230 hrs	Short Break and congregate in Theatre 3, HSC						

SCIENTIFIC SESSION – PRESENTATIONS – THEATRE 3, HSC							
Scientific Session is open to Adjudicators, Orthopaedic Residents, Faculty, Staff, Research Coordinators, the McCaig Institute, ABJHI, and Others Types of Resident Presentations (total of twenty-one presentations)							
Full Podium: 6 minutes for presentation/3 minutes Q&A/1 minute transition time (purple shading) Abbreviated Podium: 3 minutes for presentation (maximum of 6 slides)/1 minute transition time/there will be three presented in a row followed by 5 minutes Q&A (orange shading) 3MT Presentations: 3 minutes for presentation (maximum of 1 slide)/1 minutes transition time/there will be three presented in a row followed by 5 minutes Q&A (blue shading)							
1230-1235 hrs	Opening	g Remarks and Welcome	Dr. Prism Schneider				
	Туре	Title	Presenter				
1235-1245 hrs	Full	Operative Management of Anterior Shoulder Dislocations	Dr. Jarrett Moore				
	Abstract	Leads to Reduced Recurrence in Paediatric Patients: A					
		Systematic Review and Meta-analysis Presentation Number: 2025-FP1					
1245-1255 hrs	Full	Incidence and Risk Factors of Arthrofibrosis Following	Dr. Alyssa Federico				
	Abstract	Anterior Cruciate Ligament Reconstruction: A Systematic					
		Review and Meta-analysis Presentation Number: 2025-FP2					
1255-1305 hrs	Full Abstract	Weight-bearing CT Analysis of Scapholunate Ligament Injury Presentation Number: 2025-FP3	Dr. Brodie Ritchie				
1305-1315 hrs	Full	Evaluating the Cost-effectiveness of Surgical Management	Dr. Ethan Sanders				
	ADSTRACT	Options for Syndesmotic Injury Presentation Number: 2025-FP4					
1315-1319 hrs	Proposal Abstract	Impact of Low Intensity Pulse Ultrasound (LIPUS) on Femoral	Dr. Colin Rey				
	Abstract	Derotation Osteotomy Remodelling 3MT Presentation Number: 2025-3MT1					
1319-1323 hrs	Proposal Abstract	Effects of Childbearing on Spinopelvis Alignment (EChOS) 3MT Presentation Number: 2025-3MT2	Dr. Kaja Matovinovic				
1323-1327 hrs	Proposal	Functional Bracing Versus Spica Casting for the Treatment of	Dr. Ben Wajda				
	Abstract	Pediatric Diaphyseal Femur Fractures: A Feasibility Study					
1227-1222 brs	0000	3MT Presentation Number: 2025-3MT3					
1227-1352 hrs	Q&A fo	r Session One of 3MT Presentations					
1332-1332 113	Local Internal Adjudicator Presentation: "Fracture Dislocations of the Knee – Balancing the Bone Soft Tissue Relationship"						
1352-1402 hrs	Full	Optimal Construct for Fixation of Femoral Neck Fractures: A	Dr. Anna-Lee Policicchio				
	Abstract	Biomechanical Analysis Presentation Number: 2025-FP5					
1402-1412 hrs	Full	Seasonal Variability in Patient Reported Outcomes After Total	Dr. Manjot Birk				
	Abstract	Hip and Total Knee Arthroplasty Presentation Number: 2025-FP6					
1412-1422 hrs	Full	Evaluation of Coagulopathy in Patients with Tibia Fractures	Dr. Gareth Ryan				
	Abstract	Using Serial Thrombelastography Presentation Number: 2025-FP7					
1422-1426 hrs	Proposal	Elbow Hemiarthroplasty for Fracture, A Retrospective	Dr. Mallika Makkar				
	AUSTRACT	Review: The Alberta Experience					
1426-1430 hrs	Proposal	Presentation Number: 2025-AP1	Dr. Boya Oiy				
	Abstract	Fractures: Impact of Angulation on Patient Penerted	DI. Reva Qiu				
		Automes					
		Presentation Number: 2025-AP2					
1430-1435 hrs	Q&A fo	r Session One of Abbreviated Presentations	•				
1435-1500 hrs	Local External Adjudicator Presentation: Dr. Brent Edwards						
	"Improvements in Bone Quality and Fatigue Life Associated with						
	Potent						

1500-1520 hrs	Break					
1520-1525 hrs	Return	Return to Theatre 3, HSC				
1525-1535 hrs	Full Abstract	Bisphosphonate Use is Low in Patients with Metastatic Bone Disease Despite Their High Risk for Major Osteoporotic Fractures Presentation Number: 2025-FP8	Dr. Kaja Matovinovic			
1535-1545 hrs	Full Abstract	Denosumab Vs. Zoledronic Acid for Metastatic Bone Disease: A Comprehensive Systematic Review and Meta-analysis of Randomized Controlled Trials Presentation Number: 2025-FP8	Dr. Ben Wajda			
1545-1555 hrs	Full Abstract	Early Identification of Impaired Fracture Healing Using Biomarkers: A Pilot Study Presentation Number: 2025-FP10	Dr. Gareth Ryan			
1555-1559 hrs	Proposal Abstract	Inter-rater Reliability and Pathoanatomic Association of Tibiofemoral Angle in Individuals with Recurrent Lateral Patellofemoral Instability Presentation Number: 2025-AP3	Dr. Stephanie Gibbon			
1559-1603 hrs	Proposal Abstract	Can Patient and Radiographic Characteristics be Used to Predict Delayed Displacement of Distal Radius Fractures? Presentation Number: 2025-AP4	Calgary Orthopaedic Residents Research Group (CORRG) – presented by Drs. Gurprit Girn, Michael Leslie, Kaela Schill			
1603-1608 hrs	Q&A for Session Two of Abbreviated Podium Presentations					
1608-1612 hrs	Proposal Abstract	Cost Comparison Between Single and Dual-plate Constructs for Humeral Diaphyseal Fracture Management 3MT Presentation Number: 2025-3MT4	Dr. Brett Lavender			
1612-1616 hrs	Proposal Abstract	A Wearable Patient Specific Knee Device to Enhance Anterior Cruciate Ligament Rehabilitation 3MT Presentation Number: 2025-3MT5	Dr. Jared Topham			
1616-1620 hrs	Proposal Abstract	Biomechanical Analysis of Single Small Fragment Compared with Dual Mini Fragment Plate Fixation for Ulnar Diaphyseal Fractures 3MT Presentation Number: 2025-3MT6	Dr. Meredith Stadnyk			
1620-1624 hrs	Proposal Abstract	Mechanical Analysis of a Kickstand Implant for Utilization in Unstable Lumbosacral Spine Fractures 3MT Presentation Number: 2025-3MT7	Dr. Tim Lasswell			
1624-1629 hrs	Q&A for	r Session Two of 3MT Presentations				
1629-1715 hrs	Keynote	e Address:	Dr. Ted Miclau			
	"Blood	Supply and Fracture Repair: Bedside to Bench"				
1715-1720 hrs	Closing	Remarks	Dr. Prism Schneider			
1720-1735 hrs	Deliberation Time for Judges					
1735-1800 hrs	Travel to Dinner Location		Dr. P. Schneider to drive Dr. T. Miclau			
1800 hrs	Dinner (by invitation only) at Model Milk in Private Room: Model Citizen)					

#### **Biographies of Adjudicators and Moderator**

#### Guest Adjudicator: Dr. Theodore (Ted) Miclau



Theodore Miclau III, MD, is Professor and Vice Chairman of the Department of Orthopaedic Surgery at the University of California, San Francisco, and the Director of the University of California/San Francisco General Hospital Orthopaedic Trauma Institute. Dr. Miclau serves on many local and national committees and editorial and grant review panels. He is Past-President of the Orthopaedic Research Society (ORS), Orthopaedic Trauma Association (OTA), and the International Combined Orthopaedic Research Societies. He is currently the Steering Committee Chair of the International Orthopaedic Trauma Association, Committee Chair of the Osteosynthesis and Trauma Care Foundation's Research Committee, and Chair of the Clinical Science Advisory Committee for the AO Foundation. He organizes the Consortium of Orthopaedic Academic Traumatologists (COACT), which has the goal of enhancing the collaborative

efforts of North American centers that engage in education and research in low and low-middle-income countries, and the Asociación de Ciruganos Traumatólogos en las Americas (ACTUAR), which is a growing surgeon network dedicated to promoting research in Latin America. He is the course chair for the Annual San Francisco International Orthopaedic Trauma Conference, now in its 19th year, and other conferences nationally and internationally. His research focuses on clinical studies of musculoskeletal injury care and basic research of bone repair. It is supported by extramural grants from the US Department of Defense and the National Institutes of Health. He has published over 250 peer-reviewed research papers and 20 book chapters. He has teamed with various organizations to develop research and clinical courses throughout the United States, Europe, and Latin America. He is an Honorary Member of multiple national orthopaedic societies, including the Federación Mexicana de Colegios De Ortopedia y Traumatologia (FEMECOT), Cuban Society of Orthopaedics and Traumatology (SCOT), Sociedad Colombiana de Cirugia Ortopedico y Traumatologia (SCCOT), and the Argentina Association of Orthopaedics and Traumatology (AAOT). He has recently been recognized with the Alfred R. Shands Award from the ORS, the Transformative Contribution Award from the ICORS, and the Honorary Award from the Osteosynthesis and Trauma Care Foundation.

#### Local External Adjudicator: Dr. Brent Edwards



Dr. Edwards is an Associate Professor and UCalgary Research Excellence Chair within the Faculty of Kinesiology at the University of Calgary with joint appointments in the Cumming School of Medicine and Schulich School of Engineering. He is the Associate Director of the Biomedical Engineering Graduate Program, a founding member of the newly formed Department of Biomedical Engineering, and an Executive Council Member of the McCaig Institute for Bone and Joint Health. Dr. Edwards was named Co-Director of the Human Performance Lab at the University of Calgary in 2022 and has served as Secretary General for the International Society of Biomechanics since 2017. Dr. Edwards' research examines the fundamental mechanisms of fracture and fatigue in bone associated with mechanical loading and therapeutic drugs. This work spans multiple dimensional scales, from basic experiments at the tissue level that enhance our understanding of the mechanical fatigue process, to clinical treatments and interventions to improve tissue quality and decrease fracture risk. Dr. Edwards' lab is internationally

renowned for their work focused on stress fracture prediction, which combines biomechanical experimentation with advanced medical imaging and computational modeling to investigate in vivo bone mechanics in a non-invasive and subject-specific manner.

#### Local Internal Adjudicator: Dr. Ryan Martin



Dr. Martin received his medical degree from the University of Ottawa. He later went on to complete his Orthopaedic surgical residency at the Cumming School of Medicine, University of Calgary (Calgary, Alberta). After completing his surgical residency, he began his sub-specialization. He completed his Orthopaedic Trauma Fellowship at the Hospital for Special Surgery – Cornell University (New York, New York) and his Sport Medicine and Arthroscopy Fellowship at the University of Toronto (Toronto, Ontario). Since returning to Calgary, Dr. Martin has taken up practice centred out of the Foothills Medical Centre. While running a busy Level 1 trauma practice, he has focused on the arthroscopic treatment of traumatic knee conditions involving fractures as well as cartilage and ligament injuries. Dr. Martin

travels nationally and internationally to lecture and present his research. He serves on several committees, Co-Chair of the Canadian Orthopaedic Residency Forum (CORF), Co-lead of the bulk Allograft Cartilage Transplantation Program and Co-Lead for Continuing Medical Education (CME) for the Section of Orthopaedic Surgery. He also serves as an Orthopaedic Surgeon for the Calgary Stampeders Football Club and Calgary Flames. He is currently the Surgical Director at Group23 Sports Medicine and Chief Medical Officer for Tactile Orthopaedics. Additionally, he works as a consulting medical illustrator. When he is not working Dr. Martin spends most of his time with his family in the mountains, skiing and mountain biking.

#### Moderator: Dr. Prism Schneider



Dr. Prism Schneider is an Associate Professor of Orthopaedic Surgery in the Departments of Surgery and Community Health Sciences, at the University of Calgary. She also holds the positions of Orthopaedic Trauma Research Lead and the Faculty, Resident and Fellow Research Director for Orthopaedic Surgery. She obtained her MD from the University of Calgary and has completed post-graduate training including a PhD in Biomechanics and two Orthopaedic Trauma Fellowships at the University of Texas and McGill University. Dr. Schneider's research interests involve understanding the cellular and systemic inflammatory response to injury, including trauma-induced coagulopathy and post-traumatic joint contractures, clinical trials for optimizing surgical outcomes, and using advanced imaging to study the micro-architecture of fracture healing. She

also has a particular interest in identifying and assisting patients who are injured due to violence in the home. Dr. Schneider has completed several multi-centre randomized controlled trials in collaboration with the Canadian Orthopaedic Trauma Society, in order to define surgical indications following injury and to determine the optimal surgical techniques to help improve patient outcomes. Dr. Schneider's trauma-induced coagulopathy research program aims to use a precision medicine approach to prevention of venous thromboembolism and is funded by the Orthopaedic Research and Education Foundation, the Canadian Institutes for Health Research, and the Canadian Foundation for Innovation.

**Title:** Operative Management of Anterior Shoulder Dislocations Leads to Reduced Recurrence in Paediatric Patients: A Systematic Review and Meta-analysis

# Authors: Jarrett Moore, Annalise Abbott and Lisa Phillips

**Background:** Anterior shoulder dislocations are a common injury among children and adolescents due to unique anatomical features of the developing shoulder and increased participation in high-risk sports. This systematic review and meta-analysis aimed to evaluate the risk of recurrent instability following operative versus non-operative management of anterior shoulder dislocations in paediatric patients. A subgroup analysis was performed to compare management strategies in the setting of a first-time dislocation.

**Methods:** A systematic review and meta-analysis was conducted using PubMed, Embase, Medline, and Cochrane databases to identify studies comparing arthroscopic or open Bankart repairs versus non-operative management of anterior shoulder instability. Search terms included pediatric, adolescent, shoulder, glenohumeral, dislocation, management, and recurrence. Abstract, title screening, and full text review was performed in tandem by two independent reviewers. Exclusion criteria were as follows: adult patients over the age of 18, multidirectional instability, bony Bankart injuries requiring fixation, posterior instability, and non-comparative studies. A meta-analysis was performed using a random effects model. Subgroup analysis was performed for first-time shoulder dislocations, and for arthroscopic Bankart repair versus non-operative management. Quality and reporting assessments were performed using the Methodological Index for Non-Randomized Studies.

**Results:** Seven studies met the inclusion criteria with a total of 368 patients, 273 males and 102 females. The median age was 15.2 years ranging from 12-18 years of age. Mean follow up was 6.7 years (95%CI: 4.5-8.7). The average rate of recurrence in patients managed non-operatively was 0.67 (95% CI: 0.56-0.89) and 0.14 (95%CI: 0.00-0.32) in patients managed with either open or arthroscopic Bankart repair. There was a significant reduction in risk of recurrence with operative compared to non-operative management, with a risk ratio (RR) of 0.31 (95% CI: 0.22-0.44). A subgroup analysis of patients managed operatively (either open or arthroscopic) compared to non-operatively for a first-time shoulder dislocation resulted in a RR of recurrent instability of 0.33 (95%CI: 0.23-0.46). Arthroscopic Bankart repair had a RR of recurrent instability of 0.21 (95%CI: 0.08-0.55). Finally, first time anterior shoulder dislocations showed decreased risk of recurrent with operative management when compared to first time anterior shoulder dislocations managed non-operatively with a RR of 0.16 (95% CI: 0.08-0.35). MINORS scores ranged from 9-21, indicating a low to moderate overall risk of bias.

**Discussion:** Anterior shoulder instability continues to pose a significant burden on paediatric patients. The results of this metanalysis are consistent with previously published research demonstrating unacceptably high rates of recurrent instability in paediatric patients managed non-operatively. This metanalysis found that patients treated with operative management had decreased risk of recurrent instability compared to patients managed non-operatively. Furthermore, operative management for first time shoulder dislocations showed the greatest risk reduction suggesting earlier surgical intervention may benefit this population.

**Conclusions:** Surgical stabilization of anterior shoulder instability is an effective treatment strategy for paediatric patients under the age of 18, with significantly lower rates of recurrent instability than non-operative treatment. There is growing evidence to support the role for surgery after a first-time anterior shoulder dislocation in this high-risk patient population to reduce the risk of recurrence.

Acknowledgements: None COREF Funded: Yes

**Title:** Incidence and Risk Factors of Arthrofibrosis Following Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-analysis

Authors: Alyssa Federico, Reva Ye Qiu, Golpira Elmi Assadzadeh and Nicholas Mohtadi

**Background:** The anterior cruciate ligament (ACL) is the most commonly injured ligament of the knee, with up to 76.6% of ACL ruptures requiring surgical reconstruction. Of these patients, 18.9% require a second operation due to complications such as arthrofibrosis. Currently, there lacks a clear definition as to what constitutes arthrofibrosis, resulting in variable measures of incidence and uncertainty about risk factors. The primary aim of this study is to identify the incidence and risk factors for arthrofibrosis in adult patients following primary ACL reconstruction. A secondary aim is to evaluate the diagnostic criteria for arthrofibrosis.

**Methods:** Two independent reviewers conducted a systematic review according to the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) guidelines. EMBASE, MEDLINE, and PubMed databases were searched yielding 589 unique papers. Studies were included if they met the following criteria: (1) included adult patients with primary ACL ruptures treated surgically; (2) provided a clear definition of postoperative arthrofibrosis; (3) minimum follow-up period of 3 months post-operative, and (4) reported the incidence and/or risk factors for postoperative arthrofibrosis. A random-effects meta-analysis was conducted to estimate the cumulative event proportion and 95% confidence intervals (CI) across studies. Heterogeneity was evaluated using the I<sup>2</sup> statistic, and publication bias was evaluated using a funnel plot and Egger's regression test. Quality assessment analyses of included studies was performed. Non-randomized studies were assessed using the Methodological Index for Non-Randomized Studies (MINORS) criteria and randomized studies were assessed according to the Risk of Bias 2.0 protocol.

**Results:** A total of 36 studies were included in the final analysis. Of these studies, 34 reported the incidence of arthrofibrosis requiring surgery, with a mean pooled incidence of 3% (95% CI 2-5%) and range of 0.70-26.8%. There were 27 studies that reported statistically significant risk factors for arthrofibrosis. There were six patient factors, six injury factors, 10 surgical factors, and six postoperative factors identified. The three most common risk factors included acute repair (<12 weeks post-injury), female sex, and concomitant meniscal repair. The diagnostic criteria for arthrofibrosis used in the studies varied, with the most common being presence of an extension deficit 0-10° and flexion deficit 5-90°. The random-effects meta-analysis indicated substantial heterogeneity among studies (I<sup>2</sup> = 98%).

**Discussion:** Up to 76.6% ACL rupture undergo surgical intervention and it is important to recognize that arthrofibrosis is a prevalent complication that can lead to a second surgical procedure. Our study has identified a 3% pooled incidence of arthrofibrosis requiring secondary surgery following primary ACL reconstruction. The most common risk factor for arthrofibrosis identified in 13 studies was acute repair. The acute inflammatory response of the initial trauma likely contributes to a restricted pre-operative range of motion (ROM) and thus, post-operative arthrofibrosis. Female sex was identified as a risk factor for arthrofibrosis in 10 studies. While pain response and psychosocial differences may contribute to this, women have also been shown to have a stronger immune response than men leading to higher rates of inflammatory and autoimmune conditions. This may also contribute to the higher rate of arthrofibrosis observed in this population. Five studies identified concomitant meniscus repair as a risk factor for arthrofibrosis. Rehabilitation protocols often limit forced knee flexion immediately post-operatively in the setting of concomitant meniscal repair. The delay in progressing post-operative ROM likely contributes to the increased risk of arthrofibrosis.

**Conclusion:** As ACL reconstruction becomes a more common procedure, it is important to understand the implications of this surgery to undertake adequate discussion about risk factors, such as arthrofibrosis, with patients. The pooled incidence of arthrofibrosis following ACL reconstruction is 3% (95% CI 2-5%) with the most common risk factors being acute repair (<12 weeks post-injury), female sex, and concomitant meniscal repair. There is no standardized method used to diagnose arthrofibrosis, however, most studies relied on the presence of a flexion or extension deficit. It is important to recognize arthrofibrosis in patients, as it can cause significant delays in recovery and return to sport.

**Acknowledgments:** We would like to thank the UofC Sport Medicine Center research team for their assistance. **COREF Funded:** No

Title: Weight-bearing CT Analysis of Scapholunate Ligament Injury

Authors: Brodie Ritchie, Justen Saini, Zoe Mack, Alex Munn, Gurpreet Dhaliwal, Koren Roach, Sarah Manske and Neil White

**Background:** Patients with scapholunate interosseous ligament (SLIL) injury often report pain with loading in wrist extension, however the etiology of pain in this position is poorly understood. While it is known that without an intact SLIL and secondary stabilizers, dissociation of the scaphoid and lunate results in scaphoid rotatory subluxation, dorsal intercalated segment instability (DISI), and eventually dorsal scaphoid translation (DST), there is limited understanding of carpal pathophysiology in weight-bearing (WB) conditions. The purpose of this study was to evaluate how WB affects carpal bone position in healthy and SLIL-injured wrists using weight-bearing computed tomography (WBCT). We hypothesized SLIL-injured wrists in a weight bearing push up bar (WBPUB) and weight bearing extension (WBE) position would exacerbate known carpal behaviour of a decrease in scapholunate angle (SLA) and radioscaphoid angle (RSA) as the scaphoid is forced into extension and increase in radiolunate angle (RLA) as the lunate increasingly extends relative to the radius. Further, dorsal scaphoid translation (DST) and scapholunate interval (SLI) would increase while capitate-radius index (CRI) would decrease. All measurements in injured wrists would be greater than those in healthy wrists except CRI, which should be smaller.

**Methods**: This prospective cohort study is approved under University of Calgary REB21-0803. A priori calculations indicated that a minimum sample size of 5 per group would allow 80% chance of detecting a 0.5 mm or 0.5 degree change in carpal bone position. Thus, 10 healthy controls and 10 participants with arthroscopy (Geisler III or IV) or magnetic resonance imaging (MRI) proven SLIL injury underwent CT imaging in 3 positions: 1) non-weight-bearing (NWB) neutral; 2) WBPUB and 3) WBE. Radiographic parameters including scapholunate interval (SLI), capitate-radius index (CRI), radiolunate angle (RLA), radioscaphoid angle (RSA), scapholunate angle (SLA), and DST were performed by a senior resident and reviewed by consensus by three fellowship-trained hand surgeons. Measurements were compared between positions and groups using mixed-effects repeated measures ANOVA models at the  $\alpha$ =0.05 significance level, with two-tailed tests, and 95% confidence intervals. DST was anticipated to be zero in the healthy group, thus was analyzed using Wilcoxon signed-rank and rank-sum tests.

**Results:** In SLIL injury, CRI was smaller and SLI greater, however, CRI decreased while SLI remained unchanged under load. Although SLA decreased in WB positions in both groups, there was no difference in SLA between SLIL injury and healthy wrists in either WB position. In SLIL injury, RLA was greater in WBPUB position alone, with WBE demonstrating significant increase in RLA in both groups. In SLIL injury, RSA decreased significantly in both WB positions and was greater than healthy wrists in WBE. No DST was observed in either group in WBPUB position, and differences between groups were eliminated in WBE position.

**Discussion:** In WBPUB, the lunate was in greater extension and the scaphoid was in a similar position relative to healthy wrists, however WBE demonstrated similar lunate extension and increased scaphoid flexion relative to healthy wrists. Most notably, this study demonstrated reduction of the scaphoid into the scaphoid facet and decreased SLA in WBPUB, which may explain why SLIL-injured patients can weight bear more comfortably in neutral positions versus forced extension.

**Conclusion:** Application of load during x-ray or CT imaging could be used to identify reduceable SL ligament pathology prior to surgical reconstruction and may be used in the operating room to assist with obtaining anatomic scapholunate reduction. Continued WBCT research will contribute to improved diagnostic measures and surgical decision making for clinical conditions affected by load application in the hand and wrist.

**Acknowledgements:** Funding was provided by The American Society for Surgery of the Hand, University of Calgary Department of Surgery Grant, University of Calgary Orthopedic Resident Grant, and McCaig Institute for Bone and Joint Health Clinician Scientist Seed Grant. We thank Eric C. Sayre, PhD, for his excellent statistical support. **COREF Funded:** Yes

# Abstract Type: Full Abstract Research Pillar: Clinical Research and Health Services Research

**Title**: Evaluating the Cost-effectiveness of Surgical Management Options for Syndesmotic Injury **Authors:** Ethan Sanders, Jared Topham, Andrew Dodd, Paul Duffy, Robert Korley, Herman Johal, Kim Rondeau and Prism Schneider

**Background**: The optimal management of syndesmotic injuries is controversial, with wide variations in practice. The aim of this study is to evaluate the cost-effectiveness of syndesmotic fixation options, including rigid fixation (RF), and flexible fixation (FF), to provide critical information to consider in surgical decision-making. This is increasingly relevant in a single-payer system, as cost awareness and fiscal responsibility need to be considered to deliver quality care to as many Canadians as possible. We hypothesize that FF is a cost-effective surgical management option for syndesmotic injury. **Methods**: This is a model-based cost-effectiveness analysis based on a single-centre prospective cohort study of patients having undergone one of two options for the surgical management of unilateral syndesmotic injuries. Patient demographics have been collected, and outcome measures related to value-based analysis include: a) clinical outcomes including reoperation rates, surgical complications, implant failure, and return to work, and b) patient-reported outcome measures including the validated American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot, foot and ankle ability measure (FAAM), short form 12 (SF-12) questionnaires. This data will be used as model inputs, using decision tree and Markov framework to produce 1-year and lifetime estimates comparing the relative cost-effectiveness of the different treatment options. For cost effectiveness analysis, the average cost of implant associated with each treatment option was used. T-tests and Chi-squared analyses were used to compare demographic data between the two treatment groups.

**Results**: This model includes 72 patients (Figure 1). Notably patients in the FF were younger. No other significant differences in sex, body mass index (BMI) or AO/OTA Fracture Classification were observed. Reoperations were more common in the RF group (N=11, p<0.0001); all reoperations were for implant removal. There were no reoperations in the FF group. There were no significant differences observed in PROMs at 3- and 12-month follow-up. The average implant cost was \$1596.56 CAD for the FF Group and \$264.41 CAD for the RF group, largely driven by the cost of the TightRope (\$1175.00 CAD). Final data will be available prior to Resident Research Day.

Figure 1: Comparison of Patient Demographics Between Surgical Groups.							
	<b>RF</b> , N = 33	<b>FF</b> , N = 39	p-value				
Age	48 (13)	39 (13)	0.001				
Sex			0.5				
Female	15 / 33 (45%)	15 / 39 (38%)					
Male	18 / 33 (55%)	24 / 39 (62%)					
BMI	29 (7)	29 (5)	0.6				
AO/OTA Fibular Fracture Classification			0.4				
44B - Tibia/fibula, malleolar segment,	16 / 26 (62%)	12 / 24 (50%)					
transsyndesmotic fibular fracture							
44C - Tibia/fibula, malleolar segment,	10 / 26 (38%)	12 / 24 (50%)					
suprasyndesmotic fibula injury							

**Discussion:** Surgical management of syndesmotic injuries remains controversial. We have previously used fourdimensional CT to better understand the kinematics of the syndesmosis, and demonstrated high rates of malreduction with RF when compared to FF. In addition, the cost of reoperation is high, relevant in the RF group, with cost estimates ranging from \$2953 to \$3579 per case, much less than the average cost difference for flexible fixation with the negligible reoperation rate.

**Conclusion**: In patients undergoing syndesmotic fixation, FF demonstrates low rates of reoperation and equivalent PROMs when compared to RF. Preliminary cost-analysis demonstrates long-term cost-effectiveness of FF due to the high cost associated with reoperation with RF.

Acknowledgements: Luke McDougall, Jolene Allan, Souvik Mati, Ahmed Negm and Jessica Duong COREF Funded: Yes

#### Abstract Type: Proposal Abstract

#### Research Pillar: Clinical Research

Title: Impact of Low Intensity Pulse Ultrasound (LIPUS) on Femoral Derotation Osteotomy Remodelling

#### Authors: Colin Rey, Alyssa Federico and Kelly Johnston

**Background:** Femoral derotation osteotomy (FDO) is a procedure used to correct congenital femoral anteversion and retroversion when conservative management fails. Intra-operatively, various strategies are employed to promote union of the osteotomy site, including stable fixation with an intramedullary nail and bone grafting. However, there is limited research on adjuncts to promote union post-operatively. Low-Intensity pulsed ultrasound (LIPUS) is a tool that has been employed in the trauma setting to promote fracture healing. There is growing evidence that LIPUS can be useful in the management of some instances of aseptic non-union. There is, however, a lack of research on the utility of LIPUS in the elective setting - particularly for healing of osteotomy sites. Therefore, the primary aim of our study is to assess the impact of LIPUS on bone remodeling in FDO patients.

**Methods:** The proposed retrospective case-control study will include adult patients who received a FDO between 2017 and 2024 by the senior author (KJ). Patients will be categorized into two groups: those who received LIPUS treatment post-operatively and those who did not. We will aim to enroll 60 patients in each group. Patients will be matched based on age, sex, and body mass index to control for confounding variables. Radiographic healing of the osteotomy sites will be compared using a modified version of the Radiographic Union Score for Tibial fractures (RUST) score at 3, 6, and 12 months post-operatively. The modified RUST scoring system involves assessing all four cortices of the femur (anterior, posterior, lateral, and medial) on x-ray and assigning them a score based on the presence and type of callus formation. Fracture line with no callus is scored as 1 point, fracture line with visible callus as 2 points, and no fracture line with bridging callus as 3 points. Two independent reviewers (CR, AF) will analyze the x-rays and assign a modified RUST score. Inter-rater reliability will be assessed using the kappa statistic. Statistical comparisons between the LIPUS and non-LIPUS groups will be performed to evaluate the impact of LIPUS on bone remodelling at the osteotomy site.

**Results:** N/A

Discussion: N/A

Conclusion: N/A

Acknowledgments: We would like to thank the Alberta Hip and Knee Clinic for their assistance and support.

Abstract Type: Proposal Abstract

Research Pillar: Clinical Research

Title: Effects of Childbearing on Spinopelvis Alignment (EChOS)

Authors: Kaja Matovinovic, Fred Nicholls, David Hart, Taryn Ludwig, Koren Roach, Danielle Whittier and Julia Zebak

**Background:** Changes in spinopelvic alignment during pregnancy lead to shearing across spinal segments with prior studies demonstrating persistence of altered alignment at 1-month post-partum. Initial comparative data from SPINE TRAC (Surveillance of a Population to monitor the Incidence of New deformity: Effects of Time and Recreation on Alignment in Calgary) and other databases of normative alignment suggest little difference in mean spinal alignment measures between 20 and 50 years of age. Comparative studies are prone to bias and lack the granularity of longitudinal studies in explaining outlying data points with potentially small overall effect size. Thus, reimaging is needed to accurately assess the effects of gravidity/parity, if spinal alignment normalizes post-partum, and if persistent changes in alignment post-partum predispose adult spinal deformity (ASD) and degenerative spondylolisthesis (DS). Degenerative ASD and DS are spinal conditions which disproportionately affect women and cause significant disability.

The aim of this study is to compare changes in spinopelvic alignment over a similar time frame between women who have and have not experienced pregnancy and to evaluate pregnancy as a risk factor for ASD in the SPINE TRAC cohort. Elucidation of changes in alignment occurring both in women who have and have not experienced pregnancy could help identify at risk patients and clarify potential causes for development of ASD.

**Methods:** This is a longitudinal observational study where 220 female participants from the SPINE TRAC cohort will undergo repeat EOS imaging at 5-10 years post initial imaging. Spinal parameters will be measured, including alignment of the pelvis, lumbar, thoracic, and cervical spine. A questionnaire characterizing any pregnancies, including gestational age at delivery and delivery type will be completed. ANOVA will be used to assess differences in spinal parameters between pre- and post-partum states as well as between parous and nulliparous women.

**Results:** To date, the effects of gravidity and parity on spinal alignment has only been retrospectively studied and are poorly understood. To our knowledge, this is the first study to prospectively examine changes in spinopelvic alignment in post-partum women and compare spinal parameters in parous and nulliparous women. We anticipate that both gravidity and parity will result in changes to spinopelvic alignment parameters in post-partum women compared to their prepartum measurements.

**Discussion:** N/A

Conclusion: N/A

Acknowledgements: Alberta Spine Foundation (Grant Support) and McCaig Institute (SPARC Ignite Grant Support).

COREF Funded: Yes

#### Abstract Type: Proposal Abstract

#### Research Pillar: Clinical Research

**Title:** Functional Bracing versus Spica Casting for the Treatment of Pediatric Diaphyseal Femur Fractures: A Feasibility Study

Authors: Ben Wajda, Marcel Aboussaly, Simon Goldstein, Meaghan Marien, Rubini Pathy, David Parsons and Lisa Phillips

**Background:** Pediatric diaphyseal femur fractures are commonly treated with hip spica casting, which, despite its effectiveness, poses significant challenges, including caregiver burden, hygiene difficulties, and increased healthcare costs due to the need for general anesthesia and operating room (OR) resources. Functional bracing has emerged as a potential alternative, offering theoretical benefits in ease of use, caregiver satisfaction, and cost reduction. However, there is limited evidence evaluating its feasibility, safety, and cost-effectiveness compared to traditional spica casting. This study aims to assess the feasibility of conducting a full-scale randomized controlled trial (RCT) comparing functional bracing and hip spica casting in pediatric diaphyseal femur fractures.

**Methods:** This single-center feasibility study will recruit pediatric patients aged 6 months to 5 years with isolated diaphyseal femur fractures at Alberta Children's Hospital. Eligible participants will be randomized to receive either a functional brace or a hip spica cast (applied in the OR under general anesthesia). The primary feasibility outcomes include recruitment rate, retention rate, adherence to follow-up, and protocol adherence. Secondary outcomes include fracture healing, assessed by radiographic union, time to union, alignment, femoral shortening, and functional outcomes using the Flynn Scoring System. Additionally, the number of clinic visits and radiographs, patient-reported outcomes (PROOF-LE), caregiver satisfaction (EQ-5D), complication rates will also be recorded. Complications such as malunion, non-union, skin issues, and reoperations will also be recorded. Data will be analyzed using descriptive and comparative statistics to assess feasibility, clinical outcomes, and cost-effectiveness. A preliminary cost analysis will also be conducted. Follow-ups will occur at 1, 2, 4, 6, and 12 weeks, with a final assessment at one-year post-injury. Patients included in the feasibility study will also be included in the future prospective randomized study.

**Anticipated Results:** This feasibility study aims to assess the practicality of conducting a full-scale randomized controlled trial (RCT) comparing functional bracing and hip spica casting for pediatric diaphyseal femur fractures. We anticipate achieving a recruitment rate of at least 70% of eligible patients, with a retention rate of over 80% at the 12-week follow-up. Preliminary clinical data will likely show that both treatment modalities maintain acceptable fracture alignment and achieve union within expected timeframes. We anticipate that functional bracing will result in similar functional recovery compared to spica casting while providing advantages in caregiver satisfaction due to improved hygiene, ease of toileting, and mobility. From a cost perspective, functional bracing is expected to demonstrate reduced healthcare costs by eliminating the need for general anesthesia and operating room resources. Additionally, we hypothesize a decrease in unscheduled clinic visits related to cast complications.

#### **Discussion:** N/A

**Conclusion:** Overall, the findings from this feasibility study will determine the viability of a full-scale RCT by identifying potential recruitment barriers, refining study protocols, and assessing preliminary clinical and economic trends. If feasibility benchmarks are met, these results will support the development of a definitive study to evaluate the comparative effectiveness and cost-efficiency of functional bracing versus spica casting.

Acknowledgements: N/A

# Abstract Type: Full Abstract

#### Research Pillar: Basic Science

**Title:** Optimal Construct for Fixation of Femoral Neck Fractures: A Biomechanical Analysis

Authors: Anna-Lee Policicchio, Helena Greene, Scott Willms, Andrew Caines, William Oliver and Prism Schneider

**Background:** Femoral neck fractures (FNFs) in younger adults typically result in unstable vertical shear fractures. Fixation failure rates range from 30-50%, and the optimal fixation construct remains controversial. Augmented constructs with mini-fragment plates and fixed-angled devices are often used to generate increased stability to minimize complication rates. Presently, there are no cadaveric biomechanical studies comparing the stability of augmented FNF fixation using a Pauwels screw, an inferior buttress plate, or the Femoral Neck System (FNS; DePuy Synthes, Inc.; West Chester, PA). This study aims to compare the biomechanical properties of these constructs using cadaveric models to determine if an optimal configuration can be identified. We hypothesize that augmentation of the FNS implant with an inferior buttress plate will optimally withstand physiologic forces in biomechanical testing.

**Methods:** In this biomechanical analysis, 24 cadaveric proximal femurs were osteotomized to simulate unstable Pauwels type III FNFs (70-degree vertical angle) with posteromedial comminution. The models were randomized to one of six fixation constructs based on CT scan assessment of bone mineral content, and each construct will undergo non-destructive and load-to-failure testing in four separate cadavers. The constructs to be tested include:

- 1. Three cannulated screws (7.3mm) in an inverted triangle configuration, augmented with a Pauwels screw.
- 2. Three cannulated screws (7.3mm) in an inverted triangle configuration, augmented with a non-locking, inferior buttress plate (5-hole, 2.7mm limited contact plate).
- 3. 135-degree, 4-hole dynamic hip screw (DHS) and a Pauwels screw.
- 4. 135-degree, 4-hole DHS and a non-locking, inferomedial buttress plate (5-hole, 2.7mm limited contact plate).

5. FNS.

6. FNS with a non-locking, inferomedial buttress plate (5-hole, 2.7mm limited contact plate).

Using the MTS 858 Mini Bionix and custom jigs to ensure simulated weightbearing position, each FNF model will be loaded cyclically to establish torsional stiffness and axial stability. Next, construct failure strength will be measured under monotonic compressive load, in a direction consistent with peak load during gait. FNF model failure called 'functional displacement' will be defined as greater than 10 mm axial displacement, screw migration greater than 5 mm or fracture extension beyond the plane of the osteotomy. Demographic data from the specimens will be reported and compared using t-tests and Chi-squared analysis. A Kruskal-Wallis test, followed by Dunn's test, will be used to evaluate stiffness and strength differences between each construct.

**Results:** Across all specimens, the mean age is 66.7 years ( $\pm$ 13.7), with five of the 24 femurs being female (19.2%). Oneway ANOVA demonstrated no significant differences in bone mineral content between groups. Preliminary biomechanical testing is underway. A specimen in group 5 (above) completed all rounds of testing. Initially, torsional stiffness was established prior to cyclically loading the model, this demonstrated a change in stiffness of 0.01875 Newton meters (Nm). After 10,000 cycles of loading at 2-times body weight, axial stability was measured, this result was 1.072 mm of axial displacement. Next, the model underwent an additional 5,000 cycles at 3.5-times body weight. Axial stability displaced further by 5.742 mm. Torsional stiffness was again measured and compared to pre-loading value, demonstrating a difference of 0.00175 Nm. Lastly, the model underwent load-to-failure testing where 10 mm axial displacement occurred at a force of 4848 N.

**Discussion:** This will be the first biomechanical study using cadaveric specimens to compare different augmented FNF fixation constructs. Within this unique subset of younger patients with hip fractures, the choice of fixation construct is a critical determinant of fracture healing and clinical outcome. The results of this study will help guide surgical decision-making and may inform a future prospective clinical trial.

**Conclusion:** This study may support novel, augmented configurations for FNF fixation to better withstand physiologic hip forces and decrease the high complication rates seen in young patients with unstable FNFs.

Acknowledgements: Biomechanics Lab in the McCaig Institute for Bone and Joint Health, Calgary Surgical Research and Development Fund, Foothills Orthopaedic Trauma Research Team and Dr. Jessica Duong.

COREF Funded: Yes

**Title:** Seasonal Variability in Patient Reported Outcomes After Total Hip and Total Knee Arthroplasty **Authors:** Manjot Birk, Teresa Nguyen, Nicholas Desy and Richard Ng

**Background:** The lifetime risk of developing hip osteoarthritis is 25% while knee osteoarthritis is 45%.<sup>1-2</sup> In Canada, hip and knee arthroplasty are the third and second most performed inpatient surgeries, respectively.<sup>3</sup> Although complications are infrequent, given the volume of arthroplasty surgery they place a high burden on the healthcare system.<sup>4</sup> Therefore, factors that influence complication rate are of great interest. There is substantial literature on modifiable and non-modifiable risk factors in joint arthroplasty outcomes such as patient factors including sex and age, obesity, comorbidities including diabetes and peripheral vascular disease, smoking and surgery related factors. More recently, there has been some evidence to support influence of seasonal variability on infection rates, deep vein thrombosis (DVT) and pulmonary embolism (PE). The incidence of infection has been reported higher in July, August and September compared to winter months while readmission rates for TKA in June were 30.5% higher than December.<sup>5</sup> However, there is conflicting evidence reported in literature on seasonal variability in arthroplasty on complication rate with no data on variability of patient reported outcomes in arthroplasty.

**Methods:** This study is a retrospective review of the Alberta bone and joint health institute database to evaluate seasonal variability in patient reported outcome of total hip and knee arthroplasty. The data elements extracted from the ABJHI database including patients from 2013 to 2021 who are 18 or older with an elective primary THA or TKA for osteoarthritis and completed patient reported WOMAC scores. The surgical date will be used to categorize patients by season. The Fisher Exact test was employed to assess the potential associations between surgical complications, comorbidities, and the season of surgery in each of the knee and hip groups. The analyses were performed using R version 4.2.3. A linear mixed-effects model was employed to analyze WOMAC pain score, function score, stiffness score, and overall score. The model incorporated fixed effects for age, season of surgery, and pre- or post-surgery status. Random effects were included to account for variations between individual patients. The model fitting and parameter estimation were performed using the statsmodels library in Python (Python version 3.7.9). Patient length of stay was compared between hip and knee groups using non-parametric Wilcoxon rank sum test.

**Results:** Our results demonstrate a total of 31836 THA and 48420 TKA from 2013 to 2021, there was no significant difference in patient age, sex, length of stay between seasons nor comorbidities. There was no difference in complication of bleeding, CVA, delirium, dislocation, GI bleed, Ileus, infection rate, intraoperative fracture, mechanical event, MI, PE, post op fracture, readmission in 30 days, ED visit in 30days or transfusion in either THA or TKA group. However, there was an increased risk of pneumonia for THA group which was not present for the TKA group. There was no significant difference between seasons in WOMAC pain, stiff, function nor overall score in either TKA or THA group.

**Discussion and Conclusion:** Our study demonstrates that there does not appear to be a seasonal variability effect on patient reported outcomes in THA and TKA patients. However, in THA there does appear to be an increased pneumonia rate which is not present in TKA patients. Additionally, there does not appear to any seasonal variability on majority of complications, particularly of note - DVT, PE and infection in THA and TKA.

#### Acknowledgements: N/A COREF Funded: Yes

COREF Funded: Yes

# **References:**

- 1. Murphy L et al. Arthritis Rheum. 2008 Sep 15;59(9):1207-13.
- 2. Murphy LB et al. Osteoarthritis Cartilage. 2010 Nov;18(11):1372-9.
- 3. Canadian Institute for Health Information. Hip and Knee Replacements in Canada Canadian Joint Replacement Registry (CJRR) 2020-2021 Annual Report. Canadian Joint Replacement Registry (CJRR). Ottawa, ON; 2021.
- 4. Anthony CA et al. J Arthroplasty. 2018;33(2):510–514.e1.
- 5. Li T et al. Arthroplasty. 2022 May 1;4(1):11.

**Title:** Evaluation of Coagulopathy in Patients with Tibia Fractures Using Serial Thrombelastography **Authors:** Gareth Ryan, Andrew Dodd and Prism Schneider

**Background:** Venous thromboembolism (VTE) can occur in up to 60% of patients with tibia fractures without thromboprophylaxis and up to 12% with prescribed thromboprophylaxis. Despite this, most guidelines recommend against routine thromboprophylaxis for isolated fractures below the knee. Thrombelastography (TEG) is a point-of-care tool that allows for rapid assessment of coagulopathy using the maximal amplitude (MA) and coagulation index (CI) parameters. No prior studies have utilized serial TEG analysis in patients with tibia fractures. The objective of this study is to define the duration and severity of coagulopathy in patients with tibia fractures using serial TEG analysis. We hypothesize that patients with tibia fractures will experience extended postoperative hypercoagulability based on TEG analysis.

**Methods:** Ethics board approval was obtained for this single-centre prospective cohort of patients aged 18-65 years with diaphyseal tibia fractures. Patients were recruited from the emergency department and inpatient units. Patients with previous VTE, coagulopathy, active malignancy, pregnancy, pre-injury therapeutic anticoagulation, and chronic steroid use were excluded. Age, sex, comorbidities, mechanism of injury, fracture classification, concomitant injuries, and injury severity score (ISS) were recorded. Pragmatic thromboprophylaxis was permitted. Whole blood samples were collected on admission, and every two days until discharge, starting on postoperative day one (POD1). Outpatient samples were collected two, four, six, and 12 weeks postoperatively. Blood samples were analyzed using a TEG 6S hemostasis analyzer

(Haemonetics Corp; Boston, MA). Hypercoagulability was defined as an MA  $\geq$ 65mm or Cl  $\geq$ 3. Perioperative complications were recorded. Statistical analyses were performed using t-tests and a linear mixed effects model.

**Results:** Eighteen patients were included, 44.4% of whom were female with a mean age of 42.2 (SD=13.1) years. Most injuries were isolated (83.3%), closed (88.9%) fractures related to sports or motor-vehicle collisions. Intramedullary nailing was performed in 83.3% of patients and plate fixation in 16.7%. Inpatient tinzaparin followed by outpatient acetylsalicylic acid (aspirin) was the most common



thromboprophylaxis regimen. Mean CI was significantly elevated from admission until six weeks (all p<0.001). Mean MA was significantly higher than the 65mm threshold from three days until two weeks postoperatively (p<0.001) (Figure 1). All 18 patients were hypercoagulable at two weeks, decreasing to 53.8% by six weeks and 25.0% by 12 weeks. One patient developed a pulmonary embolism on POD1 and received long-term anticoagulation. No other adverse events occurred.

**Discussion:** This is the first study to quantify coagulopathy using serial TEG analysis in patients with tibia fractures. Over half of patients remained hypercoagulable at six weeks postoperatively. This study is limited by our small sample size; however, our findings will inform ongoing studies and may help surgeons balance the risks and benefits of postoperative thromboprophylaxis.

**Conclusion:** Despite receiving two weeks of thromboprophylaxis, over 50% of patients remained hypercoagulable at six weeks. Further research is needed; however, our results question the current guidelines recommending against routine thromboprophylaxis.

Acknowledgements: Casandra Tan, Marissa Grossi, Souvik Maiti and Chunfen Zhang. COREF Funded: Yes

Abstract Type: Proposal Abstract Research Pillar: Clinical Research Title: Elbow Hemiarthroplasty for Fracture, A Retrospective Review: The Alberta Experience Authors: Mallika Makkar and Neil White

**Background:** Geriatric distal humerus fractures are challenging to treat with open reduction and internal fixation (ORIF) due to comminuted, osteoporotic bone. Total elbow arthroplasty (TEA) is another option but has high failure rates and significant activity restrictions. Elbow hemiarthroplasty (EHA) – replacing only the distal humerus – is an emerging, bone-preserving option with no postoperative restrictions. This study examines mid-term outcomes of EHA for geriatric distal humerus fractures, a topic that is not well characterized in the existing literature. We hypothesize EHA will result in less pain, better function, and lower complication and revision rates than TEA or ORIF.

**Methods:** This ambidirectional cohort study includes patients in Southern Alberta aged 55 or older who underwent EHA for a distal humerus fracture. The projected sample size is 20 patients, double the median sample size in a systematic review of 13 similar studies (Piggott et al., 2022). Age, gender, mechanism of injury, and days from surgery to study visit were collected through retrospective chart review. Charts were also reviewed for complications and revisions. Clinical and patient-reported outcomes were collected during a single study visit scheduled a minimum of one year after surgery. At this visit, the Patient-Rated Elbow Evaluation (PREE), quickDASH, Single Assessment Numeric Evaluation (SANE), Mayo Elbow Performance Score (MEPS), and Oxford Elbow Score (OES) were administered. Bilateral elbow flexion, extension, pronation, and supination were measured by goniometer, and grip strength by dynamometer. Radiographs were used to assign AO fracture classification and evaluate bony healing at the study visit. Wilcoxon signed-rank tests were performed on paired differences in bilateral range of motion (ROM) and grip strength.

**Results:** Preliminary analyses include eight patients (7 female, 1 male, mean age 75.5 ± 4.7 years). Five patients had AO type 13B3 fractures and three patients had 13C3 fractures. Ground level falls accounted for 75% of injuries. The mean time from surgery to study visit was 973.8 ± 780.8 days. No major complications or revision surgeries occurred. Mean scores were as follows: PREE Pain: 11/50 (± 11), Function: 5/50 (± 9), Total: 16/100 (± 20); QuickDASH: 17/100 (± 19); SANE: 81% (± 18%); MEPS: 88/100 (± 12); OES: 14/16 (± 3) for pain, function, and social-psychological domains. Mean injured elbow ROM was 133° ± 11° flexion, 18° ± 12° extension, 84° ± 7° pronation, and 85° ± 8° supination. For the uninjured side, these were 144° ± 11°, 10° ± 20°, 86° ± 4°, and 87° ± 6° respectively. Mean grip strength was 20 versus 23 kg for the injured versus uninjured side. Paired differences were marginally significant for flexion (p=0.047) and borderline significant for grip strength (p<0.1). There were no significant paired differences in extension, pronation or supination.

**Discussion:** The mean bilateral grip strength of 20-23 kg in this study falls within normative range, suggesting that it is relatively preserved following EHA. Compared to one mid-term study (Dumoulina et al., 2024) of 58 TEAs, preliminary EHA results had lower major complication rates (0% versus 20.7%), better MEPS (88 versus 85) and quickDASH (17 versus 28) scores, and better mean ROM (133° versus 122° flexion, 18° versus 24° extension). EHA had less loosening than TEA with 0% versus 17% radiolucent lines at mid-term follow-up. There were no revisions in both studies. Compared to one mid-term study (Moursy et al., 2022) of 30 ORIFs, EHA had lower complication rates (0% versus 56%), similar MEPS (88 versus 89), and better mean ROM (133° versus 127° flexion, 18° versus 21° extension, 84° versus 68° pronation, and 85° versus 75° supination). EHA had 0% lucency compared to 26% non-union for ORIF at mid-term follow-up and no revisions compared to 1 revision ORIF. Although this study is limited by small preliminary sample size and lack of a comparator group, the mean PREE, SANE, and OES scores suggest favourable functional outcomes without major disability following EHA. Flexion loss was marginally significant but remained above functional range of 120° (Shaffer et al., 1995).

**Conclusion:** Preliminary data from eight elderly patients who underwent EHA for distal humerus fractures reveals comparable ROM and grip strength between the uninjured and injured extremity at mid-term follow-up. Early results suggest patients who undergo EHA for geriatric distal humerus fractures experience less pain, better function, and lower complication rates than TEA or ORIF, and fewer revisions than ORIF.

Acknowledgements: Adina Tarcea - Orthopaedic Research Coordinator and Eric C. Sayre - PhD, Statistician. COREF Funded: Yes

Title: Nonoperative Management of Fifth Metacarpal Neck Fractures: Impact of Angulation on Patient Reported Outcomes

Authors: Reva Ye Qiu, Taryn Ludwig, Alexandra Munn, Bevan Frizzell, Jevon Brown, Steven Boyd, Maleka Ramji, Neil White, Charley Hasselaar, Adina Tarcea and Christina Hiscox

**Background:** Fifth metacarpal neck fractures (MCNFs) are common hand injuries, comprising up to 20% of all hand fractures. Clinical decision making for treatment of these injuries relies largely on fracture radiographic parameters, specifically, angulation in the sagittal plane measured on radiographic imaging. Current biomechanical data suggests normal mechanics are altered with sagittal angulation over 30°. However, more recent studies have identified satisfactory outcomes in non-operative management of 5<sup>th</sup> MCNFs with angulation up to 70°. Controversy in fracture management was demonstrated in a report of clinical decision making where orthopedic surgeons who were shown x-rays of 5<sup>th</sup> MCNFs with between 20-70° angulation had no to fair agreement regarding management. Furthermore, reliable and precise measurement of angulation of 5<sup>th</sup> MCNFs presents a considerable challenge due to metacarpal overlap on lateral x-rays. This leads to inconsistency in inter- and intra-observer reliability in angulation measurements with up to 30° of overestimation. While computed tomography (CT) can offer a more reliable means of assessing fracture displacement in a three-dimensional plane, consideration must be taken regarding radiation exposure and accessibility. Expert opinion suggests there is a need for improved methods to measure fracture angulation and its correlation with hand function. This study aims to assess whether fracture angulation on x-ray correlates with fracture angulation on CT, as well as to assess the correlation between fracture angulation and PROMs.

**Methods:** A retrospective cohort of patients aged greater than 18 years old who were treated non-operatively for 5<sup>th</sup> MCNFs were recruited from three different centers in Calgary. All patients were identified through the AHS Data Integration, Measurement and Reporting (DIMR) database. All patients were seen for one clinical visit at least 1-year post-injury where x-rays, CT scans, clinical measurements, and PROMs were recorded. Imaging was completed at the Centre for Mobility and Joint Health. The study will comprise of two study arms.

- Correlation between angulation on x-ray and CT: Three physicians (two orthopedic hand surgeons and one musculoskeletal radiologist) measured 5<sup>th</sup> MC angulation on x-ray and CT. Inter-observer reliability will be assessed by calculating interclass correlation coefficients.
- 2. Correlation between fracture angulation and PROMs: Characteristics including demographics, hand dominance, management, hand therapy, and whether the injury was sustained at work were obtained. Pain score (visual analog scale, VAS), range of motion, grip strength, and Disabilities of the Arm, Shoulder, and Hand (DASH) and Patient Rated Wrist Evaluation (PRWE) scores were obtained. Radiographic angulation will be grouped into <30°, 30-70°, and >70°. Correlation of these scores with fracture angulation will be performed by one-way ANOVA.

**Results:** A retrospective cohort of 24 patients was identified. 87.5% sustained an injury of their non-dominant hand with 12.5% of them being workplace injuries. 91.7% of patients were initially immobilized in a cast or splint for 2-8 weeks. Patients were seen on average 3.01 years from injury date and had grip strength of 37.1kg on the injured side compared to 37.6kg on the non-injured side. The average DASH score was 5.66 (IQR 0-7.71), PRWE score (out of 95) was 9.04 (IQR 0.38-15.50), and VAS score (out of 100) was 16.13 (IQR 0-19). Further data analysis is currently ongoing. We hypothesize that 5<sup>th</sup> MCNF angulation measured on lateral hand x-ray will correlate well with angulation measured on hand CT with moderate to good interrater reliability. We hypothesize that fracture angulation will not correlate with PROMs.

Discussion: N/A

**Conclusion:** This study will provide clinical evidence for the treatment of 5<sup>th</sup> MCNFs. The outcomes of this study will help direct the use of conventional x-rays to evaluate 5<sup>th</sup> MCNF angulation and predict clinical outcomes based on PROMs when these injuries are managed non-operatively. This study will provide a foundation for future work elucidating factors contributing to symptomatic malunions for 5<sup>th</sup> MCNFs.

Acknowledgements: Tina Samuels COREF Funded: Yes

**Title:** Bisphosphonate Use Is Low in Patients with Metastatic Bone Disease Despite Their High Risk for Major Osteoporotic Fractures

Authors: Kaja Matovinovic, Lisa Yamaura, Andrew Dodd, Paul Duffy, Robert Korley and Prism Schneider

**Background:** Pathologic fractures due to metastatic bone disease (MBD) are associated with increased mortality, with lower extremity fractures demonstrating the shortest survival rates. Bone health can be monitored using dual-energy X-ray absorptiometry (DEXA) scans, which quantify bone mineral density (BMD), and fracture risk can be predicted using the Fracture Risk Assessment Tool (FRAX). FRAX scoring uses an algorithm to predict an individual's 10-year probabilities of hip fracture and major osteoporotic fracture (MOF). The National Osteoporosis Foundation recommends initiation of bisphosphonate (BP) therapy for fracture prevention when FRAX scores are  $\geq 3\%$  for hip fracture or  $\geq 20\%$  for MOF. In patients with MBD, the use of BPs is associated with improved pain management and reduced incidence of pathologic fractures. This study aimed to characterize 10-year fracture risk in patients with MBD and to evaluate the use of BP therapy in these patients. We hypothesized that patients with MBD would have low rates of BMD investigation and osteoporosis diagnosis and treatment.

**Methods:** This is a secondary analysis of a single-centre prospective cohort of adult patients ( $\geq$ 18 years) with MBDassociated pathologic fractures amenable to surgical treatment. Patients who were admitted between October 2020 and March 2023 were approached for participation in the study. Patients with primary bone cancer were excluded. Following informed consent, FRAX scores for each participant were calculated using the online tool hosted by the University of Sheffield's Centre for Metabolic Bone Diseases. Risk assessment for MOF was conducted in accordance with the 2010 Canadian Clinical Practice Guidelines for the Diagnosis and Management of Osteoporosis, which uses FRAX score thresholds to characterize patients at low risk (<10%), moderate risk (10-20%), and high risk (>20%) of MOF. Descriptive statistics were used to evaluate demographic data, fracture location, DEXA evaluation, and fracture risk.

**Results:** A total of 35 patients with a mean age of 68 years (SD = 11) were included. Of these patients, 60.0% were female. Pathologic fractures were more common in the lower extremity (hip = 68.6%; femoral shaft = 20.0%) compared to the upper extremity (humerus = 11.4%). Overall, 14.3% (n = 5) of patients had previously undergone a DEXA scan and four out of five of these patients were diagnosed with osteoporosis (80.0%). Only one of the patients who underwent DEXA scanning was male. As FRAX scores can be calculated without BMD data, in the overall cohort, the 10-year probability of hip fracture and MOF were 3.1% (SD = 2.8) and 9.9% (SD = 5.5), respectively, with 40.0% (n = 14) of patients at moderate-to-high risk of MOF. Additionally, there was a significant sex-related difference between FRAX 10-year probability for major orthopaedic fracture (p = 0.04), but not for FRAX 10-year probability for hip fracture (p = 0.56). Due to the increased risk for hip fracture (i.e., FRAX score  $\geq$ 3%), initiation of BP therapy would be recommended in 42.9% (n = 15) of the MBD patients; however, of these patients, 73.3% (n = 11) were BP-naïve.

**Discussion:** Despite their elevated fracture risk, 85.7% of patients with MBD had no prior history of osteoporosis screening or diagnostic evaluation. FRAX scores identified that nearly half of patients with MBD were eligible for first-line BP therapy based on National Osteoporosis Foundation and Osteoporosis Canada guidelines; however, nearly three-quarters of these patients were untreated.

**Conclusion:** The results of this study highlight an important care gap for patients with MBD and emphasizes the need for coordinated multi-disciplinary care to facilitate the proactive assessment of BMD and fracture risk in this high-risk population. In addition to reducing fracture risk, BP therapy can also reduce pain associated with metastatic bone lesions. Streamlining these processes may facilitate earlier initiation of BP therapy, thereby reducing pathologic fracture incidence and improving quality of life in MBD patients.

**Acknowledgements:** Jessica Duong, Souvik Maiti, Golpira Elmi Assadzadeh and Marissa Grossi. **COREF Funded:** No

# Abstract Type: Full Abstract Research Pillar: Basic Science

**Title:** Denosumab vs. Zoledronic Acid for Metastatic Bone Disease: A Comprehensive Systematic Review and Metaanalysis of Randomized Controlled Trials

#### Authors: Ben Wajda, Leah Ferrie, Annalise Abbott, Michael Monument and Joseph Kendal

**Background:** Metastatic bone disease (MBD) presents significant challenges inpatient management, leading to skeletalrelated events (SREs), compromised health-related quality of life, and heightened pain experiences. Denosumab (Dmab) and zoledronic acid (ZA) are bone-modifying agents (BMAs) commonly employed to mitigate the sequelae of MBD. Previous meta-analyses have assessed primary outcomes such as overall survival, pathological fractures, radiation to bone, and the time to SREs within studies. However, a single comprehensive analysis comparing their efficacy across multiple primary and secondary outcomes, as well as cost-effectiveness in specific cancer types, has not yet been conducted.

**Methods:** Following PRISMA 2020 guidelines, a literature search in MEDLINE and EMBASE (up to February 15, 2024) identified randomized controlled double-blind trials (RCTs) comparing Dmab and ZA in patients with bone metastases from advanced solid tumors or multiple myeloma. Eligible studies reported at least one of the following: SRE incidence, overall survival, disease progression, pain scores, quality of life, or adverse events. Primary outcomes included overall survival, disease progression, pathologic fractures, radiation to bone, and time to first and subsequent SREs. Secondary outcomes included pain, analgesic use, health-related quality of life (HRQoL), and cost.

**Results:** Analysis of seven RCTs (7,441 patients) found similar overall survival and disease progression between Dmab and ZA. Dmab more effectively reduced radiation therapy needs and delayed SREs, except in multiple myeloma. In breast cancer, Dmab lowered pathological fracture risk by 39%. It was also associated with fewer renal toxicities and acute phase reactions but increased risks of hypocalcemia and osteonecrosis of the jaw. Dmab showed improvements in health-related quality of life and reduced analgesia use in certain cancer types. Cost-effectiveness analyses present mixed results, varying based on cancer type and healthcare system, with some studies favoring Dmab for its efficacy and safety, while others found ZA more cost-effective due to its lower cost.

**Discussion:** While Dmab and ZA provide comparable survival and disease control, differences in SRE outcomes suggest Dmab may be preferable for delaying radiation therapy and fractures, particularly in breast cancer. These findings underscore the palliative role of bone-modifying agents in managing bone metastases, rather than altering overall cancer prognosis. Significant heterogeneity in time-to-SRE outcomes suggests variability in treatment response based on cancer subtypes or individual patient factors. Dmab may offer benefits in delaying pain worsening in specific cancer types and limited data hints at potential improvements in HRQoL with Dmab. Cost-effectiveness analyses vary significantly due to cancer type, geographic region, and methodological choices. These results emphasize the need for tailored treatment strategies, considering cancer-specific factors and individual patient profiles, to optimize outcomes in MBD management

**Conclusion:** This meta-analysis underscores the distinct therapeutic profiles of Dmab and ZA. While both agents are effective for MBD, Dmab offers advantages in reducing certain SREs, delaying pain progression, and minimizing renal toxicity, though at a higher cost. Further research is needed to refine pain and HRQoL outcomes and address cost-effectiveness discrepancies to optimize MBD management.

Acknowledgements: We thank Caitlin McClung (University of Calgary) for assistance with literature searches.

Title: Early Identification of Impaired Fracture Healing Using Biomarkers: A Pilot Study

Authors: Gareth Ryan, Andrew Dodd and Prism Schneider

**Background:** Femoral nonunion occurs in up to 14% of patients and results in an immense patient and societal burden. Predicting which patients will exhibit impaired healing is difficult. Radiographs identify delayed healing based on a lack of interval callus formation; however, they offer limited early prognostic ability. Biomarker analysis may allow for early identification of patients who are progressing towards nonunion, thereby facilitating early intervention. The aim of this pilot study was to determine the relationship between radiographic healing and collagen-10 (CXM), leptin, bone morphogenetic protein (BMP-2), insulin-like growth factor (IGF-1), and platelet-derived growth factor (PDGF-b). We hypothesized that biomarker levels would be correlated with radiographic healing and incidence of nonunion.

**Methods:** Ethics approval was granted for this analysis of patients aged 18-65 years undergoing intramedullary fixation of a closed unilateral diaphyseal femur fracture. Age, sex, fracture classification, and injury severity score (ISS) were collected. Blood samples were collected two and six weeks postoperatively. Leptin, BMP2, IGF-1, PDGF-b, and CXM were analyzed using analyte-specific assays (MESO QuickPlex, Meso Scale Diagnostics) and enzyme-linked immunosorbent assay (SomaScan, SomaLogic Inc.). Radiographs were reviewed at six weeks, twelve weeks, and six months post-operatively, and until union. Radiographs were classified as healed (bridging of 3 or more cortices), partially healed, or not healed, and scored using the modified Radiographic Union Score for Tibial fractures (mRUST). Time to union was measured in months. Statistical analyses were performed using t-tests, Spearman and Pearson correlation, and analysis-of-variance.

**Results:** Sixteen patients were included, 68.8% of whom were male with a mean age of 34.9 years (SD=14.1) and mean injury severity score (ISS) of 10.5 (SD=3.8). Three patients (19.0%) met the diagnostic criteria for nonunion. By six months, 79.0% of fractures had healed, with a mean time to union of 6.2 months (SD=3.4). Age, sex, and ISS were not associated with fracture healing. Patients who developed nonunion had significantly lower CXM at two weeks (p=0.006). Patients who demonstrated early callus formation at six weeks had lower BMP-2 and higher CXM at two and six weeks (p<0.05). Similarly, two- and six-week BMP-2 levels were lower in patients who healed by six months (p<0.05). Six-week mRUST was significantly correlated with CXM at two weeks (r=0.6, p=0.02) and negatively correlated with BMP-2 at six weeks (r=-0.7, p=0.03). Similarly, six-month mRUST was negatively correlated with two-week BMP-2 (r=-0.9, p=0.009). Shorter time to union was associated with lower BMP-2 at both timepoints (r=0.83 to 0.85, p<0.05) and higher six-week IGF-1 (r=-0.6, p=0.02).

**Discussion:** This is one of the first studies to evaluate early identification of impending nonunion using biomarkers in humans. Leptin, BMP-2, IGF-1, PDGF-b, and CXM were detectable two and six weeks postoperatively. We identified associations between BMP-2, IGF-1, and CXM and radiographic healing. Most notably, patients who developed nonunion had significantly lower two-week CXM compared to patients who went on to union. The pilot nature and small sample size limit this study; however, our results support our ongoing prospective studies with larger samples.

**Conclusion:** Lower levels of CXM at two weeks was associated with nonunion. These results provide promising data which have informed ongoing studies on early detection of impaired healing, in order to improve patient outcomes.

Acknowledgements: Foothills Orthopaedic Trauma Research Team, Casandra Tan, Marissa Grossi, Souvik Maiti and Chunfen Zhang.

COREF Funded: Yes

**Title:** Inter-Rater Reliability and Pathoanatomic Association of Tibiofemoral Angle in Individuals with Recurrent Lateral Patellofemoral Instability

Authors: Stephanie Gibbon, Sarah Kerslake and Laurie Hiemstra

**Background:** Many demographic and pathoanatomic factors have been identified as contributing to the risk of lateral patellofemoral instability (LPI). The contributions of malrotation and malalignment to recurrent LPI are evolving as more research is focussed on how these anatomic characteristics contribute to LPI. Diagnostic imaging assessment of coronal malalignment has been established in the literature as a risk factor for LPI. Likewise, evaluation of axial malrotation, such as increased femoral anteversion, and increased tibial tuberosity–trochlear groove (TT-TG) and tibial tuberosity–posterior cruciate ligament (TT-PCL) distances, have allowed for a more complete understanding of LPI etiology. Evaluation of these characteristics facilitates subsequent treatment and surgical decision-making; however, more recently, the combined tibiofemoral rotation angle (TFRA), or through-knee rotation, has gained traction as a novel and important factor to consider when evaluating LPI.

**Methods:** A retrospective analysis of 249 study participants with recurrent LPI was conducted. Inclusion criteria established apriori were a confirmed diagnosis of recurrent LPI based on clinical and radiographic assessment, preoperative three-dimensional imaging, and completion of the Banff Patellar Instability Instrument (BPII) 2.0 at two years from index surgery. The primary aim of the study is to assess the inter-rater reliability of the TFRA as measured by two independent assessors. TFRA will be measured and compared on magnetic resonance imaging (MR), and computed tomography (CT), by both assessors. Secondary assessments will include the association of pathoanatomic risk factors and patient-reported outcomes measured by the BPII at two years from the index procedure. Demographic data will include sex-assigned at birth, age at time of first dislocation, and body-mass index (BMI). Diagnostic imaging measures will be evaluated, including TT-TG, TT-PCL, trochlear morphology and description of dysplasia, and patella morphology, including patellar tilt angle and morphology based on the Wiberg classification.

Statistical analysis will include descriptive statistics, t-tests, and chi-squared analysis, as appropriate. Inter-rater reliability will be evaluated with Kappa statistics and compared between imaging modalities. The association between TFRA and established pathoanatomic risk factors for LPI will be assessed using multiple regression analysis.

**Results:** In total, 249 individuals met the study inclusion criteria. The participant cohort was n=191 (76.7%) female and n=58 (23.29%) male, with mean age at first dislocation of 15.0 [ $\pm$  6.2] years and mean preoperative BMI of 24.7 [ $\pm$  5.2] kg/m<sup>2</sup>. Diagnostic imaging demonstrated a mean TT-TG of 15.5 [ $\pm$  5.4] mm, and TT-PCL of 18.2 [ $\pm$  4.7] mm. Trochlear dysplasia classification revealed n=72 (28.9%) high-grade dysplasia, n=135 (54.2%) low-grade, and n=42 (16.9%) with no dysplasia. Wiberg classification demonstrated Type I = 79 (31.7%), Type II = 111 (44.6%), and Type III = 59 (23.7%). The mean patellar tilt angle was 22.1 [ $\pm$  10.9] degrees.

# Discussion: N/A

**Conclusion:** A thorough understanding of demographic and anatomic risk factors for individuals presenting with LPI is essential, where TFA is a novel parameter with the potential to inform understanding of clinical findings and subsequent treatment strategies. Evaluation of the inter-rater reliability of TFRA and its correlation with known pathoanatomic risk factors and post-operative outcomes will explore validity of this measure.

Acknowledgements: Banff Sport Medicine Foundation.

Title: Can Patient and Radiographic Characteristics Be Used to Predict Delayed Displacement of Distal Radius Fractures?

**Authors:** Calgary Orthopaedic Resident Research Group, Luke McDougall, Kelcie Witges, Jessica Duong, Golpira Elmi Assadzadeh, Andrew Dodd, Paul Duffy, Herman Johal, Robert Korley and Prism Schneider

**Background:** Distal radius fractures (DRFs) represent 17% of upper extremity fractures. Most DRFs are successfully treated with closed reduction and immobilization; however, delayed fracture displacement requiring subsequent operative management may have worse functional outcomes and prolonged recovery. Predicting which DRFs will displace is challenging and there are currently no guidelines to predict which fractures will displace. Therefore, the aim of this study is to identify risk factors for failure of nonoperative management of DRFs.

**Methods:** This is a single-center prospective cohort study of adult patients with DRFs who are seen by orthopaedic surgeons within 21 days of injury. Patients were categorized into early fixation (within 14 days of injury) or delayed displacement (radiographic loss of reduction after at least two appointments, with surgical management within 14 days of injury), or nonoperative. The primary outcome measure was rate of failed nonoperative treatment, as indicated by delayed displacement requiring surgical intervention. Secondary outcomes include radiographic parameters, grip strength, range of motion, patient-reported outcome measures (including the Patient-Rated Wrist Evaluation [PRWE] Score), and pain. Chi-squared, Fisher Exact, or Kruskal-Wallis analyses were used to compare between groups.

**Results:** A total of 80 participants were enrolled, with 12 in the early fixation group, 15 in the delayed displacement group, and 53 in the nonoperative group (18.8% delayed displacement). There was no difference in sex distribution, body mass index, hand dominance, mechanism of injury, or OTA/AO injury classification between the groups; however, those in the delayed displacement group were significantly older (median age = 62.0; IQR = 57.5 to 71.0 years; p = 0.02). There was no difference in the PRWE score or pain at the 6-week follow-up between the groups (all p>0.05).

#### **Discussion:** N/A

**Conclusion:** Up to 19% of patients experienced delayed DRF displacement requiring surgical intervention. Identifying patient characteristics and radiographic parameters at the time of injury that predict who will experience delayed DRF displacement may help inform which patients would benefit from early surgical intervention.

**Acknowledgements:** Thank you to the Foothills Orthopaedic Trauma Research team. Thank you to the Calgary Orthopaedic Research and Education Fund, Calgary Surgical Research Development Fund, and the Workers' Compensation Board of Alberta Research Grant for supporting this study.

COREF Funded: Yes.

Title: Cost Comparison Between Single and Dual-Plate Constructs for Humeral Diaphyseal Fracture Management

Authors: Brett Lavender, Laurel Collings, Herman Johal and Prism Schneider

**Background:** Single-plate constructs are traditionally used for mid-diaphyseal humerus fracture fixation. Dual-plate constructs are an alternative fixation method with advantages including less extensile dissection, provisional fixation for rotationally unstable fractures, and increased screw density. A previous study demonstrated non-inferior biomechanical properties for dual small and mini-fragment orthogonal plating when compared to single small-fragment plating using a cadaveric model.

This study aims to complete a cost analysis comparing the difference in costs between single and dual-plating constructs for isolated humeral diaphyseal fractures. We hypothesize that the costs associated with a dual-plate construct will be comparable with a single-plate construct when all direct and in-direct costs are included.

**Methods:** This is a model-based cost-effectiveness analysis based on combined data from a multi-centre randomized controlled trial that compared operative with non-operative management of isolated humeral diaphyseal fractures and a biomechanical comparison of four plate and screw configurations commonly used for fixation. The direct implant costs associated with four different plating configurations [Group A: fixation with a single anterolateral 3.5-mm Locking Compression Plate (LCP), and three different dual-plate constructs (Group B: 3.5-mm LCP and 2.7-mm LCP; Group C: 3.5-mm LCP and one-third tubular plate; and Group D: dual 2.7-mm LCP)] will be compared using itemized cost-data. Indirect costs associated with hospital stay, complications, and readmissions are estimated to be comparable between

the various plating configurations. Indirect costs associated with time off work and physical therapy requirements during the postoperative period are similarly expected to be equivalent or reduced with dual plating constructs.

A Markov framework will be used to produce 1-year and lifetime estimates comparing the relative cost-effectiveness of the different treatment options.

**Results:** Cost analysis of implants utilized in each plating configuration was compiled. The average cost for the single small fragment plate construct (Group A) was \$269. The average implant cost for dual-plate constructs were \$751, \$296 and \$1,080 for Groups B, C, and D, respectively. This study proposes to model both direct and indirect costs and we anticipate that given the previously demonstrated cost-effectiveness of surgical management for humeral diaphyseal fractures using a single implant, cost-effectiveness will be maintained with dual-plate constructs.

#### **Discussion:** N/A

**Conclusions:** Providing value-based care remains critical in a resource-constrained healthcare environment. The incremental costs associated with increased hardware when moving from a single-plate construct to a dual-plate construct ranges from \$27 to \$811 depending on the construct used. Further cost analysis will focus on comparing operative time, hospital stay, complication rates, and post-operative recovery including physical therapy requirements and return to work. The results of this analysis may be used to support the design of a prospective study comparing direct and indirect costs associated with single and dual-plating constructs for humeral diaphyseal fractures.

**Acknowledgements:** Dr. Brent Edwards from the Biomechanics Lab in the McCaig Institute for Bone and Joint Health, and the Foothills Medical Centre Orthopaedic Trauma Research Team.

**Title:** A Wearable Patient Specific Knee Device to Enhance Anterior Cruciate Ligament Rehabilitation **Authors:** Jared Topham; Matthew Topham and Prism Schneider

**Background:** Literature suggests close to 2,000 anterior cruciate ligament (ACL) injuries occur annually in Alberta (Paudel et al., 2023). Current rehabilitation relies on standardized protocols and in-person physiotherapy, limiting personalization and increased healthcare costs. The lack of real-time, quantitative data further prevents clinicians from optimizing rehabilitation strategies based on patient-specific recovery patterns (Prill et al., 2021). Wearable sensor-based rehabilitation devices offer a promising solution. Motion sensor devices enhance adherence to home-based exercises and improve recovery outcomes (Chen et al., 2022). Remote monitoring systems have reduced physiotherapy visits by 35.7%, easing healthcare burdens (Cooper et al., 2022). Moreover, multi-sensor platforms, such as *SKYRE*, improve real-time tracking, allowing objective patient rehabilitation assessments, but have yet to be implemented or properly assessed in clinical scenarios (Tedesco et al., 2022). Here, we propose a novel, sensor-based wearable device and an accompanying mobile application, *Jointly*, designed to bridge clinical gaps by collecting biometric data during clinical follow-ups to build ACL rehabilitation datasets. We hypothesize that *Jointly* will accurately measure knee kinematics, improve patient satisfaction, and provide critical novel data to help inform personalized rehabilitation protocols. By integrating real-time range of motion (ROM) and muscle activation measurements, *Jointly* aims to improve rehabilitation efficiency, enhance adherence, and support clinicians in tracking patient progress.

**Methods:** *Jointly* consists of a hinged knee brace embedded with a potentiometer and electromyography (EMG) sensors for ROM and muscle activation measurements, respectively. The proposed prospective feasibility study will occur in two phases: **Phase 1:** Healthy Control Testing – The device will first be tested on healthy control participants to validate sensor accuracy, refine data collection methods, and optimize standardized device application during clinical assessments. **Phase 2:** ACL Reconstruction (ACLR) Patient Study – *Jointly* will be used during routine physician follow-up visits with ACLR patients at the 2-, and 6-week follow-up assessments. The device will record quantitative recovery metrics, including knee flexion-extension angles, muscle activation, and joint stability measures.

Data will be de-identified and securely stored using a project-specific REDCap database, allowing for longitudinal analysis, enabling monitoring of recovery trends, rehabilitation intolerance, and refinement of rehabilitation approaches. Patient satisfaction will be collected via outcome surveys and semi-structured interviews and thematic analysis to assess device comfort, usability, and effectiveness in clinical settings. Patient-reported outcomes will include the EuroQol 5 dimensions (EQ5D) score and the Knee Injury and Osteoarthritis Outcome Score (KOOS). Descriptive statistics will be used, as well as independent samples t-tests and Chi-squared analyses to compare between healthy controls and ACLR patients. Value-based data will include direct and indirect costs such as unscheduled visits, physiotherapy visits, and return to work.

**Results**: We anticipate that *Jointly* will: 1) accurately track knee recovery metrics in both healthy controls and postoperative ACLR patients, 2) reduce unnecessary clinic visits, lowering overall healthcare costs, and 3) enhance patient satisfaction and adherence by providing objective, real-time feedback during follow-up visits.

**Discussion:** This dataset will serve as the foundation for future machine learning algorithms that will enable real-time, patient-specific rehabilitation recommendations. Additionally, quantitative data from the feasibility study will contribute to a deeper understanding of recovery timelines after ACLR and guide future AI-driven rehabilitation protocols. Patient-reported outcomes are expected to reflect higher satisfaction levels, given increased recovery transparency and clinician-driven data insights. The effectiveness of *Jointly* will be compared to conventional physiotherapy outcomes to evaluate its impact on accelerating recovery and reducing re-injury rates.

**Conclusion:** *Jointly* proposes a data-driven approach to ACL rehabilitation by leveraging real-time sensor data to optimize recovery tracking and protocol refinement. This feasibility study will determine sensor accuracy, patient usability, clinical integration viability, and patient satisfaction. By establishing a patient-specific dataset and validating real-time biometric tracking, *Jointly* aims to improve rehabilitation efficiency, reduce healthcare burden, and enhance post-operative outcomes for ACLR patients.

Acknowledgements: None. COREF Funded: No Abstract Type: Proposal Abstract
 Research Pillar: Basic Science
 Title: Biomechanical Analysis of Single Small Fragment Compared with Dual Mini Fragment Plate Fixation for Ulnar
 Diaphyseal Fractures
 Authors: Meredith Stadnyk, Joshua Mang and Prism Schneider

**Background:** Ulnar diaphyseal fractures have commonly been treated using single 3.5 mm plate and screw constructs. In recent years, there has been a trend toward using smaller plates and screws for fixation for many fracture sites, including forearm fractures. Smaller plates are particularly beneficial for fixation of bones with minimal overlying soft tissue, such as the ulna, to reduce the post-operative implant prominence and irritation that can necessitate a second surgery for implant removal. Additionally, due to the relatively small size of the ulna, smaller constructs can be used to match the anatomy of smaller patients or adolescents in which 3.5 mm plates may be irritating (Figure 1). Forearm fractures are uniquely at risk of developing post-traumatic radioulnar synostosis; therefore, utilizing surgical techniques with smaller plates allows for smaller incisions, less soft tissue and interosseous membrane disruption, and may reduce this risk of this



complication. Optimal plate constructs have been studied in other fractures, including olecranon and clavicle fractures, where current literature shows no difference in fracture union between anatomic single plating and dual mini fragment plating, but lower rates of symptomatic hardware post-operatively.

There is increasing evidence emerging to support the fixation of isolated ulnar diaphyseal fractures due to complications associated with nonoperative management, so the need for evidence to guide optimal plate and screw construct is needed. With the lack of existing biomechanical data to suggest superior outcomes in small fragment plating compared to mini fragment plating for ulnar diaphyseal fractures, this study will provide novel evidence to guide surgical decision-making. The primary aim of this study is to determine the optimal plate and screw construct for ulnar diaphyseal fractures by comparing single small fragment with dual mini fragment plating constructs for the first time. We hypothesize that a cadaveric biomechanical model will show that dual mini fragment plating of ulnar diaphyseal fractures will show equivalent outcomes in terms of stiffness and load-to-failure testing compared to single small fragment plating.

**Methods:** Twenty fresh-frozen adult cadaveric forearm specimens will be utilized. Specimens will undergo CT scan assessment of Bone Mineral Content (BMC) and will be randomized to one of four groups: 1) single 3.5 mm plate, 2) single 2.7 mm plate, 3) dual 2.7 mm and 2.4 mm plates, or 4) dual 2.4 mm and 2.0 mm plates. The ulna will be exposed, and the specimen will be potted using PMMA in a custom jig. An osteotomy will be performed to simulate a transverse diaphyseal ulna fracture. Axial, torsional, and bending stiffness will be determined through non-destructive cyclic testing using a material testing machine (MTS 858 Bionix System). Subsequently, load-to-failure testing will be performed using axial loading. Our sample size of 20 specimens is in keeping with similar biomechanical studies for diaphyseal clavicle and long bone fractures. Statistical analysis will be performed using T-tests and Chi-squared tests to compare demographic and BMC differences between groups, and independent T-tests will be used to compare construct stiffness and load to failure. **Results:** The results for the proposed study are pending. We predict that the study results will support the hypothesis of equivalent stiffness and load-to-failure testing between dual mini fragment and single small fragment plating for ulnar diaphyseal fractures.

#### Discussion: N/A

**Conclusion:** This study will be the first biomechanical study to quantify the difference in strength of fixation between single small fragment and dual mini fragment plate fixation of diaphyseal ulnar fractures in a human cadaveric model. The results of the study will support evidence-based surgical decision-making and safe clinical implementation of constructs for diaphyseal ulnar fracture fixation.

Acknowledgements: McCaig Institute for Bone and Joint Health Biomechanics Laboratory, Jessica Duong, and Leah Kennedy.

COREF Funded: Yes

# Abstract Type: Proposal Abstract Research Pillar: Basic Science

Title: Mechanical Analysis of a Kickstand Implant for Utilization in Unstable Lumbosacral Spine Fractures

Authors: Tim Lasswell, Fred Nicholls, Stewart McLachlin, Joannie Yao, Nalan Carpan, Ariana Rauliuk and Ashley Saggu

**Background:** Short segment posterior screw/rod constructs used to instrument unstable lumbosacral spine fractures are prone to failure (Fig 1a) before fusion occurs unless supplemented with anterior stabilization, which is itself associated with increased potential morbidity. The current study investigates the feasibility of a spinal implant designed to minimize implant stress, thus reducing the risk of mechanical failure of posterior-only short segment screw/rod constructs.

**Methods:** A multidisciplinary team of clinicians and engineers defined design criteria and constraints that were used to prototype a "kickstand" implant that can be added to existing short segment screw/rod constructs. Mechanical loading of four constructs were simulated using finite element analysis and experimental testing is planned as per ASTM 1798. The four constructs that will be tested are: monaxial screw/rod construct, monoaxial screw/rod construct + kickstand, polyaxial screw/rod construct and polyaxial screw/rod construct + kickstand. ANOVA with Bonferroni post hoc testing will be used to analyze the experimental failure load data and identify significant differences between constructs.

**Results:** Finite element modeling has shown that the addition of a kickstand to a screw/rod construct reduces the average equivalent implant stress by 81% when a uniaxial static load is applied as per ASTM 1798. Prototypes for experimental testing are currently being manufactured and as a result this data is not yet available. Experimental data collection and analysis will be complete by resident research day and will be presented at that time.

**Discussion:** The kickstand implant essentially acts as a truss intended to reduce stress and strain within posterior short segment screw/rod constructs. Preliminary finite element modeling has demonstrated promising results, and experimental testing is planned for March.

**Conclusion:** Design of a kickstand implant has been completed, and testing is underway. Results of this testing will be used to inform further development of the kickstand implant with the goal of decreasing short segment screw/rod construct failure prior to obtaining solid fusion in the setting of unstable lumbosacral spine fractures.

# Acknowledgements: N/A COREF Funded: Yes



Figure 1: a) failure of a short segment screw/rod construct and b) addition of a kickstand implant (purple) intended to reduce stress at the failure site