



# ORTHOPAEDIC RESEARCH DAY

Wednesday May 1, 2024 | 8:00 AM – 4:00 PM PDT

**Chair:** Dr. Fay Leung, Dr. Michael Bond

**Review Panel:**

**Tim Daniels, MD, FRCSC.** Professor, Division of Orthopaedic Surgery, University of Toronto; Head, Division of Orthopaedic Surgery, St. Michael's Hospital.

**Graham King, MD, Msc, FRCSC.** Professor and Director, Roth | McFarlane Hand & Upper Limb Centre (HULC), Schulich Medicine and Dentistry, Western University.

**Note:** All presentations are strictly limited to **6-minutes**, followed by a **4-minute** discussion period with the review panel

08:00 – 08:10 am			
Welcome and Opening Remarks – Dr. Kishore Mulpuri			
Time	Speaker	Time	Speaker
08:10 – 08:20 am	William Chu Kwan (Fellow)	Spinal Cord Injuries Secondary to Mountain Biking Accidents – A Cause for National Alarm	Dr. Brian Kwon
08:20 – 08:30 am	Brittany Lim (Grad Student)	Out-of-pocket cost of care and equity of access to care associated with limb lengthening and reconstruction in British Columbia	Dr. Anthony Cooper
08:30 – 08:40 am	Nikolaus Klogel (Fellow)	The Natural Course of Mild Degenerative Cervical Myelopathy	Dr. Nicolas Dea
08:40 – 08:50 am	Philip Hache (Fellow)	A Scoping Review of the Use of Functional Outcome Tools in Lower Extremity Trauma Literature in Low- and Middle-Income Countries	Dr. David Stockton
08:50 – 09:00 am	Oly Pearce (Fellow)	Utilization of the ABRA Surgical system in orthopaedic trauma patients: A Level 1 trauma centre perspective	Dr. David Stockton

09:00 – 09:10 am	Suroosh Madanipour (Fellow)	Liner Exchange versus Component Revision for the Treatment of Stiffness Following Total Knee Arthroplasty	Dr. Lisa Howard
09:10 – 09:20 am	Jenny He (Resident)	Long-Term Outcomes of Total Knee Arthroplasty with Distal Femoral Replacement for Non-Oncologic Indications	Dr. Michael Neufeld
09:20 – 09:30 am	Thomas Robinson (Fellow)	Cup-cage reconstruction for pelvic discontinuity: Good mid to long term survival.	Dr. Lisa Howard
09:30 – 09:40 am	Faisal AlFayyadh (Fellow)	Low Risk of Cup Fixation Failure at 10-Years Using Constrained Liners at the Same Time of Acetabular Component Revision	Dr. Michael Neufeld
09:40 – 10:00 am	<b>BREAK – 20 min</b>	<b>Coffee and light refreshments are served outside of the auditorium</b>	
10:00 – 10:10 am	Duneesha De Silva (Grad Student)	An Examination of Screening Practices for Developmental Dysplasia of the Hip across Sri Lankan Medical Specialties	Dr. Kishore Mulpuri Dr. Emily Schaeffer
10:10 – 10:20 am	Gourav Jandial (Fellow)	Tethering in sleeper plate mode for guided growth: Does the plate material matter?	Dr. Anthony Cooper
10:20 – 10:30 am	Taylor Ricci (Resident)	Hip Dysplasia: Risk Factors and their Associated Diagnostic Severity	Dr. Emily Schaeffer
10:30 – 10:40 am	Gina Peck (Resident)	Bicruciate Ligament Reconstruction: A systematic review	Dr. Parth Lodhia
10:40 – 10:50 am	Kaid van Kampen (Resident)	Women in Orthopedics Surgeon - Challenges and Barriers - A scoping review	Dr Patricia Farrugia
10:50 – 11:00 am	Mehdi Nouri Zadeh (Grad student)	Enhancing Upper Extremity Strength: Blood Flow Restriction Exercise for Individuals with Spinal Cord Injury	Dr. Babak Shadgan Dr. Kishore Mulpuri
11:00 – 11:10 am	Alice Wang (Resident)	Complex regional pain syndrome after distal radius fracture: a survey of current practices	Dr. David Stockton
11:10 – 11:20 am	Emily Bliven (Grad Student)	Prophylactic intramedullary nailing for hip fracture prevention in a fall from standing: a biomechanical study	Dr. Pierre Guy
11:20 – 11:30 am	Eryck Moskven (Resident)	Mitigating Medical Adverse Events Following Spinal Surgery: The Effectiveness of a Postoperative Quality Improvement (QI) Care Bundle.	Dr. John Street
11:30 am – 12:00 pm	Additional Questions and Answer Period		
12:00 – 01:00 pm	<b>LUNCH – 1.0 hour</b>		
01:00 – 01:10 pm	Yasir Al Shehri (Resident)	Analyzing the accuracy of human reviewers to identify scientific abstracts generated by ChatGPT compared to original abstracts	Dr. Sam Wiseman
01:10 – 01:20 pm	Yousif Murad (Resident)	Fully automated analysis of the anatomical and mechanical axes from pediatric standing lower limb radiographs using convolutional neural networks	Dr. Anthony Cooper

01:20 – 01:30 pm	Ke Xin (Katie) Chen (Grad Student)	Development and Evaluation of a Tracked 2D Ultrasound System to Generate Accurate 3D Metrics for Guiding Treatment in Developmental Dysplasia of the Hip	Dr. Antony Hodgson
01:30 – 01:40 pm	Mohammad Arafah (Fellow)	Adjacent Hindfoot Joint Preservation Versus Fusion in Patients with Ipsilateral Hindfoot and Ankle Arthritis Undergoing Total Ankle Arthroplasty: A Prospective Comparison of Outcomes	Dr. Alastair Younger
01:40 – 01:50 pm	John Steyn (Fellow)	A Retrospective, Comparative Study on Infinity® Ankle Replacements vs. Ankle Fusions	Dr. Murray Penner
01:50 – 02:00pm	Julien Zaldivar (Fellow)	Cervical Spine Chordomas: Surgical outcome assessment in a multicenter cohort from the Primary Tumor Research and Outcomes Network	Dr. Raphaelle Charest-Morin
02:00 – 02:20 pm	<b>BREAK – 20 min</b>	<b>Coffee and light refreshments are served outside of the auditorium</b>	
02:00 – 04:00 pm	<b>Poster Sessions</b>		

<b>Name</b>	<b>Title</b>	<b>Supervisor</b>
Naif Alanazi (Resident)	Fully automated IHDI scoring of pediatric radiographs using convolutional neural networks	Dr. Kishore Mulpuri
Mejbel Alajmi (Resident)	Automated Identification and Management Guidance of Pediatric Elbow Fractures	Dr. Anthony Cooper
Shahriar Shalileh (Grad Student)	Fully implantable, flexible optical probes for neuromodulation of the spinal cord	Dr. Dena Shahriari
Elham Mohseni (Grad Student)	A Soft and implantable actuator device for the management of neurogenic underactive bladder after spinal cord injury	Dr. Dena Shahriari
Shuyuan Li (Fellow)	The Use of Percutaneous Naviculocuneiform Arthrodesis to Restore Medial Column Stability in Flatfoot Reconstruction: Techniques and Outcomes	Dr. Alastair Younger
Nicole Krysa (Resident)	Assessing the impact of a rapid access adolescent knee clinic on time to diagnosis and time to management of adolescent anterior cruciate ligament injuries	Dr. Lise Leveille
Gabrielle Levesque (Resident)	Correlation of Beighton score with required traction forces during primary hip arthroscopy	Dr. Parth Lodhia
Akash Chopra (Resident)	Can Humeral Subtraction CT scans help better characterize and delineate non-operative vs operative anteromedial coronoid facet fractures with valgus posteromedial rotatory instability: A retrospective analysis	Dr. Adrian Huang
Parinaz Ranjbaran (Grad Student)	Potential for Reducing Radiation Dose in Proximal Tibia Plate Fixation Using Depth Camera Augmented Fluoroscopy (DeCAF)	Dr. Antony Hodgson
Arsh Sidhu (Resident)	Nickel Free, Hypoallergenic versus Standard Cobalt-Chrome Containing Total Knee Replacement: Is There a Difference in Synovial Metal Ions at Minimum 1-Year Follow-up?	Dr. Michael Neufeld

Nicola Horwood (Resident)	Perioperative Management of Juvenile Idiopathic Arthritis (JIA) in Anterior Cruciate Ligament (ACL) Reconstruction	Dr. Lise Leveille
Helen Crofts (Resident)	3D-MRI in the evaluation of non-arthritic hip pathology: A systematic review comparing 3D-MRI to 3D-CT and intra-operative findings	Dr. Parth Lodhia
Meg Evans (Resident)	Prognostic Factors of Clinical Outcome for Osteochondral Lesions of the Talus treated with Surgical Management: a Systematic Review	Dr. Andrea Veljkovic
Sara Koohbor (Grad Student)	Cobalt-Activation of TRPV4 in Hip Synovial Fibroblasts Induces Production of Cytokines That Promote Formation of Adverse Local Tissue Reactions	Dr. Felipe Eliot
Bitah Mojtahedzadeh (Grad Student)	Vertebral Osteosclerotic Bone Metastasis Lesions of Prostate Cancer Acquire Altered Extracellular Matrix Characteristics	Dr. Michael Cox

## Abstracts – Orthopaedic Research Day May 1, 2024

### Podium Presentations

What is the optimal management of metastatic spine patients with intermediate Spinal Instability Neoplastic Scores: To Operate or Not to Operate?

**William Chu Kwan**, Raphael Charest-Morin

**Background:** In patients with extradural metastatic spine disease, management of patients with intermediate Spinal Instability Neoplastic Score (SINS) lesions category is uncertain and remains controversial amongst clinicians.

**Objective:** We sought to systematically review the outcomes and complications of 4 different treatment approaches: 1) radiotherapy, 2) percutaneous interventions, 3) minimally invasive surgeries, or 4) open spinal surgeries.

**Methods:** Following PRISMA guidelines, MEDLINE, EMBASE, Web of Science, and Cochrane databases were queried for studies that reported on SINS intermediate patients who underwent one of the above-mentioned treatments. Dates of publication were between 2013-22. Patients with low- or high-grade SINS were excluded. Outcome measures were pain score, functional status, neurological outcome, ambulation, survival, and perioperative complications.

**Results:** Thirty-nine studies (pooled population=4554) were included that analyzed outcomes in the SINS intermediate cohort. Radiotherapy (1205 patients in 12 studies) appeared to provide temporary improvement in pain score for up to 1 year. However, new or progressive pathologic fracture and recurrent pain led to surgery in 15-20% of patients. We found limited evidence on percutaneous interventions (197 patients in 3 studies) including radiofrequency ablation and kyphoplasty; thought, they could provide improvement in pain with less complications. Minimally invasive surgery (333 patients in 8 studies) and open surgery (472 patients in 9 studies) offered improvement in pain, quality of life, neurological function, and survival. Ambulatory status was not significantly improved with MIS, but improved with open surgery. Pools data showed more complications with open surgery. Some studies have suggested dividing SINS intermediate into lower scores not requiring stabilization while higher scores would benefit from the spinal stabilization.

**Conclusion:** Different treatment options are available for the heterogeneous presentation of SINS intermediate spinal bone metastases. Surgery should not be recommended for every patient, but should be considered when mechanical pain is present. SINS on its own was not designed to determine the need for surgery. Understanding which other clinical and radiological factors associated with failure of nonoperative management is an important knowledge gap.

Out-of-pocket cost of care and equity of access to care associated with limb lengthening and reconstruction in British Columbia

**Brittany Lim, Anthony Cooper**

**Background:** Within the pediatric population, lower limb lengthening and deformity correction can require multiple major surgeries that affect patients from early childhood all the way until skeletal maturity. Little research has been done on the out-of-pocket costs incurred by patients and their families associated with treatment. While financial costs should not dictate clinical or personal health-related decision-making, cost analyses can improve efficiencies in healthcare and be used as a tool to help inform patients of what costs they can expect as they navigate their child's diagnosis and treatment.

**Objective:** To analyze the out-of-pocket costs and assess the equity of access to care associated with the treatment of limb lengthening and deformity correction in the pediatric patient population of British Columbia

**Methods:** Patients who have been treated at BC Children's Hospital for lower limb lengthening or deformity correction were invited to participate in an out-of-pocket costs survey. The survey items included: socio-demographic and socio-economic fields, as well as cost related questions pertaining to: medical devices, medication, transportation, private healthcare services and loss of income. Participants were asked to report costs as an average annual cost, thinking about costs incurred over the five year study period of April 2017 to March 2022.

**Results:** Sixty-six patients were invited to participate and 25 have completed the survey. Sixteen of the 25 participants were male, nine were female. Fifteen live in urban parts of the province and five reside in rural areas. Sixteen participants received an external fixator or nail procedure during the study period, three received guided growth and six did not have any major surgery during the study period.

The most common costs that were reported by the 25 survey respondents related to transportation to the hospital (64%), loss of income (48%), orthotics (48%), parking (48%) and mobility aids (36%). The items that had the highest median annual cost included: prostheses \$35 000 (\$6 000, \$70 000), loss of income \$3 400 (\$50, \$212 400), orthotics \$2 700 (\$200, \$18 000), transportation \$1300 (\$30, \$12 000) and non-prescription medication and supplements \$780 (\$100, \$1200).

**Conclusions:** A cost analysis on out-of-pocket costs associated with lower limb lengthening and deformity correction in the pediatric population of British Columbia has not been done before. The results from this study can be a useful component to inform prospective patients of potential costs associated with their treatment and future funding programs to best support the financial needs of this patient population.

## Mild DCM Outcomes

**Nikolaus Klogel, Nicolas Dea**

**Background:** Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction in adults. Surgery is recommended in patients with moderate or severe DCM. However, the treatment of choice is uncertain in patients with mild DCM. While some authors report meaningful improvement with surgery in the mild category, the current literature is limited by the absence of a control non-operative group. The main goal of this study was to describe the natural history of patient with mild myelopathy and to analyze risk factors for failure of non-surgical management.

**Methods:** Data from the Canadian Spine Outcomes and Research Network DCM prospective cohort study were analyzed. This cohort includes both operative and non-operative patients. For this analysis, only patients with mild DCM (mJOA 15-18) with clinical and radiographic follow-up at one year were included. The primary outcome was mJOA at 12 months post-enrollment. Secondary outcomes included various patient reported outcomes (NDI, NRS pain, EQ5D). A logistic regression was performed to assess potential risk factors for conservative treatment failure and crossover to the surgical group.

**Results:** A total of 389 patients with mild myelopathy were identified. Of those, 245 (63%) were initially treated surgically and 144 (37%) conservatively. At up to 5 years follow-up, 30 patients (17%) initially treated conservatively crossed over to surgical treatment. Most patient treated conservatively did not deteriorate neurologically. Logistic regression revealed which clinical and radiological factors were associated with a higher risk of deterioration.

**Conclusion:** Conservative management is appropriate for most patients with mild DCM. However, a thorough neurologic and radiologic assessment is key to select those patients at risk in order to offer a timely surgical intervention.

## A Scoping Review of the Use of Functional Outcome Tools in Lower Extremity Trauma Literature in Low- and Middle-Income Countries

**Philip Hache**, David Stockton

**Background:** The incidence and widespread impact of traumatic injury disproportionately affects low and middle-income countries (LMICs).

**Objectives:** The purpose of this scoping review is to determine which functional outcome scores are being successfully implemented in the evaluation of lower extremity fracture care in LMICs, as well as their overall utility and validity within the local context.

**Methods:** Medline and Embase were searched from inception to October 2023 for literature reporting functional outcome measurements on both generic and specific instruments in study populations set in LMICs. Meta-data was extracted to provide descriptive statistics. We used a scoping review technique to help identify currently established knowledge as well as identified gaps to inform future avenues of research.

**Results:** 117 studies were included, comprising 7,478 patients (57.5% male) across 29 countries in 75 unique journals. Mean age was 46.2 years. 67% of study populations were in Asia, 22.3% in Europe, 7% in Africa and 3.6% in Central and Southern America. Hip fractures were most reported (n=31 studies), followed by foot and ankle fractures (n=29 studies), then acetabulum fractures (n=12 studies) and peri-articular knee injuries (n=9 for both distal femur and tibial plateau fractures). 40 functional outcome tools were reported (13 generic and 27 specific). Psychometric testing was reported in 3 generic outcome tools and 7 specific outcome tools.

**Conclusion:** The reported use and validity testing of functional outcome tools in local settings appears to be increasing over time. Several knowledge gaps have been identified to help generate future avenues of investigation.



## An Examination of Screening Practices for Developmental Dysplasia of the Hip across Sri Lankan Medical Specialties

**Duneesha De Silva**, Kishore Mulpuri, Emily Schaeffer

**Background:** Sri Lanka does not have a formal care pathway that clinicians use to assess for developmental dysplasia of the hip (DDH), which may lead to later diagnosis, invasive treatments, and long-term adverse health outcomes.

**Objectives:** With the goal of developing a care pathway for DDH in Sri Lanka, we surveyed relevant medical specialties regarding their experience with DDH screening, diagnosis, and treatment to understand current care practices and to identify knowledge gaps.

**Methods:** Specialty-specific surveys were distributed to the members of the Sri Lankan Orthopaedic Association, Sri Lankan College of Radiologists and Sri Lankan College of Pediatricians for 6 weeks.

**Results:** 88 responses were recorded; 24 Radiologists, 27 Orthopaedic Surgeons and 37 Pediatricians/Neonatologists. Across specialties, birth to 3 months of age was the most prevalent age group for DDH presentation. Reported risk factors for DDH screening included breech presentation, family history and history of clinical hip instability. 54% of pediatricians/neonatologists reported that they were unaware of healthy hip swaddling practices. 38% of orthopaedic surgeons reported that primary care physicians are not ordering images appropriately. 56% of orthopaedic surgeons and 43% of pediatricians reported awareness of American Academy of Orthopaedics Surgeons (AAOS) clinical practice guidelines for screening and non-operative management of DDH.

**Conclusion:** We identified areas to improve screening and diagnosis, such as providing guidance on how to connect appropriate referrals and investigating quality of image interpretation. The results from these subspecialty surveys helped inform a modified Delphi process for DDH care pathway building in Sri Lanka.

Tethering in sleeper plate mode for guided growth: Does the plate material matter?  
**Gourav Jandial, Anthony Cooper**

**BACKGROUND:** Reversible hemiepiphysiodesis with 8 plate is commonly performed which allows correction of the mechanical axis of the limb. Removal of only the metaphyseal screw from the 8-plate construct after desired correction is achieved, in order to ease its reinsertion in case of deformity recurrence, is becoming common. Efficacy of this technique is debatable.

**OBJECTIVE:** Our aim was to assess the efficacy of this technique, and to investigate if the difference in material of plate used has an impact on results (tethering).

**METHODS:** We performed a retrospective study in which 29 patients were included with coronal plane deformity who underwent guided growth correction with 8 plate, operated by single surgeon. In all these patients, metaphyseal screw was removed after correction and were evaluated for rebound and tethering. The mean age of patients at the time of metaphyseal screw removal was 10.6 years and the mean follow up time from the surgery to the most recent assessment was 46.2 months.

**RESULTS:** Out of 29 patients, 14 patients had titanium plate and 15 patients has stainless steel plates. 5 patients with titanium plate had tethering in sleeper mode, however, of note, was that no patient with stainless steel plate had tethering effect. Rebound phenomenon was seen in 19 patients with no significant difference between the Titanium plate v/s stainless steel plates.

**CONCLUSION:** The sleeper plate is an acceptable treatment strategy for coronal deformities around the knee, however, tethering and rebound may occur, especially in younger patients. Based on our review, the Titanium plates may increase the risk of tethering.

## Hip Dysplasia: Risk Factors and their Associated Diagnostic Severity

Taylor Ricci, Emily Schaeffer

**Background:** Developmental dysplasia of the hip (DDH) affects 1-3% of all infants, making it the most common pediatric hip disorder. Previous studies have focused on identifying risk factors for DDH, what remains unknown however is the relationship between DDH risk factors and the severity of dysplasia at diagnosis.

**Objectives:** The aim of this study was to determine whether certain DDH risk factors had a stronger association with severity of hip dysplasia at time of diagnosis.

**Methods:** Clinical and radiologic diagnostic data was utilized to correlate DDH risk factors with severity of dysplasia. For this study, severity was characterized by four categorical variables: clinical (dislocated and irreducible hip), ultrasound ( $\alpha$ -angle  $<45^\circ$ , femoral head coverage  $<35\%$ ), and radiograph (IHDI classification three or four). Potential risk factors included breech presentation, family history, female, first born, and swaddling history, and were assessed using univariable and multivariable logistic regression models.

**Results:** 4682 patients analyzed. None of the risk factors were identified as having an increased association with a dislocated and irreducible hip on clinical examination, or with an IHDI Grade of three or four. In contrast, female and first-born infants had significant positive associations with ultrasound parameters of an alpha-angle of  $<45^\circ$  (OR of 1.53 and 1.39) and femoral head coverage of  $<35\%$  (OR 1.35 and 1.34).

**Conclusion:** In addition to clinical examination, ultrasound remains one of the main diagnostic and monitoring hip dysplasia modalities. Our study identified that first born and female infants were more likely to have ultrasound defined severe DDH at diagnosis.

## Bicruciate Ligament Reconstruction: A systematic review

**Gina Peck, Parth Lodhia**

**Background:** Multi-ligament knee injuries are uncommon but debilitating injuries. Additionally, the spectrum of these injuries range from two to all four of the major knee ligamentous structures. Outcomes following bicruciate ligament reconstruction without concomitant collateral ligament, posterolateral, or posteromedial repair are not well known.

**Objective:** We conducted a systematic review on the outcomes of single stage bicruciate ligament reconstruction.

**Methods:** A systematic review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines followed by manual retrieval of screened references. Statistical analysis in the form of weighted averages based on a random-effects model was done for post-operative Lysholm scores, International Knee Documentation Committee (IKDC) Subjective Knee grades, and Tegner scores. Pre-injury and post-operative Tegner scores were also compared.

**Results:** A total of 7682 studies were reviewed, and the final number of eligible studies was seven. One study was excluded from statistical analysis due to the heterogeneity of its outcomes. The weighted averages based on a random-effects model of the post-operative Lysholm score, IKDC Grade A, IKDC Grade B, and Tegner scores of the remaining six studies were 88.0, 0.44, 0.44, and 5.8, respectively, with a confidence interval of 95%. The change in pre-injury to post-operative Tegner scores was -0.74 with a p-value of 0.025.

**Conclusion:** There is limited literature on isolated bicruciate ligament reconstruction. Of the available data, post-operative Lysholm scores, IKDC grades, and Tegner scores indicate favourable outcomes following bicruciate reconstruction; however, patients had worse post-operative Tegner scores compared to their pre-injury scores.

## Liner Exchange versus Component Revision for the Treatment of Stiffness Following Total Knee Arthroplasty

**Suroosh Madanipour, Lisa Howard**

**Background:** This study aimed to compare outcomes of revision TKA (rTKA) with arthrolysis and liner exchange (LE) versus component revision (CR) for the treatment of stiffness post TKA.

**Objectives:** Primary outcomes were achievement of a successful range of movement (AS-ROM) and improvement in arc of motion (AOM). Secondary outcomes included survival free from all-cause and stiffness re-revision.

**Methods:** 129 rTKA for stiffness with minimum two-year follow up were included. Mean age was 63.1, BMI 30.6 and 60% were female. Mean follow-up was 8.5 years. The LE and CR cohorts had similar patient age ( $p=0.83$ ), BMI ( $p=0.99$ ), sex ( $p=0.99$ ), previous manipulation ( $p=0.45$ ), time from TKA ( $p=0.14$ ), and pre rTKA AOM ( $p=0.08$ ). AS-ROM was defined as flexion  $>90$  degrees with extension deficit of  $<10$  degrees at final follow-up.

**Results:** 69% achieved a successful ROM post rTKA and the mean AOM improved (63.2 to 88.5,  $p<0.001$ ). AS-ROM post rTKA was similar between LE (72%) and CR (62%) ( $p=0.29$ ). Mean improvement in AOM was similar between LE (24.9%) and CR (25.4%) ( $p=0.45$ ). 10-year all-cause re-revision free survival was 84.7% (SE 3.6%) for the entire cohort and similar between LE (86.2%) and CR (81.1%) ( $p=0.55$ ). Survival from re-revision for stiffness was 90.2% (SE 2.9%) at 10-years for the entire cohort, and similar between LE (91.6%) and CR (86.7%) ( $p=0.6$ ). Increased pre-operative extension deficit was associated against AS-ROM (OR 0.58, CI 0.4-0.9,  $p=0.006$ ).

**Conclusions:** rTKA for stiffness resulted in modest gains in ROM and a reasonable survivorship. LE resulted in similar AS-ROM and re-revision free survival compared with CR. When indicated, LE is a reasonable option for the treatment of stiffness after TKA.

## Long-Term Outcomes of Total Knee Arthroplasty with Distal Femoral Replacement for Non-Oncologic Indications

Jenny He, Michael Neufeld

**Background:** Distal femoral replacement (DFR) is a valuable salvage option for complex revision or primary total knee arthroplasty (TKA) in the setting of massive bone loss. Few studies report mid to long-term outcomes of DFR for non-oncologic indications.

**Objectives:** The purpose of this study was to report the implant survival of DFR in non-oncologic TKA for the entire cohort and by indication, as well as clinical outcomes.

**Methods:** We retrospectively identified all DFR performed for non-oncologic indications from 2002-2021 at a single academic center. Forty-five DFR were included. Indications included mechanical failure of prior TKA, periprosthetic fracture, and periprosthetic joint infection. Kaplan-Meier analysis was used to determine all-cause implant survival for the entire cohort and by indication. Oxford Knee Scores (OKS) and patient reported satisfaction were collected at most recent follow-up.

**Results:** Fourteen patients underwent revision. The most common reasons for first revision were infection, fracture, and hinge dislocation. The all-cause revision-free survival for the entire cohort was 74.6% at five-years and 60.2% at 10-years. The differences in survival by indication were not statistically different ( $p=0.221$ ). At final follow-up, mean OKS was 25 and 68.8% of patients were satisfied with their outcome.

**Conclusion:** DFR for non-oncological indications is associated with a high rate of revision. The mid- and long-term revision-free survival is poor and patient satisfaction is modest. Differences in survival by indication for index DFR were not statistically significant. DFR remains a valuable salvage procedure, but patients need to be counselled on expected outcomes.

Cup-cage reconstruction for pelvic discontinuity: Good mid to long term survival.  
**Thomas Robinson, Lisa Howard**

**Background:** Pelvic discontinuity is often a difficult complication to manage in revision total hip arthroplasty. There is a paucity of data assessing mid to long term outcomes of cup cages for pelvic discontinuity, and the studies done thus far typically include small numbers of patients.

**Objectives:** The purpose of our study was to review the survivorship and outcomes of cup-cage constructs used to treat pelvic discontinuity.

**Methods:** We retrospectively reviewed our institutional database to include all cases of cup-cage reconstruction performed for pelvic discontinuity between 1999 and 2019. The primary outcome was implant survival with end points of re-revision for aseptic loosening and all cause revision. The secondary outcome was radiological analysis utilizing Gill, classification for loosening as well as any ischial blade cut out/fracture, uncoupling of cage from cup or separation of a cemented acetabular component from cage. Forty-nine cup-cage revisions for pelvic discontinuity were included in the study with a mean follow-up of 6.5 years (range two months-19 years). Twenty-seven patients were deceased during the study time at an average of 7.5 years from the date of their discontinuity surgery (range two months to 18 years). At the time of surgery, the mean age included was 77 years (range 38-91), BMI was 27.9 (range 18-38) and 73% were female. All cup cage constructs were from the same manufacturer (Zimmer). Kaplan Meier Analysis was used to determine survival with all-cause and aseptic loosening re-revisions as the endpoints.

**Results:** A total of nine (18%) patients underwent revision surgery following cup-cage reconstructions at a mean time point of 31 months post index procedure (range one - 81 months). Aseptic loosening was the cause for re-revision in 3/49 (6%) of cases at a mean time point of 56 months (range 29-81 months). Of these aseptic construct failures, two of three of cases required isolated cage/liner revision as the acetabular component was well-fixed. The final case was revised to a custom manufactured tri-flanged implant. Other indications for revision included infection resistant to washout and antibiotic suppression requiring resection arthroplasty (n=three) and instability (n=three). The instability re-revisions consisted of liner exchanges as the cup-cage constructs had not failed. There were six (12%) further cases of radiological failure of the cup-cage constructs where revision surgery was considered but declined by the patients. These included five cases of cage failure and one loosening of the cemented liner with separation from the cage with an intact cup-cage construct. The all-cause re-revision survival was 82% (CI 0.67 to 0.92) at 18 years. Re-revision survival for aseptic loosening was 94% (CI 0.85 to 1.00) at 18 years.

**Conclusion:** Our study has shown cup-cage constructs used to treat arthroplasty related pelvic discontinuity is a successful solution with 82% survival to 18 years and 94% for aseptic loosening survival to 18 years. As far as we know, our study is the largest case series in the literature to date with long term follow-up.

Low Risk of Cup Fixation Failure at 10-Years Using Constrained Liners at the Same Time of Acetabular Component Revision  
**Faisal AlFayyadh**, Michael Neufeld

**Background:** There remains concern that the use of constrained liners (CL) implanted simultaneously at the time of acetabular cup revision in revision total hip replacement (rTHA) may not be safe due to loss of fixation at the bone implant interface and early cup loosening. However, there is a paucity of mid to long-term literature reporting on the outcomes of this practice.

**Objective:** Thus, the aim of this study was to determine the survival free from aseptic cup loosening (fixation failure) and all-cause re-revision in rTHA when a CL was implanted at the same time as acetabular cup revision.

**Method:** We retrospectively reviewed our institutional database to identify all consecutive rTHAs where a CL was implanted simultaneously at the time acetabular cup revision from 2001 to 2021. Eleven patients with less than two-year follow-up were excluded, none of whom underwent re-revision. One-hundred and seventy-four revisions (173 patients) were included in the study with a mean follow-up of 8.7 years (range 2.0 - 21.7). At the time of rTHA, the mean patient age was 70.7 years (range 25 - 91), BMI was 28.5 (range 17.1 - 60.0), and 60.9% were female. The most common indications for rTHA were instability (35%), second-stage periprosthetic joint infection (26.4%), and aseptic loosening (17.2%). All acetabular revisions had screw fixation, seven (4%) were cup-cage constructs and an additional five (2.9%) used highly porous augments to achieve stable cup fixation. Two-thirds (116) of the CLs were manufactured by one implant company and one-third (58) were from another. Thirteen percent (23) were cemented into the revision cup. Kaplan Meier Analysis was used to determine survival with all-cause re-revision and revision for cup aseptic loosening (fixation failure) as the endpoints.

**Results:** A total of 32 (18.3%) patients underwent re-revision at a mean time of 2.9 years (range 0.1 - 4.1). The most common reasons for re-revision were instability (14), periprosthetic joint infection (seven), and loosening of the femoral component (four). Three (1.7%) required re-revision due to aseptic loosening of the acetabular component (fixation failure) at a mean of two years (0.1 - 5.1). Acetabular component survival free from re-revision due to aseptic loosening was 98.9% (95% CI 97.3 ,100) at five-years and 98.1% (95% CI 95.8 ,100) at 10-years. There were no acetabular component fixation failures in modern highly porous shells. The all-cause re-revision-free survival was 84.9% (95% CI 79.4 , 90.3) at five-years and 79.9% (95% CI 73.0 , 86.7) at 10-years.

**Conclusion:** CLs implanted at the time acetabular cup revision in rTHA have a 98.1% 10-year survival free from acetabular cup aseptic loosening (fixation failure). There were no cup fixation failures in modern highly porous shells. Thus, when necessary, implanting a CL during revision of an acetabular component with stable screw fixation is safe with an extremely low risk of cup fixation failure.



Women in Orthopedics Surgeon - Challenges and Barriers - A scoping review  
**Kaid van Kampen, Patricia Farrugia**

**Objective:** The purpose of this scoping review is to provide a broad overview on barriers facing women in orthopedic surgery both thematically and temporarily.

**Methods:** A systematic search of EMBASE, PUBMED and MEDLINE identified relevant studies to the above objectives with the consultation of a librarian. The following search terms were used orthopedics, women, gender, inequity, gender diversity, and workforce. Articles were then coded by theme by two reviewers.

**Results:** 182 articles were included in the final scoping review and read by the lead author. Articles were sorted in categories such as: workforce (24), leadership/academia (26), medical student perspective (17), gender bias and discrimination (48) and mentorship (4); representing considerations that may impact women during their training. Workforce articles summarized the demographic changes in orthopedic surgery with more women entering orthopedics as trainees, but still being the minority of orthopedic surgeons, despite other specialties improving gender parity more rapidly such as general surgery. Leadership and academia articles demonstrated the glass ceiling; women orthopedic surgeons often fail to reach the same academic ranks as men (ie: professorship). The lack of women leaders in orthopedics further decreases lack of mentorship for aspiring orthopedic surgeon who are not men, which is a known factor on how students choose their speciality. Medical student perspectives showed that there are inherent stereotypes (ie: must be strong, play sports) that further deter women from considering orthopedics, which may decrease their exposure to the field. Gender bias articles further explored the “boys club” mentality women feel from medical school to staff-hood. Barriers in residency and staff-hood continue for women as they are often left out of informal networks because of conflicting family duties or interests (ie sports based).

**Conclusion:** Women face multiple barriers across training that can deter them from pursuing orthopaedics and thriving in the field. Not only may women not pursue orthopedics because of their perceptions of the field, but there is a further lack of exposure and mentorship. Once in residency and staff-hood, further difficulty reaching the same level of academic leadership and achievement as their gender counterparts due to gender bias. This scoping review summarizes the impact of gender when pursuing an orthopedic career in a temporal framework.

## Enhancing Upper Extremity Strength: Blood Flow Restriction Exercise for Individuals with Spinal Cord Injury

**Mehdi Nouri Zadeh, Babak Shadgan, Kishore Mulpuri**

**Background:** People with incomplete spinal cord injury (SCI) commonly experience upper extremity muscle atrophy and dysfunction, which reduce their ability to handle their activities of daily living and independence. High-intensity resistance exercise programs (60-80% of one's one-repetition maximum -1RM,) are considered the most effective intervention to improve muscle strength and hypertrophy. However, most people with SCI cannot safely tolerate high-intensity exercise protocols and cannot afford upper limb muscle overuse injuries. Blood Flow Restriction (BFR) exercise, offers a unique approach by achieving significant muscle strength gains with much lighter loads.

**Objectives:** The purpose of this study was to determine the effects of eight weeks of low-intensity BFR exercise on the strength and function of the forearm muscles in people with incomplete SCI.

**Methods:** Ten participants with SCI, aged 18 to 75, were enrolled in an 8-week BFR exercise program focused on forearm muscles, with grip strength as the primary outcome measure. Participants' experiences were also qualitatively assessed.

**Results:** Results indicated a notable increase in forearm muscle strength in the BFR group, with an average gain of  $7.5 \pm 0.37$  kg post 16 exercise sessions. This was significantly higher than the control group, who followed a conventional exercise regimen without BFR and showed a smaller strength increase of  $4.4 \pm 0.68$  kg.

**Conclusion:** The study concludes that BFR exercise is a promising, safe, and effective method to enhance upper extremity strength in SCI individuals. It suggests the potential for improving the quality of life and functional independence of this population.

Complex regional pain syndrome after distal radius fracture: a survey of current practices

**Alice Wang**, David Stockton

**Background:** Distal radius fractures are the most prevalent fracture seen in adults. Complex regional pain syndrome (CRPS) is a complication that can lead to permanent disability. While various proposed prophylaxis and treatment modalities exist, there is no high-quality evidence.

**Objectives:** This study aimed to survey orthopaedic surgeons in the Canadian Orthopaedic Association (COA) and the Orthopaedic Trauma Association (OTA) on their management preferences for patients with distal radius fractures complicated by CRPS.

**Methods:** An electronic survey was distributed to orthopaedic surgeons in the COA and OTA using the Qualtrics platform. Responses were anonymized and collected over 8 months. Response data was analyzed using descriptive statistics; thematic analysis was used on free text response.

**Results:** 134 survey responses were completed. 84% of respondents felt the incidence of CRPS in distal radius fractures was 1-10%, while 15% felt it was closer to 11-20%. 24% utilized the "Budapest Criteria" for diagnosis. 40% offered prophylaxis in patients felt to be at high risk of developing CRPS. 66% felt neutral, uncomfortable, or very uncomfortable managing CRPS in distal radius fractures. When asked to consider adopting a prophylactic therapy, 38% indicated that a therapy with 6-10% absolute risk reduction of CRPS would change their practice. Gaps in current practice included lack of evidence-based treatment and prevention strategies and diagnostic uncertainty.

**Conclusion:** Amongst orthopaedic surgeons, diagnosis, treatment, and prophylaxis strategies for CRPS in distal radius fractures are heterogeneous. Surgeons are not confident in managing CRPS. Future studies using rigorous research methods are warranted to improve management.

Prophylactic intramedullary nailing for hip fracture prevention in a fall from standing: a biomechanical study

**Emily Bliven**, Pierre Guy

**Background:** Geriatric hip fractures present a significant societal burden from their associated high morbidity and mortality rates. Prophylactic augmentation, which aims to mechanically strengthen vulnerable femurs for fracture prevention, has been demonstrated as plausible in some clinical studies.

**Objectives:** This biomechanical study aims to evaluate the effect of prophylactic augmentation by intramedullary nailing with a commercial fixation system on fracture outcomes in a sideways fall from standing.

**Methods:** Six fresh-frozen human cadaveric hip joint pairs were dissected to the bone (preserving joint capsules and pelvis ligaments) and the intact left femurs were implanted with a Gamma3 nail and lag screw. A fall simulator guided the specimens, encased in surrogate soft tissue material, in a gravitationally-driven fall impact. Post-fall fracture outcome was compared between this augmented ex vivo group and a matching control group of the native specimens built using a validated finite element model.

**Results:** Ex vivo augmented specimens showed no hip fractures but two pubic ramus/body fractures. In contrast, the control group predicted femoral neck fractures in three specimens, a pubic ramus/body fracture in one, and no fractures in the rest. Overall, fracture severity was unchanged or reduced after nailing.

**Conclusions:** Prophylactic nailing demonstrated potential in preventing hip fractures but not in reducing pubic ramus/body fracture likelihood. However, these fractures might be preferable clinically due to reduced surgical intervention needs.

## Mitigating Medical Adverse Events Following Spinal Surgery: The Effectiveness of a Postoperative Quality Improvement (QI) Care Bundle.

**Eryck Moskven**, John Street

**Background:** Spine surgery is associated with a high incidence of minor postoperative medical adverse events (AEs).

**Objectives:** Examine the clinical and cost-effectiveness of a postoperative quality improvement (QI) care bundle in mitigating postoperative medical AEs in adult surgical spine patients.

**Methods:** Fourteen-year prospective observational interrupted time series with two historical cohorts: 2006 to 2008, pre-implementation of the postoperative QI care bundle; 2009 to 2019, post-implementation of the postoperative QI care bundle. AEs were identified and graded (Minor I and II) using the previously validated Spine Adverse Events Severity system. Pearson Correlation tested for changes across patient and surgical variables. Adjusted segmented regression estimated the effect of the postoperative QI care bundle on both the annual and absolute incidences of medical AEs. A cost model estimated the annual cumulative cost savings.

**Results:** 13,493 patients over the study period; mean of 964 per year (SD $\pm$ 73). Mean age, mean Charlson Comorbidity Index (CCI), and mean spine surgical invasiveness index (SSII) increased from 48.4 to 58.1 years; 1.7 to 2.6; and 15.4 to 20.5, respectively ( $p < 0.001$ ). Unadjusted analysis confirmed a significant decrease in the annual number of all medical AEs ( $p < 0.01$ ). Adjusted segmented regression demonstrated a significant absolute reduction in the annual incidence of cardiac, pulmonary, nausea and medication-related AEs by 9.58%, 7.82%, 11.25% and 15.01%, respectively ( $p < 0.01$ ). Annual projected cost-savings for preventing Grade I and II medical AEs were \$1,808,300 CAD and \$11,961,500 CAD.

**Conclusion:** Postoperative QI care bundles are effective for improving patient care and preventing medical-related AEs, with significant cost savings.

Analyzing the accuracy of human reviewers to identify scientific abstracts generated by ChatGPT compared to original abstracts

**Yasir Al Shehri**, Sam Wiseman

**Background:** ChatGPT is an artificial intelligence (AI) chatbot launched in November 2022 and has shown potential as a co-author in original science publications, however, the quality of academic text remains uncertain. This study aims to analyze the accuracy of human reviewers in identifying scientific abstracts generated by ChatGPT compared to the original abstracts.

**Methods:** Surgical trainees and faculty at a single institution completed an online questionnaire presenting two research abstracts: one generated by ChatGPT and the original abstract. Participants were then asked to identify which abstract was generated by AI and provide feedback on their preference and perceptions of AI technology in academic writing.

**Results:** 41 participants responded, comprised of 10 (23.3%) staff surgeons. Eighteen (40.0%) of participants correctly identified the original abstract. Twenty-six (63.4%) of participants preferred the ChatGPT abstract ( $p=0.0001$ ). On multivariate analysis, preferring the original abstract was associated with correct identification of the original abstract (OR 7.46, 95% CI [1.78, 31.4],  $p=0.006$ ).

**Conclusion:** Results suggest that human reviewers cannot accurately distinguish between human and AI-generated scientific abstracts, and overall, there was a trend toward a preference for AI-generated abstracts. Concerns with data accuracy and bias remain significant barriers to the widespread implementation of these tools in academia.

Fully automated analysis of the anatomical and mechanical axes from pediatric standing lower limb radiographs using convolutional neural networks

**Yousif Murad**, Anthony Cooper

**Background:** Convolutional neural networks (CNNs) are an implementation of machine learning that has gained much attention in recent years for use in computer vision applications, including in medical imaging. Lower limb alignment is a set of parameters measured from lower limb weight bearing radiographs which are used to diagnose and monitor a wide range of skeletal conditions. We set out to develop a fully automated pipeline for the extraction of lower limb alignment parameters from weight bearing radiographs.

**Objectives:** Our goal is to develop a fully automated pipeline for the extraction of lower limb alignment parameters from weight bearing radiographs.

**Methods:** We used a set of CNNs based on the ResNet-18 and ResNet-50 architectures in combination with custom Matlab code to develop an automated workflow for the analysis of lower limb radiographs to determine limb alignment. CNNs were trained and validated on a set of pediatric standing lower limb radiographs. Results were then compared to manual measurements performed by orthopaedic surgery fellows.

**Results:** CNNs combined with mathematical algorithms to find anatomical landmarks were used to extract mechanical axis parameters (mLFDA and mMPTA). Initial results compared favourably with those measured by orthopaedic surgery fellows. mLFDA measurements showed a mean difference of -0.08 degrees with a standard deviation of 1.02 degrees. mMPTA measurements showed a mean difference of -3.25 degrees and a standard deviation of 3.06 degrees. Mechanical axis deviations (MAD) were measured with a mean difference of 1.37 mm and a standard deviation of 5.15 mm. Full axis measurements take 2-3 seconds per radiograph on a consumer grade laptop computer.

**Conclusion:** CNNs are a promising approach to automating commonly performed, repetitive tasks, especially those pertaining to image processing. The time savings are particularly important in clinical research applications where large sets of radiographs are routinely available and require analysis. With further development of these algorithms, we anticipate significantly improved agreement with expert-measured results as well as the calculation speed.

Development and Evaluation of a Tracked 2D Ultrasound System to Generate Accurate 3D Metrics for Guiding Treatment in Developmental Dysplasia of the Hip  
**Ke Xin (Katie) Chen, Antony Hodgson**

**Background:** In Canada, newborns with a suspicious physical exam are routinely referred for ultrasound (US) exams to check for Developmental Dysplasia of the Hip (DDH), which are usually performed by US technologists using 2D US probes. Unfortunately, the key measurements obtained this way are highly sensitive to probe placement and often unreliable. 3D US systems provide more consistent measures but are uncommon in pediatric practice and not readily available. Hence, patients from remote areas often have to travel long distances for DDH screening.

**Objectives:** We are developing and clinically validating a Tracked Ultrasound System (TUS) that enables clinicians to obtain reconstructed 3D volumes using standard 2D US probes. We hypothesize that these reconstructed volumes will be indistinguishable from 3D scans.

**Methods:** “Inside-out” optical tracking was used to track the position of each 2D US scan, then the volumes were reconstructed using Plus. We conducted a pilot study to assess usability and preliminary performance, and will evaluate the performance of TUS by assessing the Structural Similarity Index Metric (SSIM) between reconstructed and scanned volumes.

**Results:** We were able to collect 3D scans and reconstruct 3D US volumes for 4 pilot study participants, and preliminary results indicate that TUS can create accurate representations of 3D anatomy using a collection of 2D scans. We also refined the user interface and design using feedback from US technicians.

**Conclusion:** Next, we intend to compute the SSIM to quantify differences between reconstructed and scanned volumes, then develop and validate metrics extraction algorithms for DDH diagnosis.



Adjacent Hindfoot Joint Preservation Versus Fusion in Patients with Ipsilateral Hindfoot and Ankle Arthritis Undergoing Total Ankle Arthroplasty: A Prospective Comparison of Outcomes

**Mohammad Arafah, Alastair Younger**

**Background:** Adjacent subtalar (STJ) or talonavicular (TNJ) joint arthritis poses a dilemma in end stage ankle arthritis. The Canadian Orthopaedic Foot & Ankle Society (COFAS) Classification defines such cases as Type 4. In these cases, undergoing total ankle arthroplasty (TAA), fusion of the STJ and/or TNJ or preservation of these joints are both options. Joint preservation may reduce operative time and potential complications but has potential for ongoing hindfoot pain reflected in outcome scores. Hindfoot fusion may offer the potential of greater pain relief, but at the risk of increased OR time and complications.

**Objective:** The purpose of this study was to compare the outcomes of patients undergoing TAA with or without STJ and/or TNJ fusion in COFAS type 4 cases.

**Methods:** We retrospectively reviewed prospectively-collected multi-center data on 148 ankles with COFAS Type 4 arthritis that underwent TAA by 7 different surgeons and analyzed the trend of their Ankle Osteoarthritis Scale (AOS) and SF36 Physical Component Summary (PCS) scores pre-operatively and at 1, 2 and 3-5 years post-operatively. Scores were compared between those who underwent fusion of the STJ and/or TNJ (Fusion Group [FG], n=89) and those who did not (Preservation Group [PG], n=59). Multivariate analyses were also performed to account for potential demographic differences within the patient cohorts. The primary outcome measure was the AOS score at latest follow-up (LFU). Secondary outcomes included the SF36 PCS score, COFAS Reoperation Coding System (CRoCS) rates and survivorship.

**Results:** Mean follow up was 6.9 years. Mean pre-operative AOS scores for FG and PG were

similar (55.9 and 57.5, respectively,  $p=0.56$ ). Mean AOS scores at LFU for both groups were not significantly different (FG: 24.6; PG: 25.2;  $p=0.89$ ). SF36 PCS scores improved from 32.9 pre-operatively to 42.2 at LFU for FG and from 33.9 to 40.0 for PG; differences pre-operatively and at LFU were not significant ( $p=0.51$ ,  $p=0.26$ , respectively). Both groups achieved their lowest (best) mean scores across all measurement scales at 2 years post-operatively. Results from multivariate analyses controlling for demographics, comorbidities, surgeon, TAA implant type, and pre-operative score showed no significant difference in mean AOS scores at LFU between the two Groups. Reoperations in PG included 2 Code 3 procedures (hindfoot fusion)

**Conclusion:** In COFAS Type 4 ankle arthritis cases with adjacent hindfoot arthritis undergoing TAA, our data suggests preservation of hindfoot joints yields similar outcomes to fusion of the hindfoot while potentially avoiding greater operative time, immobilization period, and additional wound/hardware risks associated with concomitant hindfoot fusion. However, preservation carries risk of requiring future reoperation for hindfoot fusion, as seen in 3% of our cases, though this may be countered by the risk of nonunion requiring reoperation when hindfoot fusion is performed primarily. Our results suggest that deferral of hindfoot fusion is a reasonable option in COFAS Type 4 ankles undergoing TAA.

## A Retrospective, Comparative Study on Infinity® Ankle Replacements vs. Ankle Fusions John Steyn, Murray Penner

**Background:** End-stage ankle arthritis (EAA) can diminish quality of life and handicap one's daily activities. Ankle fusion or Total ankle arthroplasty (TAA) are two surgeries used to treat EAA. While ankle fusion has previously dominated, it often impairs ankle functionality, and increases the development of painful hindfoot arthritis. TAA typically has shorter recovery and wider range of motion. Historically, TAA prostheses have been inadequate due to frequent failures. Modern design and techniques have improved outcomes and failure rates, but long-term performance remains ill-defined. The use of TAA is increasing worldwide. Furthermore, TAA is better at meeting patient expectations, results in more normal biomechanical gait, and potentially reduces the risk of adjacent hindfoot arthritis. The INFINITY® Total Ankle System (Stryker Inc.) is a 2-component fixed-bearing, bone-sparing design that this study aims to compare to ankle fusion.

**Objective:** The purpose of the study is to determine whether the Infinity® ankle replacement is a more effective surgical procedure in comparison to ankle fusions (arthroscopic and open fusions), assessed through patient-reported outcomes for patients with end-stage ankle arthritis.

**Methods:** Patients at least 19 years old at the time of index procedure were selected. We compared 100 patients who had the INFINITY® TAA between 2013- August 1<sup>st</sup>, 2021, with 200 ankle fusion patients from 2008 -August 1<sup>st</sup>, 2021, all with minimum 1 year of follow up. The primary outcome was the Ankle Osteoarthritis Scale (AOS). Secondary outcomes were the MODEMS, and SF-36 scores. Revision fusion and revision INFINITY® patients were excluded.

**Results:** At 1 year follow up, Ankle Fusion AOS scores improved from a preoperative average of  $55.25 \pm 19.31$ , to  $26.01 \pm 21.64$ , vs  $52.37 \pm 19.09$  to  $22.33 \pm 21.41$  for INFINITY® TAA. At the last follow up after surgery (LFU), mean AOS scores in the Infinity cohort were significantly lower after linear regression for baseline variables with a mean difference of  $-6.76$  ( $-12.52$ ,  $-0.99$  95% CI) p-value 0.02. The difference remained significant after removing 1-year follow up, and 9-14 year follow up, at  $-6.58$  ( $-12.89$ ,  $-0.27$  95% CI), p-value 0.041. The revision rate for ankle fusion was 3.5%, while revision rate for INFINITY® TAA was 2%.

**Conclusion:** Patients undergoing INFINITY® TAA had significantly lower mean AOS scores than patients undergoing ankle fusion at their last follow up after surgery, both before and after linear regression for baseline variables. This remained significant after excluding earlier (1-year) follow up, and later (9-14 year) follow up that only had fusion cohort data.

## Cervical Spine Chordomas: Surgical outcome assessment in a multicenter cohort from the Primary Tumor Research and Outcomes Network

**Julien Zaldivar**, Raphaelle Charest-Morin

**Background:** Chordomas are rare locally aggressive primary neoplasms with recommended treatment of surgical resection with negative margins. When localized in the spine, there are significant therapeutic challenges due to the proximity to critical structures and the mechanical constraints of the mobile cervical spine. . This prospective case series aims to explore the clinical and patient-reported outcomes of surgically treated cervical chordomas in a large multicenter cohort extracted from the Primary Tumor Research and Outcomes Network (PTRON) Database.

**Methods:** This study is a multi-center case series analysis utilizing data from the prospective AO Spine Primary Tumor Research and Outcomes (PTRON) registry. The study population was restricted to patients with pathologically confirmed cervical chordomas involving C0 to C7, who underwent surgical treatment in one of the participating centers and for whom both the initially planned and post-operatively pathologically confirmed surgical margins were documented. Patient demographics, overall survival, recurrence-free survival, neurological function, type of surgery, surgical margins, complications and adjuvant treatments received were retrieved. Patient reported outcome assessment scores including SOSGOQ, EQ-5D, SF36, NRS and NDI were included. Statistical Analysis was performed using univariate analysis.

**Results:** We identified 38 patients in the PTRON database fulfilling the eligibility criteria, among which, 12 benefitted from true en-bloc resection, 18 underwent intralesional resection and 8 had failed or secondary en-bloc resection. En-Bloc resection, when compared to intralesional resection and failed en-bloc resection resulted in improvements in recurrence freedom (92% vs 83% vs 62%) and overall survival (83 vs 39 % vs 50%) within the study period. Surgical adverse events within 1 year after surgery were however higher with planned en-bloc surgery (100%), when compared to planned intralesional resection (39%) and failed en-bloc resection (75%). Patient reported outcomes showed that patients undergoing radical excision have marked difficulties getting back to their baseline status, even at 24 months from the surgery.

**Conclusion:** This multi-center case series analysis provides critical insights into the clinical and patient reported outcomes in the largest prospective cohort of surgically treated cervical spine chordomas described to date and hints to the importance of wide resection for oncological control. It however establishes the associated morbidity and negative impact on patient reported outcomes of this aggressive strategy. These findings will contribute valuable evidence to guide clinicians in optimizing patient care and the shared decision-making process.

## Poster Presentations

Fully automated IHDI scoring of pediatric radiographs using convolutional neural networks

Naif Alanzi, Kishore Mulpuri

**Background:** Convolutional neural networks (CNNs) are an implementation of machine learning that has gained much attention in recent years for use in computer vision applications, including in medical imaging. The International Hip Dysplasia Institute (IHDI) score is a widely used classification used for the diagnosis and monitoring of developmental dysplasia of the hip (DDH).

**Objectives:** We set out to develop a fully automated pipeline using CNNs for the diagnosis and classification of DDH.

**Methods:** We used a set of CNNs based on the ResNet-50 architectures in combination with custom Matlab code to develop an automated workflow for the diagnosis and classification of DDH.

**Results:** CNNs used for the classification of DDH show an overall accuracy of 0.73 and precision of 0.65 compared to orthopaedic surgeons using the IHDI scoring system.

**Conclusion:** We provide a proof of concept for the capability of CNNs to be employed for the diagnosis and classification of DDH.

Fully implantable, flexible optical probes for neuromodulation of the spinal cord  
**Shahriar Shalileh**, Dena Shahriari

**Background:** Although optogenetics has been widely employed in brain circuitry studies, it has not been broadly implemented for spinal cord research, due to hardware technical impediments caused by the mobility of the tissue.

**Objectives:** Here, we present flexible neural probes connected to a fully implantable, optoelectronic device, to deliver light with controllable parameters. We have designed the device to be rechargeable wirelessly to provide a completely standalone and implantable system.

**Methods:** The device comprises a thin (400  $\mu\text{m}$ ) printed circuit board (PCB) connected to up to 6 flexible optical probes in a plug-and-play fashion. The optoelectronic system is programmable through an ultra-low-power microcontroller. A wireless power receiver system is designed to charge the battery suitable for chronic studies.

**Results:** Our optoelectronic device enables researchers to have multi-channel optical stimulation of the spinal cord at different levels. Having two separate control LED drivers, it is possible to independently modulate neurons at different levels or different neuron types at the same level through different stimulation wavelengths.

**Conclusion:** We have developed a flexible neural probe connected to a fully-implantable optoelectronic device for chronic light delivery and stimulation of the spinal cord in freely moving animal models. The device has been fully designed with commercially available components. Hence, providing our circuit design and algorithm, it can be fabricated by any electronic circuit vendors around the world and implemented by non-engineering scientists in spinal cord circuitry and behavioural neuroscience to study neural relays. We are planning to perform a thorough in-vivo study in future.

A Soft and implantable actuator device for the management of neurogenic underactive bladder after spinal cord injury

**Elham Mohseni**, Dena Shahriari

**Background:** Bladder dysfunctions affect more than 80% of individuals with spinal cord injury (SCI). The poor contractility of the detrusor muscle in neurogenic underactive bladders after SCI causes difficult and incomplete urination, leading to vesicoureteral reflux and bladder and kidney stones.

**Objectives:** Here, we present a soft and implantable actuator device that can apply mechanical compression to the bladder to assist urination via applying a voltage. Composed of a biocompatible elastomer with optimized embedded shape memory alloy micro-helices (SMAMHs), it enables on-demand contraction of the NUAB when actuated. The device is designed by optimizing both mechanical properties and electrical parameters to achieve a lightweight implant with high voiding efficiency.

**Methods:** SMAMHs were employed as the core part of the actuator, which were contracted by applying voltage due to atomic-level transformations. They were embedded in a flexible and stretchable silicon-based elastomer using a designed 3D printed mold compatible with the animal model, Ås size. The device was connected to a commercially available circuit board and microprocessor to control the frequency and duty cycle of actuation.

**Results:** The number and arrangement of SMAMHs, as well as the thickness of the elastomer, were optimized to achieve a high strain rate. The implant can be secured on rat bladder wall with small sutures. Different frequency and duty cycles of actuation were tested on ex-vivo rat bladders to induce a high rate of volume emptying with minimized tissue overheating and damage.

**Conclusion:** The device is potentially applicable for long-term in-vivo studies for bladder management after SCI.

The Use of Percutaneous Naviculocuneiform Arthrodesis to Restore Medial Column Stability in Flatfoot Reconstruction: Techniques and Outcomes  
**Shuyuan Li, Alastair Younger**

**Background:** The NC joint arthrodesis is a powerful procedure in flatfoot reconstruction. It directly addresses the arch collapsing distal to the talonavicular joint. It can de-rotate the mid and forefoot pronation across both the medial and middle columns and therefore can be more effective than a Cotton osteotomy or 1st TMT arthrodesis which only includes the medial column. In severe flexible flatfoot deformities, NC arthrodesis combined with 1st TMT arthrodesis, lateral column lengthening, and muscle balancing can achieve correction without sacrificing the motion of the hindfoot.

**Objectives:** This study introduces a novel technique of percutaneous NC arthrodesis with non-compression subchondral fixation, with conjunctive procedures to restore the medial arch, and its outcomes.

**Results:** Outcomes of 22 percutaneous NC arthrodeses for flatfoot reconstruction were reviewed. The average union time was 3 months with a 100% union rate. The arch height ratio improved 46.8%, the pitch angle improved 24.2%, the lateral Meary angle was improved 60.1%.

**Conclusion:** Percutaneous NC arthrodesis with subchondral fixation has a high fusion rate, is easy to perform although associated with a learning curve, and includes the advantages of minimally invasive surgery. It can be combined with other procedures, such as arthroscopic subtalar fusion, percutaneous TMT fusion, or open lateral column lengthening in the correction of deformity of the foot associated with flat foot deformity.

Assessing the impact of a rapid access adolescent knee clinic on time to diagnosis and time to management of adolescent anterior cruciate ligament injuries  
Nicole Krysa, Lise Leveille

**Background:** Anterior cruciate ligament (ACL) rupture is common in active adolescents, and is frequently accompanied by meniscal tears and articular cartilage damage, which contribute to degenerative changes in the joint over time. Delaying ACL reconstruction in adolescents leads to higher incidence and severity of medial meniscal tears and irreparable chondral damage at the time of surgery. A recent study conducted by our research group identified a linear relationship between patient household income and time to referral to an Orthopaedic Surgeon. Since then, a novel rapid access knee injury clinic has been implemented at BC Children,Ås Hospital.

**Objectives:** 1) Determine if the introduction of such a clinic decreased the discrepancy in access to care associated with socioeconomic status, 2) Whether the delay in referral to an Orthopaedic Surgeon has been decreased on average for all adolescent patients in the greater Vancouver area presenting with an ACL rupture since the advent of this clinic, and 3) Has the frequency of meniscal repairs changed over this period due to more timely access to care?

**Methods:** A retrospective review of prospectively collected data, and clinical course followed through to time of surgical reconstruction. Inclusion criteria: Children and youth age <18 years who have undergone operative reconstruction for an ACL rupture between 2021 and 2023. Primary outcome measures will be time points between injury and eventual reconstruction, as well as the associations between demographic data and time to reconstruction.

**Results:** 123 candidates meet the inclusion criteria (44 male and 79 females).

**Conclusions:** No conclusions have been drawn as of yet.



Correlation of Beighton score with required traction forces during primary hip arthroscopy

**Gabrielle Levesque, Parth Lodhia**

**Background:** Hip arthroscopy is less invasive, leads to faster recovery and has less risk of ischemic changes to the femoral head for managing intra-articular hip disorders such as labral tears and femoroacetabular impingement (FAI). However, complications such as damage to cartilage or soft tissues from instruments, and nerve damage from portal placement and traction do exist. Research has shown that traction forces, rather than traction duration are responsible for traction-related complications.

**Objectives:** The aim of this study is to quantify the distraction distance for applied traction forces and determine if there is a correlation with Beighton score.

**Methods:** Ethics board approval was acquired (FHREB2022295) for retrospective analysis of prospectively collected data in patients undergoing primary hip arthroscopy by the senior author from February 2023 to present for hip pain related to femoroacetabular impingement, labral tear or loose body. Patients were grouped by Beighton score from 0-3 and 4-9 (decreased and increased ligamentous laxity, respectively). Intra-operative traction force and fluoroscopic distraction distance were measured. Means, medians, and categorical variables were compared using two sample t-tests, Wilcoxon rank sum tests, and Fisher-exact tests, respectively. Significant p-values (<0.05).

**Results:** Preliminary data included fifteen patients who met inclusion criteria. There was no significant difference in age, BMI, traction force, traction distance, external rotation, abduction, adduction, tonnis angle, LCEA, or alpha angle between the two groups. Females, flexion and internal rotation were significantly higher in the Beighton 4-9 group ( $p=0.007$ ,  $0.003$  and  $0.013$ , respectively). Participant recruitment ongoing.

Can Humeral Subtraction CT scans help better characterize and delineate non-operative vs operative anteromedial coronoid facet fractures with valgus posteromedial rotatory instability: A retrospective analysis

**Akash Chopra**, Adrian Huang

**Background:** Anteromedial coronoid facet fractures (AMCF) with valgus posteromedial rotatory instability (VPMRI) result in very severe symptomatic elbow arthritis within 2 years if not surgically corrected (Peters, 2022). The difficulty with ACMFs lies in the determining stability of the fracture pattern and distinguishing which fractures are operative. The integrity and stability of the coronoid anteromedial facet has been a primary consideration during the clinical management of AMCFs and the O'ÄôDriscoll coronoid fracture classification has classically been used to guide decision making (Wang, 2022). Recently, stress CT scans to stress the elbow and get a picture of dynamic instability have been used, but there is concern that this has led to a substantial increase in the number of patients being taken to the operating room for potentially non-operative fracture patterns.

**Objectives:** To determine if the addition of Humeral Subtraction View 3D CT scans changes the decision making of upper extremity trained orthopedic surgeons when deciding whether or not to operate on isolated coronoid facet fractures.

**Methods:** This is a retrospective study investigating all adult patients with isolated coronoid facet fractures at St. Paul's Hospital since 2000. Humeral Subtraction View 3D CT scans will be generated with post-processing of existing CT scans. These images will be reviewed independently by two upper extremity trained orthopedic surgeons and be classified as operable or non-operable.

Potential for Reducing Radiation Dose in Proximal Tibia Plate Fixation Using Depth Camera Augmented Fluoroscopy (DeCAF)  
Parinaz Ranjbaran, Anthony Hodgson, Pierre Guy

**Background:** In many orthopedic surgeries, particularly those related to trauma, the surgeon uses a C-arm fluoroscopy machine which displays the x-ray images on a bedside monitor. The surgeon must manually map the information visible on the monitor to the surgical site, which frequently necessitates retaking x-ray images to ensure that the surgical tools are placed in the correct position relative to internal patient anatomy, which is visible only in the x-ray images.

**Objectives:** To reduce the number of x-ray images needed, we designed a Depth Camera Augmented Fluoroscopy (DeCAF) device that overlays the fluoroscopic images onto a live video of the patient's surface anatomy to enable the surgeon to monitor changes in tool position without reacquiring x-ray images.

**Methods:** We evaluated the DeCAF overlay accuracy by using a reference object with markers visible both in x-ray and video. Furthermore, we evaluated the performance of DeCAF in a simulated proximal tibial plate fixation procedure performed by two experienced orthopaedic trauma surgeons.

**Results:** We found that DeCAF had clinically acceptable overlay accuracies ( $1.6 \pm 0.4$  mm) and substantially eliminated the need to use X-ray images (down from  $39.2 \pm 5.1$  and  $21.5 \pm 8.3$  to 0 for the more experienced and less experienced surgeon, respectively), without significantly changing the time required for ( $498.8 \pm 57.2$ s for conventional approach vs  $475.2 \pm 83.2$ s,  $p = 0.47$  for DeCAF both performed by more experienced and  $300.2 \pm 50.4$ s vs  $370.4 \pm 102.2$ s for the less experienced surgeon,  $p = 0.07$ ). Screws placed using DeCAF were  $\sim 3$ mm deeper on average ( $p < 0.05$ ), but were still placed at safe depths.

**Conclusion:** These findings justify advancing DeCAF towards use in live operating room scenarios. Despite acquiring only one x-ray of the proximal tibia, both surgeons were able to appropriately place all screws no significant difference in breaching and in times comparable to the conventional method. Overall, screws inserted with DeCAF were placed  $\sim 3$  mm deeper than with the conventional method but were generally still within or close to the normally targeted depth zone. These results justify moving to deploy and test DeCAF in live surgical scenarios.

## Nickel Free, Hypoallergenic versus Standard Cobalt-Chrome Containing Total Knee Replacement: Is There a Difference in Synovial Metal Ions at Minimum 1-Year Follow-up?

**Arsh Sidhu, Michael Neufeld**

**Background:** Osteoarthritis (OA) of the knee is a major cause of disability globally, leading to pain, loss of function, and reduced quality of life. Total knee arthroplasty (TKA) is a highly effective treatment for end-stage knee OA, but up to 20% of patients experience unsatisfactory outcomes. Concerns have emerged regarding metal allergies in TKA, particularly nickel (Ni) allergies, which may contribute to persistent pain and dysfunction. Despite this, there is limited evidence supporting the use of "hypoallergenic" knee implants in patients with known metal allergies. Adverse local tissue reactions (ALTR) to metal ions have been documented in hip arthroplasty, raising concerns about similar reactions in TKA, especially in patients requiring revision surgery.

**Objective:** The primary aim is to compare synovial fluid levels of metal ions (Co, Cr, Ni, Ti) in patients with hypoallergenic versus standard TKA at least 1 year post-surgery. Secondary aims include correlating synovial fluid metal ion levels with functional outcomes and serum levels, and determining differences in synovial fluid metal ion levels between hypoallergenic and standard TKA in patients without other metal implants.

**Methods:** This retrospective case-control study compares Oxinium hypoallergenic knee (cases) with standard cobalt chrome knee replacements (controls). Cases and controls are matched based on age, sex, BMI, implant type, and time from surgery. Synovial fluid and peripheral blood samples are collected for metal ion analysis. X-rays are used to confirm implant fixation. Statistical analysis will be performed to evaluate primary and secondary outcomes.

Perioperative Management of Juvenile Idiopathic Arthritis (JIA) in Anterior Cruciate Ligament (ACL) Reconstruction  
**Nicola Horwood**, Lise Leveille

**Background:** At BC Children's Hospital (BCCH), a recent case of graft failure five months post-ACL reconstruction was observed in the absence of an acute re-injury event in a patient with juvenile idiopathic arthritis (JIA), a type of chronic inflammatory arthritis.

**Objective:** A scarcity of literature guiding peri-operative ACL reconstruction medical management of JIA was revealed, therefore the optimal protocol is currently unclear.

**Methods:** A retrospective case review series was conducted of BCCH patients. Inclusion criteria consisted of diagnosis of JIA and surgical reconstruction of ACL rupture. Data collected included patient demographics, JIA diagnosis and management, orthopaedic diagnosis, management and post-operative complications.

**Results:** Three patients met the inclusion criteria. All patients had JIA, one had enthesitis-related, other two had oligoarthritis subtype. One patient was in remission and was not medically treated for JIA at the time of ACL surgery. The other two patients were on a biologic, disease-modifying antirheumatic drug (DMARD) and NSAID. Both patients had their DMARD held one week pre-operatively and altered the dosing timing of their biologic. One patient had a non-traumatic graft failure post-operatively, in context of a JIA disease flair, requiring revision ACL reconstruction.

**Conclusions:** No difference in medication management was noted between the two patients on biologic and DMARD therapy despite one patient having an atraumatic graft rupture. More research is required to determine the optimal peri-operative management protocol for biologic medications in this specific population.

## 3D-MRI in the evaluation of non-arthritic hip pathology: A systematic review comparing 3D-MRI to 3D-CT and intra-operative findings

**Helen Crofts, Parth Lodhia**

**Background:** The workup of non-arthritic hip pathology often involves multiple imaging modalities including radiographs, CT and MRI. While MRI is the best imaging modality for soft tissue, recent advances in image acquisition sequences and post-image processing have improved the osseous details obtained from MRI scans. 3D MRI imaging for evaluation of non-arthritic hip pathology has been compared to 3D CT and intra-operative findings by numerous studies, without any clear consensus on the findings.

**Objectives:** To evaluate 3D MRI in the workup of non-arthritic hip pain compared to 3D CT and intra-operative findings at the time of hip arthroscopy.

**Methods:** We conducted a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Medline, Embase and Pubmed databases were queried using the search terms “hip arthroscopy”, “hip”, “MRI”, and “three dimensional MRI”. Studies were included that directly compared 3D MRI and 3D CT findings for adult patients with non-arthritic hip pathology. Additional inclusion criteria were any studies comparing 3D MRI to intraoperative hip arthroscopy findings. Data collection will include radiographic measurements and statistical comparisons of the imaging modalities.

**Results:** 608 studies were screened with 28 selected for final inclusion. Data collection in progress.

**Conclusion:** Pending data collection and analysis.

## Prognostic Factors of Clinical Outcome for Osteochondral Lesions of the Talus treated with Surgical Management: a Systematic Review

**Meg Evans**, Andrea Veljkovic

**Background:** There is a lack of consensus regarding which characteristics of OLTs may act as prognostic factors for clinical outcome following surgical management. This systematic review represents an extensive evaluation and summary of the evidence available on this topic.

**Methods:** This study was conducted according to PRISMA guidelines. Literature searches were performed on Ovid MEDLINE, Ovid Embase and Web of Science databases in July, 2022. Covidence software was used to streamline the retrieval, screening, review and data extraction processes. Quality of evidence was evaluated using the Modified Coleman Methodology Score.

**Results:** Data was extracted from 24 studies. Lesion size and location were the most commonly investigated prognostic factors. Eight of 15 studies assessing size found an association between smaller lesion size and improved patient reported outcome. Three of 6 studies assessing lesion diameter/length showed an association between smaller diameter/length and improved outcome. Six of 12 studies assessing area showed smaller area had improved outcome. Two studies assessing lesion location found lateral lesions had improved outcome. Three studies assessing depth found shallower depth had improved outcome. Three of 5 studies assessing lesion containment found contained lesions had improved outcome. One study found that fewer number of associated lesions was associated with improved outcome. Three studies assessed cyst presence vs absence and each failed to find any significant association with outcome. The overall quality of the literature was fair.

**Conclusions:** Data synthesis supported decreased lesion size as a positive predictive factor for improved clinical outcome. No strong associations were found for the remaining factors due to lack of consistent reporting.

## Automated Identification and Management Guidance of Pediatric Elbow Fractures Mejbel Alajmi, Dr. Anthony Cooper

**Background:** Elbow fractures are one of the most common orthopaedic injuries seen in the pediatric population that require operative management. Accurate diagnosis is required for appropriate management, however, this can be challenging due to the complexity of elbow anatomy at the different stages of the child's growth. Machine learning could be helpful in this process as it has been proven in other cases.

**Objectives:** We aim to develop a machine learning workflow that can be utilized for the detection of elbow fractures in pediatric patients and provide practice-guiding recommendations based on the pattern of the injury.

**Methods:** The study is of a retrospective cohort design in which we collected reported radiographs of pediatric patients with elbow fractures that was performed in BC Children's Hospital either in the Emergency Department or in the clinic as a follow-up. These data will be used for the development of machine learning system in terms of Convolutional Neural Networks (CNNs) that is capable of identifying pediatric elbow fractures when compared to human experts. Risk matrices and receiver operator curves will be used in the interpretation of the obtained data. If needed, other forms of analysis will be used based on the data acquired.

**Results:** Data is already available through BC Children's Hospital data set. First phase of labeling elbow fractures through MATLAB by human experts to create a database for machine learning has already been performed. After that, the system was tested based on the available data. It was noticed that more data required for more accuracy, so the second labeling phase will be started. We aim to finish this by the end of the third quarter of 2024, and be able to present the final results by the first quarter of 2025.



## Vertebral Osteosclerotic Bone Metastasis Lesions of Prostate Cancer Acquire Altered Extracellular Matrix Characteristics

**Bitah Mojtahedzadeh**, Michael Cox

**Background:** Prostate cancer (PC) bone metastases (BM) is a debilitating disease morbidity that primarily affects the axial skeleton. PCBMs are mixed blastic/lytic with increased, irregular, bone density and deposition, loss of collagen alignment and increased porosity. Under pathological conditions or repair, bone matrix composition is altered and can include cartilage-associated proteins.

**Objectives:** We hypothesize that PCBMs induce dysregulated repair-like bone remodeling activity resulting in differential deposition and organization of extracellular matrix (ECM) factors relative to residual trabecular bone.

**Methods:** We analyzed lumbar vertebrae specimens from 13 cadaveric PCBMs, 6 biopsies from patients undergoing decompression surgery, and 4 age-matched cancer-free donors. We used mass spectrometry (MS) to compare the protein content of sclerotic and lytic vertebral PCBMs vs. cancer-free controls. We performed Goldner's trichrome staining to compare bone matrix organization among specimens. We performed immunohistochemistry (IHC) using antibodies against collagens (COL-I, -II, -III), osteocalcin (OSC), osteopontin (OSP), aggrecan, bone morphogenetic protein 2 (BMP2), and alkaline phosphatase (ALP) to evaluate the composition of irregular and residual trabecular PC-associated bone matrix.

**Results:** MS analysis differentially segregated sclerotic and lytic PCBMs from control specimens. Differential Goldner's staining of irregular PC-associated bone and lamellar bone under brightfield, and loss of collagen alignment under polarized light in the PCBM specimens confirmed irregular bone interspersed with lamellar (residual trabeculae) bone. Stronger COL-III, OSC, OSP, ALP and BMP2 staining in sclerotic regions of PCBMs validated noted MS findings from the sclerotic PCBM specimens. Aggrecan and COL-I levels were indistinguishable between specimen groups, and COL-II was not detected in sclerotic, PC-associated bone. We did not observe evidence of a collagenous matrix switch based on the absence of COL-II and aggrecan.

**Conclusion:** High COL-III content suggests that a process akin to bone repair occurs in the PCBM, while elevated levels of polyanionic proteins, such as OSP, suggest an accelerated process of mineralization. Our observations demonstrate structural and biochemical alterations in irregular PC-associated bone consistent with a hyperblastic dysregulation of matrix deposition that results in a disorganized sclerotic matrix distinct from healing physiology.

## Cobalt-Activation of TRPV4 in Hip Synovial Fibroblasts Induces Production of Cytokines That Promote Formation of Adverse Local Tissue Reactions

Sara Koohbor, Michael Cox

**Purpose:** Adverse local tissue reactions (ALTR) are a main consequence of hip prosthetic failure. Although the role of metal corrosion elements has been established, the mechanistic etiology has not been fully described. We previously reported that cobalt ion (Co<sup>2+</sup>)-exposure induces mitochondrial failure, and pro-inflammatory cytokine secretion by synovial fibroblasts as a feedforward mechanism of ALTR induction. Synovial fibroblasts express calcium-activated vanilloid transient receptor potential cation channels (TRPVs), known to be activated by a variety of stimuli, including pressure, tension, temperature, and divalent cations, to mediate physiological and pathologic responses.

**Objectives:** We hypothesize that Co<sup>2+</sup> activates TRPV channels to induce expression of pro-inflammatory cytokines described to promote ALTR formation in patients with failing metallic hip prosthetics.

**Methods:** RNA sequencing was performed on Co<sup>2+</sup>-stimulated synovial fibroblast primary cultures established from three patients (mean age 64 YO) undergoing primary hip replacement surgery due to osteoarthritis. We validated TRPV2 and TRPV4 expression by quantitative PCR and immunofluorescence. We evaluated the calcium influx after exposure to TRPVs agonists and antagonists by using Fura-2 AM. Conditioned media from fibroblasts exposed to Co<sup>2+</sup>, in the presence or absence of TRPV2 and 4 antagonists, were evaluated for levels of 8 cytokines (IL-6, IL-8, TNF $\alpha$ , TNF $\beta$ , MCP-1, GRO- $\alpha$ , GM-CSF, VEGF), previously documented as a signature of the Co<sup>2+</sup>-stimulated synovial fibroblast proinflammatory response, using a Luminex platform.

**Results:** We observed that TRPV2 and TRPV4 are predominant TRP channels expressed by synovial fibroblasts and observed their localization to discrete plasma membrane foci as observed by fluorescence. We determined increased intracellular calcium signaling after exposure to Cobalt ions and TRPV2 and TRPV4 agonists. We confirmed Co<sup>2+</sup>-induced secretion of previously described cytokines and demonstrated that pre-treatment with the TRPV2 and 4 antagonists suppressed expression of these cytokines, suggesting the role of calcium signaling mediated by TRPV2 and TRPV4 channels in the inflammatory reactions to metal hip implants.

**Conclusion:** Here we investigated whether Co<sup>2+</sup>-activation of TRPV channels contributes to the cytokine storm or mitochondrial failure observed in ALTR-derived synovial fibroblasts. Our results show for the first time that Co<sup>2+</sup> activates TRPV4 and induces pro-inflammatory cytokine secretion by synovial fibroblasts. Since Co<sup>2+</sup> mimics hypoxia by disrupting electron transport, the decrease of VEGF secretion in the presence of antagonist, indicates that Co<sup>2+</sup> may enter cells via the TRPV channels. We conclude that while Co<sup>2+</sup> induces a hypoxic response, Co<sup>2+</sup> induced TRPV2 and TRPV4 activation, and a subsequent calcium wave are key mediators of the cytokine storm that promotes ALTR formation in response to corrosion products from failing hip prosthetics.