



ORTHOPAEDIC RESEARCH DAY

May 3, 2023 | 7:50 AM – 5:00 PM PDT

Chair: Dr. Henry Broekhuysen

Review Panel:

Dr. Raj Rampersaud, Professor of Surgery, University of Toronto

Dr. David Stockton, Clinical Assistant Professor, UBC Department of Orthopedics

Dr. Bonnie Sawatzky, Associate Professor, UBC Department of Orthopedics

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

07:50 – 08:00:	Welcome and Opening remarks – Dr. K. Mulpuri		
	Speaker:	Title:	Supervisor:
08:00 – 08:10:	Mikaela Peters (PGY5)	<i>The Double Edged Scalpel - Experiences and Perceptions of Pregnancy and Parenthood During Canadian Surgical Residency Training</i>	K Lefaiivre
08:10 – 08:20:	Hannah Nazaroff (PGY5)	<i>Suitability of Saturated Salt Solution Cadavers in Orthopaedic Surgical Anatomy Training</i>	A Huang
08:20 – 08:30:	Mohamed J.H. Al-Amoodi (PGY3)	<i>Spine and spinal cord injuries secondary to mountain biking accidents: a 15-year review at a provincial spine referral centre</i>	B Kwon
08:30 – 08:40:	Eryck Moskven (PGY3)	<i>The Effectiveness of Prophylactic Intranasal Photodynamic Disinfection Therapy (nPDT) and Chlorhexidine Gluconate (CHG) Body Wipes on Surgical Site Infection in Adult Spine Surgery</i>	J Street
08:40 – 08:50:	Michael Hanna (Clinical Fellow)	<i>The Effect of Sanders Skeletal Maturity Staging on Growth Modulation of the Adolescent Idiopathic scoliosis' curves treated by Vertebral Body Tethering</i>	F Miyanji

08:50 – 09:00:	Alwalaa Althagafi (Clinical Fellow)	<i>The preoperative expectations of patients with Degenerative Cervical Myelopathy: a multi center retrospective cohort study</i>	R Charest-Morin
09:00 – 09:10:	Shahriar Shalileh (Grad student)	<i>Fully implantable, flexible optical probes for neuromodulation of the spinal cord</i>	D Shahriari
09:10 – 09:20:	Adan Moallemi (Grad student)	<i>Optogenetic stimulation to enhance axon growth and motor recovery following spinal cord injury</i>	D Shahriari
09:20 – 09:30:	John Steyn (PGY5)	<i>Complication and patient-reported outcome differences for staged vs non-staged progressive collapsing foot deformity reconstruction</i>	A Veljkovic
09:30 – 09:40:	Colby Finney (PGY5)	<i>Prognostic Factors of Clinical Outcome for Osteochondral Lesions of the Talus treated with Surgical Management: a Systematic Review</i>	A Veljkovic
09:40 – 10:00:	BREAK – 20 min	Coffee and light refreshments are served outside of the auditorium	
10:00 – 10:10:	Hanny Chen (PGY3)	<i>A biomechanical study on the contributors to forearm supination strength</i>	T Goetz
10:10 – 10:20:	Kellen Walsh (PGY5)	<i>Arthroscopic biceps tenolysis: A novel management technique for long head of biceps tendinopathy</i>	W Regan
10:20 – 10:30:	Mary Sun (PGY4)	<i>The Effect of Level 1 Evidence: Trends in Surgical Management of Proximal Humerus Fractures Over a 23 Year Period</i>	K Lefavre
10:30 – 10:40:	Abdulmohsen Almeshari (PGY4)	<i>Accuracy of Ultrasound Reported Distal Biceps Musculotendinous Junction Ruptures in Comparison to Intra-operative Findings</i>	T Goetz
10:40 – 10:50:	Justin Murphy (Clinical Fellow)	<i>Association between the direction of proximal humerus fracture dislocation and risk of avascular necrosis following open reduction internal fixation- A cross sectional study</i>	F Moola
10:50 – 11:00:	BREAK – 10 min		
11:00 – 11:10:	Jenny He (PGY1)	<i>Distal Femoral Replacement - A Case Series</i>	M Neufeld & L Howard
11:10 – 11:20:	Gabby Levesque (PGY2)	<i>Implementation of a patient education application for primary ACL Reconstructive surgery: Frequency of post-operative emergency department visits and perioperative rehabilitation engagement</i>	Dr. L Dielwart
11:20 – 11:30:	Arsh Sidhu (PGY2)	<i>Prehabilitation with Personalized Blood Flow Restriction Therapy in Patients with Knee Osteoarthritis on the Surgical Waitlist for Total Knee Arthroplasty: A Prospective Pilot Study.</i>	M Neufeld
11:30 – 11:40:	Taylor Crown (PGY3)	<i>A Comparison of Suspensory Versus Aperture Fixation for Isolated Soft Tissue Posterior Cruciate Ligament Reconstruction : A Systematic Review</i>	P Lodhia & J Leith
11:40 – 11:50:	Gina Peck (PGY1)	<i>Single Bundle Hamstrings Autograft Preparation Techniques for ACL Reconstruction</i>	P Lodhia
11:50 – 12:00:	Yasir AlShehri (PGY2)	<i>The association between posterior tibial slope and ACL reconstruction failure: A systematic review</i>	A Veljkovic

12:00 – 01:00:	LUNCH	Lunch is served in the Jack Bell Atrium – our helpful admin team members are here to help you find your way!	
01:00 – 01:10:	Alice Wang (PGY2)	<u>Predictors of functional outcome after intramedullary nail fixation of tibia shaft fractures</u>	D Stockton
01:10 – 01:20:	Akshay Lobo (PGY5)	<u>Outcomes of Suprapatellar versus Infrapatellar Nailing Techniques for Tibial Shaft Fractures: A Systematic Review</u>	P Guy
01:20 – 01:30:	Yousif Murad (PGY1)	<u>Fully automated analysis of the anatomical and mechanical axes from pediatric standing lower limb radiographs using convolutional neural networks</u>	A Cooper
01:30 – 01:40:	Mehdi Nouri Zadeh (Grad Student)	<u>Reviewing the Current Methods of Muscle Spasticity Assessment in Children with Cerebral Palsy</u>	K Mulpuri & B Shadgan
01:40 – 01:50:	Gourav Jandial (Clinical Fellow)	<u>Limb Lengthening and Reconstruction Society AIM Index - Reliability in assessing patient outcome</u>	A Cooper
01:50 – 02:00:	Tanya MacDonell (PGY4)	<u>The Impact of Human Leukocyte Antigen Genotype and Single Nucleotide Polymorphisms on Bacterial Infection Rates in Total Hip Arthroplasty: A Retrospective Case-Control Pilot Study</u>	M Neufeld
02:00 – 02:10:	Nathan J Katz (PGY1)	<u>Evaluating the Clinical Utility and Effectiveness of Surgical Pre-Habilitation in a Medical-based Virtual Obesity Program</u>	N Greidanus & A Zentner
02:10 – 02:30:	BREAK – 20 min	Coffee and light refreshments are served outside of the auditorium	
02:30 – 02:40:	Ankita Bansal (Clinical Fellow)	<u>Differences in Presentation between Patients Diagnosed with Developmental Dysplasia of the Hip in a Multi-Centre, Global Prospective Registry: A Comparison of Western and Indian Centres</u>	K Mulpuri & E Schaeffer
02:40 – 02:50:	Bryn Zomar (Postdoctoral Fellow)	<u>Proportion of Obesity in Stable SCFE is Higher Than in Unstable SCFE: A Multi-Centre, International Prospective Registry Study</u>	K Mulpuri
02:50 – 03:00:	Emily Bliven (Grad student)	<u>A biomechanical case study: non-linear response of the pelvis during a sideways fall impact</u>	P Guy & P Cripton
03:00 – 03:10:	Xin Zhang (Grad student)	<u>The influence of iso-value on 3D-printed sheet TPMS Ti6Al4V scaffolds' mechanical responses</u>	R Wang
03:10 – 03:20:	Jacqueline Li (Grad student)	<u>Development of a DDH Care Pathway for India: A Study Methodology to Guide Similar Efforts in Other Countries and for Other Conditions</u>	K Mulpuri
03:20 – 03:30:	Maria Jose Bonta Suarez (Grad student)	<u>Assessing the effect of age on deep-learning bone segmentation from 3D ultrasound in developmental dysplasia of the hip</u>	A Hodgson
03:30 – 03:40:	Ammarah Kaderdina (Grad student)	<u>Using Deep Learning to Spatially Locate Frames in an Ultrasound Image Sequence of an Infant Hip</u>	A Hodgson
03:40 – 03:50:	BREAK – 10 min		

03:50 – 04:00:	Hayley Spurr (Clinical Fellow)	<i>Assessing the need for long-term follow up for developmental dysplasia of the hip following a normal screening ultrasound</i>	K Mulpuri
04:00 – 04:10:	Suliman AlShammari (Clinical Fellow)	<i>Incidence of patients with intra-articular acetabular fracture displacement in anterior column acetabular fracture-dislocation</i>	D Viskontas
04:10 – 04:20:	Trevor Fowler (Undergrad student)	<i>Ultrasound Screening for Infants at-risk of Developmental Hip Dysplasia in BC: Assessing Access-to-Care</i>	A Smith
04:20 – 04:30:	Parinaz Ranjbaran (Grad student)	<i>Depth Camera Augmented C-Arm (DeCAF)</i>	A Hodgson
04:30 – 04:40:	Kevin Gilmore (Grad student)	<i>Micro-positioning of Fibula Segments for use in Mandibular Reconstruction Surgery</i>	A Hodgson
04:40 – 04:50:	Melissa Yu (Grad student)	<i>Development of a Day-of-Surgery Planning and Guidance System for Mandibular Reconstruction</i>	A Hodgson
04:50 – 05:00:	Andreas Flury (Clinical Fellow)	<i>The modified RUST score for the assessment of fractured distal femur healing revisited</i>	K Lefaivre

Abstracts:

The Double Edged Scalpel - Experiences and Perceptions of Pregnancy and Parenthood During Canadian Surgical Residency Training

Mikaela Peters, Kelly Lefavre, Alissa Zhang, Darren Roffey

Introduction:

The proportion of female medical students continuing to increase each year in Canada, but only 32% of Canadian surgeons in 2020 were female. Factors such as long length of surgical residency training, concerns regarding infertility associated with delaying pregnancy, and increased rates of obstetrical complications have been shown to contribute to the disproportionate lack of females in surgical specialties.

Methods:

An online survey was sent to all surgical residents in Canada. The survey was developed by the authors based on previous literature and included demographic questions and parenthood status. All respondents were asked about perceptions of pregnancy and parenthood during surgical training, and parents were asked about parental leave, accommodations, and pregnancy complications. Chi squared tests were used to compare opinions of male and female residents.

Results:

272 responses were obtained, demographics can be found in Table 1. We had a high proportion of female respondents (61.8%) and orthopaedic residents (29.0%). Fifty-six women reported 76 pregnancy events during training. 62.5% of pregnancies had complications. Men were less aware of the increased pregnancy complication rate in surgeons; 27.3% of men and 86.7% of women agreed or strongly agreed that surgeons have higher pregnancy complication rates than the general population ($p < 0.001$). Men were much less likely to believe that pregnant residents should be offered modified duties (74.2% of men, 90.0% of women, $p = 0.003$). Women were much more likely to experience significant stigma or bias due to their status as a parent; no men reported significant stigma or bias (43% of women, 0% of men, $p < 0.001$). Women were more likely to report having heard negative comments related to pregnancy during training from staff or co-residents compared to men (58.5% of women, 40.7% of men, $p = 0.013$). Women were also more likely to agree or strongly agree that there is negative stigma attached to being pregnant during training (62.7% of women,

42.7% of men, $p=0.01$), and men were more likely to disagree or strongly disagree that parental leave during training has an impact on future job prospects (43.8% of men, 29.3% of women, $p<0.001$).

Conclusion:

Women's experiences of pregnancy and parenthood during surgical training differ from men's. They experience high rates of pregnancy complications, negative stigma and bias, and other challenges. This must be addressed in order to work towards gender equity.

Suitability of Saturated Salt Solution Cadavers in Orthopaedic Surgical Anatomy Training

Hannah Nazaroff, Adrian Huang

Human cadaver surgical skills training remains one of the best learning modalities to simulate the operating room, learn anatomy and practice surgical exposures (Reznick et MacRae, 2006). Embalming increases the time a cadaveric specimen may be used for training and decreases the risk of disease transmission; however, it can alter the properties of the cadaver tissue, reducing the simulation fidelity and training quality (Hayashi et al, 2014).

The purpose of this study is to compare orthopaedic trainees' views of surgical training using salt solution versus formaldehyde-based cadavers. UBC Orthopaedic residents underwent an 8-week surgical anatomy course using salt-solution cadavers. At the end of the course, residents completed a questionnaire which assessed their perceived quality of cadavers embalmed in the salt solution compared to their previous experience with those embalmed in formaldehyde.

A 7-point Likert scale was used to assess elements such as range of motion; appearance; texture; decay, mold and rot; and overall suitability for surgical training. 16/18 (89%) of residents somewhat, mostly, or entirely agreed that the salt solution cadavers were better suited to surgical skills training when compared to those embalmed with formaldehyde. Therefore, when using embalmed cadavers for Orthopaedic surgical skills training, salt-solution preparation may be superior to formaldehyde.

Spine and spinal cord injuries secondary to mountain biking accidents: a 15-year review at a provincial spine referral centre

Mohamed J.H. Al-Amoodi, Brian Kwon, Pedram Laghaei, Harsh Kahlon, Tamir Ailon, Raphael Charest-Morin, Charlotte Dandurand, Scott Paquette, Nicholas Dea, John Street, Charles G. Fisher, Marcel F. Dvorak

Background:

Mountain biking (MTB) is an increasingly popular sport that has been associated with serious spinal injuries which can have devastating effects on patients and significant impacts on healthcare resources. Here, we characterized the occurrence of these MTB spinal injuries over a 15-year period and analyzed the affiliated acute-care hospital costs.

Methods:

Patients seen at Vancouver General Hospital for MTB spinal injuries between 2008-2022 were retrospectively reviewed. Demographics, injury details, treatments, outcomes, and resource requirements for acute hospitalization were collected. The Canadian Institute for Health Information was referenced for cost analysis.

Results:

Over the 15 years of analysis, 149 MTB spinal injuries occurred. The majority (87.2%) were male. 59 (39.6%) were associated with spinal cord injury; most of these were in the cervical spine (72.3%) and many were AIS Grade A (36.1%). 102 patients (68.5%) required spine surgery; 26 (17.4%) required intensive care; 34 (22.8%) required inpatient rehabilitation. Mean length of stay was 13.5 days and acute admission costs for the healthcare system averaged \$35,251 (95% CI \$27,080-\$43,424).

Conclusions:

MTB spinal injuries are associated with significant medical, personal, and financial burden. As injury prevention remains paramount, further investigation of the roles of education and safety measures is recommended.

The Effectiveness of Prophylactic Intranasal Photodynamic Disinfection Therapy (nPDT) and Chlorhexidine Gluconate (CHG) Body Wipes on Surgical Site Infection in Adult Spine Surgery

Eryck Moskven, John Street, Eric C. Sayre, Elizabeth Bryce, Titus Wong, Tamir Ailon, Raphaële Charest-Morin, Nicolas Dea, Marcel F. Dvorak, Charles G. Fisher, Brian K. Kwon, Scott Paquette, John T. Street

Background:

Spinal surgical site infection (SSI) is a devastating postoperative complication. Current prophylactic measures lack compliance and lead to antimicrobial resistance.

Aim:

Examine the clinical and cost effectiveness of intranasal photodisinfection therapy (nPDT) and chlorhexidine body wipes (CHG) in the prophylaxis of spine SSIs in adults.

Methods:

Fourteen-year prospective observational interrupted time series (ITS) with three historical cohorts: 2006 to 2010, pre-implementation nPDT/CHG; 2011 to 2014, rollout of nPDT/CHG; 2015 to 2019, post-implementation nPDT/CHG. Unadjusted bivariate Pearson Correlation tested for historical changes across patient and surgical variables. Segmented regression analysis estimated the effect of nPDT/CHG on the average yearly incidence and absolute incidence rate of SSI per period, adjusting for mean age, mean Charlson Comorbidity Index (CCI) and mean surgical severity invasiveness index (SSII). Two models estimated (a) the cost of nPDT/CHG to prevent one additional SSI per year and (b) the mean annual cumulative cost savings through SSI prevention.

Results:

13,493 patients over the study period; mean of 964 per year ($SD \pm 73$). Mean age, mean CCI, and mean SSII increased from 48.4 to 58.1 years; 1.7 to 2.6; and 15.4 to 20.5, respectively ($p < 0.001$). The proportion of SSII scores ≥ 21 and oncology surgical spine cases increased from 52.5% to 61% ($p < 0.001$) and from 8% to 11% ($p = 0.011$). Unadjusted analysis confirmed a significant decrease in the mean number (74.6 to 26.8) and mean incidence (7.98% to 2.67%) of SSIs following the implementation of nPDT/CHG ($p < 0.001$). Segmented regression demonstrated a significant reduction in the average yearly incidence and absolute incidence of SSIs by 1.32% per year, and 3.36% per year following implementation of nPDT/CHG, adjusted for mean age, CCI and SSII ($p < 0.001$). The annual cost to prevent one SSI was \$1,350 to \$1,650 CAD. Mean annual cumulative cost-savings were \$2,484,856 to \$2,495,016 CAD. No AEs were reported with the use of nPDT/CHG.

Conclusion:

Preoperative nPDT/CHG is an effective prophylactic strategy for spinal SSIs, with significant cost savings.

The Effect of Sanders Skeletal Maturity Staging on Growth Modulation of the Adolescent Idiopathic scoliosis' curves treated by Vertebral Body Tethering

Michael Hanna, Firoz Miyanji, Osama Adahamshesh

Type of study:

Retrospective Multicentric study of prospectively collected data

Objectives:

To assess the effect of vertebral body tethering on growth modulation according to Sanders skeletal bone maturity staging. And monitor the rate of complications based on Sanders classification.

Background data:

Vertebral body tethering (VBT) is an emerging option as it offers fusion-less surgical management of Adolescent Idiopathic Scoliosis. VBT utilizes the remaining growth of the patients to correct the deformity according to the Hueter-Volkman's principle. One of the tools to assess the skeletal growth remaining is the Sanders skeletal maturity staging.

Methods:

Patients treated with single VBT were included and grouped into four as: Sanders 2, 3, 4, 5-7 respectively. The first Erect X-ray was used as the baseline for each patient and the growth modulation was measured in each subsequent followup X-ray. The primary outcome measures was growth modulation (GM) success. Which was defined as growth modulation of curve by 5 degrees or more. Complications including tether failure, overcorrection and reoperation were reported.

Results:

149 patients (127 female and 22 male) with an average age of 12.5 years (9-16.7) and a minimum of two years of follow-up were included. The mean magnitude of the preoperative curve was 47.56 (range: 22-74). Sanders 2 patients had significantly higher GM success rates ($P=0.001$), whereas Sanders 5-7 patients had significantly lower success rates ($P=0.002$). Sanders 2 had significantly higher rates of over-correction and reoperation (31% and 36.8% respectively, $P0.01$). Sanders 5-7 patients had significantly lower rates of overcorrection and reoperation (0% and 4.7% respectively, $P0.02$). Overcorrection was the primary cause of reoperation in the Sanders 2 group, while tether breakage and adding-on were the primary causes in the Sanders 5-7 group. The preoperative flexibility of the curve was not found to be significant.

Conclusion:

Patient with Sanders 2 Skeletal maturity staging are more likely to achieve successful growth modulation. However, they are more prone to overcorrection and more likely to be reoperated.

The preoperative expectations of patients with Degenerative Cervical Myelopathy: a multi center retrospective cohort study

Alwalaa Althagafi, Raphaële Charest-Morin, Greg McIntosh

Introduction:

Despite the abundance of literature on degenerative cervical myelopathy (DCM), very little is known about the preoperative expectations of DCM patients undergoing surgical treatment. Our primary objective was to describe patient pre-operative expectations and rank their importance to patients. The secondary objective was to identify predictors of high pre-operative expectations.

Methods:

Our study was a retrospective observational cohort study of prospectively collected multicenter data of patients with DCM. Patients consented to undergo surgical treatment between January 2019 and September 2022 were included. An overall expectations score (0-100) was calculated by the sum of each expectation. The high-expectations group was defined by patients who had an expectation score above the 75th percentile. Predictors of patients with high expectations were determined using a multivariate logistic regression model.

Results:

262 patients met our inclusion criteria. The most common important expectation was preventing neurological worsening (40.8%), followed by improved balance when standing or walking (14.5%) and independence in everyday activities (10.3%). The mean overall expectation score was 63.05 (SD 20.86). Identified predictors of high patient expectations were having fewer comorbidities, a shorter duration of symptoms, no contribution from “failure of other treatments” on the decision to undergo surgery, and more severe neck pain. Each additional comorbidity decreased the odds of having high expectations by 30%. For each 1-point increase in NRS neck pain rating, the odds of having high expectations increased by almost 20%. Patients who did not indicate failure of other treatments as the reason to seek surgery had close to 1.5 times the odds of having high expectations. Patients with symptoms for more than two years were less likely to have high expectations (OR 0.922, 95% CI 0.349-1.1880).

Conclusions:

Our findings highlight the need for further studying of patients’ preoperative expectations and understanding their effect on post-operative satisfaction to enhance future patient-centered care.

Fully implantable, flexible optical probes for neuromodulation of the spinal cord

Shahriar Shalileh, Dena Shahriari, Alex Golab, Adan Moallemi, Min Lu, Wolfram Tetzlaff

Purpose:

Optogenetics has proven to be a revolutionary tool in neural circuit interrogation and behavioural neuroscience. Although it has been widely employed in brain circuitry studies, optogenetics has not been broadly implemented for spinal cord research, due to hardware technical impediments caused by the mobility of the tissue. Here, we present flexible neural probes connected to a fully implantable, autonomous optoelectronic device, to deliver light with controllable timing and lighting parameters. The device eliminates conventional tethered optical fibers and wires and leaves minimum interference with the natural movement of animals. We have designed the device to be rechargeable with commercially-available wireless chargers to provide a completely standalone and implantable system. Moreover, our ultra-low-power device enables automatic awakening of the device for chronic light stimulation studies without secondary surgeries on animal models. The device, therefore, offers neuroscientists the freedom for time intervals, periods as well as the frequency of stimulation throughout a study.

Methods:

The device comprises a thin (400 μm) four-layer printed circuit board (PCB) connected to up to 6 flexible optical probes in a plug & play fashion. The desired number of micro light-emitting diodes (μLED) could be arrayed on each flexible probe. The optoelectronic system is controlled by an ultra-low-power microcontroller. An external crystal resonator is provided in the design running an accurate calendar on the microcontroller to generate precise time steps for long-term and autonomous stimulations. A wireless power receiver antenna is designed to charge the battery. The entire system is insulated with Paralyne-C. A second layer of a soft polymer (PDMS) is used to reduce foreign body response.

Results:

Our optoelectronic device enables researchers in the field 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. Our device is therefore extending the optogenetics toolkit from widely used brain studies to spinal cord research.

Optogenetic stimulation to enhance axon growth and motor recovery following spinal cord injury

Adan Moallemi, Dena Shahriari, Shahriar Shalileh, Alex Golab, Min Lu, Jie Liu, Wolfram Tetzlaff, Dena Shahriari

Purpose:

Spinal cord injury (SCI) is a debilitating condition with no known cure that affects approximately 85,000 Canadians. Functional recovery following SCI depends on the regrowth of severed axons past the lesion site. For this to occur without intervention is unlikely since adult mammalian central nervous system (CNS) neurons have a limited propensity for spontaneous axonal growth. Optogenetics is a technique that involves sensitizing a targeted subset of neurons to respond to light through genetic modification. Previous work has shown that optogenetic stimulation (OS) of dorsal root ganglion cells in vitro led to increased neurite outgrowth. In addition, OS following SCI has shown improved motor and respiratory function. An important consideration is that these studies are limited to acute stimulation periods since there are technological difficulties associated with chronically delivering light to the spinal cord without hindering the natural movement of animals. To address these concerns, our lab has recently developed a soft and flexible neural probe that is fully implantable and capable of autonomously delivering light to the spinal cord of freely moving rodents. Utilizing this device, we will assess the effects of chronic spinal cord epidural OS on axon growth and motor function recovery following SCI.

Methods:

We injected adeno-associated viral vectors (AAV5-hSyn-tdTomato) with or without ChrimsonR, a light-gated cation channel, into the C4 level of the spinal cord of Long Evans rats. At least four weeks following AAV injection, we investigated c-fos immunohistochemistry (IHC) to confirm that light stimulation evokes neural activity within the spinal cord. The extent to which the AAV was expressed throughout the spinal cord was also assessed. Animals then received a C8 lateral hemi-section SCI which unilaterally abrogates spinal cord innervation on one side. During the same surgery, we implanted our optogenetic stimulator with the neural probes cemented at the C6 lamina. Three days following implantation, the optogenetic stimulator began pulsating 590-nm light for 30 minutes per day at 20 Hz for a total duration of two months. Weekly behavioural tests examining motor control of the animals were conducted via the horizontal ladder apparatus with irregular rungs, Irvine, Beattie and Bresnahan (IBB) forelimb recovery scale, and CatWalk XT system.

Results:

We have demonstrated AAV expression for up to 30 mm along the rodent spinal cord. Additionally, our c-fos IHC data suggests that neuronal populations within the spinal cord have become sensitized to light following AAV injection given the c-fos immunoreactivity following light stimulation. The feasibility of implanting our optogenetic stimulator in freely moving and injured rodents has also been validated with a robust surgical protocol to perform the implantation and SCI seamlessly in one procedure.

Conclusion:

Following the two-month stimulation period, spinal cord tissue will be harvested to assess the extent of axon regeneration and/or sprouting due to our daily stimulation. This data will then be used in conjunction with our behavioural analysis data to guide future experiments aimed at employing optogenetics to enhance recovery following SCI.

Complication and patient-reported outcome differences for staged vs non-staged progressive collapsing foot deformity reconstruction

John Steyn, Andrea Veljkovic, Alice Wang, Kevin Wing, Murray Penner, Alastair Younger

Progressive collapsing foot deformity (PCFD) is complex and consists of multiple procedures. The exact procedures done are variable, depending on the characteristics of the deformity, as well as surgeon preference. In addition to the nuances of the procedure, the operation can be performed in a single-stage with admission (SSA) or two-stage outpatient (TSO) fashion. We have previously shown that TSO surgery is associated with lower overall cost.

This study aims to determine whether staging the procedures leads to outcome differences or not. Two surgeons in our group perform TSO and SSA procedures respectively, providing the opportunity to assess the differences between these two strategies. We assessed complications via chart review, as well as patient reported outcomes. Patients who underwent PCFD reconstruction were identified via billing codes. Patient charts were reviewed, and an FAOS and PCS questionnaire were sent out to study participants. Patients who underwent a SSA procedure had a 4-night average hospital stay, while those undergoing a TSO procedure were discharged the same day. 74 feet in 66 TSO-patients and 63 feet from 60 SSA- patients have been assessed.

There was no significant difference in smoking, gender distribution, diabetes, or rheumatoid arthritis between the two groups, but there was a significant average age difference at 52 years in the TSO group and 58.5 years in the SSA group ($p=0.006$). Overall-infection rate was not significantly different (8% in the TSO group vs 12% in the SSA group $p=0.147$). Minor infection rates were similar between groups (2% SSA vs 6% TSO, $p=0.081$) However, major infections were higher in the SSA group (14.9% vs 3.2% $p=0.0334$). Patient reported outcomes are currently in the data analysis stage. In conclusion, there is a higher major infection rate in the longer SSA procedures compared to TSO patients. TSO reconstruction is associated with lower cost as well, but we anticipate similar patient reported outcomes. Ultimately, we hope to identify which patients are best suited to the two different PCFD reconstruction strategies and create an algorithm to aid decision making for PCFD management.

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

Colby Finney, Andrea Veljkovic, Meg Evans

Affiliations:

1. Department of Orthopaedics, Division of Distal Extremities, UBC; Department of Orthopedics, St. Paul's Hospital, UBC; Footbridge Centre for Integrated Orthopaedic Care Inc., Footbridge Clinic, Vancouver, BC, Canada
2. Department of Orthopaedics, UBC, Vancouver, BC, Canada
3. UBC Faculty of Medicine, Northern Medical Program, Prince George, BC, Canada

Abstract:

Background and purpose: There is a lack of consensus regarding which characteristics of OLTs may act as prognostic factors for clinical outcome following surgical management. This review represents an extensive search and summary of the available literature to investigate this topic.

Study design: Systematic review.

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. The references included in this review examined patient outcomes using an assortment of scoring systems and following a range of surgical techniques. The prognostic effect of multiple lesion characteristics were investigated, including size (area, length and diameter), location, depth, containment, number of associated lesions, cyst presence/absence and coverage by the medial malleolus. 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. For lesion size, 8/15 studies found a significant association between decreasing size and improved outcome. For lesion location, 11/13 studies refuted any association between lesion location and outcome. The remaining prognostic factors were investigated by few studies and/or had a lack of consensus. The overall quality of the literature was fair.

Conclusions:

Data synthesis supported decreased lesion size as a positive predictive factor for improved clinical outcome and refuted an association between lesion location and outcome. No strong associations were found for the remaining factors due to lack of overall consensus and paucity of literature.

A biomechanical study on the contributors to forearm supination strength

Hanny Chen, Tom Goetz

Forearm pronation-supination is important for normal arm function. Supination is primarily accomplished by two muscles: biceps brachii and supinator. These muscles move in response to stimulation from the musculocutaneous nerve and the posterior interosseous nerve, respectively. However, the relative contribution of each muscle group to supination strength remains unclear. Understanding the role each muscle plays in supination becomes important when faced with injuries that affect upper extremity function. We plan to study healthy men aged 19-65 years. We will block the function of one muscle by injecting lidocaine around its nerve, and measure the torque generated by the other muscle.

Arthroscopic biceps tenolysis: A novel management technique for long head of biceps tendinopathy

Kellen Walsh, William Regan, Taylor Crown

Introduction:

The functional significance of the biceps tendon as a humeral head depressor and stabilizer is a source of controversy and debate. Surgical management is indicated for patients who develop persistent pain localizable to the long head of the biceps tendon that is refractory to non-operative treatment. Operative management of long head of the biceps tendinopathy has typically consisted of tenotomy or tenodesis. An alternative novel arthroscopic technique for management of long head of biceps tendon pathology is presented, along with a case series of the senior author's experience with the procedure.

Methods:

A single surgeon retrospective case series was undertaken to investigate the outcomes of the novel arthroscopic procedure. Cases were identified by billing code and a retrospective chart review was undertaken to evaluate the outcomes of the procedure. Recurrent symptoms, complications and revision procedures were recorded.

Results:

Eighteen patients underwent an arthroscopic tenolysis procedure with an average follow up of 33.3 weeks (range 3.5 weeks to 127 weeks). Of the 20 patients included, 3 patients experienced adhesive capsulitis post-operatively, and 1 case was complicated by a superficial wound infection. No recurrence of symptoms at final follow up were recorded in 7 cases. Four patients reported recurrent pain that was treated with a revision biceps tenodesis procedure (revision rate 22%).

Conclusions:

Arthroscopic long head of biceps tenolysis is a low risk alternative procedure to biceps tenotomy or tenodesis. Further research in its role as a standalone or adjunctive procedure is warranted.

The Effect of Level 1 Evidence: Trends in Surgical Management of Proximal Humerus Fractures Over a 23 Year Period

Mary Sun, David J. Stockton, Penelope M. A. Brasher, Darren Roffey, Kero Yuen, Jeffrey M. Potter, Pierre Guy, Henry M. Broekhuysen, Kelly A. Lefavre

Purpose:

'Positive' surgical trials that support operative intervention have reliably led to increased surgery rates. However, the effects of 'negative' surgical trials is less well known. In 2015, a Cochrane Review and the publication of a multi-center randomized controlled trial found that surgery did not result in a better outcome for the majority of people with displaced proximal humerus fractures.

We aimed to determine the effect that these Level 1 publications had on the rates of operative treatment of proximal humerus fractures, using population-level data in a region with a single-payer healthcare system.

Methods:

We used the administrative data to identify all individuals with an International Classification of Diseases, Ninth Edition (ICD-9) designated proximal humerus fracture and a surgical fee code indicating an operative procedure in the province from 1998 to 2020. AO-OTA Classification Type 11A2, A3, B, and C fractures were included. Isolated greater tuberosity fractures, pathologic fractures, and humeral shaft fractures were excluded.

We used an interrupted time series (ITS) design. We determined age-standardized rates (ASR) of open reduction internal fixation (ORIF) and arthroplasty for proximal humerus fractures for each calendar year. These rates accounted for changes in population size and age. We fit a segmented regression model with knots at 2013 and 2015 to examine changes in surgical rates. Secondly, we explored the effect of age and sex in stratified analysis.

Results:

The age-standardized rates for surgical management increased from 1998 to 2013, decreased rapidly from 2013 to 2015, and more slowly after 2015 (Figure 1). Trends were similar in males and females but differed across age groups.

Conclusion:

There was a significant decrease in the rate of surgical management of proximal humerus fractures after publication of Level 1 evidence. This should motivate the pursuit of randomized trials in orthopaedic trauma, and supports the importance and impact of surgical trials that demonstrate no clinically important benefit.

Accuracy of Ultrasound Reported Distal Biceps Musculotendinous Junction Ruptures in Comparison to Intra-operative Findings

Abdulmohsen Almeshari, T. Goetz, T. Okamoto

Purpose:

Distal biceps tendon rupture injuries have been reported to be relatively rare injuries in the past. More recent studies show an increased incidence, especially amongst the young, active male population. Many of these individuals get referred to orthopedic surgeons with a diagnostic ultrasound indicating a rupture of the distal biceps tendon. Traditionally, ruptures at the musculotendinous junction have been managed non-operatively. The goal of our study is to assess the accuracy of these ultrasound findings, specifically ruptures being reported to occur at the musculotendinous junction.

Methods:

This is part two of a retrospective cohort study. The data will be collected from Vancouver General Hospital's center database. The included patients will be ones who suffered a distal biceps rupture over the past 10 years, had a diagnostic ultrasound, and underwent surgical repair/reconstruction. Demographics, ultrasound report findings and intra-operative findings will be tabulated into a data set. Consistency between the US reports and intra-operative findings will be compared as a dichotomous outcome.

Hypothesis:

We hypothesize there is variability/inconsistency between the US reports of biceps tendon musculotendinous ruptures in comparison to the intra-operative findings. In this paper, we aim to assess the consistency between US reports describing distal biceps rupture in the musculotendinous junction as compared to intra-operative findings.

Conclusion:

Pending

Association between the direction of proximal humerus fracture dislocation and risk of avascular necrosis following open reduction internal fixation- A cross sectional study

Justin Murphy Farhad Moola, Bertrand Perey

Objectives:

The incidence of proximal humerus fractures is increasing and is one of the most common fractures seen in the adult population. Proximal humerus fracture dislocations, however, are less common. Previous literature has examined patterns of proximal humerus fractures and has suggested predictable indicators that may lead to humeral head avascular necrosis (AVN). It is known that fracture dislocations contribute to an increased risk of developing AVN, but details regarding direction of dislocation and how it may contribute to the increased risk are limited. Recent studies have examined the long-term functional outcomes on surgical fixation of proximal humerus fracture dislocations in general. However, it is still unclear whether the direction of dislocation affects the risk of AVN, or if it influences the long-term functional outcomes. In this study, we hypothesize that the direction of dislocation does affect the risk of AVN and does contribute to poorer long-term functional outcomes.

Methods:

A cross-sectional study was conducted on a cohort of patients who underwent open reduction internal fixation for a proximal humerus fracture dislocation, by one of two upper extremity and trauma surgeons between the years of 2011 and 2021 (n = 65). Patients were grouped into one of four categories based on direction of proximal humerus fracture dislocation (Anterior, Posterior, Varus, or Valgus). Patients were seen at a minimum two years at a post-operative follow-up visit in order to assess for radiographic evidence of AVN, as well as to look at long-term functional outcome scores. Statistical significance was assessed using both Fisher's exact test and one-way analysis of variance (ANOVA), for AVN and functional outcomes respectively.

Results:

Long term follow up was limited to 25 patients (38%). Overall incidence of AVN in this cross-sectional study was 20%. Two patients in the anterior group (n=9), and 3 patients in the valgus group (n=4) developed AVN. Fischer's exact test demonstrated a significant increased odds of developing AVN amongst groups. The odds of developing AVN were increased in both the anterior and valgus groups, with the latter having a greater odds of developing AVN than the former. Overall, the ANOVA tests revealed a significant group difference ($p=0.0303$ and $p=0.033$) for the functional outcome scores, DASH and Constant respectively. However, post hoc pairwise comparisons did not reveal any significant differences for either DASH or Constant scores.

Conclusion: Direction of proximal humerus fracture dislocation may increase the odds of developing AVN. Further research with larger cohorts is needed for further assessment, as well as to establish the effects on long term functional outcomes.

Distal Femoral Replacement Study (working name)

Jenny He, Michael Neufeld, Lisa Howard, Barry Congdon

Distal femoral replacement (DFR) can be used in both tumour and non-tumour indications when bone stock is compromised. In the non-tumour setting, DFR is used most commonly in revision total knee arthroplasty (TKA), and less commonly for non-salvageable distal femoral fractures. Although DFR benefits include immediate weight-bearing, restoration of stability and robust initial fixation, there are few studies describing long-term outcomes and survivorship data. The purpose of this study will be to determine long-term radiographic results, clinical outcomes and implant survivorship for TKAs performed with contemporary DFR techniques. Firstly, the University of British Columbia institutional registry was used to identify all DFRs performed by the UBC Adult Lower Extremity Reconstruction group for non-tumour indications from 2001 to 2021.

Demographics were collected for all DFR cases, including age, BMI, follow up range, sex, indication, implant system, amongst others. Survivorship data was also collected based on rate of revision, indication for revision, and years between primary DFR and revision. Radiographs were evaluated based on the Knee Society Radiographic Evaluation and Scoring System. Subsequently, Knee Society Scores, used as a patient reported outcome measure (PROM), were collected from consenting patients to assess quality of life and functional outcomes. Based on the results to be obtained, survivorship and quality of life outcomes for DFRs performed by the UBC group will be compared to existing literature.

Implementation of a patient education application for primary ACL Reconstructive surgery: Frequency of post-operative emergency department visits and perioperative rehabilitation engagement

Gabby Levesque, Lane Dielwart, Mariana Salazar

Background:

Perioperative patient education and rehabilitation has been shown to improve overall patient outcomes and satisfaction, including reduced post-operative morbidity and shorter length of stay (LOS) after primary ACL reconstruction 1–3. This may be in part due to aligning patient expectations with the realities of surgery⁴. Multiple studies have noted that mobile app peri-operative monitoring is feasible, results in good or excellent patient satisfaction scores, may minimize the number of post-operative follow-ups^{1,5,6} and can provide early identification of post-operative complications and relapse^{5,7,8}.

Purpose:

To assess peri-operative rehabilitation participation, post-operative visit to the ED and extrapolation of healthcare costs post-implementation of a patient education application (CareSense) for primary ACL reconstruction surgery

Methods:

Retrospective and prospective data gathered for 40 control patients and 80 experimental patients who have undergone primary ACL reconstruction between January 2020 and November 2023 at Kelowna Bone and joint by Dr. Dielwart. The control group includes those who have not used the CareSense app and undergone ACL reconstruction between Jan 2020 and Oct 2021. The experimental patients will have used the CareSense app and undergone surgery between Nov 2021 and Nov 2023. Inclusion criteria includes patients 19 years or older, primary ACL surgery done by Dr. Dielwart and patients who can read and write in English. Exclusion criteria include patients less than 19 years old, polytrauma patients, multi-ligamentous knee injuries, patients with previous operation to the operative knee and surgeries not performed by Dr. Dielwart. Chart review will be performed for patient demographic data, hospital length of stay and return visits to the ED. Control patients will undergo a telephone questionnaire regarding peri-operative rehabilitation participation and return visits to the ED. Experimental group patients will have access to the CareSense app with questionnaires regarding pre- and post- operative physiotherapy engagement and rehabilitation protocols to follow within the app. Experimental group data will be prospectively gathered based on patient inputted data into the app. Ethics approval March 2023, ID H22-01500.

Results:

We expect that patients who participate in the CareSense application will have improved participation in perioperative rehabilitation exercises, less visits to the ED and therefore less healthcare associated costs and increased perceived readiness for surgery. We will

be performing basic statistical analysis including 95% confidence intervals, odds ratio, t-test, Wilcoxon and rank sum tests dependent on the distributions of scores. Chi-squared tests will be used for categorical scores and linear regression will be applied for any baseline differences between the two groups. A p-value < 0.05 will be considered statistically significant.

Limitations include recall bias, incomplete reporting, selection bias of patients who choose to use the app, single surgeon outcomes, small sample size and patient access to online app use.

Prehabilitation with Personalized Blood Flow Restriction Therapy in Patients with Knee Osteoarthritis on the Surgical Waitlist for Total Knee Arthroplasty: A Prospective Pilot Study.

Arsh Sidhu, Michael E Neufeld, Susan Deslippe, Lisa C. Howard, Bassam A Masri

Purpose:

Osteoarthritis (OA) of the knee is a leading cause of physical disability globally and is associated with significant pain, loss of function, and impaired quality of life for patients. The direct and indirect economic cost of OA is enormous, with an estimated burden of \$405 billion in Canada alone. Total knee arthroplasty (TKA) is a highly successful and cost-effective treatment for knee OA when conservative measures fail. Nearly 1 million TKA are performed in North America annually and these numbers are projected to increase substantially due to increasing demand. Patients on the waitlist for TKA often experience increasing pain, decreased function, decreased quality of life, and longer wait-times have been associated with poorer outcomes post TKA. An important proportion of patients on the waitlist for TKA report their health status of “worse than death”. Pain management and opioid use remains a significant problem for knee OA patients pre and post TKA. Additionally, the income lost and economic cost to patients and healthcare systems encountered when patients are waiting for total joint replacement are substantial. The outcomes of preoperative physiotherapy for TKA patients have been mixed, the quality of the evidence is moderate to poor, and adequately powered, well designed RCTs are needed. Studies have suggested that pre-operative heavy-resistance strength training is effective in knee OA patients in terms of knee extension strength and functional capacity 3 months post TKA. Blood flow restriction resistance training exercise (BFR-RT) allows for a lower load intensity that offers a more tolerable and effective resistance training solution in this patient population. Resistance training with a lower exercise load intensity (weight) with concurrent partial blood flow occlusion in the working limb has gained clinical and scientific interest in many domains.

Our primary aim is to assess if a 6-week PBFR exercise program will improve patient reported outcomes, physical function, pain, and quality of life in patients with knee OA on the waitlist for TKA. Additionally, we will aim to determine the effects on PBFR on patients physical performance, quality of life, along with pain and pain medication usage. Finally, this is a pilot study to determine feasibility of comparative multi-surgeon RCT at our center, determine if time benchmarks can be achieved, and identify best PBFR-RT training program methodology for a trial comparing PBFR-RT versus standard therapy in pre-op period to evaluate pre and post op outcomes

Methods:

The proposed study is a prospective, single center, single surgeon design. There will be only 1 cohort (n=10) for this pilot study, with all patients undergoing PBFR-RT intervention over a 6-week period (18 total sessions) while on the waitlist and prior to TKA. Outcome assessments will be collected at baseline (prior to PBFR-RT therapy), after PBFR-RT therapy (prior to TKA), and at 3 months post TKA. Upon enrollment in the study, patients will have a 6-week PBFR-RT program booked within 2-3 months to reduce the influence that

wait time has on outcomes. The PBFR-RT program will occur over a 6-week period and conclude a maximum of 4 weeks from the surgery, but sooner if possible. We will track patient demographics, knee injury and osteoarthritis outcome score (KOOS), physical function tests, pain numeric rating scale, pain medication use, and health-related quality of life and EuroQol-5d-5L scores.

Results:

Results will be presented in a written manuscript. Frequencies, counts and proportions will be reported. Means or medians (with associated measures of dispersion) will be used as appropriate, based on normality of data. For the primary outcome, a Wilcoxon Rank sum test (non-parametric equivalent of a Paired t-test) for the KOOS pre and post PBFR-RT. Differences in the subdomains of the KOOS will also be evaluated. The same statistic methods will be applied to differences in other continuous outcomes measure pre and post PBFR-RT. Differences in categorical outcomes of interest will be analysed with Fisher's exact test. Analysis of post-operative outcomes (3-months) will use the same methods

Conclusion:

Blood flow restriction resistance training in patients awaiting total knee arthroplasty has the potential to improve pain, function, and quality of life for patients on lengthy surgical waitlists. We hypothesize patients undergoing a PBFR exercise program pre-operatively will have improvements in their KOOS, functional scores, along with their pain and pain medication use.

A Comparison of Suspensory Versus Aperture Fixation for Isolated Soft Tissue Posterior Cruciate Ligament Reconstruction : A Systematic Review

Taylor Crown, Parth Lodhia, Jordan Leith, G Laforest

Introduction:

Isolated posterior cruciate ligament (PCL) tears are uncommon and range between 1-4% in the general population (1). Reconstructive techniques and graft fixation types vary, and outcomes are inconsistent throughout the literature and most effective graft and fixation type has not been illustrated (2). Few articles discussing failure rate are available in recent literature and systematic reviews on such outcomes would not produce enough data to review. The purpose of this systematic review is to evaluate and compare the biomechanical properties between two soft tissue PCL reconstructive fixation types: suspensory and aperture fixation.

Methods:

A systematic review was completed with 2 primary investigators using both Medline and Embase electronic databases. Inclusion criteria comprised of English studies that described isolate PCL reconstruction with soft tissue graft, using either suspensory or aperture fixation. The primary outcome of the study was maximal load to failure. Secondary outcomes included mean maximal load, stiffness, and failure type. Any study that did not discuss the primary outcome was excluded and any data point on fixation types other than suspensory and aperture fixation were not included in the review.

Results:

221 studies were selected for review, 61 duplicates removed, and 160 abstracts were screened. 16 studies went on to full text review, with a final of 7 studies included for data extraction and systematic review. Data extraction was duplicated by both reviewers in entirety, and statistics will be completed by a biostatistician and is currently being processed for review. The data will be synthesized using a meta-analysis using a random effects model for the primary outcome and secondary outcomes if able. Meta -regression will be used to estimate the pooled rates with the fixation methods as the primary moderator.

Project status:

The data has been extracted and is currently under review with the biostatistician. Results are pending while the manuscript is also being generated.

Single Bundle Hamstrings Autograft Preparation Techniques for ACL

Reconstruction

Gina Peck, Parth Lodhia, Alex Hoffer, Jordan Leith

Anterior cruciate ligament reconstruction (ACLR) is one of the most common orthopedic procedures, and huge variation exists in the surgical technique. Single bundle hamstrings autograft reconstruction is a common method and has good clinical outcomes. A criticism of the hamstrings autograft is a small graft diameter, often less than 8-millimeters, which has been associated with increased re-rupture rates. Several graft preparation techniques for single bundle hamstrings autograft exist. Perioperative decisions include the number of tendons utilized, number of graft strands, graft configuration and femoral and tibial fixation methods. Awareness of the minimum tendon and graft length required to produce each graft variation is necessary to avoid common pitfalls. However, intraoperative graft modification is possible to maximize graft diameter, and obtain proper fixation. The purpose of this review is to describe the indications, surgical anatomy, intraoperative tips, clinical outcomes, and complications for single bundle hamstrings autograft preparation techniques in ACLR.

The association between posterior tibial slope and ACL reconstruction reconstruction failure: A systematic review

Yasir AlShehri, Andrea Veljkovic

The anterior cruciate ligament (ACL) plays an essential role in knee kinematics, preventing anterior tibial translation and tibial rotation. The ACL is the most common completely disrupted tendon in the knee and injury is most often due to non-contact mechanisms involving pivot cuts and landing maneuvers. ACL reconstruction (ACL-R) is the standard surgical treatment to restore knee stability in the ACL-deficient knee and the number of yearly procedures is continuing to increase. ACL-R failure is thought to be multifactorial and strongly influenced by surgical factors such as technical errors and graft characteristics, in addition to patient factors such as increased BMI, younger age, female sex, and increased activity level. The relationship between increased posterior tibial slope (PTS) and non-contact ACL injuries has been extensively researched in the past. Numerous studies have reported a strong association between the two. There has also been a large amount of research put into assessing the relationship between increasing PTS and failure of ACL revisions. The relationship between increasing PTS and failure of primary ACL reconstructions however has been much less understood. Several studies have suggested that an increased posterior tibial slope may be associated with a higher risk of ACL reconstruction failure. A larger slope may lead to greater forces on the ACL graft, potentially leading to graft failure. However, other studies have produced conflicting results, and the relationship between posterior tibial slope and ACL reconstruction failure is still a topic of ongoing research and debate in the field of sports medicine.

Predictors of functional outcome after intramedullary nail fixation of tibia shaft fractures

Alice Wang, David Stockton, Kelly Lefavre, Pierre Guy, Peter O'Brien, Henry Broekhuysse, Jeffrey Potter, Darren Roffey

Purpose:

Inherent tibial anatomic factors (the anterior tubercle angle, ATA) have been shown to adversely affect the entry point position (EPP) of intramedullary nails for tibial shaft fractures. The resultant effect on fracture alignment and functional outcome is not known.

We aimed to describe the effect that entry point position has on fracture alignment and functional outcome one year after intramedullary nailing of tibia shaft fracture.

Methods:

This was a retrospective review of prospectively collected data at a Level 1 trauma centre. Adult patients with tibial shaft fractures were included (AO/OTA Type 42A, B, and C). Functional outcomes using Short Form-36 (SF-36) Physical Component Summary (PCS) and Mental Component Summary (MCS) and Short Musculoskeletal Function Assessment (SMFA) scores were collected at baseline (pre-injury recall) and at 6 and 12 months post-operatively. Radiographic parameters measured on full-length AP and lateral radiographs of the affected tibias included: anterior tubercle angle, EPP relative to ideal, and coronal and sagittal plane alignment. Unadjusted bivariate analysis was performed to identify potential associations between EPP, alignment, and functional outcome. Adjusted multivariate analysis was performed to test these associations, controlling for patient and injury factors.

Results:

128 patients were included (29% female; average age 41 years) with 2% proximal third, 43% middle third, and 55% distal third diaphyseal tibial fractures. Type III open fractures occurred in 20 patients (16%). EPP was weakly but significantly correlated with coronal plane alignment ($r = 0.21$; $P = 0.02$), and was not correlated with sagittal alignment ($r = 0.01$, $P=0.92$). Alignment was weakly and insignificantly correlated with 12-month SF-36 PCS scores (Pearson's $r < 0.20$, $P>0.05$). There were similar findings for the SF-36 MCS and SMFA scores at 12 months. Distal third fractures were associated with a higher mean PCS score compared to midshaft fractures (5.2 points, 95% CI 0.9 to 9.5, $P=0.01$). Type III open fractures were associated with lower mean PCS scores compared to Type I and closed fractures (-8.7 points, 95% CI -17.2 to -0.27, $P=0.04$). The effects of fracture location and Type III open fractures on functional outcome persisted in the adjusted analyses.

Conclusion:

Nail entry point position has a weak but significant effect on coronal plane alignment that did not affect functional outcome. Non-modifiable injury factors have a more significant effect on functional outcome.

Outcomes of Suprapatellar versus Infrapatellar Nailing Techniques for Tibial Shaft Fractures: A Systematic Review

Akshay Lobo, Pierre Guy, Aresh Sepehri, Daniel You

Purpose:

We conducted a systematic review and meta-analysis to compare outcomes between fixation of tibial shaft fractures with suprapatellar versus infrapatellar intramedullary nailing (IMN) techniques.

Methods:

We searched MEDLINE, EMBASE, and CENTRAL from inception to December 6, 2019 to identify studies which included outcomes on a minimum of 20 patients with acute tibial shaft fractures treated with suprapatellar nail technique. Results were summarized using descriptive statistics. Random-effects meta-analyses were used to pool mean differences in operative time and functional outcome (Lysholm Score) between suprapatellar and infrapatellar nailing.

Results:

Of the 283 citations identified within our search, 18 studies involving 1,133 patients who underwent suprapatellar IMN for tibial shaft fractures were identified. Ten studies compared outcomes of suprapatellar and infrapatellar IMN. Compared to infrapatellar IMN technique, suprapatellar IMN technique was associated with a 5.17 point improvement in Lysholm knee outcome score (95% CI: 2.81, 7.53; $p < 0.001$) (Figure 1). There was no significant difference in operative time between suprapatellar and infrapatellar IMN techniques (mean difference: 1.30 minutes; 95% CI: -3.57, 6.17; $p = 0.60$).

Conclusion:

Surgical treatment of tibial shaft fractures with suprapatellar IMN technique is associated with improved functional outcome without an increase in operative time. Future cost-analysis and prospective, comparative studies are required to assess the potential benefit of treating tibial shaft fractures with suprapatellar IMN given the improvement in functional outcome.

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

Yousif Murad , Anthony Cooper, Hapreet Chhina, Sophie Harasymchuck

Introduction and Objectives:

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.

Materials and 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.

Conclusions:

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.

Reviewing the Current Methods of Muscle Spasticity Assessment in Children with Cerebral Palsy

Mehdi Nouri Zadeh, Kishore Mulpuri, Babak Shadgan

Cerebral palsy (CP) is a disorder with various etiological events that causes posture and movement disorders. Muscle Spasticity accounts for one of the common complications of CP, indicated by a wide range of symptoms from pain to hip dislocation. An accurate understanding of the spasticity level can help physicians manage and optimize the treatment plan. This understanding can be utilized in adjusting Botox, one of the non-invasive cost-effective and long-lasting treatments of muscle spasticity in CP children.

This literature review aims to evaluate and compare the current potential methods of muscle spasticity assessment in children with CP. A literature search included articles published between January 1995 and December 2021, using keywords related to muscle spasticity, cerebral palsy, Botox treatment, and assessment methods. The study selection criteria included articles involving children with cerebral palsy, assessing muscle spasticity using objective or subjective measures, comparing different assessment methods, or evaluating the effectiveness of a specific assessment method. Thirty-six articles were included in the review, which evaluated various methods for assessing muscle spasticity, such as the Modified Ashworth Scale (MAS), Tardieu Scale (TS), Real-time sonoelastography (RTS), Electromyography (EMG), the Hofmann's reflex or H-reflex, Acoustic Radiation Force Impulse Elastography (ARFI), and the Dynamic Evaluation of Range of Motion (DAROM) scale. The review discussed the strengths and limitations of each method and concluded that more reliable methods are needed to measure the level of muscle spasticity.

Limb Lengthening and Reconstruction Society Aim Index – Reliability in Assessing Patient Outcome

Gourav Jandial, Anthony Cooper, Harpreet Chhina

Introduction:

LLRS is one of the few classification systems that is simple yet comprehensive, and in which apart from taking into consideration the location of the primarily involved pathological limb segment; several other domains are factored in, keeping in view the concept that generally in paediatric deformities the whole limb is pathological rather than a limb segment. The purpose of our study was to validate this scoring system on a large number of patients. Also, we tried to identify whether there is any correlation between the score and the final patient outcome. We also tried to identify the additional criteria to further strengthen this scoring system.

Materials and methods:

In this retrospective study of first 50 patients with age less than 16 years with lower limb deformities in our limb deformity database were evaluated and LLRS AIM scoring was done for them. During the scoring, limitations of scoring system were focussed on in detail. The score was correlated with the final patient outcome which was measured in the form of total number of surgeries done at the time of final follow up, associated complications and patient/ parent's satisfaction score.

Results:

The LLRS AIM scores ranged from 0 to 14. Out of 50, 20 underwent surgery, 15 have been planned for surgery and 15 did not need surgery. Maximum complications were in patients with score higher than 10. The scores were low in pathologies like rotational malalignments, hip pathologies, CPT compared to rest of the paediatric limb deformities. Amongst the pathologies like limb deficiencies, there was not much correlation between severity and score. In dysplasias, score doesnot correlate with the severity as early diagnosis results in lower score. Patients with high scores correlated with the final patient outcome and had more surgeries, more complication and lesser patient/ parent satisfaction score but low scores did not correlate with the final outcome.

Conclusion:

LLRS scoring system is not very reliable in rating the severity of some pathologies especially rotational malalignments, hip pathologies, CPT, etc. High scores correlate with the final outcome but low scores do not. A more comprehensive score with broader categories might be needed to address these limitations.

The Impact of Human Leukocyte Antigen Genotype and Single Nucleotide Polymorphisms on Bacterial Infection Rates in Total Hip Arthroplasty: A Retrospective Case-Control Pilot Study

Tanya MacDonell, Michael E. Neufeld, G.A. Sheridan, P. Keown, K. Sherwood, D.S. Garbuz

Introduction:

The genetic predisposition of certain total hip arthroplasty (THA) patients developing pseudotumour in metal-on-metal joint replacements has been explored in recent literature, as has the role of single nucleotide polymorphisms (SNPs) in developing prosthetic joint infection (PJI) and aseptic loosening. Infectious disease literature has demonstrated that host genetics and human leukocyte antigen (HLA) loci play an important role in susceptibility to bacterial infections, and in clearing certain infections, in non-arthroplasty domains. The role of HLA genotype in developing and eradicating PJIs is currently unknown. This study aims to determine if a patient's HLA genotype, as well as a panel of known high risk SNPs, are associated with the development and eradication of bacterial PJI in total hip arthroplasty.

Methods:

We employed a case-control, retrospective study design. Patients were enrolled from our prospectively maintained academic institutional arthroplasty database. THA patients treated surgically for bacterial PJI (defined as per 2013 ICM criteria) with single or two-stage revision (minimum of 3 years follow-up) were variable-matched to controls that underwent THA during the same study period with no evidence of PJI during the follow-up interval. Baseline, demographic, clinical, and PJI data were collected. Genetic data will be drawn from high resolution HLA and SNP genotype analysis using DNA isolated from whole blood, and HLA gene frequencies compared between cases and controls. Controlling for relevant confounders, an odds ratio will be used to quantify the clinical association between HLA genotype and the development and eradication of bacterial PJI. This analysis will be repeated for all relevant SNPs.

Results:

For the study period spanning January 2011 to August 2019, 49 patients consisting of 23 cases and 26 controls were enrolled (63% female). Mean follow up was 7.88 years. Patients were variable-matched according to age, sex, BMI, McPherson stage, and follow-up ($p > 0.05$ for all). Of the cases, 18 patients (78%) had successfully eradicated their infection at the time of follow-up. Genetic analysis is pending at the time of writing.

Conclusion:

Our current study aims to further develop the knowledge base around certain HLA gene alleles and high-risk gene SNPs that may identify high-risk patients for the development of prosthetic joint infection. In time, we may be able to prospectively identify patients that are at high genetic risk for prosthetic joint infection and appropriately tailor their management.

Evaluating the Clinical Utility and Effectiveness of Surgical Pre-Habilitation in a Medical-based Virtual Obesity Program

Nathan J Katz, Nelson Greidanus, Ali Zentner, Rory Trevorrow

Background:

Obesity is a leading cause of hip and knee osteoarthritis (OA) in adults. In 2018, over 26% of Canadians had a BMI ≥ 30 kg/m, meeting the clinical definition of obesity. Total Joint Arthroplasty (TJA) is the current gold-standard treatment for advanced hip and knee OA; however, many orthopaedic surgeons deem high-BMI patients – typically those with BMI > 40 – unfit for surgery, citing increased technical challenges, and increased post-operative complications, morbidity and mortality. High-BMI patients with OA are frequently told to “lose weight” to become eligible for surgery, but without further guidance or healthcare interventions, fewer than 1% of patients will independently attain a normal weight, leaving these patients bereft of treatment options. Two approaches may help to increase accessibility for this cohort of patients: 1) Redefining the criteria for surgical ineligibility to better reflect evidence-based, rather than bias-based, perioperative risk, and 2) facilitating patients’ weight loss by targeting the metabolic and neurohormonal underpinnings of obesity as a complex disease. This project focusses on the latter approach.

There currently exists a novel perioperative program in British Columbia called ‘Get To Surgery’, in which patients are referred to a virtual pre-operative weight optimization program with dual goals of 10% body weight loss and management of metabolic and cardiovascular risk factors. The program is novel among perioperative weight-loss programs in that it provides a structured multidisciplinary program that addresses three surgical risk factors in its approach to surgical optimization: 1) Weight loss [measured as a percentage of body weight] including physician prescribed/supervised pharmacologic intervention; 2) Malnutrition; 3) Comorbidities. All other perioperative programs have focused largely on a combination of calorie restriction and increased exercise, with remarkably few programs incorporating pharmacological treatments and no programs addressing the inappropriate starvation state that is the hallmark of obesity as a disease.

Hypothesis:

Patients who complete the ‘Get To Surgery’ program will attain an optimization of surgical preconditioning, and will be eligible for TJA within 12 months. Mean weight-loss will be clinically and statistically significant.

Purpose:

The purpose of this study was to evaluate the clinical utility and effectiveness of the virtual 'Get To Surgery' program, by extracting descriptive statistics on those patients currently enrolled in and those who have completed the program.

Methods:

The study was designed as a retrospective review of a cohort of patients who participated in the 'Get To Surgery' program. A chart review was performed on all (consecutive) patients enrolled in the 'Get To Surgery' program, from 1st February 2021 to 28th March 2023. Inclusion criteria were: patients scheduled for a TJA, who have completed or are still enrolled in the program (minimum of 3 consecutive visits with the multidisciplinary health team). Exclusion criteria were: patients not scheduled for a TJA, patients with fewer than 3 clinical encounters, patients lost-to-follow-up or those who declined to continue in the program after the intake appointment. Primary outcome measures included percentage body-weight loss, duration in program, and demographics characteristics.

Results:

Retrospective chart review was performed for 494 patients: 289 patients were included in preliminary analysis, and 205 were excluded from analysis as they did not meet all inclusion criteria. Of the patients included in analysis: fifty-three patients (N=53) completed the program; 2 experienced substantial symptom improvement without requiring surgery and requested to not proceed with surgery; 51 were post-surgery; and 236 patients are still enrolled and pending surgery. Of those (N=53) patients who completed the program, they had a mean of 10 (SD=3) visits, over a period of 8 (SD=4) months. They lost a mean of 13% body weight (SD=7%, range 3%-30%, $p < 0.001$), equivalent to an average of 33lbs (SD=20). This cohort was 74% female, with an average of 64.6 years (SD=9.3). Data were highly consistent between the cohort of patients who completed the program (N=53) and the cohort of all patients currently enrolled or completed the program (N=289); the latter group had an average of 10 (SD=5) visits, over a period of 8 (SD=6) months. They lost an average of 10% body weight (SD=10%, $p < 0.001$), equivalent to an average of 26lbs (SD=27). This cohort was 77% female, with an average age of 63.0 years (SD=9.5).

Conclusions:

The 'Get To Surgery' pre-surgical arthroplasty optimization program demonstrates excellent clinical utility and effectiveness. If a treatment is feasible, useful and can be applied in a range of settings it is considered to have clinical utility. This innovative program uses widely accessible virtual health platforms enabling patients to participate throughout British Columbia and attempts to reduce disparity in access that may arise from geographical region or socioeconomic status. It incorporates a structured multidisciplinary team approach to optimize compliance and adherence and benefits from adjuvant physician prescribed medications for obesity management, along with simultaneous optimization of comorbid diseases or malnutrition. A medical intervention is considered

effective if there is evidence that it eliminates or reduces a given health problem. Our retrospective cohort review and data suggests that patients who participate in this innovative 'Get To Surgery' program experience a reduction in the burden of their health problem (obesity and related medical conditions) and experience optimization for surgery. Patients not only proceed with the desired arthroplasty intervention but experience objective measures of improvement in health status and a mean 10% change in body weight.

Differences in Presentation between Patients Diagnosed with Developmental Dysplasia of the Hip in a Multi-Centre, Global Prospective Registry: A Comparison of Western and Indian Centres

Ankita Bansal, Kishore Mulpuri, Emily K Schaeffer, Alaric Aroojis, Hitesh Shah, Venkatadass Krishnamoorthy, Sandeep Patwardhan, Chittaranjan Sahu,

Introduction/Aims:

DDH represents a spectrum of hip joint abnormalities ranging in severity from mild dysplasia to irreducible dislocations. Both patient age at diagnosis and severity of DDH can influence treatment decisions and impact clinical and functional outcomes. However, little strong evidence exists to identify optimal screening, diagnostic and management approaches for DDH. Consequently, screening practices for DDH can vary widely across centres and between countries, and may depend on resource availability. Multi-centre, prospective studies have the potential to generate high-quality evidence to guide screening and management practices, but typically fail to include a truly global representation of the patient population. There may be critical differences in presenting patient populations in different regions that will provide better insight into how best to optimize outcomes for this condition. The aim of this study was to compare presentation and initial management approaches for patients with DDH at Indian and Western centres contributing to a prospective, global hip dysplasia registry.

Methods:

A multi-centre, global prospective registry of patients with DDH was established in 2016, with 21 centres from five countries across four continents contributing data analyzed in this study. Patients were enrolled if they were diagnosed with any form of DDH before skeletal maturity. Patient demographics, clinical and radiologic diagnostic information and initial management approaches were entered into a REDCap electronic database and compared between 5 centres in India and 16 centres from Canada, the United States, Australia and Great Britain.

Results:

A total of 3824 patients across 16 Western centres and 238 patients across 5 Indian centres were included in analysis. Patient age at presentation was significantly lower at Western centres compared to Indian centres (4.01 months vs. 35.05 months). There was a higher prevalence of patients presenting with DDH risk factors of breech presentation (34.1% vs. 21.8%) and family history (15.66% vs. 2.5%), and a higher prevalence of swaddling (48.7% vs. 9.2%) in the Western group compared to the Indian group. Reflective of age difference at presentation, 78% of diagnoses in the Western group were confirmed by ultrasound, compared to 99% of diagnoses confirmed by radiograph in the Indian group. Irreducible dislocations were predominant in the Indian group, comprising 84.1% of all dislocated hips, while reducible dislocations comprised 66% of dislocations in the Western group. 72.85% of Western

patients were initially conservatively managed by bracing and/or monitoring, while almost all (>99%) of Indian patients were initially treated with closed/open reduction.

Conclusion:

There are important differences in patient age and severity of dislocation for patients presenting with DDH to Western and Indian centres. Therefore, initial management approaches were also in marked contrast, with a predominance of conservative treatment at Western centres, and closed/open reduction at Indian centres. These patient population differences will be critical to consider when assessing treatment outcomes. Prospectively capturing data on these patients will be valuable to understand the impact of DDH pathology and current screening and management practices on a globally representative patient population, with the ultimate goal of improving outcomes worldwide.

Proportion of Obesity in Stable SCFE is Higher Than in Unstable SCFE: A Multi-Centre, International Prospective Registry Study

Bryn Zomar, Emily Schaeffer, Eduardo Novais, David Bade, Wubdhav Sankar, Kevin Smit, Debra Bartley, Kishore Mulpuri, SLIP Study Group

Purpose:

Incidence, and presentation of slipped capital femoral epiphysis (SCFE) varies across geographic regions and ethnic groups, and may be influenced by certain risk factors. The purpose of this study was to examine variability in baseline presentation of patients presenting with stable and unstable SCFE at centres contributing to a multicentre international registry.

Method:

Data from a prospective multicentre international SCFE registry was analyzed. Patients receiving a confirmed diagnosis of SCFE under 18 years of age without underlying conditions such as cerebral palsy, spina bifida or osteogenesis imperfecta were eligible for inclusion. A total of 15 centres across four countries contributed patients for analysis. Patient demographics, risk factors, hip affected, slip stability and initial surgical procedure were compared across all centres.

Results:

In total, 292 patients were included (56.8% male). Average patient age at presentation was 12.2 years (95% confidence interval [CI] 12.0,12.5]), with mean age ranging across centres from 11.9 to 13.2 years. Median reported duration of symptoms prior to diagnosis was 5 weeks (range 1-250 weeks). Unilateral left SCFE was most common (50.0%, 146/292), followed by unilateral right (34.9%, 102/292) and bilateral (15.0%, 44/292), totalling 336 affected hips. The majority of slips were stable (65.6%, 244/332, stability not reported in 4 hips). Obesity was the most commonly seen risk factor, present in 38.4% (112/292) of cases. Significantly fewer ($p=0.008$) patients with unstable SCFE were obese (25/88, 28.4%) than those with stable SCFE (109/244, 44.7%).

Conclusion:

In this large multicenter cohort, obesity was present in only 40% of patients with SCFE. Notably, patients with stable slips were more likely to be obese than patients with unstable slips.

A biomechanical case study: non-linear response of the pelvis during a sideways fall impact

Emily Bliven, Pierre Guy, Peter Crompton, A Fung, A Baker, B Helgason

Hip fracture, in the geriatric context, is prevalent and often leads to catastrophic levels of disability. One approach towards mitigating hip fracture risk is prophylactic strengthening of the vulnerable femur with an orthopaedic augmentation. The efficacy of such augmentations has been investigated in biomechanics studies that simulate a sideways fall from standing, which is how most hip fractures occur. However, these studies lack sufficient representation of the pelvis, a critical medial boundary condition for the femur during sideways falls. Understanding the breadth of pelvic biomechanics in this loading mode is one key to designing effective augmentation approaches. The objective of this work is to describe one complex case of cadaveric pelvis failure and deformation captured in an augmented specimen during a simulated sideways fall impact and explore the potential implications for future injury prevention approaches.

The donated specimen in this case study was a 63-year-old female. The cadaveric femur-pelvis construct was cast in a mold of ballistic gel shaped to represent their soft tissue. The femur that was impacted was augmented with a commercially available intramedullary nail. The specimen was subjected to an inertia-driven sideways fall impact using a previously-developed inverted pendulum simulator. We collected impact force-time data, pelvic marker deformations (using high speed videography), and x-ray video of the impact. The biplanar x-ray system included two each of x-ray sources, image intensifiers, and high-speed cameras.

Post-fall inspection of the specimen revealed damage to the pelvis at the superior pubic ramus on the impacting side, and no evidence of hip fracture. Analysis of pelvic marker deformation at the impacting pelvic brim and pubic symphysis showed large deformations initiating shortly after the peak surface impact force of 3.58 kN. Observation of the x-ray video confirmed this, displaying an S-shaped deformation pattern propagating along the superior pubic ramus on the impacting side throughout the fall event.

The deformations and bending observed in this pelvis (8 mm and 37°, respectively) without displaced fracture are consistent with dynamic buckling, a force response has been previously documented in other parts of the human body like the cervical spine. Our findings expand on other work characterizing the non-linearity of the pelvis under lower forces, highlighting the high apparent stiffness of the pelvis at high loads. This is further enhanced by offering the real-time visualization of this phenomenon as it occurs within a biofidelic soft tissue surrogate.

Classifying pelvic response and fracture potential is imperative when investigating prophylactic femoral augmentations. Pelvic fractures are preferred to femur fracture as a clinical outcome in falls because they are associated with far less operative morbidity and possibly mortality. However, to optimize femoral augmentation systems, any increased likelihood of pelvic fracture associated with augmenting the femur must be assessed. This case study demonstrates the high tolerance of the pelvis to extreme deformations at high rates, with the ability to sustain only a nondisplaced and relatively small fracture. Understanding the biomechanics of such injurious events is essential for advancing effective treatment and prevention strategies.

The influence of iso-value on 3D-printed sheet TPMS Ti6Al4V scaffolds' mechanical responses

Xin Zhang, Rizhi Wang

Mechanical properties of porous implants contribute important functions for load-bearing bone tissue reconstruction. There is a significant need to study their mechanical properties and fabricate optimized porous scaffolds for bone tissue engineering. Sheet TPMS, compared with truss structures and skeletal TPMS, shows better mechanical performance and biological advantages. Although there are some works that studied sheet TPMS's properties, the mechanical performance of offset sheet TPMS is still unclear. Here, four iso-values 0, 0.25, 0.5, and 0.75 were designed to illustrate how iso-value will influence sheet TPMS's mechanical properties for selective laser melted (SLM) porous Ti6Al4V implants. Our results show that the as-printed porosity was about 10% lower than the CAD designs and the printing error could be minimized greatly after acid etching. The compression results show that the effective elastic modulus and yield strength of porous samples range from 1.5-6 GPa and 30-180 MPa, respectively. By fitting the Gibson-Ashby model, we found that at high relative density(>0.25), OSD0 shows the highest effective elastic modulus and yield strength; while at low relative density(<0.25), OSD0.5 shows the highest than other OSD structures. The failure mechanisms of OSD are different by changing iso value C. For OSD0, OSD0.25, and OSD0.75, the failure mode is mixed domination of stretching and bending; while for OSD0.5, the failure is stretch dominated. FEA results show local yielding initiates at cell nodes upon loading, followed by surface bending and wrinkles forming single or multiple deformation bands near the cell nodes.

This work systematically studied how iso-value influences sheet diamond's mechanical performance and compared them with truss structure Octet. It explained different shear band formations and failure mechanisms. It also found that changing iso-value C could improve the mechanical property at a high porosity level. This work could be a starting point to find how to improve each sheet TPMS structure's mechanical property at different iso-values for certain purposes.

Development of a DDH Care Pathway for India: A Study Methodology to Guide Similar Efforts in Other Countries and for Other Conditions

Jacqueline Li, Kishore Mulpuri, Emily Schaeffer, Alaric Aroojis, Kevin Shea

Background:

Developmental dysplasia of the hip (DDH) represents a range of hip joint instability, present at birth or developed during infancy, ranging from mild instability to a complete dislocation. In India and other Global South countries, DDH is often diagnosed after walking age, requiring more complex and invasive surgeries with greater risk of complications and long-term disability. A DDH care pathway is a decision-making tool that coordinates and standardizes screening, with the aim of reducing late detections. We describe a multi-phase methodology for context-specific DDH care pathway development, demonstrating its use in India.

Methods:

In Phase I, seven relevant Indian organizations partnered together and assembled a multidisciplinary working group, which then met fortnightly to establish an evidence base and prepare for the subsequent consensus-building phase. Group members also developed specialty-specific surveys for local providers in India, which were distributed to organizational memberships. During Phase II, panelists participated in a modified Delphi method to reach consensus on a list of best practice statements regarding DDH screening in the Indian context. Phase III applied the statements to build the care pathway.

Results:

The entire process was completed within a one-year time span, with all procedures conducted remotely using virtual communication and requiring minimal funds or resources. Specialty surveys demonstrated low awareness about DDH, limited practice of DDH screening, and variability in the quality of ultrasound. The Delphi method concluded after a preliminary survey and two Delphi rounds, reaching consensus on 47 statements, which were condensed into 35. The developed care pathway for India features periodic clinical hip examinations integrated with the country's immunization schedule and selective imaging screening, providing flexibility in the timing and modality of imaging.

Discussion/Conclusion:

In Global South countries, there is a need for DDH care pathways that are specific to local contexts. Care pathway development is strengthened through the involvement of a multidisciplinary team of local providers and stakeholders. The methodology requires strategies to identify country-specific barriers to care and facilitate group engagement. The cost- and time-effective approach used in India is feasible and can be applied to other conditions and/or countries wishing to establish care pathways.

Assessing the effect of age on deep-learning bone segmentation from 3D ultrasound in developmental dysplasia of the hip

Maria Jose Bonta Suarez, Antony Hodgson, Ben Hers

Background:

Developmental dysplasia of the hip (DDH) is an orthopaedic condition involving the malformation of the hip joint with worsening prognosis linked to late diagnosis. Infants with risk factors of DDH are currently assessed by 2D ultrasound (US) of the hip yet this approach requires manual annotations and suffers from poor measurement repeatability.

Purpose:

Deep learning (DL)-based approaches for automatic diagnosis of DDH have been increasingly explored to improve diagnosis accuracy beyond that of manual assessments but have yet to become widely available in the clinical setting. US imaging offers high flexibility at the time of acquisition, making it difficult to ensure good generalizability of the trained models over a broad spectrum of machine settings and anatomical variations. In this work we recognize that the recommended US screening age of 0-6 months corresponds with the time of active hip bone development and thus we seek to evaluate the potential effect of patient's age on the performance of DL models in the task of hip bone segmentation.

Methods:

Previous work in our lab has demonstrated the advantages of 3D volumetric US coupled with automatic hip bone segmentation using DL methods followed by the extraction of relevant DDH diagnostic metrics. Using a dataset of 3D US volumes from 118 participants, we train separate 3D UNet models to segment the hip bone and femoral head from expert annotations and explore the effect of bone development – reflected by patient's age – in the performance of the model. We propose to decouple the training of the hip bone segmentation into the ilium and acetabulum by regularizing on the segmentation loss of these two separate anatomical structures with the hopes of encouraging better bone feature representation.

Results:

We show that classical DL networks may be sensitive to changes in US bone features due to bone development and that these differences could affect segmentation performance in a subset of the diagnosed population. Decoupling the loss of the hip bone segmentation into the ilium and acetabulum improves segmentation performance by more than 3% and reduces the variability in DDH metric calculations from repeated measures of the same hip by more than 4%.

Conclusion:

Enhancing our understanding on the potential sources of variability involved in US diagnosis and their effect in the performance of automatic approaches can help us design robust implementations that could be effectively translated to the clinical setting to improve diagnosis of DDH.

Using Deep Learning to Spatially Locate Frames in an Ultrasound Image Sequence of an Infant Hip

Ammarah Kaderdina, Antony Hodgson, María José Bontá Suárez, Rafeef Garbi, Emily Schaeffer, Kishore Mulpuri, Antony J. Hodgson

Purpose:

Developmental dysplasia of the hip (DDH) in infants is currently diagnosed based on 2D ultrasound (US) images. Although 3D US has shown to markedly reduce inter-rater variability, 3D US scanners are not widely available in pediatric clinics. Instead, we propose reconstructing a 3D US volume based on a sequence of spatially located US image frames. In this study, we investigated the ability of deep learning architectures to spatially locate US images of the infant hip.

Methods:

Fan-shaped sets of image slices with varying inter-slice angular displacements were extracted from a database of 1403 3D US volumes, taken from 118 infant hips. Participants were divided into training, validation, and test sets using the ratio 70:10:20. A previously proposed standard convolutional neural network (CNN) as well as two variations of a deeper CNN (one augmented with optical flow (OF) information) were trained to estimate angular distances between separated slices.

Results:

The deeper CNN most accurately predicted the inter-slice angular displacements, with a mean absolute error of 0.02° , for displacements of up to 3.0° (corresponding to a center-frame displacement of 5.3mm). Adding OF showed no improvement in prediction accuracy. The deeper CNN achieved a mean end-to-end sweep angle error of $-0.8\% \pm 13.2\%$, compared with an error of $25.3\% \pm 14.7\%$ for the previously proposed standard CNN.

Conclusions:

The relatively low error suggests it may be feasible to accurately reconstruct a 3D representation of an infant hip from a sequence of 2D US images, without requiring additional probe-tracking devices. In the future, we intend to evaluate the variability of DDH diagnostic metrics extracted from the reconstructed 3D volumes and compare it to reference volumes acquired with a standard 3D US probe.

Assessing The Need For Long-Term Follow-Up For Developmental Dysplasia Of The Hip Following A Normal Screening Ultrasound

Hayley Spurr, Kishore Mulpuri, Varun Nair, Emily K. Schaeffer

Hypothesis and Purpose:

Significant variability exists in longitudinal monitoring for Developmental Dysplasia of the Hip (DDH) among patients with known risk factors. The purpose of this study is to assess the incidence of DDH following a normal screening ultrasound in patients with one or more risk factors. This can be used to determine the extent of follow-up required for patients with risk factors for DDH to mitigate delayed presentation of dysplasia requiring intervention.

Methods:

This is a retrospective cohort study with prospectively collected data for patients enrolled in the International Hip Dysplasia Registry (IHDR). The population is paediatric patients with risk factors for DDH allocated to radiographic screening after an initial ultrasound with no evidence of dysplasia (Arm IV). Radiographic measurements of acetabular indices, Shenton's line, and IHDI grading were used to assess for acetabular dysplasia.

Results:

BC Children's Hospital enrolled 1000 patients in the IHDR database, 464 of these patients were allocated to the screening arm (Arm IV). Preliminary analysis for the first 100 patients enrolled in Arm IV demonstrated that 36% of patients were monitored with one follow up radiograph after a normal ultrasound with an average follow up of 2.12 radiographs. 10% of patients had radiographic findings of dysplasia during this time period. None of these patients developed dysplasia requiring treatment.

Conclusion:

All patients in Arm IV with radiographic evidence of dysplasia at one time point during monitoring resolved without intervention.

The incidence of patients with intra-articular acetabular fracture displacement in anterior column acetabular fracture-dislocation

Suliman AlShammari, Darius Viskontas, Trevor Stone

Objectives:

The incidence of patients with intra-articular acetabular fracture displacement in anterior column acetabular fracture-dislocation

Design:

Retrospective case series.

Setting:

Local trauma center.

Patients:

46 patients who sustained an isolated anterior column acetabular fracture-dislocation from January 2010 until January 2020.

Intervention:

The medical record and the computed tomography (CT) scan of pelvis were reviewed including axial, coronal, and sagittal reconstruction images and 3D.

Main outcome measurements:

every pelvic CT scan done for the patient was evaluated for displacement of the intra articular fracture associated with anterior column acetabular fracture-dislocations. The reduction accuracy was assessed for each patient with intra articular displacement using postoperative CT scans. The final radiology report was reviewed to see whether the intra articular fractured dislocation was noted.

Results:

32 of the 46 patients had identifiable areas of intra articular fractured dislocation on preoperative CT imaging. Reduction accuracy demonstrated anatomical reduction, The final CT report did not comment on any patient with displacement of the intra articular fracture associated with anterior column acetabular fracture-dislocations.

Conclusions:

Our study shows that the patients sustain displacement of the intra articular fracture associated with anterior column acetabular fracture-dislocations. preoperative imaging should be done to identify this clinical entity. As part of the preoperative plan, the surgeon can anticipate the method of the reduction and whether any additional steps or altered surgical approaches are needed to achieve an anatomical reduction.

Level of evidence: Level IV.

Ultrasound Screening for Infants at-risk of Developmental Hip Dysplasia in BC: Assessing Access-to-Care

Trevor Fowler, Anya Smith, Miles Jaques, David Stephen-Tammuz, Kishore Mulpuri, Emily Schaeffer

Developmental dysplasia of the hip (DDH) is a pediatric hip condition affecting 1 in 1000 newborns. Characterized by the presence of an abnormally developed hip socket(s), DDH progression can usually be reversed with minimal intervention if diagnosed early. Missed cases can lead to severe orthopaedic conditions requiring invasive procedures to address. Currently, infants province-wide are being referred to BC Children's hospital for an ultrasound scan (US) and further clinical care related to DDH. This Quality Assurance/Quality Improvement project aims to provide baseline data critical to understanding the landscape of DDH care in BC.

We will assess: 1) Average age of infant at first US; 2) Risk factors/physical findings among infants referred for an US; 3) Distance travelled by patient families for DDH care at BCCH. Included are all children less than a year old who received an US at BCCH in 2020 and 2021. Select preliminary summary statistics are presented.

To-date, a total of 1723 patient records have been abstracted across years 2020-2021. 32.2% of infants resides in a health authority other than Vancouver coastal. Median age at first US was 7.3 weeks (Range: 0.5-33.4 weeks). Top indications for US referral were breech position (65.9%), a hip click (14.6%), and first-born status (9.4%).

Preliminary results suggest some infants are receiving US screening for DDH beyond the recommended age range (4-8 weeks) and indications for US referrals match known DDH risk factors. Completion of data abstraction will allow for a thorough assessment of travel distances for DDH care in BC.

Depth Camera Augmented C-Arm (DeCAF)

Parinaz Ranjbaran, Pierre Guy, and Antony J Hodgson

Purpose:

Our goal in this project is to markedly reduce radiation exposure and improve workflow efficiency in orthopaedic trauma surgeries by enhancing C-arm fluoroscopy with real-time X-ray video overlays.

Method:

DeCAF uses a 3D depth camera mounted to the image intensifier tube of the C-arm to generate an augmented reality view using the recently acquired X-ray image overlaid on a live video view. The use of a pointer tool allowing depth measurement allows proper scaling of the X-ray image within video feed. The system allows the surgeon to easily and intuitively understand the relationship between the patient's surface anatomy, surgical tools in the operating field, and anatomical and surgical structures within the patient.

Results:

The X-ray overlays are shown in a couple of examples in Figure 1. We found that the overlay accuracy is $1.58 \pm 0.37\text{mm}$ at target-II distance of 270 - 430 mm, the typical anatomical distance to image-intensifier in many orthopaedic procedures, meaning that there's no significant dependence of accuracy on depth.

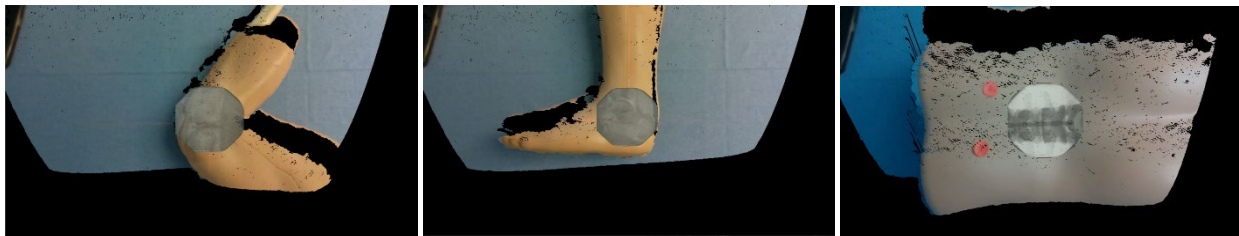


Figure 1. X-ray overlays of A) knee joint, B) ankle, and C) spine

Conclusions:

In this work, the main functionalities for the DeCAF system to create real-time X-ray overlays have been developed. The overlay accuracy is found to be acceptable for further clinical studies in which the impact of the system in terms of radiation exposure and

time is evaluated in simulated lab and OR clinical studies. Our insight is that improved perception of the relative positions of surgical tools and the patient's anatomy would enable the surgeon to avoid taking multiple X-ray images to verify the relative position of their tools and the anatomy.

Micro-positioning of Fibula Segments for use in Mandibular Reconstruction Surgery

Kevin Gilmore, Antony Hodgson

Purpose:

Mandibular reconstruction surgery uses a fibula free flap, or other donor site, to repair a segmental defect in the mandible and restore form and function to the patient. Freehand techniques suffer from dependency on surgeon experience and skill, whereas the more recently developed 3D printed cutting guides present inadaptability to intraoperative plan changes. To help facilitate intraoperative planning and navigation of the procedure, a guided positioning device has been previously developed as a proof of concept. To improve upon the existing macro-scale positioning of the proof of concept, a micromanipulator, allowing for both iterative and precise positioning of fibula segments, will be designed and validated.

Methods:

To successfully design the micromanipulator device, the typical engineering design process of function definition, iterative prototyping and evaluation will be followed. One such requirement to be defined is the necessary range of motion for the micromanipulator, based on the positional error seen with solely the macro stage adjustments. The final design prototype will be tested under load using a finite element stress analysis to ensure structural integrity within the use setting. Confirmation of this design is then followed by the definition and validation of device-specific kinematic equations used in the surgical navigation of the device. The device, once fabricated, will be evaluated through both cadaver and user testing with the purpose of determining the accuracy of the manipulation devices relative to the surgical plan as well as gathering qualitative feedback about the device from surgeons.

Results:

The macromanipulation stage demonstrates a maximum positional deviation of ± 5 mm and ± 15 degrees. As such, a micromanipulator device utilizing a double stacked pantograph mechanism and allowing for controlled fibula segment positioning has been designed with this range of motion. This device benefits from having all actuation points facing the surgeon for ease of accessibility during surgery and presenting a small footprint within the surgical workspace. Under a 100N load, the device's

maximum stress is below the yield point of the proposed build material. To implement accurate surgical navigation, the kinematic equations of the device have been defined and show sufficient accuracy.

Conclusions:

The proposed micromanipulator design allows for iterative fibula segment positioning within the required range of motion and surgical guidance through integration with the navigation software. Success in developing the micromanipulator will provide a platform for initial clinical testing of the combined intraoperative planning, surgical navigation, and positioning system.

Development of a Day-of-Surgery Planning and Guidance System for Mandibular Reconstruction

Melissa Yu, Antony Hodgson

Purpose:

Mandibular reconstruction with a fibula free flap is a common method for restoring form and function to patients with segmental mandible defects. The conventional strategy for this surgery is a freehand technique but it can be difficult to achieve adequate contact between bone segments. More recent technology uses virtual surgical planning to print 3D models of the mandible and fibula cutting guides. However, this strategy offers limited flexibility with the potential for intraoperative changes to render these plans obsolete. Therefore, the objective is to develop and validate a day-of-surgery system that allows surgeons to integrate the precision of guided techniques with the flexibility of free-hand methods. Previous graduate students developed a proof-of-concept system and workflow to validate this concept. This work aims to prepare that system for clinical implementation by addressing key issues identified during previous cadaver testing, namely reducing the intraoperative time required to execute the workflow and improving the accuracy of positioning tasks.

Method:

We characterized the surgical procedure using a motor cognitive modelling diagram (MCMD) to identify and prioritize the most inefficient stages in the existing workflow. These findings were used to guide subsequent software modifications to improve the efficiency and usability of the system.

To validate these changes, user testing will be conducted to collect qualitative feedback on the updated workflow. This insight will be used to refine system usability prior to pre-clinical testing. Following those updates, cadaver testing will be conducted to evaluate the performance of the system in a simulated surgical setting. We plan to evaluate the operative and ischemia time, the accuracy and precision of positioning tasks, and the quality of the overall reconstructions. Qualitative feedback regarding the surgeon's experience will also be collected.

Results:

Through the MCMD, we found that segment positioning with the system was a time-consuming task for surgeons to execute. To improve this process, we implemented a guided micromanipulation system to assist surgeons with precise segment positioning tasks. We also updated the virtual surgical plan to streamline the user workflow and prepare for future dental implant considerations. We plan to evaluate these changes during user and cadaver testing.

Conclusions:

Overall, this work aims to develop and validate a clinically feasible approach for introducing virtual surgical planning and micromanipulation guidance into the operating room. This day-of-surgery system can provide surgeons with the flexibility to respond to intraoperative changes while maintaining the benefits of guidance, ultimately leading to improved functional and aesthetic outcomes for the patient.

The modified RUST score for the assessment of fractured distal femur healing revisited

Andreas Flury, Kelly Lefavre, Darren Roffey, Taylor Kim, Marc-Oliver Dion, David Stockton

Background:

Universally recognized and reliable guidelines to grade the stages of distal metaphyseal femur fracture healing on plain X-rays are lacking. The use of inconsistent measures of fracture healing between studies limits their generalizability. Especially in plate constructs, agreement of mRUST (modified Radiographic Union Score for Tibial fractures) scores was reported to be only fair.

Aim:

The goal of this study was to improve the radiographic assessment of fractured distal femur healing in terms of reliability and clinical utility.

Methods:

This is a retrospective analysis of a prospective cohort of patients who sustained a distal femur fracture (OTA 33-A, B, C) and underwent open reduction and internal fixation with a plate (NCB Zimmer) as part of an international, multicenter, randomized controlled trial. Periprosthetic fractures and patients who received a different form of treatment (nonoperative, IMN, external fixator, distal femur replacement) were excluded. Basic patient demographics and injury information including age, sex, injury mechanism, and injury severity score (ISS) were collected. The FIX-IT questionnaire was completed. Patient radiographs at 2 weeks, 6 weeks, 12 weeks, 6 months, and 1 year were blinded and randomized (for timepoint and subject ID). Four reviewers independently evaluated the following radiographic parameters: Binary value of clinicians' impression of union, RUST score, mRUST score, hardware complications, extent of medial and lateral comminution, medial translation, and frontal (varus/valgus) or sagittal (flexion/extension) deformity. Interclass correlation coefficients (ICC) were calculated to determine the interobserver reproducibility for RUST and mRUST scores. We then re-visited the mRUST score in order to augment inter-observer reliability. The sensitivity and specificity of the re-visited mRUST score were calculated using an uneventful 12-month course without clinical failure as a gold standard for ultimate fracture healing. A receiver operating characteristic curve was also performed to determine the cut-off points at each time point. A binary logistic regression model was used for the calculation of odds ratio between radiographic parameters and clinical outcome.

Results:

Inter-observer reliability of the revisited mRUST score was significantly higher compared to conventional mRUST (X vs. X, $p=?$) or RUST scores (X vs. X, $p=?$). The mean re-visited mRUST score of ? at ?? weeks revealed a X% sensitivity, X% specificity, and X%

accuracy of predicting ultimate fracture healing. Medial comminution of X mm and post-fixation medial translation were significantly associated with reoperations within the first year after treatment.

Conclusion:

The re-visited mRUST score will help synchronize future distal femur fracture research assessing fracture healing and evaluating the effectiveness of surgical techniques.