



## 40<sup>th</sup> ANNUAL MEETING

April 19 – 23, 2023

Hilton Sandestin Beach Golf Resort | Miramar Beach, FL

### 2023 PODIUM & POSTER ABSTRACTS

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#### Thursday, April 20, 2023

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#### Saturday, April 22, 2023

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\*Denotes Presenter

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**Paper 001**

**Comparing Patient-Reported Outcome Measures and Postoperative Healthcare Utilization After One- and Two-Level ACDF Procedures**

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Jeremy Marx, M.D. / Chicago, IL  
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**INTRODUCTION:** Anterior cervical discectomy and fusion (ACDF) remains an exceedingly common procedure for a variety of cervical spine pathology. Excellent outcomes have been demonstrated for one-level ACDF. The outcomes of two-level ACDF, however, have been less consistent. The purpose of this study is to compare patient-reported outcome measures and postoperative healthcare utilization after 1- and 2- level ACDF procedures.

**METHODS:** Patients undergoing elective ACDF at a single, tertiary academic center were prospectively followed for 24 months after surgery. One- and two-level ACDF procedures were identified. Baseline patient demographics and underlying comorbidities, surgical variables, PROMs and metrics of healthcare resource utilization were compared between these two groups. Two computer adaptive PROMs – physical function (PF) and pain interference (PI) – were assessed at 6 weeks, 3 months, 12 months, and 24 months postoperatively. A minimally clinically important difference (MCID) of 5 was selected for PF and PI scores based on prior literature. Healthcare resource utilization was quantified – including cervical imaging studies, emergency department visits, urgent care visits, postoperative opioid prescriptions, epidural or other spinal injections, and pain management referrals at 90-, 180-, and 365-days postoperatively.

**RESULTS:** 101 patients total were included in the final cohort: 56 (55.4%) single-level and 45 (45.6%) two-level ACDF procedures. Improvement in PI scores at 6 weeks were significantly greater in the one-level ACDF cohort ( $p=0.002$ ). Significantly more patients in the one-level ACDF cohort achieved MCID in PI scores at 6 weeks postoperatively ( $p=0.004$ ). However, there were no significant differences in PROMs or percentage of patients achieving MCID by 3 months, 12 months, and 24 months postoperatively. Patients undergoing two-level ACDF had a significant greater number of XRs obtained within the 1-year postoperative period ( $p=0.012$ ). However, there were no significant differences in other metrics of healthcare utilization – advanced imaging studies, emergency department visits, urgent care visits, opioid prescriptions, and spinal injections.

**CONCLUSION:** Patients undergoing one-level ACDF had greater improvement in PI-PROM at 6 weeks postoperatively relative to two-level ACDF. However, there were no differences in PI-PROM or PF-PROM at 3 month-, 12 month- and 24 month- follow-up between the one- and two-level ACDF cohorts.

**Paper 002**

**Return to Sport and Patient Reported Outcomes of Collegiate Gymnasts Following Subpectoral Biceps Tenodesis for Treatment of SLAP Tears**

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**INTRODUCTION:** The biceps-superior labral complex is a known source of shoulder dysfunction in young, high-level athletes. Biceps tenodesis has increasingly been utilized as a primary surgery for SLAP tears. However, minimal data has been published on patient reported outcomes and return to play in gymnasts. The purpose of this study is to evaluate return to play, complication rates, and patient reported outcomes following biceps tenodesis for the treatment of SLAP tears in collegiate-level gymnasts < 25 years old.

**METHODS:** This retrospective case series evaluated gymnasts < 25 years old who underwent open subpectoral biceps tenodesis for SLAP tears with or without biceps tendon pathology from 8/20/2014 to 8/20/2021. Patients with a minimum 2-year follow-up qualified for this study. Patient reported outcomes that were assessed included return to sport, postoperative activity level, Visual Analog Scale (VAS), American Shoulder and Elbow Surgeon (ASES), and Disabilities of the Arm, Shoulder, and Hand (DASH) scores.

**RESULTS:** Of the 16 shoulders in 14 gymnasts undergoing biceps tenodesis for SLAP tear during the study period, follow-up was obtained for 13 of 16 (81%) at average follow-up  $4.3 \pm 1.5$  years. The average age of patients at the time of surgery was  $21.8 \pm 2.2$ , with 12 (92%) male patients. Biceps tenodesis was the primary procedure for diagnosis of SLAP tear in 12 patients (92%), and for failed prior SLAP repair in 1 patient (8%). Intraoperatively, 10 patients (77%) had type II SLAP tears, while 3 (23%) had type IV tears. Two patients demonstrated paralabral cysts that were decompressed, and the SLAP tear underwent repair along with biceps tenodesis. Patient reported outcomes at follow-up were VAS of  $1.8 \pm 1.7$ , ASES of  $89.1 \pm 9.1$ , and DASH of  $2.4 \pm 3.2$ . Following surgery, 8 (62%) patients returned to their prior level of collegiate gymnastics. Five (38%) did not return to gymnastics due to reasons unrelated to their shoulder, and 100% were able to perform recreational sports without issue. Higher DASH scores were noted in the group that did not return to sport ( $p=0.04$ ). No other significant differences in patient reported outcomes were noted. No patients experienced postoperative complications or reoperation.

**CONCLUSION:** Biceps tenodesis is an effective primary operation for high level gymnasts with SLAP tears, with high rate of return to the same level of sport and excellent patient reported outcomes.

**Paper 003****Why Do Infants and Children Recover from Nerve Injury Better than Adults? Differential Expression of Acetylcholine Receptor Subunits and Localization of Motor Endplates**

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It is widely recognized that there is a difference in how adult and pediatric patients respond and recover after a brachial plexus injury or traumatic nerve injuries. To date, there is no clear understanding as to the etiology for this differential response to neural injury. As nerve injuries induce Wallerian degeneration and initiate degradation of the target end-organ motor endplates (MEPs), it is our hypothesis that there is a differential expression in MEP morphology, subunit composition and distribution between adult and children that may account for their differential response to injury. To assess this, an animal model was used to harvest whole leg and the tibialis anterior (TA) muscles from neonatal and adult mice at weekly intervals following birth through 4 weeks, then at monthly intervals through 4 months (n=24, 3 animal specimens at each time point). Muscle tissue was evaluated for alpha-bungarotoxin ( $\alpha$ -BTX) and acetylcholine receptor-gamma (AChR- $\gamma$ ) expression with fluorescent microscopy. In addition, Western blot analysis was performed to quantify AChR- $\gamma$  protein expression and compared against Glyceraldehyde-3-Phosphate Dehydrogenase (GAPDH) control. The data from this study details that adult vs. fetal MEPs differ in subunit composition and morphology. Analysis of MEP morphometry revealed that both mature and immature endplates were present in fetal tissue whereas only mature endplates were present in adults. Mature endplates in fetal animals are less complex than the mature endplates found in adult animals. Moreover, immature endplates were distributed throughout fetal muscle in two patterns: 1) individual endplates adjacent to mature MEPs and 2) clusters of endplates not adjacent to mature MEPs. Importantly, there is also a differential expression and spatial localization of AChR subunit  $\gamma$  between early postnatal and adult animals. These novel data provide insight into potential pathways that may account for the well-documented differential response to nerve injury across the human lifespan. Accordingly, further investigation is warranted as these findings open new possibilities for adjunct treatment modalities following nerve injury.

**Paper 004**

**Bedside Hip Aspiration Results in Decrease in Total General Anesthesia Time in Pediatric Patients: A Multicenter Study**

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**PURPOSE:** Septic arthritis of the hip joint is a potentially devastating disease in the pediatric population. Evaluation includes hip aspiration to evaluate the synovial fluid. This fluid can be obtained either in operating room (OR) under general anesthesia or via bedside aspiration under moderate sedation. The purpose of this study, therefore, is to compare these two approaches and delineate the anesthetic time required.

**METHODS:** A database query conducted at two academic institutions identified all patients under the age of 17 who underwent hip aspiration between 2000 and 2017. At one institution, aspiration was performed in the OR under general anesthesia. Patients were kept anesthetized until cell count was complete. At the second institution, aspiration was performed in the emergency room at bedside under sedation. The medical record was reviewed for demographic data, hip aspiration results diagnoses, treatment, and anesthesia time.

**RESULTS:** Two hundred thirty-three patients (233 hips) with a mean age of 7.2 years were identified. Seventy-five patients underwent aspiration in the OR, and 158 patients underwent bedside aspiration. One hundred (43%) patients were diagnosed with septic arthritis. In total, 116 (50%) patients underwent irrigation and debridement (I&D). Patients with a negative aspiration performed in the OR averaged 87 minutes under anesthesia, while patients with a negative aspiration performed at bedside averaged 29 minutes under sedation. Patients with a negative aspiration performed in the OR after 5pm averaged 99 minutes under anesthesia, and 73 minutes under anesthesia when performed between 7am and 5pm ( $p < 0.01$ ). Seventy-eight (49%) patients who underwent bedside aspiration did not require operative intervention and therefore avoided any general anesthesia.

**CONCLUSION:** Pediatric hip aspiration performed in the OR results in prolonged anesthesia times while synovial fluid is transported and processed. Anesthesia times are significantly longer after 5pm. Aspiration performed at bedside resulted in significantly less anesthesia exposure, with 1 of every 2 patients undergoing bedside aspiration avoiding general anesthesia altogether.

**Paper 005**

**Searching for a Job: Survey of Hand Fellowship Applicants and Current Hand Surgeons**

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**INTRODUCTION:** The purpose of this study was to survey current hand fellowship applicants and current fellows to gain an understanding of what they are looking for in their first job. In addition, hand surgeons were surveyed for comparison of responses to determine how expectations of hand fellows differ from the reality of practice as a hand surgeon.

**METHODS:** We performed two anonymous web-based surveys of current hand fellowship applicants, fellows, and hand surgeons in practice. The survey was administered through survey monkey in 2022. We performed a descriptive analysis and comparative statistics of the survey results.

**RESULTS:** A total of 73 of 95 surveys were completed by the hand fellowship applicant cohort and 23 of 175 fellows. Sixty-three of 107 hand surgeons completed the survey. Most hand surgeons found their first job through residency connections via mentors and faculty, friends or family, or cold calling. Current fellows have had an average of 3.19 interviews (range 1-10). The majority of fourth year applicants, 42 of 65 (64%), are not currently searching for a job. Forty-four (45.83%) applicants and fellows plan to bring a niche to their future practice such as microsurgery/peripheral nerve surgery, arthroscopy, elbow, trauma, and brachial plexus surgery. Most applicants and fellows intend to take both hand and general call (68%), whereas only 16 (25%) current hand surgeons take both. 96.8% of the hand surgeons feel that their fellowship was vital to their career and stated that they would not do hand surgery without a fellowship.

**DISCUSSION:** Up to half of orthopedic surgeons and 32% of hand surgeons switch jobs within the first 5 years, many noting that they had minimal training in selecting a job and that their first job was not as advertised. In the current study, applicants and fellows are mainly finding jobs via family and residency faculty connections. What they want to bring to their practice as a niche differs from the majority of current hand surgeons. This may be due to differences in desires but also could indicate that certain expectations may not be a reality in actual practice. Almost all hand surgeons felt their fellowship was vital to their career further reinforcing the importance of the fellowship year. Additional study and work are needed to find the best way to prepare residents and fellows in choosing their future job.

**Paper 006**

**Nerve Recovery After Compression in a Diabetic Rat Model**

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**PURPOSE:** To establish an animal model that reproduces the “double crush” phenomenon of compressive neuropathy in the diabetic population. Utilizing the sciatic nerve of a the Zucker Diabetic Fatty (ZDF) diabetic rat, this study investigates nerve recovery after external nerve compression and elucidates the clinically relevant differences in recovery between the diabetic and non-diabetic population after surgical decompression.

**METHODS:** Twenty healthy rats and 20 ZDF diabetic rats were divided into four groups of n=10 each: Group 1 - non-diabetic rats; Group 2 - non-diabetic rats with sciatic nerve compression; Group 3 - ZDF diabetic rats; and Group 4 - ZDF diabetic rats with sciatic nerve compression. Groups 1 and 3 went through sham surgery. Groups 2 and 4 underwent surgery to place a compression device around the sciatic nerve to produce a peripheral compressive neuropathy (PCN).

After 6 weeks, n=5 rats from each group were euthanized. Remaining animals from each group received a second sham surgery (Groups 1 and 3) or a treatment “decompression” surgery (Groups 2 and 4) to remove the compression device. Six weeks later, all remaining animals were euthanized. Nerve conduction velocities and distal sensitivity (vonFrey filaments) were obtained on all animals throughout the study. Qualitative and quantitative histological analysis compared the harvested nerves after euthanasia.

**RESULTS:** Neurophysiological measurements including nerve conduction velocities and distal sensitivity measures demonstrated substantial decreases after compression with recovery after decompression to near baseline levels in both diabetic and non-diabetic populations. Histological analysis demonstrated qualitative and quantitative to nerve architecture after compression. These changes were reversed after 6 weeks after decompression in non-diabetic animals, but not in diabetic animals.

**CONCLUSIONS:** This animal nerve compression model results in histological and neurophysiological changes that reproduces the properties of peripheral compressive neuropathies. It demonstrates that compressive neuropathies have a profound effect on nerve structure and function that is reversible with decompression surgery. The effect of diabetes in this model demonstrates more severe alterations of the nerve with slower recovery after decompression surgery.

**Paper 007**

**You Have Got Some Nerve: Joint Denervation for Thumb Carpometacarpal Joint Arthritis**

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**INTRODUCTION:** First carpometacarpal (CMC) joint arthritis in the younger, high demand patient is problematic, and, as of yet, there is no definitive treatment strategy. While first CMC joint arthroplasty is a treatment option, there is an associated extended time for recovery as well as concern about the longevity of the reconstruction. Furthermore, in higher demand individuals, there may be some additional consideration of residual grip strength and thumb stability for more intensive activities. In this study, we evaluated denervation of the first carpometacarpal joint as a treatment for thumb CMC joint arthritis in the relatively young patient.

**MATERIAL & METHODS:** In this IRB approved study, prospectively collected data on 56 thumbs in 51 patients being treated for first CMC joint arthritis with an average follow-up period of 12.8 months and an average age of 49 years was retrospectively evaluated. The patients in this cohort were treated with an open denervation procedure of their first CMC joint as described by Dr. Arenas-Prat. The patients were selected for the procedure by the treating surgeon based on their age, activity level, and goals. Preoperative and postoperative VAS, Jamar, and Quick Dash Data were used to evaluate the outcomes, and patients with complete preoperative and postoperative values were analyzed for each outcome score analysis.

**RESULTS:** Preoperative average Quick Dash was 47.7 and postoperative Quick Dash improved to 17.28 ( $P < 0.0001$ ). There was no statistically significant change in the average grip Jamar grip strength, average 59.0 preoperatively and 59.9 postoperatively. The VAS pain score decreased from an average of 7.65 preop to 0.95 postop ( $P < 0.0001$ ). There were no reoperations or postoperative complications in any of the participants during this study.

**CONCLUSION:** In younger patients, a CMC denervation procedure of the first carpometacarpal joint tends to provide reliable improvement in patient disability and pain without affecting grip strength and with a low complication rate.



**Paper 008****Comparative Costs in Carpal Tunnel Release Surgery by Specialty**

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**INTRODUCTION:** Carpal tunnel release (CTR) is the most common hand surgery in the United States and significantly improves patient quality of life post operation. Between 400,000 to 500,000 procedures are performed annually with costs estimated in excess of \$2 billion (Palmer & Hanrahan, 1995). Both orthopedic and hand specialized plastic surgeons routinely perform carpal tunnel release; however, despite the frequency and major economic implications, there is limited literature on comparing the costs across specialties. The goal of this study is to determine treatment cost trends between orthopedic and plastic surgeons.

**METHODS:** A national insurance database was queried for patients who underwent CTR between the years 2007-2020. Two cohorts based on provider specialty, orthopedic surgery or plastic surgery, were generated. The two cohorts were then matched using the following factors: age > 60, sex, diabetes, obesity, tobacco, and Elixhauser Comorbidity Index (ECI). Average cost, median cost, and total reimbursement by specialty were then calculated and compared using Mann Whitney U Test. Rates of therapy within 3 months post operation and Electromyography (EMG) and nerve conduction velocity studies ordered within 3 months pre-procedure were also tabulated and compared using Chi Squared analysis.

**RESULTS:** The matched cohorts consisted of patient groups each totaling 38,725, treated by orthopedic and plastic surgeons, respectively. There were significantly higher average (\$3,257.27 vs. \$3,107.11,  $p < 0.001$ ), median (\$1,933.50 vs. \$1,881.50,  $p < 0.001$ ), and total costs (\$125,027,088.00 vs. \$115,989,640.00,  $p < 0.001$ ) associated with CTR procedures performed by a plastic surgeon relative to an orthopedic surgeon. In pragmatic terms, these differences were small overall, despite reaching significance. Plastic surgeons were also significantly more likely to order preoperative EMGs and NCSs (23.6% vs. 23.0%,  $p = 0.048$ ) and equally likely to order postoperative therapy (11.2% vs. 11.2%,  $p = 0.704$ ).

**CONCLUSION:** The current study demonstrates that orthopedic surgeons perform CTRs at a significantly, albeit small absolute, lower cost than plastic surgeons. In addition, orthopedic surgeons are also significantly less likely to order EMG and NCVs for their patients. Further studies include comparing the outcomes and postoperative complications between orthopedic and plastic surgeon performed CTRs. Given the wide prevalence of CTR surgery, cost reductions per procedure could lead to significant economic savings.

**Paper 009**

**Motor Branching Pattern of the Radial Nerve and Applications for Hyperselective Neurectomy for Triceps Spasticity**

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**HYPOTHESIS:** Spasticity of the triceps following upper motor neuron injury can limit function. Surgical management of spasticity includes step or fractional lengthening, aponeurotic release, and hyperselective neurectomies. The aim of this study was to delineate the course and innervation pattern of the radial nerve in the upper arm to determine the optimal approach to address triceps spasticity with nerve-based procedures.

**METHODS:** Five fresh frozen cadaveric upper extremity specimens were used for this study. A longitudinal incision was made over the posterior edge of the deltoid extending distally in the midline towards the olecranon. The radial nerve was identified between the long and lateral tricep heads, traced proximally from its emergence under the teres major (TM), and then distally until its muscle entry points. The origin and number of branches, branching pattern, and muscle entry points were recorded and measured with reference to the TM tendon and interepicondylar line (IEL, - proximal, + distal).

**RESULTS:** The first branch from the radial nerve was consistently to the long head of triceps, with 1-3 branches in total, entering the muscle at a mean distance of 4cm (range: 1 – 8cm) from TM. The next branch was to the lateral head of triceps. Two specimens had a single division and 3 specimens had upper and lower divisions, each with 1-4 terminal branches that entered the muscle between 3-9cm (upper division) and 12-14cm (lower division) from TM. One specimen had an upper and lower division to the medial triceps head and the remaining 4 had a single division entering the muscle at a mean distance of 17.2cm (range 14 – 21cm) from TM and -9.3cm (range -6cm to -13cm) from the IEL.

**CONCLUSION:** A combined approach is recommended including fractional lengthening of the long and lateral heads of triceps, combined with hyperselective neurectomy of the medial head of tricep. The proposed incision would be a longitudinal posterior midline in the distal upper arm centered around 9.3cm proximal to the IEL to access the medial tricep motor branches.

**Paper 010**

**Long-Term Outcomes of the Darrach Procedure in Patients 40 Years and Younger**

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**PURPOSE:** To assess the long-term patient-reported, clinical, and radiographic outcomes after distal ulnar resection (the Darrach procedure) in young adults. We hypothesized that the Darrach procedure would produce good functional outcomes with high satisfaction and pain relief in the long term.

**METHODS:** A retrospective chart review identified all adult patients who underwent the Darrach procedure at 40 years of age or younger (mean 32 years, range 20-40 years) and had minimum of 5-year follow-up (mean 18 years, range 7-26 years). Twenty-two patients (24 wrists) were available for final follow-up. Fifteen patients (16 wrists) returned for in-person evaluation, while the remaining 7 patients (8 wrists) completed questionnaires by phone. Questionnaires included the Patient-Rated Wrist Examination (PRWE) and the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH). Subjective outcomes consisted of the visual analog scale (VAS) for pain (0-4) and for satisfaction (0-4). During in-person evaluation, range of motion, grip strength, and x-rays (including Scheker view) were obtained.

**RESULTS:** Mean PRWE and QuickDASH scores were 32 (SD 24) and 34 (SD 21), respectively. Mean VAS for pain at rest was 0.2 (SD 0.6) and 1.1 (SD 1.2) with activity. Mean satisfaction score was 3.3 (SD 1.2). In 88% of cases (21/24), patients reported they would have the same surgery again. Of those who were employed preoperatively, 81% (13/16) returned to work. Wrist flexion was a mean of  $-15^{\circ}$ , wrist extension  $-18^{\circ}$ , radial deviation  $+16^{\circ}$ , ulnar deviation  $-8^{\circ}$ , pronation  $-2^{\circ}$ , and supination  $-11^{\circ}$  compared to the unaffected wrist. Grip strength was 64% of the contralateral side. Radioulnar convergence occurred in all patients but only 3 (23%) were symptomatic.

**CONCLUSION:** The Darrach procedure reflects good long-term patient-reported outcomes. Overall, patients can expect low pain scores, high satisfaction and return to work rates, and low reoperations following distal ulnar resection. Radioulnar convergence occurs universally but is asymptomatic in most cases. Therefore, the Darrach procedure may be a viable surgical option for DRUJ pathology in younger, more active adults, especially when other options are unavailable.

**LEVEL OF EVIDENCE:** Therapeutic IV

**Paper 011**

**Anatomic and Biomechanical Study of Thumb Carpometacarpal Dislocations: A Laboratory Study**

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**INTRODUCTION:** Isolated carpometacarpal (CMC) dislocations of the thumb are an infrequent injury and optimal management remains unclear. No previous study has recreated a CMC dislocation in the laboratory. We sought to analyze the biomechanics of the ligamentous complex of the CMC joint with dislocation as well as ligament repair with suture augmentation technique.

**METHODS:** Biomechanical analysis was performed in 10 fresh frozen specimens. A pure posteriorly directed force or axial loading with hyperflexion through the CMC joint was applied. Load was applied at a rate of 1 mm/s until posterior CMC dislocation was achieved. The maximum load, displacement under nominal loading, stiffness and mode of failure were recorded. The native ligament was repaired, augmented with high tensile suture, and the testing was repeated.

**RESULTS:** Posteriorly directed force produced posterior CMC dislocations, while axial loading and hyperflexion through the CMC joint caused fractures. Load to failure of the native CMC joint was 217.76 N (SD 66.03). Stiffness of the ligamentous complex on average was 18.86 N/mm (SD 8.83 N/mm). Mean load to failure after repair with suture augmentation was 94.62 N (SD 39.77), with a stiffness 8.21 N/mm (SD 3.06) on average. All native ligament failures were mid-substance. The native ligament was noted to have greater stiffness ( $p = 0.002$  using paired t-test) and greater load to failure ( $p = 0.0001$  using paired t-test) than the repair with suture augmentation. Maximum displacement to failure of the native ligament was 14.5 mm compared to repair with suture augmentation 11.9 mm ( $p = 0.068$ ).

**DISCUSSION & CONCLUSION:** Isolated CMC dislocation was achieved with a posteriorly directed force rather than hyperflexion of the joint. The ultimate failure load of the repaired ligaments with suture augmentation was about half of that of the native ligaments. However, between the ligament reconstruction and the dynamic stabilizers, the procedure may provide enough stability in the post-repair period to reduce the need for k-wire fixation or complete immobilization. Further research into this technique is warranted.

**Paper 012**

**Metacarpophalangeal Joint Pyrocarbon Arthroplasty for Osteoarthritis: An Analysis of 44 Consecutive Arthroplasties**

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**INTRODUCTION:** Osteoarthritis affecting the metacarpophalangeal (MCP) joint can be painful and functionally limiting. MCP arthroplasty can relieve pain and preserve function in severe cases of MCP arthritis. Patients specifically affected by noninflammatory MCP arthritis have shown to benefit from arthroplasty. Since the landmark paper by Swanson in 1972, the silicone implant remains the gold standard in MCP arthroplasty. However, studies have demonstrated a high rate of implant fracture, recurrent deformity, joint instability, and limitations in motion, in part due to the “pistoning” effect of this flexible spacer and its deterioration over time.

Pyrocarbon implants were designed to overcome some of these deficiencies with a semi-constrained design and elastic modulus similar to cortical bone. In addition, the pyrocarbon implant requires minimal bone resection, and evidence suggests excellent wear properties, with no reports of inflammatory reaction in response to wear particles. The objective of this study was to analyze postoperative outcomes in a large group of patients who underwent metacarpophalangeal (MCP) arthroplasty utilizing a pyrocarbon prosthesis for non-inflammatory arthritis.

**METHODS:** An analysis of 44 consecutive MCP joint arthroplasties over a 12-year time period in 30 patients with >2 years of follow-up was reviewed. The mean age was 63 years. The primary operative indication was pain and stiffness from osteoarthritis refractory to non-operative management for all arthroplasties.

**RESULTS:** At a mean follow-up of 6±3 years, 8 (18%) joints underwent reoperation, including 5 (11%) that underwent revision arthroplasty. The 2 and 5-year survival-free of revision arthroplasty were 95% and 93%, respectively. One (2%) operation was complicated by intraoperative fracture. Postoperative complications occurred in 8 (18%) fingers and included ligament/tendon rupture (n=3) and instability (n=2). There was significant postoperative improvement in pain levels, MCP arc of motion, pinch, and grip strengths. At a mean 5 years of radiographic follow-up, 7% had progressive implant instability due to grade 3 or greater loosening. No joints experienced implant instability from progressive subsidence.

**DISCUSSION & CONCLUSION:** MCP arthroplasty using a pyrocarbon implant for osteoarthritis demonstrates an 8% revision rate at 5 years postoperative. Complications lead to reoperation in one of five arthroplasties. Radiographic evidence of implant instability was uncommon. Overall, patients experienced predictable pain relief and improvements in their range of motion and pinch strength.

**Paper 013****Short-Term Outcome of Unicortical Intramedullary Repair of Distal Biceps Ruptures - A Retrospective Cohort Study**

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**INTRODUCTION:** Modern distal biceps reconstruction techniques have generally satisfactory outcomes however are not without complications. Posterior interosseous nerve (PIN) palsy is a rare but potentially devastating complication of bicortical metal button fixation. Recently a unicortical, intramedullary, repair technique utilizing a polyester anchor has been described. The primary aim of this study was to compare short-term functional and patient-reported outcomes and complication rates in patients receiving unicortical suture anchor fixation against those receiving bicortical metallic button. We hypothesized that unicortical suture anchor repair would have equally satisfactory outcomes without the complication profile.

**METHODS:** Retrospective chart review was conducted for patients undergoing fixation of distal biceps tendon ruptures from 2015-2021 by two fellowship-trained hand and upper extremity surgeons at our institution. Twenty patients received bicortical button fixation and eight received unicortical suture anchor. Patient demographics and surgical complications were compared. QuickDASH scores at two-month and latest in-person and telehealth visits, as well as elbow and forearm range of motion were also collected and analyzed.

**RESULTS:** Average patient age in the bicortical metallic button and unicortical suture anchor cohorts were  $49.3 \pm 9.3$  and  $42.1 \pm 6.2$  years respectively. There was no statistical difference in patient age, sex, hand dominance, injury laterality, injury chronicity, and follow-up duration. Elbow and forearm range of motion were comparable and excellent in both groups at final follow-up. QuickDASH improved between two-month and latest timepoints in both cohorts however did not differ significantly in head-to-head comparison. Complications included a case of PIN palsy, distal biceps tendon re-rupture, and LABC neuropraxia in the metallic button group and two cases of LABC neuropraxia in the suture anchor group. The number-needed-to-treat (NNT) for the prevention of one additional case of PIN palsy using unicortical suture anchor fixation is 22 patients.

**CONCLUSION:** Short-term functional and patient-report outcomes in bicortical button and unicortical suture anchor repair of distal biceps tendon ruptures are comparable and excellent. Unicortical suture anchor fixation did not have higher failure rate despite follow-up well beyond what is reported for re-ruptures. In this limited retrospective cohort study, suture anchor fixation also did not encounter postoperative PIN palsy and had a NNT of 22 patients. In the appropriate clinical setting, this provides early evidence supporting utilization of unicortical suture anchor fixation of distal biceps tendon ruptures as well as associated perioperative interventions such as preoperative nerve blocks.

**Paper 014**

**Is Therapy Associated with Lower Rates of Surgical Treatment in Thumb Carpometacarpal Arthritis?**

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**INTRODUCTION:** Thumb carpometacarpal (CMC) osteoarthritis (OA) causes functional disability and increased healthcare burden in the aging population. The role of therapy in thumb CMC OA has been minimally analyzed in the literature. We queried a large national insurance database evaluate the effectiveness of therapy in delaying or reducing the conversion to surgical treatment. We hypothesized that patients prescribed therapy treatments for thumb CMC OA would have lower rates of subsequent surgery for this diagnosis.

**METHODS:** Using a national insurance dataset, all patients with a minimum of 2 years of follow-up with an ICD-9 or ICD-10 code for thumb CMC OA were identified. A 2:1 propensity-matched control cohort of patients who underwent more than one session of physical or occupational therapy versus those who did not was created. The primary outcome of the study was the rate of thumb CMC OA surgery at two years. Multivariate regression was used to identify risk factors for conversion to surgical treatment.

**RESULTS:** The therapy cohort comprised 14,548 patients, with a matched control group of 28,930 patients. The overall rate of surgery was 22.5% and was significantly higher for those who did not undergo therapy (29.3%) compared with those who did (13.1%) ( $p < 0.001$ ). Patients who underwent therapy had significantly longer mean times to surgery than those without therapy ( $p < 0.001$ ), but there was an inverse relationship between number of therapy treatments and surgery, such that those who had  $> 10$  therapy sessions had a higher rate of surgical treatment than those who had 2-10 sessions. In multivariate regression of all included variables, lack of therapy intervention conferred the highest odds of surgical conversion (odds ratio 4.3). Corticosteroid injections were associated with increased rates of surgery (OR 2.3). Age, female gender, opioid use, and tobacco use were associated with higher rates of surgery, and medical comorbidities (hypertension, coronary artery disease, rheumatoid arthritis, and diabetes) were associated with lower rates of surgical conversion.

**DISCUSSION/CONCLUSION:** We present the findings of a large insurance database evaluating rates of surgical treatment in thumb CMC arthritis. Two-year surgical conversion rates for patients diagnosed with thumb CMC arthritis were significantly higher in those who did not undergo therapy compared with those who did.

**Paper 015**

**Investigating the Cost-Effectiveness of Operative vs. Nonoperative Treatment for Distal Radius Fractures**

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**PURPOSE:** To conduct a cost-effectiveness study of nonoperative and operative treatments for distal radius fractures (DRFs) utilizing distinct post-treatment outcome patterns.

**METHODS:** We created a decision tree to model the following treatments for DRFs: nonoperative management, external fixation, percutaneous pinning with Kirschner wires (K-wires), and plate fixation. Each node of the model is associated with specific costs, in dollars (\$), a utility adjustment (QALY), and a percent likelihood. The decision tree nodes included uneventful healing, eventful healing and no further intervention, failure of reduction and further operative management, carpal tunnel syndrome, trigger finger, and tendon rupture. Percent probabilities of each transition state, QALY values, and costs of intervention were gleaned from a systematic review. Rollback and incremental cost-effectiveness ratio (ICER) analyses were conducted on the data to identify optimal treatment strategies. Threshold values of \$50,000 per QALY and \$100,000 per QALY were used to distinguish modalities in ICER analysis.

**RESULTS:** Rollback analysis revealed nonoperative management as the predominant strategy which yielded a net monetary benefit of \$34,738/QALY, compared to \$32,333/QALY for plate fixation, \$33,437/QALY for percutaneous pinning, and \$31,400/QALY for external fixation. Similarly, nonoperative management proved cost-effective in ICER analysis when compared to the other modalities. Nonoperative management dominated external fixation and plate fixation, although was comparable to percutaneous fixation—yielding a \$2,242 lesser cost and 0.0166 lesser effectiveness.

**CONCLUSIONS:** The cost-effectiveness of nonoperative management is driven by its decreased cost to the healthcare system. Plate fixation and external fixation have been shown to be both more expensive and less effective than other proposed methodology. Percutaneous pinning demonstrates more favorable effectiveness in the literature, and thus may be more cost effective in certain circumstances. Future studies may find value in investigating further clinical aspects of DRFs and their association with nonoperative management versus plate fixation.



**Paper 016**

**Challenging the Dogma of Distal Radioulnar Joint Examination**

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**HYPOTHESIS:** Examination maneuvers of the DRUJ are frequently performed comparing the contralateral, "normal" wrist with the injured wrist, but there is no data to support that the biomechanics of the wrists are symmetric. We hypothesize that evaluation of bilateral wrist CT studies in normal subjects will demonstrate no appreciable difference between the left and right DRUJ, validating the concept of using the uninjured wrist as a control for physical examination.

**METHODS:** Subjects without any history of previous wrist pathology were recruited and positioned prone in the CT-scanner with both arms partially elevated above their head. The forearms were supported and secured into well-padded channels such that the elbows and wrists were suspended to allow optimal, simultaneous imaging of the DRUJ. Images were acquired in neutral, maximum pronation and supination with resistance. A board-certified hand surgeon and musculoskeletal radiologist reviewed each study to select the axial CT images that best represented the DRUJ and its morphology/alignment. Alignment, specifically the degree and direction of subluxation of the ulna relative to the sigmoid notch, was then assessed utilizing the modified radioulnar line method as described by Nakamura et al. In neutral and pronation, the amount of subluxation was recorded relative to the dorsal extent of the DRUJ, while in supination this was measured relative to the volar extent of the DRUJ. The measurements were recorded independently by 2 authors. Continuous variables were summarized using mean, range, and standard deviation.

**RESULTS:** Sixty-four wrists in 32 patients were reviewed (13F, 19M) with an average age of 30 years (range=22-47). There was no significant difference in the mean displacement when comparing the right and left sides in neutral (0.86mm,  $p=0.13$ ), pronation (0.8mm,  $p=0.36$ ), or supination (0.73mm,  $p=0.17$ ). The mean displacement was also compared between males and females, and there was no statistically significant difference in neutral (male=0.99mm vs. female=1.38mm,  $p=0.16$ ) or supination (male=-0.57mm vs. female=-0.23mm,  $p=0.27$ ). However, the difference in pronation was statistically significant (males=2.69mm vs. female=3.26mm,  $p=0.03$ ). Of the 192 sequences, the authors measurements of displacement were within 1mm 86% of the time (166/192).

**SUMMARY:** Radiographic measures in resisted pronation, supination, and neutral demonstrate symmetry between right and left DRUJ, supporting the concept of using the contralateral side as a control to identify pathology in an injured wrist.

**Paper 017****Is There an Association Between Femoral and Acetabular Retroversion and Idiopathic Cam Morphology: Analysis of 986 Hips**

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**BACKGROUND:** Previous studies have correlated symptomatic femoroacetabular impingement (FAI) with femoral retroversion and cam lesions. The purpose of this study is to investigate the association between both femoral and acetabular version with cam deformity in a random and presumably largely asymptomatic sample population.

**METHODS:** 986 cadaveric hips were randomly selected from a historical osteological collection. Each hip was assessed to determine femoral and acetabular version, anterior offset, and alpha angle. Cam morphology was defined as alpha angle greater than 60 degrees. Multiple regression analysis was performed to determine the relationship between age, femoral version, acetabular version, and either alpha angle or anterior femoral offset.

**RESULTS:** The mean alpha angle and anterior offset for the sample population were  $48.1 \pm 10.4$  degrees and  $0.77 \pm 0.17$  cm, respectively, with cam morphology in 150/986 (15.2%) specimens. There was no significant difference between cohorts with and without cam morphology with respect to femoral version ( $10.8 \pm 10.0$  vs.  $10.3 \pm 9.6$  degrees,  $p=0.58$ ) or acetabular version ( $17.4 \pm 6.0$  vs.  $18.2 \pm 6.3$  degrees,  $p=0.14$ ). Multiple regression analysis did not demonstrate any statistically significant association between femoral version, acetabular version, and alpha angle. Multiple regression analysis demonstrated a small, but significant association between increasing femoral and acetabular version and decreased anterior offset (both  $p < 0.01$ ).

**CONCLUSIONS:** In a large random sample population, cam morphology was not associated with femoral or acetabular retroversion. When combined with the existing literature, these findings suggest that retroversion is not associated with cam development but may increase the likelihood a cam becomes symptomatic. Further clinical study is needed to validate these findings. This study provides further insight into the development of cam morphology which may eventually aid in evaluation and treatment of femoroacetabular impingement.

**Paper 018****Sex-Based Differences in Arthroscopic Treatment of Femoroacetabular Impingement: 10-Year Outcomes with a Nested Propensity-Matched Comparison**

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**BACKGROUND:** Sex has been associated with different pathological characteristics in painful hips undergoing hip arthroscopy. The purpose of this study is to compare minimum 10-year PROs and survivorship in a cohort of patients who underwent primary hip arthroscopy for FAIS and labral tear according to sex.

**METHODS:** Data from patients who underwent primary hip arthroscopy between March 2009 and May 2011 were reviewed. Patients with minimum 10-year follow-up for the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score-Sports Specific Subscale (HOS-SSS), and Visual Analog Scale (VAS) were eligible. The exclusion criteria were previous ipsilateral hip conditions or surgical procedures, Tönnis grade >1, or dysplasia. In the sub-analysis, female patients were matched to male patients using a 1:1 ratio by age, sex, and body mass index.

**RESULTS:** A total of 375 hips had minimum 10-year follow-up. There were 249 female patients (age  $36.8 \pm 13.1$ ) and 121 male patients (age  $38.9 \pm 13.1$ ). Survivorship was defined as patients that did not convert to total arthroplasty. Females and males exhibited similarly high rates of survivorship (80.3% vs. 72.1%,  $p = 0.076$ ). Female patients underwent revision arthroscopy at a higher rate ( $p = 0.021$ ). Female patients had higher rates of capsular repair and iliopsoas fractional lengthening ( $p < 0.0001$ ,  $p < 0.001$ ). Males had significantly higher rates of grade 3-4 ALAD and acetabular Outerbridge cartilage damage ( $p < 0.001$ ) and underwent femoroplasty and acetabular microfracture at significantly higher rate ( $p < 0.001$  for both). Comparison between sexes revealed similar PROs at the minimum 10-year time point. However, the female cohort demonstrated significantly higher improvement in HOS-SSS and VAS after minimum 10 years ( $p < 0.001$ ,  $p = 0.020$ ). In the sub-analysis both propensity-matched groups showed significant improvement from baseline (for all values,  $p < 0.001$ ). Females had higher satisfaction ( $p = 0.003$ ) and greater magnitude of improvement. However, all final PROs at minimum 10-year follow up were similar between males and females.

**CONCLUSIONS:** After undergoing hip arthroscopy for FAIS, both female and male patients reported significant improvement in all PROs at minimum 10-year follow-up and high patient satisfaction, with similar final functional scores. While females demonstrated higher rate of secondary arthroscopies, they had higher satisfaction and greater magnitude of improvement.

**LEVEL OF EVIDENCE:** 4

**Paper 019****Cam Sclerosis and Return to Sport in Femoroacetabular Impingement**

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**INTRODUCTION:** Femoroacetabular impingement (FAI) is common in young, active patients and can be a significant source of pain, preventing full participation in sports. Hip arthroscopy has been shown to be an effective method for treating FAI by performing head-neck offset correction and removing the cam deformity. We sought to evaluate postoperative return to sport relative to the size and density of sclerosis at the cam lesion. We hypothesized that patients with higher density of sclerosis would have higher rates of return to sport. To our knowledge, this is the first study of its kind.

**METHODS:** We performed a retrospective study of athletes aged 15 to 39 who underwent hip arthroscopy for cam-type FAI with or without labral repair. Basic demographics and data regarding pre and postoperative sports participation were recorded. Two independent observers reviewed the cam deformity on oblique CT cuts of the affected femoral neck and measured cam sclerosis width, depth, and density of sclerosis. Sclerosis was graded on a scale of 1-3, 1 being isointense with cancellous bone and 3 being isointense with femoral neck cortex. Femoral version was also recorded. Multivariate analysis was performed using Fisher's exact test, logistic regression, and Wilcoxon rank sum testing.

**RESULTS:** Ninety-nine patients (42 male, 40 left) were identified who had complete data and appropriate CT scans. Mean age at time of surgery was 21.3 years. Eighty-one patients (81%) returned to sport postoperatively. Lower BMI and greater sclerosis depth correlated to higher return to sport rates ( $p \leq 0.05$ ). There was no statistically significant difference in return to sport rates in regard to cam sclerosis density, width, or femoral version ( $p < 0.05$ ).

**DISCUSSION & CONCLUSION:** Cam-type FAI is associated with sclerosis at the femoral head-neck junction. Surgical resection can alleviate symptoms and help young athletes return to sport. The results demonstrate greater cam sclerosis depth and low BMI correlated higher return to sport rates postoperatively. The density of the cam sclerosis did not seem to correlate with return to sport rates. Limitations include small sample size.

**Paper 020****Dancers Following Primary Hip Arthroscopy for Demonstrate Favorable Outcomes and High Rate of Return to Dance at Minimum Five-Year Follow-Up**

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**BACKGROUND:** There is a paucity of literature surrounding the mid-term outcomes in dancers following primary hip arthroscopy.

**PURPOSE:** To report a minimum five-year follow-up patient-reported outcome measurement scores (PROMS), clinical benefit, and return to dance in dancers who underwent primary hip arthroscopy.

**STUDY DESIGN:** Case-series; Level of evidence, 4.

**METHODS:** All primary hip arthroscopy data was prospectively collected and retrospectively reviewed for dancers was recorded between May 2010 and June 2016. Patients were eligible if they indicated they participated in dance one year prior to surgery at the professional, college, high school, organized amateur, or recreational level and had preoperative and minimum five-year follow-up scores for the modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), Hip Outcome Score – Sports Specific Subscale (HOS-SSS), and Visual Analog Scale for pain (VAS). Dancers were excluded if they were unwilling to participate, had a previous hip condition (i.e. hip dysplasia (lateral-center-edge angle (LCEA) < 18°), underwent previous surgery on ipsilateral hip, or had a Tönnis osteoarthritis grade > 1. The minimal clinically important difference (MCID) and patient acceptable symptomatic state (PASS) were used to evaluate patient postoperative satisfaction and improvement.

**RESULTS:** Fifty-two hips (49 dancers) (82.5%) had minimum 5-year follow-up. The average age of the cohort was 30.0 ± 17.1 years, and all patients were female. The average follow-up time was 79.1 ± 23.2 months. Dancers significantly improved in all PROMS (P < 0.001). Additionally, they had a high rate of satisfaction of 8.4 ± 2.1 at minimum 5-year follow-up. They achieved high rates of MCID for the mHHS, NAHS and VAS for pain, 83.3%, 85.7% and 85.7%, respectively and high rates of PASS for the mHHS, and iHOT-12, 90.5% and 81.0%, respectively. Six dancers (14.3%) underwent revision hip arthroscopy and 3 dancers (5.8%) converted to total hip arthroplasty. The rate to return to dance was 79.1% , and of those that returned to dance, 89.7% continued to dance at minimum 5-year follow-up. Of those that returned to dance, 57.7% dancers were able to return at the same or higher level prior to surgery.

**CONCLUSION:** Primary hip arthroscopy in dancers was successful as they experienced favorable PROMS, and achieved high rates of MCID for the mHHS, NAHS, and VAS and high rates of achievement for the MCID and PASS. Dancers experienced a high rate of 89.7% of continuing to dance at least 5 years after surgery with 57.7% returning to the pre-injury or higher performance level.

**Paper 021****Outcomes of Hip Arthroscopy in Patients with Hypermobile Ehlers-Danlos Syndrome**

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**INTRODUCTION:** Hypermobile Ehlers Danlos Syndrome (EDS) demonstrates a very high prevalence of chronic generalized musculoskeletal pain and functional impairment of daily activities. As such, the purposes of this study were to evaluate 1) preoperative characteristics (demographics, physical exam, imaging), 2) patient reported outcomes, and 3) the rate of revision procedures among a cohort of hypermobile EDS patients undergoing hip arthroscopy.

**METHODS:** Data was prospectively gathered and stored in an online hip arthroscopy database at a single academic sports medicine center from January 1, 2007 to May 1, 2021. Patient data was retrospectively reviewed for confirmation of hypermobile EDS diagnosis and adequate clinical follow-up of 1+ years. Patient reported outcomes (PROs) including the Harris Hip Score (HHS), Hip Outcome Score (HOS), and VAS pain scores were collected at final follow-up.

**RESULTS:** Nineteen patients (24 hips) with hypermobile EDS were ultimately included, with an average age of 30.3 years at the time of surgery. Eighty-nine percent (17) of the patients were female. 100% demonstrated a labral tear on MRI, and the mean lateral center edge angle was 35.0°. At a mean follow-up of 5.5 years, 3 (13%) underwent revision hip arthroscopy and 1 (3%) converted to THA. Mean HOS ADL was 78 and HOS sports was 63, with a mean mHHS of 76. Three hips reported subjective instability at final follow-up without any reported cases of dislocation or instability requiring medical attention for relocation. Overall, visual analog pain scores (VAS) improved significantly from 6.2 to 1.5 ( $p < 0.001$ ) postoperatively.

**CONCLUSION:** In a cohort of 19 hypermobile EDS patients (24 hips) who underwent arthroscopy, 12.5% (3 hips) underwent revision arthroscopy and 4% (1 hip) underwent conversion to THA over an average follow-up of five and a half years. Patients, on average, demonstrated a fair result on the mHHS at final follow-up as well as a statistically significant improvement in VAS scores. Thirteen percent reported subjective hip instability. There was no association with preop opioid use, continued pain, or initial subjective instability regarding PROs at final follow-up.

**Paper 022****Long-Term Survivorship and Outcomes of Patients Undergoing Capsular Repair and Primary Hip Arthroscopy for Femoroacetabular Impingement Syndrome**

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**BACKGROUND:** There is a paucity of literature evaluating long-term outcomes and survivorship of patients undergoing primary hip arthroscopy with capsular repair for femoroacetabular impingement syndrome (FAIS).

**PURPOSE:** The purpose of this study is to report minimum 10-year survivorship and patient-reported outcomes (PROs) following primary hip arthroscopy with capsular repair for FAIS.

**METHODS:** Data were prospectively collected and retrospectively reviewed on all patients undergoing primary hip arthroscopy with capsular repair between October 2008 and February 2011. Survivorship was defined as a non-conversion to total hip arthroplasty (THA). Patients with minimum 10-year follow-up for the modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), and Visual Analog Scale for pain (VAS). If available, preoperative and minimum 10-year follow-up for the Hip Outcome Score—Sports Specific Subscale (HOS-SSS) were reported. Survivorship defined by non-conversion to THA, PROs, and clinical benefit (minimal clinically important difference (MCID) and patient acceptable symptomatic state (PASS)) were reported. An additional propensity-matched sub-analysis comparing patients undergoing capsular repair with patients undergoing capsular release over the age of 40 with acetabular labrum articular disruption  $\geq 2$  was performed.

**RESULTS:** 145 (130 patients) out of 180 eligible hips (165 patients) had minimum 10-year follow-up (80.6%). 126 hips (86.9%) were female, and 19 hips (13.1%) were male. The average patient age was  $30.3 \pm 12.9$  years. The survivorship rate was 91.0% at minimum 10-year follow-up. The cohort experienced significant improvement ( $P < 0.001$ ) in the mHHS, NAHS, HOS-SSS, and VAS for pain. Additionally, the cohort achieved high rates of PASS for the mHHS (89.8%), and high rates of the MCID for the mHHS (82.4%) and VAS for pain (80.6%). 29 capsular repair patients were matched to 81 capsular release patients. Both groups experienced significant improvement in all PROs ( $P < 0.05$ ). The release group underwent conversion to THA at a higher rate than the repair group ( $P < 0.05$ ).

**CONCLUSION:** Patients undergoing primary hip arthroscopy with capsular repair experienced a high rate of survivorship of 91.0% at minimum 10-year follow-up. Patients that did not convert to THA saw favorable improvements in PROs and achieved high rates of clinical benefit. In the subanalysis, patients undergoing capsular repair demonstrated higher rates of survivorship.

Paper 023

The Impact of Competition Level and Concomitant Procedures on Return to Sport After Hip Preservation Surgery

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**BACKGROUND:** Femoroacetabular impingement (FAI) is common in young, active patients, especially young athletes. There is inconsistent data regarding successful return to competition following hip preservation surgery.

**PURPOSE:** To evaluate patient factors contributing to return to sport after hip preservation surgery.

**METHODS:** We reviewed competitive athletes undergoing hip arthroscopy with or without concomitant periacetabular osteotomy (PAO) or femoral osteotomy (FO). We calculated the return to sport rate as well as associations between various patient factors and ability to return to sport. When comparing type of sport played, sports were grouped and classified as one of the following categories: Cutting, Flexibility, Contact, Impingement, Asymmetric/Overhead, and Endurance. Statistical significance was assessed using Chi-square test for categorical variables.

**RESULTS:** We identified 128 athletes (129 hips) with documented return to play decisions. For procedures performed, 110 (85%) underwent arthroscopy alone, 16 (12%) concomitant PAO, and 3 (2%) concomitant FO. The mean age of our cohort was  $19.7 \pm 6.1$  years (range 14 to 43). The most common sports were running/track (36, 28%), dance/cheer (24, 19%), volleyball (13, 10%), and basketball (12, 9%). Ninety-six athletes (74%) returned to competition postoperatively, 22 (23%) at the professional or collegiate level and 74 (77%) at the high school or recreational level. Athletes undergoing arthroscopy alone returned to sport at a significantly higher rate than athletes undergoing concomitant PAO or FO (79% vs. 47%,  $p=0.003$ ). College and professional athletes were also significantly more likely to return than high school or recreational athletes ( $p=0.031$ ). The type of sport played was not significantly associated with successful return to play ( $p>0.05$  for all categories).

**CONCLUSION:** Competitive athletes undergoing isolated hip arthroscopy (without concurrent PAO or FO) are more likely to return to competition. Professional and collegiate athletes are also more likely to return to sport postoperatively. The type of sport played does not appear to impact return to play ability.



**Paper 024****10-Year Outcomes Following Endoscopic Gluteus Medius Repair**

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**BACKGROUND:** Gluteus medius tears are a historically misdiagnosed pathology, however, they have proven to be an important cause of hip pain and impairment. Studies have demonstrated endoscopic surgery to be an effective treatment of abductor tendon tears. To date, long-term outcomes of this procedure have not been published.

**PURPOSE:** To evaluate 10-year patient-reported outcome (PRO) scores following endoscopic surgery for gluteus medius partial and full-thickness tears with concomitant hip arthroscopy for labral tears and/or femoroacetabular impingement syndrome (FAIS).

**METHODS:** Prospectively collected data on patients followed for a minimum of 10 years after endoscopic gluteus medius repair with concomitant hip arthroscopy performed by a single surgeon were retrospectively analyzed. Patients with preoperative and 10-year follow-up for the following PROs were included: modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), Hip Outcome Score-Sports Specific Subscale (HOS-SSS), and Visual Analog Scale (VAS) score for pain.

**RESULTS:** There were 13 patients eligible for inclusion, 11 (84.6%) of whom had 10-year follow-up, with a mean of 127.6 months (range, 120.0-140.2 months). The group consisted of 10 females (90.9%) and one male (9.1%) with a mean age at surgery of 60.1 years (range, 46.2-74.8 years). PRO scores improved from preoperative to 10-year follow-up as follows: mHHS from 60.4 to 88.0 ( $p=.011$ ); NAHS from 50.1 to 90.6 ( $p<.001$ ); HOS-SS from 37.5 to 85.1 ( $p=.001$ ); and VAS from 4.8 to 1.2 ( $p=.006$ ). Mean patient satisfaction rating was 8.3. Patients achieved PASS and MCID for mHHS and HOS-SSS at a rate of 81.8%. There was no significant decline in PROs or satisfaction between 2, 5, and 10 years postoperatively. All patients underwent concomitant hip arthroscopy and labral treatment (debridement or repair). One patient, who had arthroscopic findings of acetabular and femoral outerbridge grade 4 lesions, subsequently underwent total hip arthroplasty; however, the GM was assessed during the THA, and it was verified that the repair was intact. There were no clinical failures, secondary operations, or complications.

**CONCLUSIONS:** Endoscopic repair of gluteus medius tears is a safe procedure with favorable and durable long-term outcomes at minimum 10-year follow-up.

**LEVEL OF EVIDENCE:** Level IV, therapeutic case series

**Paper 025****The Physics of Postless Hip Arthroscopy**

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**BACKGROUND:** Hip arthroscopy is commonly performed to treat Femoroacetabular Impingement Syndrome. A postless technique significantly reduces, or likely eliminates, complications associated with a perineal post, such as pudendal nerve, perineal, or genitourinary dysfunction. There are misconceptions in the hip arthroscopy community regarding the degree of Trendelenburg bed positioning required to perform a postless approach. The purpose of this investigation is to use perioperative data to describe the physics associated with postless hip arthroscopy.

**METHODS:** A retrospective case series of a single surgeon's most recent 100 primary hip arthroscopy cases with a post-free distraction table (Pivot Guardian Distraction System; Stryker, Greenwood Village, CO) was performed. Inclusion criteria were primary hip arthroscopy in the central and peripheral compartments. Exclusion criteria included revisions, open hip surgery, isolated peritrochanteric and/or deep gluteal space endoscopy, and insufficient perioperative data available. An air arthrogram was utilized prior to joint distraction. General anesthesia with muscle paralysis was used, without regional or neuraxial anesthesia. Patient demographics, initial distraction force, bed Trendelenburg angle, distraction distance (joint space, mm), traction time, and any iatrogenic chondrolabral injury were recorded for each case.

**RESULTS:** One-hundred hip arthroscopy cases were identified from 94 patients (53 female, 41 male; mean age 34.9 years; mean body mass index of 26.6 kg/m<sup>2</sup>. Mean traction time was 50.0 minutes. Mean bed Trendelenburg angle was 4.0 degrees (range 2-7.5; 5 degrees or less in 96 cases). Mean initial hip joint distraction force was 72.6 pounds (range, 35-130). Distraction force decrease 8.6+/-14.2 degrees after interportal capsulotomy. There were no groin-related nerve or soft tissue complications. There were no iatrogenic chondrolabral injuries.

**CONCLUSION:** Hip arthroscopy can be effectively performed using a postless technique with Trendelenburg angle of less than 5 degrees in nearly every case. All hips were able to be distracted sufficiently for safe joint entry without iatrogenic chondrolabral injury. Using the coefficient of static friction of the pad's surface, bed Trendelenburg angle, and patient body weight, the magnitude of joint distraction can be calculated. Similarly, using the desired minimum joint distraction, the bed Trendelenburg angle can be calculated.

**Paper 026****Learning Curve of Hip Dysplasia Treated with Periacetabular Osteotomy Based on Patient Reported Outcomes**

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**BACKGROUND:** Learning curve is of concern for newly trained orthopedic surgeons. Periacetabular osteotomy (PAO) is a well-established surgical procedure to treat pre-arthritic hip dysplasia in young adults that requires specialized training. The learning curve has been described in terms of complications, but not assessed by patient reported outcomes (PROs). The purpose of this study was to determine the impact of experience on outcomes of hip dysplasia treated with PAO.

**METHODS:** 100 patients with hip dysplasia were treated with PAO by a single, new in practice surgeon from 1/24/2018 to 11/9/2020. Second side operations on the same patients were not included in the analysis. Demographics and radiographic measurements were recorded prospectively. PROs were collected prior to surgery and at minimum 1-year follow-up including modified Harris Hip Score (mHHS) and International Hip Outcome Tool (iHOT). The first 50 (Group-I) and second 50 (Group-II) surgeries were separated, and complications, reoperations, radiographic measurements, and PROs were compared.

**RESULTS:** At minimum one-year follow-up, 91/100 patients completed PROs and all patients completed documentation of complications or reoperations. There was no significant difference in age or BMI (Group-I mean age  $24.5 \pm 8.86$  years vs. Group-II  $22.0 \pm 7.95$  years,  $p=0.072$ ). Two patients in each group underwent blood transfusion. Four in Group-I and three in Group-II underwent another operation to the hip (1 total hip arthroplasty, 3 superior ramus nonunion fixations, and 3 hip arthroscopies). THA excluded this patient from PRO analysis. Seven hips had greater than Tönnis grade 0 in Group-I and only one in Group-II. The only significant difference comparing pre- and postoperative LCEA and Tönnis angle was lower postoperative Tönnis angle in Group-II ( $p=0.015$ ). Comparing PROs, 7/45 patients that completed PROs did not have a minimum increase of 10 points in iHOT score for Group-I, and 1/46 did not have the minimum increase in iHOT score for Group-II.

**CONCLUSION:** With surgical experience, patients with hip dysplasia treated with PAO were more likely to have significant improvements in PROs at short-term follow-up. This may be due to indications, as there was a trend toward patients later in the learning curve being younger and have less arthritis prior to surgery. New surgeons should seek mentorship to guide early practice and improve clinical outcomes.

**Paper 027****Elevated Joint Contact Stress Increases Risk of Joint Failure When Hip Dysplasia is Treated with Periacetabular Osteotomy**

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**BACKGROUND:** Periacetabular osteotomy (PAO) is a well-established surgical treatment for pre-arthritic hip dysplasia in young adults. Quality of deformity correction with PAO is important to optimize long-term clinical outcomes. Computational techniques allow for advanced assessment of pathologic mechanics that may predict hip joint failure at intermediate-term follow-up. The purpose of this investigation was to determine if quality of deformity correction assessed with computational modeling is associated with clinical outcomes at minimum 10-year follow-up.

**METHODS:** We identified 77 patients with 89 hips that were treated for hip dysplasia with PAO who had pre- and postoperative pelvis CT scans and completion of Patient Reported Outcome Measurements (PROMs) a minimum of 10 years after surgery. Joint failure was classified as conversion to total hip arthroplasty (THA) or modified Harris Hip Score (mHHS)  $\leq 70$ . Patient-specific preoperative and postoperative hip models were generated from each patient's CT scans and joint contact stress while walking was computed using Discrete Element Analysis (DEA). Contact stress patterns in preserved and failed hips were compared using Wilcoxon Rank Sum tests. Results are presented as median (inter-quartile range).

**RESULTS:** 48/89 hips were classified as failed: 25 converted to THA and 23 preserved hips had mHHS  $\leq 70$ . BMI at the time of surgery was significantly higher among those with failed (29.0 [22.8-32.8] kg/m<sup>2</sup>) vs. preserved hips (23.9 [22.1-28.6] kg/m<sup>2</sup>,  $p=0.016$ ). However, failed vs. preserved groups did not significantly differ in age at time of surgery (36 [23-40] vs. 25 [19-40] years,  $p=0.073$ ) or in gender distribution (83% vs. 88% female,  $p=0.552$ ). Preoperatively, failed hips versus preserved hips had higher mean contact stress (7.5 [5.6-9.0] MPa vs. 6.0 [4.2-8.0] MPa,  $p=0.020$ ), peak chronic stress-time exposure (31.9 [18.7-42] MPa-years vs. 20 [12.1-39.5] MPa-years,  $p=0.030$ ), and mean chronic stress-time exposure (6.5 [4.5-9.9] MPa-years vs. 4.1 [2.7-7.3],  $p=0.005$ ). Postoperatively, failed hips had significantly higher mean contact stress (6.6 [4.9-7.7] MPa vs. 5.1 [3.7-6.5] MPa,  $p=0.008$ ) than preserved hips, and significantly less radiographic lateral coverage as assessed with lateral center edge angle (30 [24-36] vs. 33 [30-37],  $p=0.015$ ).

**CONCLUSION:** Despite improved radiographic measures of dysplasia with PAO, pathologic joint mechanics persist with detrimental impact on clinical outcomes. Techniques beyond current 2D radiographic assessment hip dysplasia correction may improve indications for surgery, quality of deformity correction, and long-term clinical outcomes.

**Paper 028****Risk Factors for Superior Ramus Osteotomy Nonunion When Hip Dysplasia is Treated with Periacetabular Osteotomy**

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**BACKGROUND:** Periacetabular osteotomy (PAO) is a well-established surgical treatment for pre-arthritis hip dysplasia in young adults. Few studies report risk factors for development of superior ramus osteotomy nonunion. The purpose of this investigation was to document the incidence and risk factors for this complication with a new focus on surgical technique.

**METHODS:** We identified 316 consecutive hips that underwent PAO for symptomatic acetabular dysplasia with a minimum of one-year radiographic follow-up performed by two surgeons. Demographic and radiographic variables were recorded. We developed and validated a technique to measure the location of the superior ramus osteotomy on postoperative AP pelvis radiographs and CT. Logistic regression with generalized estimating equations was used to evaluate the relationships between odds of nonunion and potential predictor variables in univariate and multivariate analyses.

**RESULTS:** Twenty-nine (9.2%) hips developed superior ramus nonunion. There were significant differences between healed and non-united osteotomies in age (median [IQR] 23 years [18-35] healed vs. 35 years [26-40] non-united,  $p=0.001$ ), preoperative lateral center edge angle of Wiberg (LCEA) (median [IQR] 16° [11-20] healed vs. 10° [16-13] non-united,  $p<0.001$ ), and the distance from the superior ramus osteotomy to the ilioischial line measured on AP pelvis radiograph (15.8mm [13.2-18.7] healed vs. 18.1mm [16.2-20.5] non-united,  $p<0.001$ ). BMI and location of the osteotomy on CT did not differ between groups ( $p>0.05$ ). Using multivariate analysis, moderate-to-severe dysplasia (LCEA  $< 15^\circ$ , OR 5.95, SE 3.32, CL95% 1.99-17.79,  $p$ -value=0.001), increased age (5-year incremental increase, OR 1.29, SE 3.32, CL95% 1.105-1.60,  $p$ -value=0.018) and location of the osteotomy on AP pelvis radiograph (each 3mm increase, OR 1.67, SE 0.22, CL95% 1.29-2.18,  $p$ -value<0.001) were at increased risk of developing nonunion.

**CONCLUSION:** We found that superior ramus osteotomy nonunion is common when hip dysplasia is treated with PAO. Older age, moderate-to-severe dysplasia, and location of the osteotomy were independent risk factors for nonunion. Consideration should be made in high-risk patients for a more lateral superior ramus osteotomy and adjuvant surgical treatment to prevent nonunion.

**Paper 029****Clavicle Fracture: Does Plate Type Predict Fixation Failure?**

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**BACKGROUND:** Despite the increased incidence of surgically treated midshaft clavicle fractures, plate choice for fixation remains controversial. While prior studies evaluate the benefit of surgical treatment, the available literature does not compare the performance and costs of the commonly employed 3.5 mm reconstruction plate, precontoured plate, 2.7 mm reconstruction plate, and 3.5 mm limited contact dynamic compression (LC-DC) plate. We hypothesized that these implants demonstrate similar union rates, allowing physicians to safely choose the most cost-effective option.

**METHODS:** We retrospectively reviewed all midshaft clavicle fractures (OTA code 15) treated with open reduction and internal fixation (ORIF) from October 2001 through August 2010 at a Level I trauma center. Patients with midshaft clavicle fractures (OTA 15.2) treated with plate fixation with a minimum follow-up of 6 weeks were included. Plate type and cost, time to union, union rate, comorbidities, and patient demographics were reviewed.

**RESULTS:** Of the total 103 operatively treated midshaft clavicle fractures, 19 were excluded due to inadequate follow-up (81% follow-up). Mean follow-up was 47.5 weeks (range, 6-209). 32 fractures were treated with a 3.5 mm reconstruction plate, 20 with 2.7 mm reconstruction plates, 20 with LC-DC plates, and 12 with precontoured plates. Mean time to union was 23.3 weeks (range, 6-119 weeks). There were 3 open fractures, 1 of which developed nonunion (1.2%). None of the plate designs were significantly associated with different rates of nonunion, failure, or time to union when compared to the other plates. On Cox proportional hazard regression, female gender (HR: 0.59, p=0.04) and older age (HR: 1.02 p=0.003) were associated with decreased and increased time to union, respectively. The least expensive construct was the LC-DC plate, followed by 3.5 mm and 2.7 mm reconstruction plates.

**CONCLUSION:** The different plates performed similarly and no association with union rate, time to union, or failure was found. These findings suggest that employing the cheaper LC-DC plate or reconstruction plates over more expensive designs could decrease costs without increased failures. Additional studies evaluating risk factors for nonunion, different methods of fixation and their cost effectiveness are warranted as many surgeons are unaware of the cost variability.

**Paper 030****Proximal Trans-Ulnar Fracture Dislocations of the Elbow: A Systematic Review and Clarification of Classification Systems**

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**INTRODUCTION:** Complex elbow dislocations in which the dorsal cortex of the ulna is fractured have been described in the literature as either Monteggia injuries or trans-olecranon fracture-dislocations. A new coronoid-centric classification of proximal trans-ulnar fracture-dislocations categorizes these fractures in three types according to what the coronoid is separated from: trans-olecranon fracture-dislocations (the coronoid is separated from the olecranon, but still attached to the ulnar metaphysis), Trans-ulnar basal coronoid fracture-dislocations (the coronoid is separate from both the olecranon and the ulnar metaphysis), and Monteggia fracture-dislocations (the coronoid is separated from the ulnar metaphysis, but still attached to the olecranon). The purpose of this study was to evaluate the outcomes of these injury patterns in the current literature using this classification system.

**MATERIALS & METHODS:** We conducted a systematic review and identified 17 studies with a total of 296 elbows. Elbows presenting with a basal subtype 2 or Regan/Morrey III coronoid fracture and Jupiter IIA and IID injuries were classified as trans-ulnar basal coronoid fractures. Patients with Monteggia or trans-olecranon fractures were classified as such if the coronoid was not fractured or if there was only a coronoid fracture classified as O'Driscoll tip, anteromedial facet, basal subtype I, or Regan Morrey I/II.

**RESULTS:** There were 49 trans-olecranon, 165 basal coronoid, and 82 Monteggia fracture-dislocations. The mean follow-up time was 3.5 years. The all-cause reoperation rate for basal coronoid was 28%, compared to 17% for Monteggia and 21% for trans-olecranon fracture-dislocations. The mean flexion extension arc for basal coronoid was 100°, compared to 116° for Monteggia and 105° for trans-olecranon. Mean pronation supination arc was 66° for Monteggia, 99° for basal coronoid, and 110° for trans-olecranon. The mean Mayo Elbow Performance Score (MEPS) was 84 for trans-ulnar basal coronoid, 92 for Monteggia, and 95 for trans-olecranon fracture-dislocations. Disabilities of the Arm, Shoulder and Hand (DASH) and American Shoulder and Elbow Surgeons (ASES) scores were 22 and 82 for basal coronoid, respectively compared to 15 and 89 for trans-olecranon and DASH of 13 for Monteggia. Basal coronoid fractures had an increased rate of complications (OR 2.8; 95% CI 1.2-7.3, p=.02).

**DISCUSSION:** Trans-ulnar basal coronoid fracture-dislocations are associated with worse reoperation rates than trans-olecranon or Monteggia proximal trans-ulnar fracture-dislocations, as well as worse flexion extension arcs, MEPS, DASH, and ASES scores and a statistically significant increased risk of complications.

**Paper 031****CAMKK2 Inhibition Protects Against Chondrocyte Apoptosis and Cartilage Degradation In Human Osteoarthritis**

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**BACKGROUND:** Post-traumatic osteoarthritis (PTOA) is cause of substantial morbidity in the United States, and causes 12% of symptomatic osteoarthritis cases. There are no effective treatments to prevent or mitigate PTOA. We recently reported in an animal model that Ca<sup>2+</sup>/calmodulin-dependent protein kinase kinase 2 (CAMKK2), a serine-threonine protein kinase, plays a key role in PTOA. We hypothesize that CAMKK2 is elevated in human OA, and that its blockade will reduce chondrocyte apoptosis and cartilage catabolism.

**METHODS:** Human specimen usage was approved by the Institutional Review Board. Osteochondral plugs were collected from patients undergoing total hip arthroplasty for osteoarthritis. Plugs were extracted from damaged and healthier portions of each femoral head. Half of the plugs were flash frozen and underwent RNA isolation for qRT-PCR analysis of CAMKK2, matrix metalloproteinase 13 (MMP13), type II Collagen (COL2A1), and aggrecan (ACAN) expression. Remaining plugs were fixed, decalcified and paraffin-embedded for histology and immunohistochemistry (IHC). Safranin O-stained sections were graded for OA severity using the Osteoarthritis Research Society International (OARSI) scoring system. Sections were also immunostained to detect CAMKK2, COL2 and MMP13 protein. Terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL) staining was used to evaluate apoptosis in chondrocytes.

Primary chondrocytes were isolated from healthy and OA cartilage derived from the same femoral head, cultured and transfected with scrambled or CAMKK2 siRNA (4 siRNA mix, Horizon Discovery Biosciences Limited, Cambridge, UK), for 3 days, and total protein isolated for immunoblotting to assess CAMKK2, MMP13, BAX and BCL2 levels. Healthy primary chondrocytes were also infected one of 3 lentiviral vectors (GFP-control, CAMKK2, or kinase-defective mutant CAMKK2), and immunoblotting was performed to assess CAMKK2, MMP13, BAX, and BCL2 levels. Chondrocyte apoptosis was analyzed using flow cytometry following treatment with vehicle or the CaMKK2 inhibitor STO-609 (2  $\mu$ M) for 24 hours in growth media.

**RESULTS:** OA chondrocytes had increased expression of CAMKK2 and MMP13, and decreased expression of ACAN and COL2A mRNA relative to GAPDH ( $p < 0.05$ ), compared to healthy chondrocytes. Osteoarthritic cartilage had higher OARSI score ( $p < 0.001$ ), MMP-13 positivity ( $p < 0.01$ ) and CAMKK2 positivity ( $p < 0.01$ ), whereas COL2 positivity was decreased ( $p < 0.01$ ). Osteoarthritic cartilage possessed had increased TUNEL positive cells ( $p < 0.05$ ), compared to healthy cartilage from the same femoral head. CAMKK2 knockdown ( $p < 0.0001$ ) resulted in lower BAX ( $p < 0.0001$ ) and MMP-13 ( $p < 0.001$ ) levels, whereas the overexpression of CAMKK2 lead to elevated BAX and MMP-13 ( $p < 0.05$ ) expression without affecting BCL2 levels ( $p > 0.05$ ). Furthermore, treatment with STO-609 attenuated apoptosis in primary osteoarthritic chondrocytes by 50%.



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CONCLUSION: OA cartilage possessed enhanced CAMKK2 expression. Modulation of CAMKK2 with either knockdown or overexpression led to concordant changes in BAX and MMP-13 levels. CAMKK2 inhibition protected against chondrocyte apoptosis. Our results suggest that CAMKK2 is a potential therapeutic target for osteoarthritis to protect against chondrocyte apoptosis and cartilage degradation.

**Paper 032****Survivability of the Femoral Neck System for the Treatment of Femoral Neck Fractures in Adults**

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**BACKGROUND:** The Femoral Neck System (FNS) has recently emerged as an alternative treatment option for femoral neck fractures, challenging the traditional methods of cannulated cancellous screws and sliding hip screws. Studies have investigated biomechanical properties and potential advantages of the FNS, but limited data exists on long-term clinical outcomes. This study aims to report survivability of FNS implants in patients sustaining femoral neck fractures and investigate risk factors for implant failure.

**METHODS:** Retrospective study of adult patients who received the FNS for femoral neck fracture within a regional hospital system from January 1, 2016 to August 31, 2021. Demographic data, surgical information, and radiologic records were collected from patient charts. Fractures were classified by Garden and Pauwels classifications and fixation quality was assessed using Tip to Apex Distance (TAD) and Parker Ratios (PR). Unpaired t tests and chi-square tests were used to analyze data.

**RESULTS:** A total of 114 patients were included in this cohort (35 males, 79 females). Average age was 74.6 years and BMI was 25.4. Average patient follow-up was 25.7 months (ranged from 9-47 months). The 1-year mortality rate was 13.2% (15/114), for which age was a risk factor ( $P=0.0007$ ). Overall implant failure rate was 12.3% (14/114). Time to implant failure ranged from 10 days to 35 months, however, half (7/14) occurred within 90 days. Implants failed due to cut-out (5), periprosthetic fracture (4), nonunion (3), and osteonecrosis (2). Implants failed in Pauwels Type III fractures more than Type I & II ( $P=0.0026$ ). Garden classification, TAD, and PRs did not predict implant failure, nor did age, gender, or BMI.

**CONCLUSION:** This is the largest single-system cohort to date that has investigated postoperative outcomes following FNS implantation. Rates of revision and one-year mortality were acceptable when compared to literature, suggesting that the FNS is safe and effective for femoral neck fractures. Important considerations include fracture extension and Pauwels classification. In the four periprosthetic fractures, review of preoperative imaging suggested that these were extensions of the original fracture that may not have been appreciated prior to the index procedure. This suggests that periprosthetic fractures are a potentially avoidable complication, and surgeons should utilize advanced preoperative imaging for fractures with potential trochanteric extension. Furthermore, the FNS performed worse in Pauwels Type III fractures, suggesting prognostic value of Pauwels classification for implant choice and a possible limitation of the FNS.

**Paper 033****Proximal Tibia Anatomic Variation May Impact Tibial Intramedullary Nailing**

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**PURPOSE:** The aim of this anatomic descriptive study was to examine proximal tibial morphological variation in patients with tibial shaft fractures. Few studies in the orthopedic trauma literature evaluate variations in proximal tibia anatomy. Proximal tibial metaphysis can vary markedly between patients and sagittal angular variation can impact the technical difficulty of insertion of a tibial IMN.

**METHODS:** This retrospective study evaluated 150 patients at a level one trauma center with tibial shaft fractures who underwent intramedullary nailing. The tibial slope and tibial tubercle-proximal metaphyseal (TT-PM) angle were measured on a fluoroscopic lateral radiograph. Measurement of the tibial slope was obtained by extending a line along the posterior tibial cortex and another line tangential to the tibial plateau. Measurement of the TT-PM angle was obtained by extending a line along the anterior tibial cortex distal to the tibial tubercle, and a second line along the anterior tibial metaphysis proximal to the tibial tubercle. Two sub-investigators performed measurements which achieved an intraclass correlation coefficient of 0.94 for tibial slope, 0.90 for TT-PM.

**RESULTS:** The mean tibial slope was  $6.8^\circ \pm 3.0^\circ$ , while the mean TT-PM angle was  $161^\circ \pm 5^\circ$ . The correlation between these angles was statistically significant ( $p < 0.0001$ ) with a weak negative correlation ( $r = -0.32704$ ). The angles are inversely proportional to one another. Type A tibia has an increased tibial slope (Tibial Slope  $14^\circ$ , TT-PM  $155^\circ$ ). Type B tibia has a decreased tibial slope and less prominent IMN insertion site (Tibial Slope  $1.5^\circ$ , TT-PM  $166^\circ$ ).

**CONCLUSION:** Tibial slope and TT-PM are inversely proportional to one another. An increased tibial slope causes anterior tibial translation, making the IMN insertion site more posterior. This can make suprapatellar nailing more challenging. Additionally, posterior cortical disruption is theoretically more likely in tibias with high slope. Examining proximal tibia morphology prior to surgery can help anticipate intraoperative challenges and determine the ideal approach, suprapatellar or infrapatellar, for tibial IMN.

**Paper 034****No Association Between Mortality and Early Postoperative Ambulation After Distal Femur Fracture Fixation in Elderly Patients**

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**INTRODUCTION:** There has been an increased interest in the orthopedic literature regarding the impact of ambulation on outcomes in elderly patients who sustain lower extremity fractures. This study sought to evaluate the effect of early postoperative ambulation on both 30-day and 1-year mortality in patients  $\geq 65$  years of age who sustained a distal femur fracture.

**METHODS:** This is a retrospective review of all patients  $\geq 65$  years who underwent surgical fixation of a distal femur fracture as determined by CPT billing codes 27511, 27513, and 27514 over a span of 9 years at a single academic medical center. Subjects were divided into all-comer and isolated fracture cohorts. Mortality was defined by documented expiration within the medical chart or published obituary. Early postoperative ambulation was defined as any documented ambulation  $\geq 5$  feet with a physical therapist within the first three postoperative days. A modified 5-factor frailty index (mFI-5) score was calculated for each patient as a global assessment of health.

**RESULTS:** Of the 137 included patients, 46 patients achieved early postoperative ambulation while 91 patients did not. There was no association between early postoperative ambulation and 30-day or 1-year mortality rates in either the all-comer or isolated fracture cohorts. Patients were more likely to achieve early postoperative ambulation when no other concomitant fractures were present ( $p=0.0037$ ). In both cohorts, the mFI-5 score was associated with early postoperative ambulation and 1-year mortality.

After adjusting for age, fragility score, and concomitant fracture, early postoperative ambulation was not associated with increased 30-day ( $p=0.2750$ ) or 1-year survival ( $p=0.4033$ ). Only the mFI-5 score was associated with survival (OR= 0.583, 95% CI 0.389-0.873;  $p=0.0088$ ).

**DISCUSSION:** When controlling for age, presence of concomitant fractures, and mFI-5 scores, early postoperative ambulation is not a reliable predictor of 30-day or 1-year postoperative mortality in elderly patients undergoing surgical fixation of distal femur fractures. In this study only mFI-5 scores was associated with survival.

Postoperative ambulation is a worthy goal with the established benefit of a decreased risk of various morbidities and should be encouraged. However, when counseling patients and families regarding prognosis and expectations within this patient population, overall health status should be a main point of discussion.

**Paper 035****Fascia Iliaca Blocks in the ED Decrease Opioid Consumption in Femoral Shaft and Distal Femur Fracture Patients**

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**INTRODUCTION:** Care of patients with femoral shaft and distal femur fractures represents a significant cost and resource burden to hospitals. Patients who sustain a femoral shaft and distal femur fracture often arrive in the emergency department (ED) in severe pain and receive opioid medications. Although opioids are effective in relieving pain, they increase the risk delirium and altered mental status particularly in the elderly. Furthermore, the opioid crisis in the United States has led to renewed interest in the use of multimodal analgesia and regional nerve blocks as an alternative to opioids for pain control in hip fracture patients. In this study, we report our institution's experience with the use of fascia iliaca (FI) blocks performed in the emergency department for pain control in femoral shaft and distal femur fractures.

**METHODS:** After IRB approval, retrospective review of prospectively collected data was performed on patients diagnosed with femoral shaft (AO/OTA 32) or distal femur (AO/OTA 33) fractures from January 1, 2020 to May 31, 2022. Opioid consumption during the inpatient hospital stay was recorded in morphine milliequivalents (MME). Patients were grouped based on receiving (FI block group) or not receiving FI block (control group) in the emergency department. Opioid consumption, length of stay, and discharge disposition were compared between groups. Student t test and chi-square tests were used for analysis with  $p < 0.05$  indicating statistical significance.

**RESULTS:** During study period 91 patients with femoral shaft and distal femur fractures presented to our institution. Twenty-four of 91 patients (26.4%) without contraindications to undergoing FIB received fascia iliaca block. Mean age (75.1 vs. 65.3) was higher in the FI block group, while BMI (29.9 vs. 30.2), and fracture type (femoral shaft vs. distal femur) were similar between patients receiving FI block and not receiving block. The FI block group had significantly lower opioid consumption in the emergency department (3.46 vs. 30.47 MMEs), preoperatively after admission (7.83 vs. 25.63 MMEs), and over total hospital stay (107.89 vs. 175.34 MMEs). This remained true when examining mean opioid consumption per day of hospital stay (26.01 vs. 45.74 MMEs). There was no significant difference in length of stay, discharge disposition to home, skilled nursing facility, or acute rehab between groups. No patients reported complications of FI block.

**DISCUSSION/CONCLUSION:** This study demonstrates that FI block can be a useful tool in multimodal pain control while significantly decreasing the amount of opioid medication consumed by femoral shaft and distal femur fracture patients.

**Paper 036****Fascia Iliaca Compartment Block and Pericapsular Nerve Group Block Reduce Opioid Consumption in Hip Fracture Patients**

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**INTRODUCTION:** Effective pain control and reduced opioid consumption can improve outcomes and reduce complications in hip fracture patients. The fascia iliaca compartment block (FICB) has been shown to be effective and safe in the management of acute hip fracture pain, while reducing opioids in elderly patients at high-risk for medication side effects. The pericapsular nerve group (PENG) block is theorized to provide improved analgesia and limit motor weakness by targeting the highly innervated anterior hip capsule, as well as sensory branches of the femoral, obturator, and accessory obturator nerves. The evidence of the hypothesized advantages of the PENG block are limited to small case series; therefore, the goal of this retrospective analysis was to compare pain scores and morphine milligram equivalents (MME) in hip fracture patients treated with a FICB, PENG block, or no regional nerve block.

**METHODS:** IRB approval was obtained. Patients presenting to a single institution between December 2011 and August 2021 were included. Patients were excluded for age less than 65 and high energy trauma. Primary outcomes were patient reported pain scores (0-10) and MME.

**RESULTS:** 2,662 hip fracture patients were identified, including 2,024 FICB patients, 285 PENG blocks, and 353 no block patients. FICB and PENG block patients had significantly lower mean MME preoperatively (37.5 and 33.6 respectively) than 60.6 for patients without a block ( $p < 0.001$ ). The mean total MME in postoperative days 1 through 4 for the FICB and PENG blocks was 72.3 and 58.3, which was significantly lower than 98.6 for patients in the no block group ( $p < 0.001$ ). The PENG block demonstrated significantly lower MME compared to the FICB on postoperative day 2 (14.4 vs. 19.1,  $p = 0.046$ ). The mean pain scores for FICB patients was 2.0 and 2.2 on postop days 1 through 2, which was significantly lower than 2.6 for both days in the no block group ( $p < 0.001$  and  $p = 0.005$ , respectively).

**CONCLUSIONS:** FICB and PENG blocks used in the acute management of hip fractures significantly reduced mean opioid consumption during admission without meaningful effects on pain scores. Reduced MME in the block groups was most notable preoperatively and on postoperative day 1. While there was a trend towards lower MME in the PENG block group, there was not sufficient evidence that the PENG block provided clinically superior analgesia to the FICB block in hip fracture patients.

**Paper 037****The Use of the Piriformis Fossa Radiographic Landmark to Predict "In-Out-In" Placement of the Posterosuperior Femoral Neck Screw**

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**INTRODUCTION:** Despite being a common treatment of femoral neck fractures (FNF), cannulated screw fixation (CSF) is associated with a high incidence of cortical breach leading to the "in-out-in" (IOI) posterosuperior screw, with a recent study demonstrating an incidence of 58% using postoperative CT scans. A subsequent small cadaveric study demonstrated that placement of the posterosuperior screw caudal to the radiographic landmark of the piriformis fossa (PF) may prevent IOI screw placement. The purpose of the study was to determine if the use of the radiographic landmark of the PF can be used to predict IOI placement diagnosed on postoperative CT scan.

**METHODS:** Four fellowship trained orthopedic trauma surgeons blindly and independently evaluated intraoperative AP fluoroscopic images of 104 patients treated with CSF of a FNF at a level I trauma center. Inclusion criteria included patients who were treated with CSF of a FNF and had a postoperative CT scan. Patients with fluoroscopic views demonstrating cortical breach, inadequate fluoroscopic views, or screws too central within the femoral neck (>1 screw diameter from the cortex) were excluded. Each surgeon reviewed AP fluoroscopic views and assigned patients to two groups: above the piriformis fossa (APF) and below the piriformis fossa (BPF). After grouping into APF or BPF, the incidence of IOI screw placement as previously identified on postoperative CT scan was compared. APF screws were considered to predict IOI placement, and BPF screws were considered safe. Accuracy, sensitivity, specificity, and interobserver reliability for the PF landmark prediction of posterosuperior IOI screws were assessed.

**RESULTS:** A total of 73 patients were evaluated. In comparison to the CT results, the overall accuracy of responses was 89% (range 85-93%). In using the relation of the screw to the PF to predict IOI placement, the average sensitivity was 90% (range 84-93%) and specificity was 88% (range 80-93%). There was statistically almost perfect agreement among surgeons ( $\kappa = 0.81$ , range 0.74 to 0.91).

**CONCLUSION:** The relationship of a screw relative to the radiographic margin of the PF on fluoroscopy to predict IOI placement appears to be highly sensitive and specific when compared to the gold standard of CT. Clinical studies using a technique that incorporates the use of the PF landmark are warranted to determine if IOI placement can be prevented by placing the posterosuperior screw caudal to the PF.

**Paper 038****Cemented vs. Cementless Total Hip Arthroplasty for Acute Femoral Neck Fractures: A Multicenter Study**

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**INTRODUCTION:** The AAOS CPGs report moderate evidence for cementing femoral stems during arthroplasty for hip fractures. However, this recommendation derives from hemiarthroplasty literature. Little data exists on this topic in total hip arthroplasties (THAs). Recent registry data supports these guidelines. This is the first non-registry study comparing outcomes of cemented vs. cementless THA for acute femoral neck fractures.

**METHODS:** A multi-center retrospective study of 709 THA cases (199 cemented, 600 cementless) for femoral neck fractures from 2006-2021 at three academic institutions. Demographics and perioperative characteristics were reviewed. Proximal femur radiographs were assessed for femoral quality using the Dorr classification. Complication rates were compared at multiple time intervals. Univariate and multivariate analyses were performed with significance set at  $p \leq 0.05$ .

**RESULTS:** Patients receiving cemented implants were older ( $p < 0.001$ ), of lower BMI ( $p = 0.025$ ), more likely to be female ( $p = 0.003$ ), had a higher rate of osteoporosis ( $p < 0.001$ ), more likely to have Dorr C bone ( $p < 0.001$ ), had longer operative times ( $p = 0.010$ ), had longer hospital stays ( $p < 0.001$ ), and were more likely to be discharged to a skilled nursing facility or rehab ( $< 0.001$ ). There was no difference between groups in terms of ASA score or Charlson comorbidity index (CCI) ( $p > 0.05$ ).

Cementless stems had a higher all-cause aseptic femoral revision rate (5.1% vs. 0.5%,  $p = 0.002$ ) and periprosthetic femoral fracture rate (4.3% vs. 0%,  $p = 0.001$ ). Each successive Dorr grade had a higher fracture rate with cementless implants: 2.3%, 3.7%, and 15.9% in Dorr A, B, and C respectively ( $p < 0.001$ ). Logistic regression confirmed that cementless stems and Dorr C bone are associated with periprosthetic fractures ( $p < 0.05$ ). There was no difference in sex between patients who sustained a fracture ( $p = 0.374$ ). Collared stems and prophylactic cables did not confer protect against fractures in cementless fixation ( $p > 0.05$ ).

There was no difference in dislocation or septic revision rates between cohorts ( $p > 0.05$ ). The mortality rate of the cohort was 1.3% at 30 days, 2.5% at 90 days, and 4.5% at 1 year postoperatively. One-year mortality was associated with age ( $p = 0.013$ ), BMI ( $p = 0.123$ ), CCI ( $p = 0.024$ ), diabetes ( $p = 0.014$ ), and length of hospital stay ( $p = 0.033$ ).

**CONCLUSIONS:** Cementless stems utilized during THA for femoral neck fractures have higher periprosthetic fracture and all-cause aseptic femoral revision rates. While femoral fractures occurred in all types of bone quality, Dorr C bone was particularly with cementless stems. All fractures occurred in cementless cases, suggesting that cemented stems may minimize this complication, regardless of patient or implant characteristics.



**Paper 039**

**Revision Sacroiliac Joint Fusion: One-Year Outcomes Using a Principles-Based Approach - Joint Decortication, Bone Grafting, Compression, and Rigid Internal Fixation**

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**BACKGROUND:** Sacroiliac joint fusion (SIJF) has been established as an effective treatment for sacroiliac joint dysfunction (SIJD). However, failure necessitating revision has been reported in up to 30% of cases. Little is known regarding outcomes of revision SIJF.

**METHODS:** We retrospectively reviewed all revision SIJF at a single academic center between 2017-2020. Revision surgery was performed using the principles of joint decortication, bone grafting, compression, and rigid internal fixation. Outcomes were assessed at 6 months and 1 year after surgery using the Oswestry Disability index (ODI), Numerical Pain Rating Scale (NPRS), and Single Assessment Numerical Scale (SANE). Fusion was assessed with CT scan at 12 months postoperatively.

**RESULTS:** Twenty-one revision sacroiliac joint fusions (SIJF in 15 patients) were included. The mean age was 55.7 years (range 31 – 80). Mean BMI was 27.8 (range 21.7-36.7). 53% of the patients were female. The indications for revision were pseudoarthrosis without fixation failure in 15 cases (71.4%), hardware failure (loosening) in 3 cases (14%), implant malposition in 2 cases (9.5%), and continued pain after partial fusion in 1 case (4.7%). ODI and NPRS scores demonstrated significant statistical and clinical improvements at all time points. Mean (SD) ODI scores improved from 51.6 (19.63) preop to 37.3 (19.22) at 6 months, and 34.4 (21.2) at 12 months. Improvement in ODI was found in 17 joints (81%) and the minimal clinically important difference was achieved in 12 joints (57%). Mean (SD) NPRS scores improved from 6.7 (1.39) preop to 3.62 (2.82) at 6 months, and 3.7 (2.59) at 12 months. Improvement in NPRS was also identified in 17 joints (81%), and 13 joints (62%) achieved MCID for NPRS. Mean SANE score (SD) was 72.1% (32.24) at 6 months and 69.6% at 12 months. Sixteen cases (76%) achieved the MCID for SANE score (MCID 30). There were no radiographic lucencies, implant subsidence, or implant fractures at final follow-up. We identified an 86% fusion rate with definitive bridging bone across the SIJ.

**CONCLUSION:** Revision SIJF utilizing a principles-based technique of 1) joint decortication, 2) compression, and 3) rigid internal fixation shows improvement in patient reported outcomes as well as high rate of fusion at 12 months. The most common indications for revision SIJF are symptomatic pseudoarthrosis and implant loosening.

**Paper 040****Outcomes of Patella Fracture Fixation: Novel Wagon Wheel Construct vs. Tension-Band Construct**

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**PURPOSE:** Internal fixation of patella fractures remains technically challenging. Tension band constructs (TBCs) are associated with high rates of implant prominence and fracture comminution can make application of a tension band impractical. We present the results of a novel technique utilizing a transtendinous/transligamentous mini-fragment plate positioned peripherally around the patella with radially directed screws: termed the wagon-wheel (WW) construct. Clinical outcomes were compared to a cohort of patella fractures treated with TBCs.

**METHODS:** A retrospective review was performed on 59 patella fractures (OTA/AO 34) from 2010 to 2021 at a Level I trauma center. Patients were treated with a WW (n=22) or TBC (n=37). Postoperative protocols were similar between groups. Clinical and radiographic outcomes were compared. Categorical variables were assessed via Fisher's exact test. ANOVA was used for continuous variables. Kaplan Meier analysis and Cox Proportional Hazard Regression were performed to evaluate time to event outcomes (i.e., union). Mean follow-up was 23 months.

**RESULTS:** Range of motion at final follow up was 114.7° vs. 113.8° in the WW and TBC groups, respectively (p=0.94). Two patients (10%) treated with WW were gait aid dependent, compared to 14 patients (38%) treated with TBC (p=0.031). There was no difference in the rate of nonunion between groups (WW: 0% vs. TBC: 6%, p=0.075). The WW construct had a significantly decreased incidence of symptomatic implants (5% vs. 32%, p=0.02) and rate of reoperation (9% vs. 38%, p=0.018). Treatment with WW was associated with faster time to union (HR: 2.2; 95% CI 1.28-3.95, p=0.005).

**CONCLUSION:** The WW construct was designed with the goal of obtaining peripheral plate fixation to maximize fragment specific fixation while minimizing implant prominence. In our study, patients treated with the WW had statistically significant improvements in numerous outcomes including lower rates of gait aid usage, symptomatic implants, reoperations, and faster time to union.

**Paper 041****Preoperative MRI Delays Surgery in Pediatric Patients with Infectious Atraumatic Extremity Pain**

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**INTRODUCTION:** Management of atraumatic extremity pain in a pediatric patient often poses a dilemma to the treating orthopedic surgeon. The benefits of timely intervention must often be weighed against the utility of preoperative MRI to better characterize the responsible infection or other pathology. To determine if outcomes were superior for patients who underwent preoperative vs. postoperative MRI, this multicenter study reviewed the hospital courses of pediatric patients who presented with atraumatic extremity pain, underwent irrigation and debridement, and received at least one preoperative or postoperative MRI during their admission.

**METHODS:** This study is a multi-institution retrospective review from four pediatric tertiary referral centers of patients 0-16 years who presented with atraumatic pain of an extremity, underwent irrigation and debridement, and received at least one preoperative or postoperative MRI from 2010 through 2019. Primary outcomes were time to OR, length of stay (LOS), number of MRIs, and number of I&Ds. Secondary outcomes included accompanying aspirations, number of hospitalizations, acuity of symptoms, and laboratory test results.

**RESULTS:** 158 patients were identified, of which 77.2% had at least one preoperative MRI while 22.8% only had postoperative MRI. Members of the postoperative MRI cohort were more likely to undergo aspiration during admission ( $p < 0.0001$ ). Patients that received preoperative MRI had significantly greater time to OR (mean difference 1.07 days,  $p = 0.0003$ ). There were no significant differences in the average LOS ( $p = 0.4029$ ), total number of surgeries ( $p = 0.2314$ ), total number of MRIs ( $p = 0.5015$ ), and total hospitalizations ( $p = 0.2158$ ). When limiting the analysis to the 63 patients who were diagnosed with a septic joint, time to OR remained the only significant difference in outcome ( $p = 0.0003$ ).

**DISCUSSION:** Pediatric patients that received preoperative MRIs had longer time to OR and greater overall numbers of MRIs without any reductions in LOS, additional surgeries, or total number of hospitalizations. In patients with clinical and laboratory findings concerning for infection with radiographs and/or aspiration supporting a diagnosis of osteomyelitis, abscess, or septic joint, preoperative MRI may not be necessary.

**Paper 042**

**Assessing the Safety and Efficacy of Tranexamic Acid Usage in Osteogenesis Imperfecta Patients**

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**BACKGROUND:** This study aims to evaluate the safety and efficacy of tranexamic acid (TXA) usage to reduce blood loss in surgeries in children with Osteogenesis Imperfecta (OI). We want to assess the potential benefits, risks, and complications involved in the usage of TXA in this pediatric orthopedic population.

**SIGNIFICANCE OF PROBLEM:** Due to increased fracture burden and bone deformity caused by OI, patients tend to have numerous operations throughout their life. In addition to these skeletal manifestations, there is a potential increase in susceptibility to bleeding due to the increased frequency of orthopedic procedures. Increased blood loss during orthopedic procedures warrants investigation into potential ways to mitigate any risk of excessive intraoperative blood loss.

**HYPOTHESIS, PROBLEM, OR QUESTION:** Our hypothesis is that there will be a reduction in intraoperative blood loss and perioperative transfusion rate between OI patients that received TXA intraoperatively during femoral rodding procedures vs. those who did not receive the intervention.

**EXPERIMENTAL DESIGN:** TXA-receiving patients (cases) were matched 1:1 with non-TXA receiving controls on the following criteria: age within 2 years, bone category, and OI Type. Descriptive statistics were used to summarize the data. Fisher's Exact Test was performed to compare transfusion status between groups. A Wilcoxon Rank Sum test was performed to assess differences between the groups in days of stay, length of surgery, and EBL. All analyses were conducted using SAS version 9.4.  $P < 0.05$  was considered statistically significant.

**RESULTS/DATA:** Our TXA-receiving population of 30 patients consisted of 11 females and 19 males. One patient was OI type I, 13 were OI type III, 14 were OI type IV, and 2 were categorized as other (not one of the four most common types). We found a significant difference in transfusion status ( $p = 0.02$ ), with no TXA patients requiring a transfusion compared to 20% of the control cases. There is also a significant difference in median EBL ( $p = 0.0004$ ) between groups, with TXA patients having a lower intraoperative EBL (20 mL vs. 62.5 mL). There was also a difference in median days of post-operative stay between TXA receiving and non-TXA receiving patients ( $p = 0.001$ ; 2.6 days vs. 4 days).

**CONCLUSIONS:** Our study concluded that the use of TXA in this patient population is associated with a lower rate of perioperative transfusions and intraoperative blood loss. These results support the standard usage of TXA in these patients to reduce intraoperative blood loss.

**Paper 043**

**Unplanned Return to the Operating Room (UPROR) Occurs in Half of MCGR Patients at 2.4 Years After Initial Implantation**

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**HYPOTHESIS:** A majority of MCGR implants would survive to achieving maximal lengthening without UPROR.

**STUDY DESIGN:** Multiple institution, retrospective review of prospective data.

**INTRODUCTION:** At the onset of the MCGR era, several cost-analysis studies were published assessing the potential cost-effectiveness of MCGR compared to TGR. These studies found MCGR to be cost effective compared to TGR, but they were limited by small numbers and low level of evidence. Because these studies assumed a low rod failure rate over the life of the initial implant, the survivability of the initial implant directly influences the accuracy of these initial cost estimates. The goal of this study was to determine an accurate accounting of the rates for UPROR of the initial MCGR implant from a large multi-center prospective database.

**METHODS:** EOS patients that underwent MCGR implantation, and had at least one lengthening were reviewed. Age at placement, preop cobb diagnosis, lengthening duration, and cause of UPROR were analyzed.

**RESULTS:** 376 EOS patients were included in the review. No patients had surgery prior to initial MCGR implantation at a mean age of 7.7 years. The mean preop cobb was 76.7°, and immediate postop correction was 41%. We found that 45% (168/376) of MCGR patients experienced an UPROR prior to maximal actuator length being achieved. UPROR occurred at an average of 2.42 years after initial implantation. The most common reason for UPROR was MCGR implant (44/376: 11.7%) or anchor related complications (70/376: 18.6%). Wound related: 32/276 (8.51%), Neuro related: 6/376 (1.59%), and Other: 16/376 (4.25%) accounted for the remaining UPROR occurrences.

Patients that experienced an UPROR were younger at MCGR insertion (6.98 vs. 8.07 yrs.)  $p = 0.00001$ , and stiffer, with less initial correction (38.6° vs. 42.7°)  $p = 0.0441$ . There were no differences when comparing preop cobb (76.6° vs. 76.8°,  $p = .9$ ), or BMI (16.5 vs. 16.3,  $p = .9$ ) between the patients that experienced and UPROR and those that did not. Patients with an underlying neuromuscular diagnosis were more likely to experience a wound related UPROR ( $p = 0.001$ )

**CONCLUSION:** Approximately half (45%) (168/376) of MCGR patients experience an UPROR prior to maximal actuator length being achieved. The most common reason for UPROR was MCGR implant or anchor related (114/376) 30.3%. Patients that experienced an UPROR were younger at MCGR insertion (6.98 vs. 8.07 yrs.)  $p = 0.00001$ , and stiffer, with less initial correction (38.6° vs. 42.7°)  $p = 0.0441$ .

**TAKE HOME MESSAGE:** MCGR UPROR rate was 168/376 (45%) after an average of 2.42 years post implantation. The "true" survival rate of the MCGR rod is lower than the initial estimates, and this may impact initial cost estimates and the time required to achieve cost neutrality of this implant.

**Paper 044**

**A Novel Technique for Delivery of Nusinersen After Posterior Spinal Fusion in Patients with Spinal Muscular Atrophy**

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**INTRODUCTION:** Spinal muscular atrophy (SMA) is one of the leading genetic causes of infant mortality. There is a high incidence of scoliosis in patients with SMA. Due to the short life expectancy for patients with this disease, spinal management with posterior spinal fusion (PSF) has historically not been discussed. New therapies have led to a better prognosis for these patients, increasing the prevalence of management of their scoliosis. The most common treatment for SMA is nusinersen, an antisense oligonucleotide drug that is administered via intrathecal injection. An arising issue is how SMA patients can continue to receive intrathecal injections after posterior spinal fusion. Previous literature has suggested multiple avenues to allow continued intrathecal injection including leaving lumbar levels unexposed during fusion, performing laminotomy or laminectomy during or following fusion, and implanting intrathecal pumps. The objective of our study was to examine the efficacy of a novel technique for nusinersen administration after posterior spinal fusion in patients with Spinal Muscular Atrophy.

**METHODS:** We retrospectively conducted a chart review at our institution to identify patients with SMA who underwent placement of a 6.5mm cannulated screw into the intact L3 spinous process at the time of PSF. The novel technique of screw placement was designed to allow for continued intrathecal injections postoperatively. We analyzed short- and long-term follow-up and assessed for any complications with nusinersen administration after posterior spinal fusion utilizing this novel delivery technique.

**RESULTS:** Four patients underwent this technique at our institution over a 3-year period. Patients had an average of 24.5 months of follow up. 22/23 nusinersen intrathecal injections were performed without any complications. One injection attempt was aborted when CSF return was unable to be achieved through the screw construct, but multiple successful intrathecal injections were later performed through the same construct. No cases of implant failure, prominence, or irritation was found.

**CONCLUSIONS:** Utilization of a 6.5mm cannulated screw placed into the intact L3 spinous process of patients with SMA who undergo PSF appears to be an efficacious delivery device for nusinersen injection. Short- and long-term follow-up did not find any complications with nusinersen administration. This appears to not only be an effective delivery technique, but also safe and cost effective.

**Paper 045**

**Adolescent Idiopathic Scoliosis Treated with a Unilateral Posterior Peri-Apical Distraction Device (ApiFix): Preliminary Results at One-Year Follow-Up**

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**INTRODUCTION:** The ApiFix system has been proposed as a potentially less invasive, motion-preserving treatment option for adolescent idiopathic scoliosis (AIS) compared to posterior spinal fusion. Eligible patients must have a single, flexible Lenke 1 or 5 curve (i.e. reduces to 30° or less on side-bending). The patients' Cobb angle must be between 35-60° with thoracic kyphosis less than 55° from T5 to T12. The purpose of this study is to report preliminary outcomes of patients undergoing ApiFix implantation with 1-year follow-up.

**METHODS:** IRB approval was obtained for this longitudinal, multi-center prospective study. Patients who met inclusion criteria for ApiFix were consented for enrollment. Preoperative radiographic measurements recorded coronal curve magnitude and flexibility, sagittal alignment, and maturity stages. These values were again recorded at one-year follow-up. All complications were recorded. Preliminary results are reported.

**RESULTS:** The present analysis included 130 patients with AIS treated with ApiFix with 35 patients reaching the 1-year follow-up. Lenke 1 and 5 curves represented 23 and 12 patients, respectively. Length of stay averaged 1.37 days. 119 minutes was the average length of surgery and blood loss averaged 45.5mL. Average initial primary Cobb angle was 46.8° and secondary Cobb angle averaged 29.5°. At one-year primary curves averaged 17.3° and secondary curves 16.9°. There were four returns to OR. A patient with 21° degrees of correction underwent removal of implant 20 months after index procedure for painful hardware. A Lenke 1 patient with initial curve of 47° had revision of implant for progression of curve to 36°. Two Lenke 5 curve patients required revision, one for breakage of hardware at 6.5 months and the other for ApiFix screw pullout at 15.5 months.

**DISCUSSION & CONCLUSION:** Preliminary results including operative times, lengths of stay, and estimated blood loss indicate that the ApiFix device may present a less invasive surgical treatment for AIS. Most patients achieved desired correction of their scoliotic curves at one-year follow-up. No patients in this series went on to definitive fusion. The 11% re-operation rate (4/35) of patients with at least one-year follow-up is worth noting. While this is far lower than previous studies utilizing non-fusion techniques, further follow-up and continued investigation into the risks and benefits of fusionless correction of AIS is warranted.

**Paper 046**

**Patient Reported Outcomes Following Calcaneal Lengthening Osteotomy for Treatment of Pediatric Painful Flexible Flatfoot**

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**BACKGROUND:** Calcaneal lengthening osteotomy (CLO) is commonly used to treat idiopathic flexible flatfoot (IFF) in children. The purpose of this study is to investigate the impact of CLO on pain and mobility PROMIS scores of pediatric patients treated for IFF.

**METHODS:** Children aged 8-18 who underwent CLO to treat IFF were included. PROMIS scores for pain and mobility were retrospectively collected. In patients who received a unilateral procedure, preoperative PROMIS scores were compared to PROMIS scores collected within 6-12 months postoperatively. Among patients who received bilateral procedures, the preoperative scores of the first foot were compared to the second foot's final scores collected within 6-12 months postoperatively. Five PROMIS points was determined to be a minimal clinically significant difference, as this is half of the standard deviation of the PROMIS metric.

**RESULTS:** 21 patients with 31 feet were included in the study, with an average age of 12.2 (range 9 - 15) years old at the time of surgery. Mean preoperative pain and mobility PROMIS scores were 53.6 (range 32.2 - 69.6) and 42.5 (range 25.5 - 56.4) respectively. Mean postoperative pain and mobility PROMIS scores were 47.1 (range = 32 - 59) and 48.3 (range = 31.6 - 61.7) respectively. Paired t-test returned a statistically significant improvement in both pain ( $p = 0.005$ ) and mobility ( $p = 0.017$ ). Average pain decreased by 6.5 points and average mobility increased by 5.8 points after CLO, both clinically significant changes following CLO.

**CONCLUSION:** There is an association between calcaneal lengthening osteotomy procedures and a significant improvement in pain and mobility PROMIS scores in children treated for idiopathic flexible flatfoot.



**Paper 047****Preliminary Results of Access to Orthopedic Care in Pediatric Patients with Osteogenesis Imperfecta**

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Osteogenesis imperfecta (OI) is a connective tissue disorder caused by collagen mutations. Manifestations include multiple or atypical fractures, short stature, scoliosis, hearing loss, and opalescent teeth. Patients visit providers in orthopedic surgery, dentistry, and physical and occupational therapy. Frequent visits and procedures may place financial burdens on OI patients. This study sought to identify socioeconomic barriers to care for pediatric OI patients.

This study consists of an IRB-approved survey for caregivers of children with OI, ages 0-19. It is collected and secured via REDCap. Demographic questions include age, OI subtype, and gender identity. Additional topics include health insurance type, insurance denials, caregivers' highest level of education, access to multidisciplinary medical care, and distance traveled for care. The Osteogenesis Imperfecta Foundation (OIF) emailed a survey invitation to 2,500 members throughout the USA. There are 67 responses thus far.

Results include patients ages 0-17, with 28 identifying as male and 32 as female (5 preferred not to respond). The OI subtypes represented are 1, 2, 3, 4, 5, 7, 8, 14, and 15; the majority (39.7%) are type 1. The most reported highest level of education for caregivers is a bachelor's degree. Twenty responders reported at least one primary caregiver left the workforce to care for their child's needs. The most reported health insurance type is private, with the majority (46 of 53) acquired through a parent employer. Ten responders indicated they have avoided a medical visit or declined an orthopedic procedure for their child due to fear of high costs and/or debt. Twenty-six responders stated their child does not visit a multidisciplinary OI clinic (i.e., multiple specialists in a single visit). Of those, 21 said they wished this was an option for their child. Twenty-six responders travel out of state or over 100 miles for their child's OI care. Of those, the average round-trip miles traveled is 887.65; 22 stated they consider this a financial burden for their family.

To our knowledge, this survey is the first to investigate barriers to care for pediatric OI patients. Preliminary results indicate that travel is a financial burden for some families seeking OI care. Access to a multidisciplinary clinic is desired by the majority of families; financial burden is one of the biggest concerns for this access.

**Paper 048****Retrospective Analysis of Opioid Prescription Patterns Following Anterior Cruciate Ligament Reconstruction in a Pediatric Population**

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**PURPOSE:** The opioid epidemic sparked discussions surrounding opioid prescription patterns and the role of healthcare in mitigating the effects of opioids on patients. In 2017, Ohio implemented the Opioid Prescribing Guidelines limiting narcotic prescriptions for acute pain. This analysis of opioid prescriptions associated with pediatric ACL reconstruction provides data regarding pain management practices and the impact of the OPG on prescription patterns.

**METHODS:** This study retrospectively analyzed 86 ACL reconstructions in patients aged  $\leq 18$  at a single pediatric hospital system from 2016-2018. Analysis included predictors of Morphine Equivalent Dose (MED) at discharge, predictors of receiving an opioid prescription within 90 days of surgery, the effect of OPG on discharge and total MED, and the likelihood of receiving an opioid prescription within 90 days of surgery both pre-OPG and post-OPG.

**RESULTS:** Discharge NSAIDs, sex, body mass, and sport had no significant impact on discharge MED. However, patient age had a significant relationship with discharge MED ( $P=0.002$ ), predicting that MED at discharge increases by 20.7 (CI 12.3-29.1) on average per year increase in patient age; 20.7 MED is roughly 3 additional 5mg Oxycodone tablets or 4 additional 5mg Hydrocodone tablets. Significantly less discharge MEDs were prescribed post-OPG compared to pre-OPG ( $P<0.001$ ). In addition, significantly less total MEDs were prescribed within 90 days of surgery post-OPG ( $P<0.001$ ). However, in the pre-OPG sample, 7.9% of patients received a follow up opioid prescription, compared to 33.3% percent in the post-OPG sample ( $P=0.008$ ). Additional analysis confirms that patients were significantly more likely to receive a follow-up opioid prescription post-OPG ( $P=0.003$ ; OR 5.833; CI 1.554-21.903) after controlling for sex, age, discharge NSAIDs, sport, discharge MED, follow-up NSAIDs, and body mass.

**CONCLUSIONS:** This study indicates that age independently predicted MED at discharge and this was not confounded by body mass. Discharge and follow-up NSAIDs had no significant impact on the likelihood of receiving a follow-up opioid prescription. Although patients were significantly more likely to receive a follow-up opioid prescription post-OPG, prescription guidelines did modify physician behavior leading to a significant decrease in the amount of opioids prescribed at discharge and overall within 90 days of surgery.

**Paper 049****Changes in Incidence of Pediatric Fractures During the Covid-19 Pandemic**

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**PURPOSE:** The cancellation of in-person scholastic and athletic events during the Coronavirus-19 (COVID-19) pandemic has affected rates and patterns of pediatric orthopedic trauma. The purpose of this study was to compare fracture incidence, mechanism of injury, and treatment patterns for pediatric patients presenting to a level 1 trauma center between the pre-pandemic (March to September 2019) and pandemic (March to September 2020) periods.

**METHODS:** Patients were identified using our institutional database. The following inclusion criteria were utilized: age 18 years or younger at the time of presentation to the Emergency Department (ED), clinical and radiographic diagnosis of a fracture involving the upper/lower extremity or spine, and adequate imaging. Retrospective chart review was performed and the following information was obtained: age, gender, mechanism of injury, diagnosis (using orthopedic Trauma Association and Salter Harris classifications), treatment, and follow-up. Basic descriptive statistics and comparative analyses were performed between the pre-pandemic and pandemic cohorts.

**RESULTS:** 965 fractures were identified during the two time periods. Fracture incidence decreased 21.3% between the pandemic (n=425) and pre-pandemic (n=540) timeframes ( $p < 0.01$ ). There was a decrease in the average monthly fracture rate pre-pandemic ( $77.1 \pm 16.0$ ) vs. during the pandemic ( $60.7 \pm 17.5$ ) ( $p = 0.06$ ). Comparing the pre-pandemic and pandemic cohorts: fractures resulting from bicycles increased from 3% to 6% ( $p = 0.03$ ), motor vehicle/ATV collisions increased from 13.5% to 20.5% ( $p < 0.01$ ), and ballistic injuries increased from 9.6% to 13.3% ( $p = 0.07$ ). Sports-related fractures decreased from 18.1% to 6.8% ( $p < 0.01$ ), and playground injuries decreased from 11.1% to 6.8% ( $p = 0.02$ ).

**CONCLUSION:** Results show a decrease in the total number of fractures between the pre-pandemic and pandemic cohorts, with a decrease in fractures from sports and playground injuries being most notable. High energy motor vehicle/ATV collisions and ballistic injuries increased, consistent with locally reported increases in gun violence and motor vehicle accidents during 2020.

**SIGNIFICANCE:** These data raise public health concerns regarding the effects of the pandemic as it relates to gun violence and driving habits. In addition, these findings may imply that sports may be a path to violence reduction.

**Paper 050****Pediatric Radial Neck Fractures: Clinical and Radiographic Outcomes of Closed Reduction in the Emergency Department**

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Radial neck fractures account for 5% to 10% of pediatric elbow fractures and 1% of all pediatric fractures. It is generally accepted that radial neck fractures angulated < 30 degrees and translated < 2 mm can be managed successfully with simple immobilization. Controversy exists regarding the optimal approach to managing radial neck fractures with angulation between 30 and 60 degrees. In this retrospective cohort study, our goal was to determine the success rate and any predictive factors for failure of closed reduction in the emergency department in pediatric patients with radial neck fractures.

A total of 114 pediatric patients between ages 3 and 16 with radial neck fractures were identified at our institution between January 1, 2010 and December 31, 2018. Twenty-two fractures were reduced in the operating room without an initial attempt in the emergency department, 54 were managed with immobilization without reduction, and 13 were excluded for inadequate imaging or concomitant injuries. Twenty-five patients were included in our final analysis and underwent attempted closed reduction in the emergency department. Seventeen of these were managed nonoperatively following successful closed reduction (68%). The remaining 8 patients failed initial closed reduction attempt and required operative intervention as follows: 4 underwent open reduction, 2 underwent closed reduction with percutaneous fixation, 1 underwent closed reduction, and 1 underwent open reduction with percutaneous fixation.

The primary factor predictive of failed closed reduction was higher initial anterior-posterior angulation (62.6 degrees vs. 41.1 degrees;  $p=0.01$ ). Patient age, injury laterality, and initial displacement were not predictive of failure. Treatment of pediatric radial neck fractures with initial angulation between 30 and 60 degrees should include attempted closed reduction in the emergency department. For fractures with initial angulation greater than 60 degrees, it is reasonable to proceed directly to operative intervention.

**Paper 051****Is Prematurity A Risk Factor for Developmental Dysplasia of the Hip? A Systemic Review and Meta-Analysis**

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**INTRODUCTION:** Developmental dysplasia of the hip (DDH) is the most common orthopedic disorder in newborns. Early diagnosis is critical to prevent hip osteoarthritis and severe functional limitations in young adults. While several risk factors including breech position, female sex, and family history have been identified, the association between prematurity and DDH remains unclear. Our analysis sought to analyze the available literature exploring the relationship between prematurity and DDH.

**METHODS:** PubMed, EBSCO host, Medline, and Google Scholar databases were utilized to identify articles evaluating prematurity and DDH published between January 1, 2000 and February 1, 2022. All identified articles were independently assessed by two reviewers with a third reviewer used in arbitration, following PRISMA guidelines. Initial query yielded 649 publications, with 50 undergoing full-text review and 11 fulfilling our inclusion and exclusion criteria. Meta-analysis was conducted when two or more articles reported data regarding the same outcome measure.

**RESULTS:** A total of 8,720 patients with 4,552 males (52%) and 4,168 (48%) females were included. The gestational age ranged from 23-36 weeks for preterm and  $\geq 37$  weeks for term. Seven of the included studies demonstrated that gestational age did not have a significant impact on DDH. Pooled analysis of available data demonstrated no significant difference in DDH among preterm and term infants (OR, 1.11; 95% CI, 0.82-1.51,  $p=0.49$ ). Sub-group analysis of two studies reporting data on very preterm ( $\leq 32$  weeks) and term infants revealed no significant difference in occurrence of DDH (OR, 4.58; 95% CI, 0.09-244.78,  $p=0.45$ ). Four studies found early gestational age to be associated with a significantly higher incidence of mature hips compared to late preterm or term babies. Pooled analysis demonstrated significantly lower Graf classification among preterm infants (OR, 0.13; 95% CI, 0.03-0.61,  $p=0.009$ ).

**DISCUSSION & CONCLUSION:** The majority of available studies demonstrated no association between prematurity and the rate of DDH. Our pooled analysis likewise showed no association. Current recommendations are for ultrasound screening in infants at high risk for DDH, and the findings of our study suggest that prematurity in isolation would not warrant ultrasound assessment of the hip. Furthermore, our pooled analysis showed that prematurity was associated with increased hip maturity. This is hypothesized to be related to decreased intrauterine restrictions for premature infants or to decreased exposure to maternal hormones, however, this requires further investigation.

**Paper 052**

**Pediatric Patients are Ready to Return to Sport at Six Months Following Meniscal Repair Based on Isokinetic Dynamometry Testing**

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**OBJECTIVES:** Many meniscal tears occur during sport activity, and the goal of surgery is to return an athlete to sport activity (RTP). Strength symmetry is a RTP criteria when considering return to cutting pivoting sports. The purpose of this study was to establish appropriate knowledge and expectations for RTP following meniscus repair in patients ages 18 and under. It was hypothesized that patients will not meet RTP criteria based on dynamometry at four months postop, but will at six months postop.

**METHODS:** Records were reviewed to identify patients who underwent meniscus repair at a single institution between 2009 and 2018. Patients were included if 18 years of age or under at the time of surgery and underwent dynamometry testing at 4 and 6 months postoperatively. Isokinetic dynamometry testing measured quadriceps and hamstring strength at 60°/sec and 300°/sec (ft/lbs). Limb symmetry index (LSI (%)) was calculated [(involved/uninvolved) x 100%], and RTP eligibility was deemed as LSI >85%.

**RESULTS:** Twenty-three patients met all inclusion criteria for analysis. The mean age was 16±1.24 years, with sex distribution being 52% male and a mean BMI of 24.3±4.47. Athletes participated in the following sports: basketball, football, soccer, lacrosse, wrestling, volleyball, softball, track and field; including three multi-sport athletes. All had a Tegner activity scale >7. 83% of patients had concurrent ligamentous reconstruction at the time of meniscus surgery.

**CONCLUSION:** Only ~50% of patients with isolated meniscus repair met RTP criteria at 4 months. However, 75% or greater met criteria at 6 months. Additionally, patients with a concurrent ligamentous repair were less likely to meet RTP criteria. These data suggest that formal physical therapy for 6+ months is beneficial to achieve RTP strength criteria for those with isolated meniscus repair, while those with concurrent ligamentous repair require additional time to meet RTP strength criteria.

**Paper 053****Preoperative Coronal Plane Deformity May Affect Accuracy of Robotic-Arm Assisted Total Knee Arthroplasty**

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**INTRODUCTION:** Initial literature report precise bone cuts in robotic arm assisted total knee arthroplasty (raTKA). There is concern that sclerotic bone, often seen in patients with advanced osteoarthritis with resultant preoperative coronal plane deformity (POCD), can affect the accuracy of bone cuts during raTKA. The purpose of this study was to investigate the association between the magnitude of POCD and the accuracy of raTKA bone cuts.

**METHODS:** Intraoperative measurements from 116 consecutive patients undergoing primary raTKA with a single robotic arm were obtained at a single institution. Using CT based intraoperative navigation, the magnitude of deviation from the pre-cut plan for distal femoral varus/valgus angle (FVV), femoral depth (FD), and femoral flexion/extension (FFE) angle as well as tibial varus/valgus angle (TVV), tibial depth (TD), and tibial slope angle (TS) were measured after an initial bone cut was complete. At the surgeon's discretion, secondary bone cuts were performed with the robotic arm set at the same parameters to correct any remaining angular or depth deviations from the pre-cut plan. Pearson Correlation test was used to determine if there was an association between the magnitude of POCD and the magnitude of deviation in resection parameters after initial bone preparation. In addition, paired t-tests were used to see if secondary bone preparation resulted in a significant decrease in deviation from the preoperative plan.

**RESULTS:** The mean POCD was 7° (Range, 0 – 16). The mean deviation from the plan after initial bone cut for FVV, FD, and FFE was 0.5° (range, 0 – 2.6), 0.4 mm (range, 0 – 2.6), and 0.7° (range, 0 - 4.2), respectively. The mean deviation from plan after the initial preparation for TVV, TD, and TS was 0.4° (range, 0 -1.7), 0.5 mm (range, 0 – 2.5), and 0.5° (range, 0 – 3.4). FVV was the only variable that significantly correlated with POCD ( $r=0.21$ ,  $p=0.02$ ). Secondary bone preparation resulted in a significant reduction in deviation from plan for all femoral and tibial parameters,  $p<0.001$ .

**CONCLUSION:** There was a significant, albeit weak, correlation between the magnitude of the POCD and the accuracy of the distal femoral bone cut after initial bone cut. Performing a secondary cut significantly enhanced the accuracy of the cuts for all parameters. Surgeons may consider checking the accuracy of raTKA cuts, especially the distal femoral cut, in the setting of large PCOD or sclerotic bone.

**Paper 054**

**Reverse Coronal Deformity: Use of Robotic Total Knee Arthroplasty for Identification and Correction**

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**BACKGROUND:** Despite continued advances in techniques and implant designs, a population of patients who are dissatisfied after total knee arthroplasty (TKA) remains. During robotic-assisted arthroplasty, real-time intraoperative assessment of patient knee alignment is performed. Here, we assess the prevalence of an under-appreciated deformity, reverse coronal deformity (RCD), and the benefits of utilizing robotic-assisted knee arthroplasty to help correct this dynamic deformity.

**METHODS:** A retrospective study evaluating patients undergoing robotic-assisted cruciate-retaining TKA was performed. Intraoperative measurements were obtained using tibial and femoral arrays to assess coronal plane deformity at full extension and at 90° flexion. RCD was defined as  $\geq 2^\circ$  varus in knee extension that reversed to  $\geq 2^\circ$  valgus in flexion, or vice-versa. Coronal plane deformity was then reassessed after robotic-assisted bony resection and implant placement.

**RESULTS:** Of 204 patients that underwent TKA, 16 patients (7.8%) were found to have RCD, with 14 patients (87.5%) transitioning from varus in extension to valgus in flexion. The average coronal deformity was  $7.75^\circ$ , with a maximum of  $12^\circ$ . These improved to an average coronal change of  $0.93^\circ$  post-TKA. Final medial and lateral gaps were all balanced to within  $1^\circ$  in extension and flexion. Another 34 patients (16.7%) had  $\geq 5^\circ$  change in coronal plane deformity from extension to flexion (average  $6.39^\circ$ ), however, did not experience a reversal of their coronal deformity. Outcomes were assessed with KOOS Jr. scores postoperatively.

**CONCLUSION:** Computer and robotic assistance were utilized to demonstrate the prevalence of RCD. We also demonstrated accurate identification and successfully balancing of RCD utilizing robotic-assisted TKA. An increased awareness of these dynamic deformities could aid surgeons in proper gap balancing even in the absence of navigation and robotic-assisted surgery.

**LEVEL OF EVIDENCE:** Level 4



Paper 055

**Robotic-Assisted Total Knee Arthroplasty Increases the Frequency of Achieving Target Postoperative Mechanical Alignment**

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**INTRODUCTION:** Robotic-assisted total knee arthroplasty (rTKA) has been shown to reduce the number of alignment outliers and to improve component positioning compared to manual TKA (mTKA). The primary purpose of this investigation was to compare the radiographic outcome differences between mTKA and rTKA cases.

**METHODS:** A retrospective comparative study was performed on patients who underwent primary TKA by two fellowship trained surgeons. One surgeon performed 53 rTKA cases with the ROSA knee system (Zimmer Biomet, Warsaw, IN), and the other performed 53 mTKA cases using standard instrumentation system. Pre- and postoperative weightbearing knee and long-leg radiographs were evaluated in all patients. Target mechanical alignment for rTKA and mTKA was 0 and 2 degrees of varus, respectively. The femoral and tibial component alignments were evaluated in the coronal and sagittal planes using Modern Knee Society Radiographic Evaluation System. Alignment measurements were performed independently by two blinded reviewers. An independent samples t-test was used to compare patient demographics and alignment measures between the two techniques. An f-test was used to compare variance in postoperative alignment measures and degrees of correction. Chi-square analysis was used to compare frequency of postoperative alignment in the target zone ( $\pm 2^\circ$  from predefined target). Type-I Error was set  $\alpha=0.05$  for all analyses.

**RESULTS:** 66% of rTKA was within the target zone of  $0^\circ$  of mechanical alignment, and 49% of mTKA was within the target zone of  $2^\circ$  of varus. Although the percentage within the target zone trended toward a greater frequency in the rTKA group, this difference was not statistically significant ( $p=0.076$ ). Correction variance was significantly lower in the rTKA group compared to the mTKA group (2.97 vs. 4.30,  $p=0.041$ ). There were no differences in functional outcomes between groups.

**DISCUSSION & CONCLUSION:** Surgeons performing rTKA may achieve target postoperative mechanical alignment at a greater frequency compared to mTKA with a statistically significant lower variance.

**Paper 056****Improved Patellar Tracking in Image-Free Robotic-Assisted Total Knee Arthroplasty**

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Patellar maltracking and patellar complications are significant contributing factors for revision TKA and patient dissatisfaction. External rotation of the femoral component has been used to optimize patellar tracking in manual TKA (mTKA). Robotic total knee arthroplasty (rTKA) enables rotation of the femoral component to be quantified and adjusted to optimize flexion gap balance. This study investigated incidence of patellar tilt between mTKA and rTKA.

The last 100 mTKA (performed at 5° external rotation to posterior condylar axis and neutral mechanical alignment) were compared to the first 100 rTKA performed with an image free robotic-assisted system. All rTKA allowed for rotation of the femur to balance the flexion gap. Sunrise radiographic tilt measurements were compared between groups. Tilt was defined as having  $\geq 1^\circ$ .

There was a higher incidence of patellar tilt in the mTKA cohort, than the rTKA (14/100 vs. 3/100) ( $p=0.009$  – Fisher's exact test). For the 14 cases in mTKA showing tilt, the mean angle was 5.9° (range 0.9-14.5°); 7 occurred in knees with valgus long leg alignment, 3 in varus, and 4 in neutral knees. For the 3 cases in rTKA showing tilt, the mean tilt angle was 6.1° (0.9-9.1°); 2 of these were in knees with neutral long leg alignment and 1 in varus. 27 of 100 rTKA were at 5° external rotation, 38 were externally rotated  $\geq 5^\circ$  (mean 6.47°, range 5.5-8°), and 35 were internally rotated  $< 5^\circ$  (mean 3.197° from 5°, range 0.5-11° of internal from 5° of external).

The incidence of patellar tilt was reduced using an image-free robotic-assisted system. Internal rotation of the femoral component with rTKA was not correlated with patellar tilt. Patella tilt in the mTKA group was proportionally more prevalent in valgus knees. Soft tissue balance may have a stronger correlation to central patellar tracking than femoral component rotation.

**Paper 057****Optimal 3-Dimensional Component Position in TKA: Targeting Native Alignment Optimizes MCIDs in PROMs**

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**INTRODUCTION:** Advanced technologies, like robotics, provide enhanced precision for implanting total knee arthroplasty (TKA) components; however, optimal component position and limb alignment remain unknown. This study identified sagittal and coronal alignment target zones that correlated with achievement of minimal clinically important differences (MCID) in patient-reported outcome measures (PROMs).

**METHODS:** 1,311 consecutive TKAs were retrospectively reviewed. All were anterior-lipped (41.5%) or conforming polyethylene (58.5%) bearing designs. Posterior tibial slope (PTS), femoral flexion (FF), and tibiofemoral alignment (TFA) were measured radiographically. Patients were grouped based on whether they achieved established MCIDs for KOOS Jr., UCLA Activity Level, and Knee Society pain scores, and by combinations of MCIDs representing "best case scenarios" of meeting all MCIDs for all PROMs. Classification and Regression Tree machine learning models were utilized to identify optimal alignment zones.

**RESULTS:** At mean follow-up of 2.4 years, the change in PTS and postoperative TFA were most predictive for achieving MCIDs in 90% of models. Approximating native PTS to within 4° from native correlated with MCID achievement and superior PROMs. Additionally, preoperative varus and neutral aligned knees were more likely to meet MCIDs and superior PROMS when not overcorrected into valgus postoperatively ( $\geq -7^\circ$ ). Interestingly, preoperative valgus aligned knees also correlated with MCID achievement when postoperative TFA was not overcorrected into varus ( $<0^\circ$ ). Albeit less impactful, FF +1°-7° also correlated with MCID achievement and superior outcome scores. Finally, all three sagittal and coronal alignment measurements had moderate to strong interactions in 13 of 20 models.

**CONCLUSION:** Optimized PROM MCIDs correlated with approximating native PTS while maintaining similar preoperative TFA and incorporating moderate FF. In addition, this is the first study that reports optimal postoperative TKA alignment for valgus knees. Study findings demonstrate an interaction between sagittal and coronal alignment parameters to optimize PROMs, highlighting the importance of 3-dimensional implant alignment targets.

**Paper 058****Resource Utilization with VELYS Robot and Manual TKA**

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**OBJECTIVES:** Total knee arthroplasty (TKA) is one of the most common surgeries performed worldwide for osteoarthritis of knee. Precise component positioning is crucial for ideal outcomes in TKA. The conventional TKA approach in which a series of equipment are used to align the resection to anatomical landmarks has been proven to be less accurate especially when preparing the femur and tibia. In the past few decades, robotic-assisted TKA has been adapted as a novel approach for improving the accuracy of component positioning and reducing errors in limb alignment compared to conventional TKA. The objective of this study is to evaluate clinical outcomes and healthcare resource utilization with the use of VRAS VELYSTM robotic-assisted in TKA.

**METHODS:** This study used existing de-identified patient-level clinical data at data collected from Cuyuna Regional Medical Center from January 2021 to May 2022. The outcomes of interest included tourniquet time, length of stay (LOS), complication rates, readmission rates, rates of returning to OR, rates of ED visit within 30 days, morphine milligram equivalents (MME), and patient reported outcome measurement (PROM) on pain intensity. Bivariate analysis was performed to compare outcomes of interest among TKA cases using VRAS and manual surgery.

**RESULTS:** In total, 104 TKA cases using VRAS and 121 TKA cases using no robotic surgery platform were included in this. No differences were observed on age, gender, BMI, tobacco usage, and ASA score between VRAS and non-robotic groups. The mean (SD) tourniquet time was 45.4 ( $\pm 9.7$ ) and 32.5 ( $\pm 5.0$ ) minutes for VRAS and non-robotic cases, respectively. It was noticed that the VRAS group had a shorter mean LOS ( $1.1 \pm 0.7$  days) than the non-robotic group ( $1.3 \pm 0.4$  days). The rate of ED visit within 30 days for VRAS patients (5.8%) was slightly lower than that of non-robotic patients (8.3%). VRAS patients also had lower MME usage 86.6 ( $\pm 94.6$ ) compared to non-robotic patients 112.9 ( $\pm 96.3$ ) on average. The PROM on postoperative pain intensity was similar between the VRAS and non-robotic groups ( $4.7 \pm 2.0$  vs.  $4.6 \pm 2.0$ ). No discrepancy was found on complication rates, readmission rates, rates of returning to OR, and PROM on pain intensity among VRAS and non-robotic TKA cases.

**CONCLUSION:** VRAS patients had reduced LOS, lower rates of ED visit within 30 days and postoperative MME usage of TKA. VRAS did have higher tourniquet time, however, this may be due to learning curve as these procedures represent the first 3 months with VRAS.

**Paper 059****Public Perception of Robotic-Assisted Total Hip Replacement Surgery**

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**PURPOSE:** Computer-assisted and robotic (CA/R) total hip arthroplasty (THA) has gained considerable attention due to its superior accuracy and precision. However, few studies have evaluated the public's understanding and appraisal of this technology. Here, we evaluate the public's initial perception of technology-assisted compared to traditional THA, and if interactive education may alter an individual's preferences.

**MATERIALS & METHODS:** A prospective cohort study was developed utilizing a 48-question, paid survey distributed via a clinically validated, public, online marketplace in April 2022. After collecting baseline demographics and knowledge regarding THA, participants were queried whether they would prefer a CA/R THA or traditional THA without additional information. Participants were then separated into "Tech" and "Traditional" THA cohorts. Respondents then completed an educational questionnaire which gathered respondent preferences while presenting evidence-based information regarding the surgical modalities. Upon completion of the educational questionnaire, cohorts were asked again which THA modality they would prefer. Statistical analyses were performed with Student's t-tests and  $\chi^2$  tests.

**RESULTS:** Of 567 surveys, 507 surveys were completed with 311 (61.34%) Tech and 196 (38.66%) traditional THA respondents. Tech respondents took fewer daily prescription medications ( $1.07 \pm 1.83$  vs.  $1.48 \pm 2.41$ ,  $p < .05$ ). These respondents were also more likely to have heard of CA/R THA (45.02% vs. 28.57%;  $p < .001$ ), but less likely to have any previous orthopedic surgery (12.22% vs. 22.45%,  $p < .05$ ). All other demographics were similar between the cohorts.

After completing the educational questionnaire, 95 (48.47%) of traditional and 267 (85.85%) of Tech THA respondents (total 71.40%) would choose CA/R THA if they needed a hip replacement now. Among this subset of individuals, 73.20% would switch surgeons for CA/R THA. With regards to cost, 88.27% traditional and 94.53% Tech respondents believed health insurance should cover the costs of CA/R THA ( $p < .05$ ). However, the percentage of individuals willing to supplement their insurance costs was lower (40.51% Tech vs. 27.04% traditional,  $p < .01$ ).

Although significantly different, both groups in general indicated current surgeons should be trained for CA/R THA in its current state (aggregate 69.63%). Similarly, semi-active robotic THA would be preferable to fully-active robotic and computer-assisted THA.

**CONCLUSION:** Computer-assisted and robotic THA appears well regarded and valued by the public, with a sizable proportion willing to change surgeons in favor of those trained in this technology. Given this bias, it is recommended younger surgeons be familiar with this technology to accommodate the growing demand.

**Paper 060****Quantifying the Importance of Orthopedic Surgeon Attributes by the Public**

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**INTRODUCTION:** With an evolving patient population, new modalities and strategies for finding surgeons are available to our patient population. Few studies evaluate what attributes are currently important to our patients, and what modalities may be most effective.

**METHODS:** An online survey was developed and distributed in January 2022 using an online platform. In total, 510 responses were collected. Participants responded to questions regarding their demographics and the relative importance physician characteristics. This included technical competency, experience, and non-modifiable attributes and were graded on a unipolar Likert scale. Descriptive statistics were performed.

**RESULTS:** Respondents on average were 40.4 years old, Caucasians (83.14%), and with a bachelor's degree (45.49%) or higher and earning between \$25,000-74,000 USD (56.07%). Most applicants lived in a suburban location (47.05%) in the southern region of the US (40.78%). Medically, 60.59% of patients were privately insured and averaged  $2.91 \pm 4.99$  PCP visits annually. 32.55% had seen an orthopedist in the past.

When evaluating various surgeon attributes on a unipolar Likert scale, surgical skill was quantifiably the most important with 81.96% ranking it as "most important." This was followed by years in practice (Most important: 50.39%), which was ideally reported to be  $11.2 \pm 6.13$  years. Medical school was third (Most important: 35.69%), outranking qualities such as bedside manners (Most important: 29.80%) and fellowship training location (Most important: 18.43%). Conversely, the three least important factors were surgeon gender (Least important 60.2%), race (Least important: 65.1%), and religion (Least important: 68.63%).

Foreign medical graduates were generally seen as no different (53.92%) or positively (27.84%) from US trained surgeons. While 62.55% respondents reported no preference for surgeon gender, male surgeons were actively preferred by 24.51% - double that of female respondents (12.75%) in the context 54.12% female respondents.

With regards to the most effective method of marketing, referral from a physician or therapist was ranked #1 by 72.16%, while family and friend recommendations were #2 with 23.33%. Social media and traditional advertisement were #3 and #4 and collectively made up less than 5% of respondents. 78.63% still utilized the internet to research their surgeon.

**CONCLUSION:** Skill and experience are the most important attributes choosing an orthopedic surgeon, above academic performance, race, gender, or religion. Despite the rise of social media platforms, physician referrals and recommendations remain the most important marketing tool to orthopedic surgeons.

**Paper 061**

**A Pilot and Feasibility Study to Assess an Interactive Voice Response Intervention in the Follow-Up of Primary Total Joint Arthroplasty**

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**BACKGROUND:** The rate of unexpected emergency department visits following hip and knee arthroplasty remains greater than 10% along with a readmission rate of nearly 6%. We propose that an early-phase telephone adapted intervention, Interactive Voice Response System (IVR), will both mitigate premature/unnecessary emergency department visits while also monitoring patients regularly for early symptoms of more severe conditions such as deep infection and formation of clots.

**METHODS:** 24 patients were assessed, consented, and randomized to either the control or intervention groups at their preoperative visit and patient information was logged into REDCap. Patients in the intervention group received automated phone calls in addition to their regularly scheduled in person follow-ups. Phone calls started on postoperative day 2, initially occurring daily and progressively reducing in frequency over 12 weeks. Phone calls assessed for pain control, signs of infection, and initial signs of DVT (deep vein thrombosis) formation. Based on patients' response, further questions would be asked and ultimately the physician notified if needed. Outcomes were monitored using Short Form 36 Health Survey Questionnaire (SF-36), either Hip disability and Osteoarthritis Outcome Score (HOOS) or Knee injury and Osteoarthritis Outcome Score (KOOS) surveys, and Visual Analog Scale (VAS) at 2 weeks, 6 weeks, and 12 weeks postoperative along with any further patient complaints. Retention rate, patient satisfaction, and overall feasibility were considered the primary outcomes of this pilot study. Descriptive statistics were used to evaluate the feasibility and acceptability of this intervention among patients.

**RESULTS:** 12 control and 12 intervention patients completed the 12 week study with a retention rate of 80%. The overall response rate to the IVR calls was 82%. There were a total of 10 notifications to the healthcare team, 8 of which were related to pain control and 2 related to difficulty breathing. Two emergency room visits were avoided in the IVR group due to the IVR calls. 100% of patients provided positive feedback regarding the calls and rated the questions as relevant to their surgery. 100% of patients stated they would use the IVR service again if they had to undergo another procedure. While this study is not well powered to assess efficacy, patients in both groups demonstrated improvement over the course of 12 weeks based on the short form survey, HOOS/KOOS joint outcome score, and visual analogue scale.

**CONCLUSION:** We suggest that IVR can be a helpful tool in the follow-up of postoperative total joint patients.

**Paper 062**

**YouTube as a Source of Patient Information for Distal Radius Fractures: Quantitative Analysis of Video Reliability, Quality, and Content**

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**BACKGROUND:** This study investigates the quality of YouTube content on distal radius fractures hypothesizing that this non-peer reviewed resource would be insufficient to comprehensively educate patients on this common orthopedic injury.

**METHODS:** YouTube was queried on 9/4/2021 with the key phrases “wrist fracture” and “distal radius fracture,” and the top 50 results discussing adult distal radius fractures were analyzed. Video data collected included upload date, duration, number of views, number of likes, number of dislikes, video upload source, and content type. The video power index (VPI), the views ratio, and like ratio were calculated. Video source reliability and overall educational quality were scored using the Journal of the American Medical Association (JAMA) benchmark criteria and the Global Quality Score (GQS). A novel Distal Radius Fracture Specific Score (DRFSS) was created to grade the quality of information specific to distal radius fractures. Two authors scored all videos, and Cohen’s kappa statistic was used to assess inter-rater reliability.

**RESULTS:** The most common video upload sources were academic institutions (44%) followed by physicians (20%). The most common type of content was disease-specific information (34%) followed by patient experience (34%). The average time since upload was approximately 4 years, mean duration was 15.98 minutes, and average number of views was 52,070 with cumulative total views across all videos of 2,603,511. Mean number of likes was 360, number of dislikes was 19, like ratio was 94.5, views ratio was 32.2, VPI was 31.8, GQS across all videos was 3.24, and JAMA score was 2.6. Within the DRFSS, mean patient presentation score was 0.68/2, background information score was 1.78/3, diagnosis and evaluation score were 1.51/4, treatment score was 3.07/4, postoperative course score was 1.13/4, and total score was 8.17/23 (Figure 2). Inter-rater reliability was moderate ( $\kappa=0.57$ ,  $p<0.0001$ ) for GQS, fair for JAMA ( $\kappa=0.39$ ,  $p<0.0175$ ), and substantial for total DRFSS ( $\kappa=0.6587$ ,  $p<0.0001$ ).

**CONCLUSION:** DRFSS is a comprehensive, reliable score for assessing the quality of YouTube videos about distal radius fractures. Although YouTube content on distal radius fractures is readily accessible to patients, the informational content is unfortunately low in quality. The DRFSS can be utilized as a tool in the improvement of online patient-orientated resources.



## SECOND PLENARY SESSION

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### Paper 064

#### Telehealth in Orthopedic Sports Medicine

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**BACKGROUND:** Literature on the use of telehealth in orthopedic sports medicine is limited. The purpose of our investigation was to compare patient satisfaction, total duration of care, and overall experience between in-person clinical visits and telehealth.

**METHODS:** A cross-sectional, survey study was conducted from March to November 2020. The target population included all patients presenting to a single orthopedic sports medicine physician. Demographic data and descriptive characteristics were documented. Health Insurance Portability and Accountability Act (HIPAA) compliant surveys were utilized to record patient responses and compared by Two-Sample T-Tests. P-value <0.05 was considered statistically significant.

**RESULTS:** The overall composite satisfaction score did not differ between in-person clinical visits and telehealth, with a mean difference of 1.3% ( $p = 0.63$ ). Around 91% of patients in the telehealth group reported a total duration of care less than 30 minutes, while 66% of patients in the in-person clinical visit group had a total duration of care greater than 30 minutes ( $p < 0.001$ ). Almost 70% telehealth patients stated their experience was 'no different' than any in-person clinical visit. Of patients who had in-person visits, 70% were willing to utilize the virtual alternative and only 16% stated they were unwilling under any circumstance.

**CONCLUSION:** Most patients presenting to an orthopedic sports medicine clinic are open to telehealth, recognize its utility, and believe it to be just as comparable to in-person clinical visits.

**LEVEL OF EVIDENCE:** IV

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### Paper 065

#### Isolated Thoracic and Lumbar Transverse Process Fractures, Do They Need Spine Surgeon Evaluation? A High Volume Level I Trauma Center Experience with Cost Analysis

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**INTRODUCTION:** Transverse process fractures (TPF) of the thoracic and lumbar spine have become increasingly identified due to CT imaging. At many institutions the spine service, neurosurgical or orthopedic, is consulted for further evaluation and management. There are several studies that demonstrate no difference in clinical outcome with or without spine service intervention (bracing, surgery, etc.). However, no study to our knowledge provides an additional cost analysis. We hypothesize that isolated transverse process fractures of the thoracolumbar vertebrae are structurally and neurologically stable injuries. Furthermore, spine service consultation and evaluation results in increased healthcare costs.

**METHODS:** Patients were identified using the trauma registry data at Saint Louis University (SLU) from January 2012 to August 2018. The registry was queried for CPT code 22305 (closed treatment of vertebral process fracture). Chart and imaging review was performed to determine if any additional spine fractures were identified by the spine team which were not included in the initial radiology report. TPF associated with other spinal injuries were characterized by the presence of one or more thoracic and/or lumbar TPF in addition to any other acute fracture or dislocation in the cervical, thoracic, or lumbar spine. A separate cost analysis with institution-specific charges was also performed.

**RESULTS:** Six hundred and eighty-two patients with TPF from January 2012 to August 2018 were identified. Two hundred and twenty-eight patients met the criteria to be included in this study. Of these, 477 lumbar TPFs and 103 thoracic TPFs were identified. Additional spinal pathology that was not included in the initial radiology report was identified in 5 (2.19%) patients, none of which required surgical intervention. These included two nondisplaced facet fractures (T6 and L3) that were treated nonoperatively, a nondisplaced C7 laminar fracture treated with a rigid cervical orthosis, and a T3/4 widening which was suggestive of possible posterior ligamentous injury on a subsequent MRI exam which was treated with bracing. Cost analysis demonstrated additional costs associated with spine service intervention totaled \$1,725,360.28. Average cost per patient in our cohort summed to \$2,529.85

**CONCLUSION:** These data support that isolated TPF of the thoracic and lumbar spine are stable injuries that likely do not require spine service intervention and in fact may represent unnecessary financial burden. Foregoing unnecessary consultation can alleviate time constraints within spine service practices and reduce health care costs by eliminating costly extraneous interventions from the patient's care.

Paper 066

Hemiarthroplasty for Femoral Neck Fracture. Does Approach Affect Outcomes?

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**INTRODUCTION:** Femoral neck fractures are common injuries, and hemiarthroplasty is frequently utilized to treat displaced femoral neck fractures in the elderly. The purpose of this study is to compare postoperative outcomes between anterior, posterior, and lateral surgical approaches in hemiarthroplasty for femoral neck fractures.

**METHODS:** Nine hundred and thirty-nine femoral neck fractures were treated with hemiarthroplasty from 2010-2021 at multiple institutions. The mean follow-up was 20 months (15-25 months). Analyses were performed to examine differences in outcomes based on surgical approach, including intraoperative data points, postoperative complications, and functional outcomes. Multivariate analysis was performed to adjust for confounders. All analyses were performed using SPSS 27 (IBM, Armonk, NY).

**RESULTS:** Of the 939 femoral neck fractures treated with hemiarthroplasty, 70 (7.5%) were performed by direct anterior approach (DAA), 250 (26.6%) by direct lateral approach (DLA), and 619 (65.9%) were posterior approach (PA). Statistically significant differences in operative time were noted between DAA and DL approaches (83.8 vs. 104.9 min,  $P < 0.0001$ ). The mean length of stay was significantly lower for DAA (5.2 days), compared to DLA (7.2 days), and PA (7.5 days) ( $P = 0.0081$ ).

Dislocations were significantly higher with PA (42, 6.7%) compared to DLA (3, 1.2%) and DAA (2, 2.7%) ( $P = 0.0001$ ). Using multivariate analysis, there were almost 5 times greater odds of dislocation at one year in the PA when compared with DLA (OR= 4.98, CI= 1.40-17.17,  $P = 0.032$ ). Additionally, there were two times greater odds of dislocation at 90 days for patients who were tobacco users, regardless of approach (OR= 2.28, CI= 1.13-4.57,  $p = 0.021$ ).

Ambulation status also varied amongst the different surgical approaches with DAA having a lower percentage of postoperative patients classified as non-ambulatory at discharge (11, 16%) when compared with DLA (52, 21%) and PA (175, 28%). Lower mortality was seen at two years postoperatively with DAA vs. PA (18, 26% vs. 261, 42%,  $P = 0.132$ ).

**CONCLUSION:** In this cohort, DAA was found to have decreased operative times, decreased length of stay, a higher likelihood of ambulation prior to discharge, and lower mortality at two years compared to other approaches. PA and tobacco were independent risk factors for dislocation. These differences may help lessen the morbidity and mortality associated with femoral neck fractures treated with hemiarthroplasty.

Paper 067

A Comparison of Clinical and Radiographic Outcomes in Humeral Shaft Fracture

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**BACKGROUND:** Humeral shaft fractures represent 1-5% of all fractures and are increasing in incidence. There is conflicting literature regarding the superiority of operative vs. nonoperative treatment of these fractures. We hypothesized that patients treated operatively would have a faster time to radiographic union and improved functional outcomes relative to patients treated nonoperatively.

**METHODS:** This was a retrospective cohort study performed at a single healthcare system. All humeral shaft fractures treated between 2010-2020 were identified using ICD-9, -10, and CPT codes. Information on demographics, fracture, treatment, and outcomes was collected through chart and radiograph review. These measures were compared between patients treated operatively and nonoperatively.

**RESULTS:** 517 adult patients with unilateral humeral shaft fractures were identified, 233 were treated nonoperatively and 284 were treated operatively. Patients treated operatively had a mean age of 50.2 years relative to 59.9 years in patients treated nonoperatively ( $p < 0.001$ ). A higher proportion of the nonoperative group were female and unemployed than the operative group ( $p = 0.007$  and  $p < 0.001$  respectively). Ground level fall as a mechanism of injury was significantly more common in the nonoperative group than in the operative group (75% of patients vs. 46.8%, relatively,  $p < 0.001$ ). The humeral shaft fracture was also more likely to be an isolated injury in the nonoperative group (93.1% vs. 72.5% respectively,  $p < 0.001$ ). Operatively-treated patients had significantly faster time to radiographic union at a median of 113 days vs. 161 days in nonoperatively-treated patients ( $p = 0.001$ ). The operative group was made weight-bearing as tolerated at a median of 84 days, significantly less time than the nonoperative group at a median of 98 days ( $p = 0.002$ ). There was no difference in complication rates between groups. There were no differences in range of motion at time of radiographic union. However, at time of last follow-up, patients treated operatively were up to two times more likely to achieve full shoulder forward elevation than those treated nonoperatively ( $p = 0.011$ ).

**CONCLUSION:** Operative treatment of humeral shaft fractures leads to faster time to union and earlier weight-bearing without increased complications.

**Paper 068****Nationwide Analysis of Cardiopulmonary Outcomes After Multiple Long Bone Fracture Fixation**

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**PURPOSE:** Multiple long bone lower extremity fractures repaired with intramedullary nail (IMN) fixation have been associated with cardiopulmonary events and mortality. These patients are at risk of developing fat embolism syndrome, pulmonary embolism, adult respiratory distress syndrome (ARDS), and pneumonia. We aimed to determine if simultaneous or staged IMN fixation of multiple long bone lower extremity fractures is superior in mitigating cardiopulmonary complications and death.

**METHODS:** The Trauma Quality Improvement Program (TQIP) database was queried to identify patients who sustained multiple long bone lower extremity fractures between January 2016 and December 2019. Patients were split into two cohorts: simultaneous fixation (fixation of all fractures in the same operation/calendar day) and staged fixation (two or more operations each > 24 hours apart).

**RESULTS:** There were 202,784 records of patients with tibial and/or femoral fractures identified in the TQIP database; 3,202 patients met the inclusion criteria. In total, 75.9% underwent simultaneous IMN fixation of two or more long bones and 24.1% had staged fixation. The most frequent fracture pattern was one femur and one tibia (48.3%) followed by bilateral femur fractures (36.1%). The groups were similar across multiple variables; the staged fixation group, however, was older (42 vs. 37,  $p < 0.0001$ ), had higher comorbid rates of CHF (1.6% vs. 0.5%,  $p = 0.0051$ ), COPD (4.0% vs 2.3%,  $p = 0.0109$ ), and history of myocardial infarction (MI) (0.7% vs. 0.1%,  $p = 0.0223$ ) and a higher ISS (19 vs. 17,  $p < 0.0001$ ). For outcomes, the staged group had a significantly higher rate of ventilator associated pneumonia (VAP), ARDS, and acute kidney injury. The rate of in hospital MI, cardiac arrest, and death was the same between the groups. The staged group had a longer ICU length of stay (LOS) (7 vs. 5 days,  $p < 0.0001$ ) and total hospital LOS (17 vs. 11 days,  $p < 0.0001$ ).

**CONCLUSION:** In our analysis, simultaneous fixation of multiple long bone lower extremity fractures is not associated with increased cardiopulmonary events and expedites time to discharge. Staged fixation is associated with an increase in complications, including ARDS and VAP. Simultaneous IMN fixation should be considered when feasible and may decrease cardiopulmonary complications and LOS in at risk patients. Analyses are underway to evaluate the impact of comorbid factors on outcomes.

**Paper 069****Pre- and Postoperative Patient-Reported Outcomes of Gastrocnemius Recession for Refractory Pain in Plantar Fasciitis**

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**INTRODUCTION:** There has been an established relationship between increased loading on the Achilles tendon and tension on the plantar fascia. This supports the idea that either tight gastrocnemius and soleus muscles or contractures of the Achilles tendon are risk factors for plantar fasciitis. Gastrocnemius recession has gained popularity as a viable surgical intervention for cases of chronic plantar fasciitis due to isolated gastrocnemius contracture. To our knowledge, this is the first study to investigate PROMIS scores in patients with plantar fasciitis before and after gastrocnemius recession.

**METHODS:** The Electronic Medical Record was queried for medical record numbers associated with Current Procedural Terminology code 27687 (gastrocnemius recession). Our study included all patients with a preoperative diagnosis of chronic plantar fasciitis with treatment via isolated gastrocnemius recession with one-year minimum follow-up. 40 patients were included in our study. Patient variables were collected via chart review. Preoperative and postoperative PROMIS scores were collected in the clinic.

**RESULTS:** Preoperative and postoperative PROMIS scores improved for physical function and pain interference from 39.27 and 62.78 to 44.54 and 56.5 ( $p=0.0005$ ,  $p=0.0001$ ) respectively, PROMIS Depression scores were not significantly different ( $p=0.6727$ ). VAS scores significantly decreased from 7.05 to 1.71 ( $p<0.0001$ ). Patients with preoperative peripheral neuropathy had significantly lower improvement in PROMIS physical function scores ( $p=0.0029$ ). Tobacco use led to significantly lower improvement in PROMIS depression ( $p=0.0202$ ).

**CONCLUSION:** Gastrocnemius recession is an effective option for patients with refractory pain in plantar fasciitis. Our PROMIS and VAS data confirm this procedure's utility and highlight its ability to significantly decrease pain and improve physical function in patients with chronic plantar fasciitis. We believe we have added to the literature by incorporating the, inherently superior, PROMIS scores. Based on the results of this study, the authors recommend gastrocnemius recession for patients who fail conservative management for plantar fasciitis.

**Paper 070****Weight Changes After Ankle Fracture**

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**INTRODUCTION:** Ankle fractures are a common orthopedic injury that frequently require surgery to reduce the joint and lengthy periods of weight-bearing restrictions during recovery. This period of inactivity could lead to decreased energy expenditure and increases in patient weight and BMI. The purpose of this study was to evaluate weight changes patients experience postoperatively following ankle fracture surgery.

**METHODS:** Hospital billing records were retrospectively reviewed to identify patients who underwent open reduction internal fixation of the ankle within our hospital system between January 1, 2018 and June 30, 2021. Patient records were reviewed for weight data at their postoperative visits at 2 weeks, 3 months, 6 months, and 1 year. Patients were excluded if their charts lacked complete weight data up to 3 months out from surgery or if data was copied from their previous visits. Student's t-test was used for statistical analysis.

**RESULTS:** 58 patients met inclusion criteria. At time of surgery, the mean weight was  $198.3 \pm 53.3$  lbs and BMI was  $30.4 \pm 7.0$  kg/m<sup>2</sup>. At their first postoperative visit, the mean weight was  $197.8 \pm 53.5$  lbs and BMI was  $30.4 \pm 7.1$  kg/m<sup>2</sup> ( $p > 0.05$ ). At 6 weeks postoperative, the mean weight was  $197.5 \pm 53.5$  lbs and BMI was  $30.4 \pm 7.1$  kg/m<sup>2</sup> ( $p > 0.05$ ). At 3 months postoperative, the mean weight was  $199.5 \pm 52.2$  lbs and BMI was  $30.7 \pm 6.9$  kg/m<sup>2</sup> ( $p > 0.05$ ). At 6 months postoperative, the mean weight was  $207.9 \pm 52.6$  lbs and BMI was  $31.9 \pm 7.2$  kg/m<sup>2</sup> ( $p > 0.05$ ). At 1 year postoperative, the mean weight was  $219.2 \pm 51.6$  lbs and BMI was  $33.5 \pm 7.1$  kg/m<sup>2</sup>, which were both significantly different compared to weight and BMI at time of surgery ( $p = 0.0491$  and  $0.0330$ , respectively). Similar increases in weight (about 20 lbs) and BMI (about 3 points) were observed across all preoperative BMI groups at 1 year.

**DISCUSSION & CONCLUSION:** To our knowledge, this is the first study to evaluate weight changes following ankle fracture. Weight and BMI do not change in the early postoperative period. By 6 months, however, patients gain about 10 lbs and 1.5 BMI points, on average; by 1 year, they gain about 20 pounds and 3 BMI points, on average. Awareness of these increases is crucial for providers so they may address this risk with patients and establish methods for preventing unhealthy weight gain during recovery.

**Paper 071**

**Intramedullary vs. Plate Fixation of Distal Fibula Fractures: Demographics, Outcomes, and Trends**

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**INTRODUCTION:** The most common surgical treatment for distal fibula fractures is open reduction and plate fixation (PF). However, intramedullary fixation (IMF) has been theorized to provide advantages over PF, particularly in cases involving higher risks of soft tissue complications. Using a national database, this study aims to compare patient demographics and complication rates between fibular PF and IMF and also aims to examine usage trends within the US.

**METHODS:** Patients treated with fibular IMF or PF between October 2015 and October 2020 were identified using a US insurance claims database and grouped according to fixation type. To assess demographics, the average Elixhauser Comorbidity Index (ECI) and the rates of diabetes (DM), tobacco use, obesity, chronic kidney disease (CKD), female gender, age above 60, rheumatoid arthritis (RA), and concomitant tibia shaft fractures were determined for each group. To assess complication rates, a 1:4 matched comparison was performed to control for DM, tobacco use, obesity, CKD, gender, age, and ECI. The complications examined were infection, nonunion, malunion, revision surgery, pulmonary embolism (PE), and deep vein thrombosis (DVT). Groups were compared using Pearson's Chi-Squared Test for categorical variables and Student's T-test for means. Usage trends were determined by calculating monthly totals of patients receiving IMF or PF across the US.

**RESULTS:** Of 20,780 patients identified, 875 underwent IMF and 19,905 underwent PF. The rate of concomitant tibia shaft fractures was significantly higher in the IMF group (IMF: 49.03% vs. PF: 9.18%,  $p < 0.001$ ). Counterintuitively, the mean ECI and the rates of DM, obesity, female gender, and age above 60 were significantly lower in the IMF group (all  $ps < 0.001$ ). After matching, there were no significant differences found between groups in complication rates. Use of IMF across the US trended upwards relative to the use of PF during the study period .

**CONCLUSION:** This study did not demonstrate preferential use of IMF in higher-risk patients (e.g. CKD, obesity, etc.). The higher rate of concomitant tibia shaft fractures in the IMF group is, however, consistent with the use of fibular IMF in cases involving higher-energy trauma and soft-tissue disruption. Fibular IMF appears to be a viable alternative to PF when used in similar populations and has increased in popularity within the US.



**Paper 072**

**Rates of Complications and Readmissions: In-Patient vs. Outpatient ORIF of Calcaneus Fractures**

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**BACKGROUND:** The safety of in-patient vs. outpatient treatment in patients with calcaneus fractures remains unclear. The aim of the present study was to assess differences in wound complications and readmissions in operative calcaneus fractures treated with open reduction and internal fixation (ORIF) in an in-patient vs. outpatient setting.

**METHODS:** Patients undergoing ORIF for calcaneus fractures treated with the sinus tarsi approach (STA) from 2012 to 2020 were reviewed. A total of 113 patients met inclusion criteria with 24 (21%) managed inpatient and 89 (79%) managed as outpatient. The primary outcomes were deep infection defined as return to the operating room for debridement with positive cultures and readmissions.

**RESULTS:** Inpatients had a higher percentage of ASA classification 3&4 patients (58.3% vs. 29.2%,  $p=0.008$ ). Outpatients had a longer delay in days between injury and definitive fixation (mean 8 (8.9 SD, 0-31 range) vs. 14 (12.4 SD, 0-91 range) days,  $p=0.009$ ). There were no statistically significant differences in the incidence of deep infections (8.3% vs. 4.5%,  $p=.606$ ), implant related pain (8.3% vs. 15.7%,  $p=.516$ ), return to the operating room (16.7% vs. 15.7%,  $p=1.0$ ), or readmissions (4.2% vs. 3.4%,  $p=1.0$ ) between inpatient and outpatient groups including in binary logistic regression models ( $p>.3$  for all).

**CONCLUSION:** In our retrospective study of patients undergoing operative repair of isolated calcaneus fractures with STA, there was no increased risk of wound complications or readmissions when calcaneus fractures were treated in an outpatient setting.

**LEVEL OF EVIDENCE:** Level III

**Paper 074****Midfoot Nail-Plate-Constructs for Charcot Neuroarthropathy: A Cohort Study with Mid-Term Follow-Up**

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**INTRODUCTION:** Charcot neuroarthropathy (CN) is a complex disease process with progressive degeneration of normal bone architecture. Treatment for CN includes conservative measures and operative management with the goal of achieving a plantigrade ulcer-free foot. Operative treatment of CN varies with regards to timing and type of interventions. Surgical interventions include debridement, exostectomy, and complex reconstructions. The technique of intramedullary beaming with supplemental medial locking plate (referred to here as a Midfoot Nail Plate Construct (MNPC)) utilizes large diameter intramedullary screws linked to a medial locked plate for midfoot stabilization which is the focus of this study.

**METHODS:** Nineteen patients (20 limbs) with midfoot CN treated at our institution by a single surgeon between January 2017 – December 2021 met inclusion criteria and were included in our MNPC cohort. Retrospective chart review provided demographic data, comorbidities, previous treatment data, ambulation status, Brodsky classification, time to intervention, and outcomes after operative management with MNPCs with a descriptive statistical analysis. Furthermore, post-intervention outcomes (rates of postoperative ulceration, postoperative infection, and amputation) were compared to the our previously studied institutional baseline data of post-surgical complications of CN in 58 patients treated between 2005-2016 with limited and reconstructive techniques without MNPCs.

**RESULTS:** The mean age of the MNPC cohort was 56.3 (range 37 – 73 years), mean BMI was 39.4, and 73.7% of patients had diabetes (mean A1c 7.34, A1c range 5.8 to 10.5). 43% had undergone previous nonoperative management and 19% received prior operative treatment. Mean follow-up was 19.9 months (range 3 – 47 months). Average time from presentation to intervention was 10.1 months (range 1 – 32 months). Post-intervention rates of ulceration, infection, and amputation for the MNPC cohort were 30%, 25%, and 15% respectively. Compared to our institutional baseline data of complications after limited and reconstructive surgical techniques without MNPCs from 2005-2017, MNPC had a lower rate of ulceration and amputation. Ulceration rate after limited, reconstructive, and MNPC were 34.4%, 42.3%, and 30% respectively. Infection rates were 25%, 42.3%, and 25%, with amputation rates of 21.9%, 23%, and 15% respectively.

**CONCLUSIONS:** Despite continued innovation in surgical management of CN of the foot, post-intervention complication rates remain high. This study provides outcome data for MNPCs as a treatment for CN in a large cohort with mid-term follow-up. Compared to our own institutional historical data prior to adoption of this technique, MNPCs have a lower rate of ulceration and amputation at an average of 19 month follow-up.

**Paper 075**

**Anatomic Structures at Risk When Utilizing Percutaneous Intramedullary Fibular Screw Fixation for Lateral Malleolus Fractures: A Cadaveric Study**

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**INTRODUCTION:** Isolated lateral malleolus fractures are common fractures encountered by orthopedic surgeons. Retrograde intramedullary fixation for unstable lateral malleolus fractures has become a viable option for patients at higher risk for wound complications. The aim of this cadaveric study was to assess the relative risk of injury to adjacent anatomic structures with percutaneous implantation of an intramedullary fibular screw for lateral malleolus fractures.

**METHODS:** Seven fresh-frozen below-the-knee cadaver specimens were used for this study. Prior to investigations, specimens were inspected with fluoroscopic radiographs for preexisting pathology or prior surgical intervention. Lateral dissection of the lateral malleolus was performed after screw placement to determine the proximity of the peroneus longus (PL), peroneus brevis (PB), and sural nerve (SN) to the inserted hardware. The mean, standard deviation, and range for distances were calculated for all structures.

**RESULTS:** Percutaneous intramedullary fibular screw placement was performed in seven specimens, six females and one male, with an average age of  $79.3 \pm 8.1$  years. Amongst the seven specimens, only one resulted in an injury to a structure of interest (sural nerve). The peroneus longus and peroneus brevis were not injured in any of the specimens.

**CONCLUSION:** This study shows the potential risks to lateral structures when placing an intramedullary fibular screw for unstable lateral malleolus fractures. We suggest that orthopedic surgeons exercise caution when performing critical steps of the procedure to minimize avoidable injury to structures of importance in an attempt to decrease the incidence of iatrogenic injury.

**Paper 076**

**Tibiototalcaneal Arthrodesis with Hybrid Nail-Plate Constructs: A Novel Technique for Treatment of Unstable Ankle and Hindfoot Deformities**

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**INTRODUCTION:** Tibiototalcaneal (TTC) arthrodesis is a treatment option for several pathologies of the ankle and hindfoot. Traditional fixation options include intramedullary nailing or plate-screw constructs. In certain patients, more robust fixation may be desired. Charcot neuroarthropathy (CN) patients in particular often have complex deformities, poor bone quality, and impaired sensation. New trauma literature shows hybrid nail-plate constructs (NPCs) may permit early weight bearing in osteoporotic distal femur fractures. We report early results of TTC arthrodesis using NPCs in patients with complex deformities of the ankle and hindfoot.

**METHODS:** Patients undergoing TTC arthrodesis via intramedullary nail fixation plus plating by a single surgeon from September 2020 to November 2021 were included in our study. Indications included CN, post-traumatic deformities, and advanced arthritis. Age, comorbidities, hemoglobin A1c, presence of an ulcer, implants, bone graft used, and postoperative complications were retrospectively recorded.

**RESULTS:** Ten patients with unstable ankle and hindfoot deformities were included. Six patients had CN; three patients had post-traumatic deformities; and one patient had an arthritic cavovarus deformity. Average age was 58 years (range 38-72 years). In patients with CN, the average HbA1c was 7.3 (range 5.2-10.7). Four patients had an active or impending ulcer. Eight patients were treated with a lateral tibiototalcaneal variable-angle locking plate; one was treated with an anterior tibiotalar arthrodesis plate; and one was treated with a 3.5mm fibular reconstruction plate. All patients were treated with a tibiototalcaneal hindfoot arthrodesis nail. In all cases, cellular bone matrix was used; in 9 cases, autograft was also used, most commonly from the fibula. Follow-up ranged from 3-13 months. Seven patients have a stable, non-infected, ulcer-free foot. Two patients, both poorly controlled diabetics with CN, underwent below-knee amputation, one for deep infection and the other for hardware failure. One patient with peripheral vascular disease continues to have delayed wound healing.

**CONCLUSION:** TTC arthrodesis can be used for a variety of indications, and many of these patients present complex challenges. Patients with CN in particular often have severe deformities and poor bone quality. Hybrid fixation methods provide added stability in complex cases. We report a 70% favorable outcome rate in our case series, with major complications being confined to patients with significant medical comorbidities. We believe that TTC arthrodesis with hybrid nail-plate constructs represents an attractive solution to complex ankle and hindfoot deformities.

**Paper 077****Intermetatarsal Screw Fixation: Reduced Intermetatarsal Angle Following Modified Lapidus Procedures**

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**INTRO:** The Modified Lapidus arthrodesis is a historically established surgical technique for treatment of hallux valgus, providing quality patient outcomes and reproducible results. Addition of a transverse first to second intermetatarsal screw spanning the base of the metatarsals in this procedure can increase stability. However, no study evaluates the radiographical parameters following application of this intermetatarsal screw fixation to procedures without first to second intermetatarsal screw fixation. The purpose of this study was to assess the quality of radiographic parameters between individuals receiving a first to second intertarsal screw fixation to those that did not receive intermetatarsal screw fixation following a non-saw cut Modified Lapidus procedure.

**METHODS:** A retrospective review was performed on 74 patients that underwent a Modified Lapidus arthrodesis between 2016-2020 at a single institution. Preoperative indications for the procedure included first ray instability, first ray hypermobility, hallux abductovalgus, and metatarsal primus elevatus. Inclusion criteria consisted of skeletally mature patients undergoing non sawcut Modified Lapidus procedure. Patients that received the procedure due to a traumatic event or patients with concomitant second metatarsal arthrodesis were excluded. Review of patient's charts was performed. Basic demographics data, implant type, and radiographic parameters including intermetatarsal angle (IMA) and first metatarsal length were obtained from preoperative as well as postoperative films.

**RESULTS:** A total of 74 patients who underwent a Modified Lapidus arthrodesis were included in the study. A group of 43 patients received the Modified Lapidus arthrodesis with the addition of a first to second intermetatarsal screw fixation compared to a group of 31 patients who only received the Modified Lapidus arthrodesis procedure. The average IMA in all patients prior to surgery was 13°. The patients who received intermetatarsal screw fixation had significantly higher IMA reductions between preoperative and postoperative films than those who did not receive the intermetatarsal screw (-8.41° vs. -5.78°, p=.005). The difference in first metatarsal length on preoperative and postoperative films was less in patients who received the screw fixation, but this was not statistically significant.

**CONCLUSION:** The Modified Lapidus procedure is a commonly used procedure to treat hallux valgus. The results of this study found that the addition of a first to second intermetatarsal screw significantly reduced the IMA when compared to individuals who did not receive the screw construct. These findings will help surgeons further delineate if an intermetatarsal screw is required and how it will contribute to the radiographic parameters of interest.

**Paper 079**

**Definitions of Failure in Lateral Ankle Instability Surgery: A Systematic Review**

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**PURPOSE/HYPOTHESIS:** To review the literature for current definitions of lateral ankle instability surgical failure.

**METHODS:** A systematic search of Medline, SportDiscus, CINAHL, Embase, and Web of Science was conducted to identify clinical studies that included patients who underwent surgical treatment for lateral ankle instability and included information about surgical failures. Studies with level of evidence I to IV were included for this review. Animal studies, biomechanical studies, cadaveric studies, review articles, and expert opinion were excluded. These studies were then reviewed for definitions of failure of any surgical procedure used to correct lateral ankle instability.

**RESULTS:** Of the 1,200 studies, 3.5% (42/1,200) published between 1984 and 2020 met inclusion criteria and were analyzed. After reviewing the data, numerous definitions were found in the literature for LAI surgical failure. The most common was "recurrent instability" (40%, 17/42) followed by "re-rupture" (24%, 10/42). For the original operation, the Modified Brostrom Gould technique was used most frequently (40%, 17/42) in cases treated operatively. The failure rate of this procedure ranged from 1.1% to 45.2% depending on the definition of "failure".

**CONCLUSION:** There were multiple definitions of failure for surgical treatment of lateral ankle instability and is one of the reasons why the rate of failure can vary greatly. The literature would benefit greatly from a standardization of ankle instability treatment "failure" definition. This definition should incorporate multiple facets, including history, physical examination findings, outcome scores, imaging, and surgical findings for an inclusive understanding of failure.

**CLINICAL RELEVANCE:** To help physicians and researchers understand the array of LAI treatment "failure" definitions currently used in the literature.

**Paper 080**

**Medial Malleolus Reconstruction with Iliac Crest Autograft: A Case Report**

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**PURPOSE:** Reconstruction of the medial malleolus after traumatic loss is sparsely described in the literature. In this article we describe the case of a young female who sustained a traumatic open ankle fracture with complete destruction of the medial malleolus.

**METHODS:** A 19-year-old female presented to the emergency department with a Gustilo IIIB open ankle fracture with complete bony loss of the medial malleolus. The injury was treated in stages: first, irrigation and debridement with temporizing external fixation; second, soft tissue reconstruction with a posterior tibial artery perforator flap; and third, definitive fixation with reconstruction of medial malleolus using the inner table of the iliac crest as an autograft. Due to the relatively young age of the patient, reconstruction of the medial malleolus with an iliac crest autograft was selected over ankle fusion. During the definitive procedure, a 4.4 by 1.9 cm section of iliac crest was harvested from the inner table and shaped to fill the defect. Provisional fixation of the autograft was performed with Kirschner wires, and intraoperative radiographs demonstrated satisfactory reduction of the graft. A medial 1/3 tubular buttress plate was applied for definitive fixation. Postoperatively the patient remained non-weight-bearing in the external fixator for 6 weeks. The patient was then made weight-bearing as tolerated in a fixed double-upright brace, which was subsequently unlocked at 6 months.

**RESULTS:** At six months follow-up the patient was able to fully weight-bear without pain and showed no signs of infection or radiographic nonunion. The patient demonstrated marked improvement in AOFAS scores from 13 preoperatively to 64 at six months. At 8 months follow-up the patient had 15 degrees of plantar flexion and 5 degrees of dorsiflexion, and remained pain free with ambulation.

**CONCLUSION:** For patients with complete destruction of the medial malleolus surgical options include reconstruction with a 3D-printed graft, reconstruction with an iliac crest graft, or ankle fusion. This case study provides further evidence that the use of iliac crest inner table autograft is a viable option for reconstruction of the medial malleolus in cases of severe bone loss.

**Paper 081****Effect of Gender and Player Position on Season Impacting Foot and Ankle Injuries for Women's National Basketball Association Athletes**

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**INTRODUCTION:** The literature surrounding injuries in the NBA is robust but there remains a paucity in literature surrounding the WNBA despite increasing popularity in the sport in recent years. The most common injuries in the WNBA are ankle injuries, however, little data exists on risk factors and impact of these common injuries. The purpose of this study was to identify the effect of gender and player position on the duration and severity of foot and ankle injuries in the WNBA compared to NBA players.

**METHODS:** Type of injury was collected from publicly available resources such as Fox Sports, ESPN, and various validated online news sources. Player gender, positions, demographics, date of injury, consecutive games missed, total games missed, and performance statistics were collected from Rotowire and validated using secondary sources. Performance statistics were verified by the official WNBA and NBA websites. Season impacting injuries were defined as missing 5 or more consecutive games. Foot and ankle injuries were defined as ankle sprains, ankle injuries, foot injuries, and Achilles injuries. The player statistics, age, and BMI were compared using a t-test. Categorical data was analyzed using a chi-squared test.

**RESULTS:** Of the 78 players with foot or ankle injuries reported during 2019-2021 WNBA seasons, 22 females were found to have season impacting injuries (>5 games missed). Of the 128 NBA players with foot and ankle injuries during 2020-2021 reviewed, 40 males were affected. The mean number of consecutive games and total games missed were significantly less in WNBA (9) players compared to 17 for NBA players ( $p < 0.05$ ). The mean number of seasons played was significantly less in WNBA players (4.5) compared to NBA players (7) ( $p < 0.05$ ). There was no significant differences observed in gender when compared by injury type: ankle sprain, unspecified ankle injury, Achilles, and unspecified foot injury. In total, NBA players were found to significantly play more games and play more minutes ( $p < 0.01$ ). Further, position was found to not significantly affect rate of foot and ankle injuries in WNBA or NBA players.

**CONCLUSION:** WNBA players have less consecutive and total games missed because of foot and ankle injuries when compared to NBA players. Player position and experience were not risk factors for elite level WNBA players. Focused prevention programs and conditioning training may be of future benefit.



**Paper 082****Superior Capsular Reconstruction and Lower Trapezius Transfer Both Provide Good Outcomes in Properly Selected Patients with Irreparable Rotator Cuff Tears**

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**INTRODUCTION:** Irreparable rotator cuff tears (IRCT) continue to pose clinical challenges, with ongoing debate regarding optimal management strategies. Superior capsular reconstruction (SCR) and lower trapezius tendon transfer (LTT) have been proposed as effective treatment options for IRCTs with limited comparative data. The purpose of this study was to assess the clinical, radiographic, and postoperative outcomes of SCR and LTT for posterosuperior IRCTs.

**METHODS:** Over a 6-year period (2015 – 2021), 32 SCRs and 72 LTTs performed for posterosuperior IRCTs at a single institution were identified. Exclusions consisted of patients with an irreparable subscapularis tear, hamada grade  $\geq 4$ , and neurologic pathology of the ipsilateral shoulder. Outcomes collected included the visual analog scale (VAS) for pain, active shoulder range of motion (ROM), strength, satisfaction, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), Single Assessment Numerical Evaluation (SANE), Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) scores, complications, and reoperations.

**RESULTS:** Compared to the SCR group, the LTT cohort had a younger age (61.6 vs. 56.8;  $P = .003$ ), more frequent preoperative external rotation (ER) lag signs (15.6% vs. 48.6%;  $P < .001$ ), higher teres minor fatty infiltration (0.3 vs. 1.1;  $P = .009$ ), and global fatty infiltration index (1.5 vs. 1.9;  $P = .035$ ). At a mean follow-up of  $2.9 \pm 1.3$  years, significant improvements in pain, ROM, and strength were observed in both groups with no differences in ASES ( $P = .513$ ), SANE ( $P = .732$ ), or quick-DASH scores ( $P = .407$ ). Postoperatively, the SCR group had a lower VAS (0.3 vs. 1.1;  $P = .017$ ), higher forward elevation (FE) ( $156^\circ$  vs.  $143^\circ$ ;  $P = .004$ ), FE strength (4.8 vs. 4.5;  $P = .005$ ), and a greater magnitude of improvement in VAS (6.8 vs. 5.1;  $P = .009$ ), FE ( $56^\circ$  vs.  $31^\circ$ ;  $P = .004$ ), and FE strength (1.0 vs. 0.4;  $P < .001$ ). The LTT cohort had a more significant improvement in ER ( $17^\circ$  vs.  $29^\circ$ ;  $P = .026$ ). There were no statistical differences in complications (9.4% vs. 12.5%;  $P = .645$ ), reoperations (3.1% vs. 10%;  $P = .231$ ), or survivorship free of reoperation ( $P = .240$ ), between SCR and LTT cohorts, respectively.

**CONCLUSIONS:** Both SCR and LTT provided satisfactory clinical outcomes in patients with posterosuperior IRCTs at a mean follow-up time of three years. In this cohort, SCR led to better pain relief and restoration of forward elevation while LTT provided more reliable improvement in ER.

**Paper 083****Unsupervised Machine Learning to Identify Clinically Meaningful Subgroups in Patients Undergoing Arthroscopic Rotator Cuff Repair**

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**BACKGROUND:** Rotator cuff tears are estimated to affect 20.7% of the population and arthroscopic rotator cuff repair (ARCR) is the current standard for full thickness tears; with outcomes measured by clinically significant outcomes (CSOs). This study aims to partition patients based on achievement of CSO thresholds following elective ARCR by unsupervised machine learning (UML).

**METHODS:** A retrospective case-cohort analysis of a prospectively collected database was performed to identify patients who underwent elective ARCR from 2017-2018. Tear dimensions were measured on MRI utilizing a validated technique. CSO achievements on the American Shoulder and Elbow Surgeon (ASES), the Single Assessment Numerical Evaluation (SANE), and the Constant Murley Subjective Score (CMS) at 2-years follow-up were calculated. An unsupervised random forest algorithm was utilized to partition patients into optimal and suboptimal CSO achievement subgroups and internally validated. A total of 30 demographic, clinical, and preoperative PROs were entered into a stepwise multivariable logistic regression to identify predictors of suboptimal achievement.

**RESULTS:** A total of 346 patients (male: 192, 55.5%; Age: 57.2±9.1, BMI: 30.1±5.4) were eligible for inclusion and followed for an average of 3.8 (range: 2.0 – 6.2 years) years. The random forest algorithm arrived at an optimal partition of 2 subgroups, with 176 patients in the optimal achievement subgroup and 157 patients in the suboptimal achievement subgroup. The two subgroups differed significantly ( $P \leq 0.004$ ) in the likelihood of achievement of all CSOs. Stepwise multivariable logistic regression identified an increase of 1 mm in tear size in the sagittal dimension to predict a 10% increase in the probability of suboptimal achievement. Additional, additive risk factors for suboptimal CSO achievement included increased preoperative Constant-Murley shoulder score (OR: 1.11, 95% CI: 1.04-1.18,  $P < 0.001$ ), increasing number of tendons involved (OR: 14.07, 95% CI: 4.5-44.02,  $P < 0.001$ ) and subscapularis involvement (OR: 8.67, 95% CI: 2.45-30.71,  $P = 0.01$ ). Protective factors included performance of a subpectoral biceps tenodesis compared to biceps tenotomy (OR: 0.26, 95% CI: 0.05-0.92,  $P = 0.03$ ).

**CONCLUSION:** Clinically meaningful subgroups were uncovered using an UML algorithm in patients undergoing ARCR. Tear size, number of tendons involved, and subscapularis involvement were highly significant and additive predictors of suboptimal CSO achievement at 2-year minimum follow-up. Treatment of concurrent biceps pathology with tenodesis confers 74% increased likelihood of CSO achievement vs. tenotomy.

**Paper 084****Liposomal Bupivacaine vs. Interscalene Nerve Block for Arthroscopic Shoulder Surgery: A Prospective Randomized Clinical Non-Inferiority Study**

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**INTRODUCTION:** The use of regional anesthesia is common in arthroscopic shoulder surgery but the optimal protocol is unclear. This study aims to evaluate the potential value of single injection liposomal bupivacaine nerve block (LB) over ropivacaine interscalene catheter (ISC) following shoulder arthroscopy pertaining to patient complications.

**METHODS:** Patients undergoing arthroscopic shoulder surgery were prospectively surveyed after randomization into either ISC or LB arms. Preoperatively, patient demographics, and baseline pain (VAS), function (SANE), American Shoulder and Elbow Society (ASES) and Penn shoulder scores were obtained. For the first four days post operation, pain, medication usage, sleep, anesthetic site discomfort and irritation were assessed. Twelve weeks postoperatively, VAS, SANE, ASES, and Penn scores (PSS) were reassessed.

**RESULTS:** Sixty-three patients were allocated into LB arm (N=28) and ISC (N=35). Demographics did not differ between groups. LB experienced significantly fewer (13.1%) complications than ISC (29.8%) ( $p < 0.001$ ), with ISC reporting more anesthetic site discomfort (36.4% vs. 7.1%,  $p = 0.007$ ), leakage (30.3% vs. 7.1%,  $p = 0.023$ ), and "other" complications (LB:3.6%; ISC:21.2%;  $p = 0.042$ ). No differences were noted in perioperative pain, sleep, opioid use or satisfaction. VAS, SANE, ASES, or PSS did not differ between groups preoperatively or after 12 weeks. The cost for the liposomal injection was \$355 while the cost for the indwelling interscalene catheter was \$1,559.

**DISCUSSION & CONCLUSION:** Interscalene regional anesthesia in shoulder surgery with a single injection of liposomal bupivacaine achieves similar analgesia, sleep, and overall satisfaction to an interscalene catheter but at a lower cost, with less catheter related site irritation, and perceived discomfort. Single injection of liposomal bupivacaine may offer a less cumbersome and similarly efficacious means of regional anesthesia for those undergoing arthroscopic shoulder surgery compared to a continuous indwelling catheter.

**Paper 085****Patients Undergoing Arthroscopic Rotator Cuff Repair with Bioinductive Patch Augmentation Achieve Greater Range of Motion But Equivalent Patient-Reported Outcomes at One Year: A Retrospective Matched Cohort Study**

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**PURPOSE:** To compare Patient-Reported Outcome Measurement Information System (PROMIS) Upper Extremity (UE) and Pain Interference (PI) scores, range of motion (ROM), and complications of patients undergoing arthroscopic rotator cuff repair augmented with a bioinductive collagen patch compared to standard repair.

**METHODS:** A retrospective review of patients undergoing primary arthroscopic rotator cuff repair with and without bioinductive bovine collagen patch augmentation for supraspinatus and/or infraspinatus tears from 2016 to 2021 at a single institution was performed. Patients who underwent rotator cuff repair augmented with collagen patch were matched 1:1 to patients who underwent standard rotator cuff repair based on tear thickness and size.

**RESULTS:** The final cohort consisted of 54 patients with patch augmentation and 54 undergoing standard repair. No significant differences were found between groups in terms of demographics and rotator cuff tear characteristics. At final follow up, the patch group had significantly increased ROM compared to controls (forward flexion  $162.2 \pm 21.9$  vs.  $148.4 \pm 26.4$  degrees,  $p < 0.01$ ; abduction  $136.7 \pm 37$  vs.  $117.3 \pm 39.6$ ,  $p = 0.047$ ). PROMIS PI scores were significantly lower in the patch group at 6 months ( $55.2 \pm 8.0$  vs.  $61.9 \pm 2.0$ ,  $p < 0.01$ ) and 1 year ( $56.0 \pm 7.5$  vs.  $62.1 \pm 3.6$ ,  $p < .01$ ) compared to controls. PROMIS UE scores approached significance at 6 months for the patch group ( $39.3 \pm 6.9$  vs.  $34.5 \pm 4.5$ ,  $p = 0.06$ ), but was not significantly different at 1 year ( $39.5 \pm 7.7$  vs.  $38.5 \pm 6.8$ ,  $p = 0.75$ ). The patch augment group, however, had 7 retears (13.0% vs. 0%) and 1 biceps tenodesis rupture, with 5 requiring revision surgery, while no retears were found in the control group. Two of these revisions were for a retear of a previous subscapularis tear not augmented and a ruptured biceps tenodesis. No other complications were observed between groups.

**CONCLUSIONS:** Patients undergoing arthroscopic rotator cuff repairs for supraspinatus and/or infraspinatus tears augmented with a bioinductive patch led to increased range of motion, equivalent physical function, but improved pain with regards to patient reported outcome scores at one year.

**Paper 086****Comparison of Long Head of the Biceps Autograft vs. Human Dermal Allograft for Superior Capsule Reconstruction After Rotator Cuff Tear**

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**OBJECTIVES:** Superior capsule reconstruction (SCR) is one surgical option for irreparable rotator cuff tears in the younger active patient population. While the use of various autograft and allograft materials has been described, the optimal graft choice remains unclear. This study aimed to biomechanically investigate the effect of SCR using a long head of the biceps tendon (LHBT) autograft and human dermal (HD) allograft on functional abduction force and superior translation of the humeral head.

**METHODS:** Eight fresh-frozen cadaveric shoulder specimens were tested in 5 conditions: 1) intact rotator cuff, 2) complete massive supraspinatus tear, 3) LHBT autograft, 4) LHBT autograft with side-to-side suturing, and 5) HD allograft with side-to-side suturing. Functional abduction force, superior translation of the humeral head, translational range of motion, and rotational range of motion were tested at 0°, 30°, 60°, and 90° of abduction within each condition. Data was analyzed using analysis of variance with post-hoc Tukey testing for pairwise comparison with a significance value set at 0.05.

**RESULTS:** Functional abduction force in the LHBT, LHBT+ suture, and HD+ suture conditions was significantly increased compared to the supraspinatus tear condition at abduction angles of 30° ( $p=0.011$ ,  $0.001$ , and  $0.017$  respectively), 60° ( $p=0.004$ ,  $0.001$ , and  $0.002$  respectively), and 90° ( $p=0.013$ ,  $0.001$ , and  $0.038$  respectively). Additionally, superior translation of the humeral head in the LHBT, LHBT+ suture, and HD+ suture conditions was significantly decreased compared to the tear condition at abduction angles of 30° ( $p=0.03$ ,  $0.049$ ,  $0.03$  respectively) and 60° ( $p=0.02$ ,  $0.04$ ,  $0.03$  respectively). All three reconstructive techniques were statistically identical to the intact rotator cuff condition for translational and rotational range of motion.

**CONCLUSION:** SCR with LHBT autograft without side-to-side suturing, LHBT with posterior side-to-side suturing, and HD allograft with posterior side-to-side suturing all equivalently restore functional abduction force and decrease superior translation of the humeral head after a complete supraspinatus tear. Additionally, all three reconstructive techniques display no deficits in both translational and rotational range of motion, resembling the intact rotator cuff state.

**SUMMARY:** SCR with LHBT autograft and HD allograft both effectively restore functional abduction force and decrease superior translation of the humeral head after a complete supraspinatus tear in this biomechanical investigation.

**Paper 087****Many Patients Fail to Achieve Minimum Clinically Important Difference Following Nonoperative Management of Partial- and Full-Thickness Rotator Cuff Tears**

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**BACKGROUND:** The purpose of this study was to define thresholds and determine likelihood of achieving minimum clinically important difference (MCID) in nonoperatively managed full and partial-thickness tears (PTRCT).

**METHODS:** We performed a retrospective cohort study evaluating nonoperatively managed patients with MRI-confirmed FT and PTRCT's from January 2, 2020 to March 24, 2021. Patients were included if they underwent an initial course of rest, activity modification, physical therapy, and/or corticosteroid injection, and excluded if they underwent surgery during the index study period or had incomplete follow up at six months. All patients received PROMIS forms for Upper Extremity (UE) and Pain Interference (PI). Treatment modalities and follow-up PROMIS scores at least six months after initial visit were recorded. Using a distribution technique, the minimum clinically important difference (MCID) was calculated.

**RESULTS:** A total of 128 FTRCT and 108 PTRCT patients were included, with average age of 61.52 years and 58.9% (n=139) females. At 6 months from initial presentation, the MCID for PROMIS UE was 3.79 and 3.63 for FTRCT and PTRCT patients, respectively. For PROMIS PI, the MCID was 3.71 and 3.22 for FTRCT and PTRCT, respectively. In FTRCT, baseline scores significantly improved from 31.3 to 33.1 ( $p=0.02$ ) for PROMIS UE, compared with 31.4 to 34.9 ( $p<0.001$ ) for PTRCT. In total, 62.1% of FTRCT and 61.4% of PTRCT achieved MCID for PROMIS UE. In FTRCT, baseline scores improved slightly from 63.0 to 60.9 ( $p<0.01$ ) for PROMIS PI, compared with 62.5 to 60.7 ( $p=0.02$ ) for PTRCTs. In total, 51.0% of FTRCT and 51.0% of PTRCT achieved MCID for PROMIS PI. There were no significant differences in achievement of MCID ( $p=0.92$ ) between PTRCT and FTRCT. A logistic regression model was created and found that patients with FTRCT who were Black (OR=5.97, 1.57-22.73,  $p=0.01$ ) were more likely to achieve MCID for PROMIS UE at 6 months, but females were less likely to achieve (OR=0.25, 0.07-0.88,  $p=0.03$ ). No other pretreatment variables significantly correlated with achieving MCID.

**CONCLUSION:** Only half of patients achieved MCID for pain interference (51% for FTRCT and 51.0% for PTRCT) while a slightly higher proportion achieved MCID for physical function (62% for FTRCT and 61% for PTRCT).

**Paper 088****Initial Operative Treatment of Anterior Shoulder Instability in Patients >50 is Associated with Decreased Recurrent Instability**

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**INTRODUCTION:** There is limited knowledge about treatment outcomes regarding patients who experience a first-time anterior shoulder instability event after age 50. The goals of this study were to compare the clinical outcomes of initial operative and nonoperative management of patients >50 with first time anterior shoulder instability and identify risk factors for recurrent instability and progression to surgery after initial nonoperative management.

**PATIENTS & METHODS:** An established geographic database was used to identify 179 patients with first time instability after the age of 50. 14% (26 patients) were treated with initial nonoperative management, which was defined as occurring within 3 months after the initial instability event. Eight operations (31%) involved fracture open reduction internal fixation, 17 (65%) required a rotator cuff repair, and 6 operations (23%) involved an anterior labral repair. Outcomes were evaluated using Chi-square tests and survivorship curves were generated using Kaplan-Meier methods. A Cox model was developed to evaluate for potential risk factors of recurrent instability and progression to surgery.

**RESULTS:** 19% of both the nonoperative and the operative cohort reported moderate-severe pain at their final follow-up visit. The incidence of adhesive capsulitis was similar between the nonoperative (8.7%) and the operative cohort (7.7%). Nerve palsy was observed in 19.2% of surgically treated patients and 8.1% of nonoperatively treated patients ( $p=0.081$ ). 14% of the nonoperative cohort and 20% of the operative cohort progressed to symptomatic osteoarthritis at an average of 7 years and 3 years after their initial instability event, respectively. 15% of the nonoperative cohort and 8% of the operative cohort experienced recurrent instability at an average of 3 years and 16 days after initial instability event, respectively. There were no instances of instability after surgical management. Any previous instability event was a significant risk factor for both recurrence of instability and progression to surgery ( $p<0.001$ ,  $p<0.010$ )

**CONCLUSIONS:** Patients who underwent initial operative intervention of anterior shoulder instability had a decreased risk of recurrent instability but an increased risk of developing osteoarthritis at an earlier time point. There was no difference in pain severity, rates of adhesive capsulitis or nerve palsy between patients who underwent nonoperative and operative treatment. Any previous instability event increased the rate of recurrent instability or progression to surgery after initial nonoperative management.

**Paper 089****A Retrospective Evaluation of External Rotation at 0° and 90° of Abduction After Arthroscopic Latarjet Procedure**

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**BACKGROUND:** Several papers have shown that shoulder stabilizing procedures, including the Latarjet procedure, lead to postoperative external rotation (ER) deficits. However, no study on arthroscopic Latarjet procedures has investigated the effect on ER when the arm is abducted at 0° and 90°. This study examined the relationship between the arthroscopic Latarjet procedure and the subsequent effect on external rotation at both 0° and 90° of abduction compared to the contralateral extremity.

**METHODS:** Records of patients who underwent an arthroscopic Latarjet Procedure from December 2015 to April 2021 were retrospectively evaluated for this study. Requirements included both a three- and six-month follow-up visit. Any procedure that was done open or was a combined open-arthroscopic approach was excluded. Patients were also excluded if they had a previous surgery on the contralateral shoulder as this extremity was used for external rotation comparison. Preoperative range of motion (ROM) including ER with the arm adducted by the patient's side (ER0) and ER at 90° abduction (ER90) were obtained from the contralateral shoulder. External rotation values of the operative side were subsequently collected at both the three- and six-month postoperative appointments. A repeated measures ANOVA was performed to assess the mean values between the preoperatively measured contralateral extremity and the operative extremity as measured at both the three- and six-month timeframes. Statistical significance was set at  $p < 0.05$ .

**RESULTS:** Forty-six patients met the inclusion criteria. Mean ER0 for the three- and six-month time frames measured 44.2° and 54.6°, respectively. Mean ER90 for the three- and six-month timeframes measured 78.4° and 90.4°, respectively. Comparison to the contralateral arm at the three-month follow-up period showed a deficit of 14.9° ( $p=0.0001$ ) and 17.2° ( $p=0.0001$ ) for ER0 and ER90, respectively. At the six-month follow-up period, patients demonstrated an average decline in ER0 and ER90 of 4.57° ( $p=0.063$ ) and 5.11° ( $p=0.008$ ), respectively.

**CONCLUSION:** A nominal deficit in external rotation occurred at both 0° and 90° of shoulder abduction status post arthroscopic Latarjet procedure. Although the loss was only 5.11°, there was a significant loss of range of motion between the six-month ER90 of the operative extremity versus the preoperative contralateral extremity. Despite loss of ER90 at six-months achieving statistical significance, the clinical impact is arguably inconsequential. Regaining range of motion including ER at 0° and 90° provides more information regarding bony procedures being a more definitive treatment for glenohumeral instability and the ability to restore native motion.



**Paper 090**

**The Intraoperative Diagnosis and Procedures Performed for Shoulder Pathology Diagnosed on Arthroscopy Following Normal MRI: A Retrospective Case Series**

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**BACKGROUND:** Magnetic resonance imaging (MRI) and arthrogram (MRA) have shown utility along with a thorough history and physical exam in the diagnosis of shoulder pathology. However, false negatives remain especially common amongst labral pathology. We sought to characterize a subset of patients who show clinical signs of operative shoulder pathology, receive a normal MRI or MRA result, and are indicated for diagnostic arthroscopy.

**METHODS:** This is a retrospective case series of patients who underwent shoulder arthroscopy with normal preoperative imaging. Patients were included if they had a preoperative MRI or MRA read as normal by a board-certified musculoskeletal radiologist and underwent diagnostic shoulder arthroscopy. Clinical notes, operative reports, and radiology reports were retrospectively reviewed, and univariate statistical analysis was performed.

**RESULTS:** A total of 35 patients were identified who met the inclusion criteria. There were 19 males and 16 females with an average age of 21 years. 12 of 35 (34.2%) had a documented traumatic event while 23 of 35 (65.7%) presented with complaints of atraumatic shoulder pain. The dominant extremity was affected in 26 (74.3%) patients. On average, patients waited 273 days from first evaluation until surgical intervention. 25 of 35 (71.4%) patients required a distinct repair (labral, SLAP, cuff, etc.) at the time of arthroscopy.

**CONCLUSION:** A small subset of patients exists for whom modern imaging technologies do not accurately diagnose shoulder injuries. These patients tended to be younger and presented with a clinical history of atraumatic pain in their dominant shoulder. Posterior labral tears and capsular laxity were the most common intraoperative pathologies encountered. These results highlight the necessity of a good clinical history and physical exam and the use of modern imaging technologies as an adjuvant, rather than conclusive, diagnostic tool for shoulder injuries.

**LEVEL OF EVIDENCE:** IV

**Paper 091****Changes in Elbow Stress and Ball Velocity During Reduced Effort Pitching: A Marker-Based Motion Capture Analysis**

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**BACKGROUND:** Baseball pitchers often participate in throwing programs that involve throwing at reduced effort levels to gradually increase the amount of stress experienced across the elbow. It is unknown how reduced effort pitching compares to maximum effort with respect to elbow stress and ball velocity.

**PURPOSE:** To determine whether elbow stress and ball velocity correlate with reduced effort pitching, whether elbow stress and ball velocity decrease proportionally while throwing at a reduced effort, and to assess intrathrower reliability.

**METHODS:** Ten healthy male high school baseball pitchers threw 5 pitches from a regulation pitching mound at 3 effort levels: maximum effort, 75% effort, and 50% effort. Elbow stress, specifically elbow varus torque, was calculated for all pitches using a marker-based 3D motion capture system. Ball velocity was measured using a Doppler radar gun. Intrathrower variability was calculated for each effort level.

**RESULTS:** Elbow stress and ball velocity decreased with reduced effort throws ( $p < 0.001$  and  $p = 0.003$ , respectively). However, the reductions in elbow stress and ball velocity were not proportional. At 75% effort throws, elbow stress decreased only 19% and ball velocity decreased only 10%. At 50% effort throws, elbow stress decreased only 25% and ball velocity decreased only 15%. Intrathrower reliability was excellent for elbow stress and ball velocity, with intraclass correlation coefficients all  $\geq 0.80$ .

**CONCLUSIONS:** Pitching at a reduced effort level resulted in decreased elbow stress and ball velocity. However, for every 25% reduction in perceived effort, elbow stress decreased by a mean of 13% and ball velocity decreased 8%. When baseball pitchers attempt to throw at a reduced effort of maximum, throwing metrics do not decrease proportionately.

**Paper 092****Osteochondritis Dissecans of the Capitellum of the Elbow: A Comparison of Nonoperative and Surgical Outcomes at Long-Term Follow-Up**

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**INTRODUCTION:** Osteochondritis dissecans (OCD) of the humeral capitellum is an often painful condition that typically affects the adolescent athlete. There is little consensus on treatment and scarcity of long-term outcomes data. The purpose of this study was to 1) report the long-term outcomes associated with both operative and nonoperative management of capitellar OCD, 2) identify factors associated with failure of non-operative management, and 3) determine whether delay in surgery affects final outcomes.

**METHODS:** All patients diagnosed with OCD of the capitellum from 1995-2020 within a defined geographic cohort were included in the study. All medical records, imaging studies, and operative reports were manually reviewed to record demographic data, treatment strategies, and outcomes. Comparisons across treatment strategies were made. Surgical treatment was considered delayed if it occurred more than six months after symptom onset.

**RESULTS:** A total of 50 elbows with a mean follow-up of 9.4 years were included in the study. Of these, 7 (14%) were treated nonoperatively and never underwent surgery during follow-up, while 43 (86%) underwent surgical intervention (27 had early surgery and 16 underwent delayed surgery after  $\geq 6$  months of nonoperative treatment). When compared to nonoperative management, surgical management resulted in superior MEPI scores (90 vs. 83,  $p=0.05$ ), decreased persistence of mechanical symptoms (9% vs. 50%,  $p<0.01$ ), and better elbow flexion ( $141^\circ$  vs.  $131^\circ$ ,  $p=0.01$ ) at long-term follow-up. Older patients had a trend toward increased failure of nonoperative management ( $p=0.06$ ). The presence of an intra-articular loose body strongly predicted failure of nonoperative management ( $p=0.01$ ; OR 13). Plain radiography and MRI had poor sensitivities for identifying loose bodies (27% and 40%, respectively). Differences in outcomes following early vs. delayed surgical management were not demonstrated.

**CONCLUSION:** Patients with capitellar OCD that was treated nonoperatively failed nonoperative treatment 70% of the time. Elbows that did not undergo surgery had slightly increased symptoms and decreased functional outcomes compared to those treated surgically. In this cohort, the greatest predictors of failure of nonoperative treatment were older age and presence of a loose body; however, an initial trial of nonoperative treatment did not adversely impact the success of future surgery at long-term follow-up.

**Paper 093****Elbow Medial Ulnar Collateral Ligament Repair vs. Reconstruction: How Has the Trend Changed?**

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**INTRODUCTION:** Over the past 20 years, elbow medial ulnar collateral ligament (UCL) reconstruction has been a common procedure among adolescent athletes. Medial UCL repair was previously less commonly utilized. There has been a renewed interest in direct repair of the medial UCL, however, there is a paucity of literature detailing this shift. The purpose of the study is to determine current trends in rates of repair vs. reconstruction for elbow medial UCL tears. Our hypothesis is that in the last decade, medial UCL repair has been performed more frequently in patients under the age of 24.

**METHODS:** Patients that underwent elbow medial UCL repair (CPT 24345) or medial UCL reconstruction (CPT 24346) were retrospectively evaluated using data from the PearlDiver database. The number and incidence of these procedures from 2010 to 2019 were collected for patients aged 10 to 24. The incidence rate ratio (IRR) for repair vs. reconstruction was determined. Statistical significance was defined as  $p < 0.05$ .

**RESULTS:** 2,858 total medial UCL repairs and reconstructions were performed in this cohort between 2010 and 2019, with 765 repairs and 2,145 reconstructions. The incidence of total repairs and reconstructions per 100,000 was less in 2015-2019 when compared to 2010-2014 (IRR 0.91, 95% CI 0.84-0.97). The incidence of repair was greater in 2015-2019 compared to 2010-2014 (IRR 1.35, 95% CI 1.17-1.56) while the incidence of reconstructions was less in 2015-2019 compared to earlier years (IRR of 0.80, 95% CI 0.74-0.87). Of medial UCL surgeries, in 2010-2014, 21.08% were repaired and 78.92% were reconstructed. In 2015-2019, repairs increased to 31.02% ( $p < 0.001$ ). The IRR of repair vs. reconstruction was greater in 2015-2019 compared to 2010-2014 ( $p \leq 0.001$ ). Additionally, more reconstructions were performed in ages 20-24 compared to the younger cohort, ( $p \leq 0.001$ ) while the incidence of repair was similar in both age ranges.

**CONCLUSIONS:** From 2010 through 2019, there has been a decrease in incidence of medial UCL repairs and reconstructions. When surgery is indicated, there has been increased utilization of repair, over reconstruction. When comparing medial UCL repairs and reconstructions directly, there has been a greater increase in repairs over the last five years of the decade. Additionally, while medial UCL repair incidence is utilized at a similar rate in ages 10-19 vs. 20-24, the incidence of reconstructions is greater in the older cohort.

**Paper 094****Incidence and Epidemiology of Symptomatic Osteochondritis Dissecans of the Capitellum of the Elbow**

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**BACKGROUND:** Osteochondritis dissecans (OCD) of the capitellum is an increasingly recognized condition in young active individuals. There are limited data regarding the incidence and change in incidence over time of capitellar OCD in the United States (U.S.) population.

**HYPOTHESIS/PURPOSE:** The purpose of this study was to determine the incidence of symptomatic capitellar OCD in a representative U.S. subpopulation and identify changes in incidence over time. Secondary aims were to identify the relationship between the incidence of capitellar OCD and sex and age.

**METHODS:** A retrospective review of patients aged <24 with symptomatic capitellar OCD over a 25-year period (1995-2019) from a defined geographic cohort was performed. Patients with acute osteochondral injuries, Panner's disease, and hereditary arthropathy were excluded. Poisson regression was utilized to identify predictors of a capitellar OCD diagnosis. Incidence rates were assessed for changes over time and were expressed per 100,000 people. Groups aged 10-15 and 16-24 years old were compared.

**RESULTS:** Forty-five patients (78% male) with a diagnosis of capitellar OCD were identified. Mean age was 14 (range 10-24). Thirty-one were 10-15 years old, and 14 were 16-24 years old. Eighty-nine percent of patients participated in sports. Of these, 90% were overhead athletes and 58% were throwers. The incidence of symptomatic capitellar OCD between the ages of 10-24 was 6/100,000 overall, 9.5/100,000 for males, and 3/100,000 for females. The estimated incidence rate ratio (IRR) for younger (10-15 years) vs. older (16-24 years) patients was 3.3 ( $p < 0.001$ ). The IRR for males compared to females was 3.5 ( $p < 0.001$ ). There were no changes in the incidence of capitellar OCD over time as a continuous or 5-year categorical variable ( $p = 0.290$  and  $p = 0.460$ , respectively). Overall, 82% of patients were treated surgically. There were no significant changes in surgical rates over time; however, older patients were more likely to undergo surgery (100%), than younger patients (74%) ( $p = 0.040$ ).

**CONCLUSIONS:** In our representative U.S. subpopulation, the overall incidence of symptomatic capitellar OCD between the ages of 10-24 was 6 per 100,000 over the 25-year study period: substantially higher than previously reported U.S. estimates. This incidence was highest for 10-15 year old males (15.3/100,000) and lowest for 16-24 year old females (0.8/100,000). Older patients were more likely to undergo surgical intervention compared to younger patients. Incidence rates and treatment strategies did not change significantly over the 25-year study period.

**Paper 095****Reliability of Proxy and Self-Assessed Pre-Injury Functional Status in Orthopedic Trauma**

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**BACKGROUND:** Patient-Reported Outcomes Measurement Information System (PROMIS) is a tool that aids providers in quantifying the patient's perspective on their health and recovery. Within the orthopedic trauma community, the patient's first interactions with providers occur post-injury which precludes obtaining a functional status baseline score pre-injury. Our study seeks to determine the reliability of obtaining pre-injury baseline functional status by comparing patient retrospective baseline PROMIS scores at different timepoints post-injury, and with a familiar proxy. We hypothesize there will be high correlation in patient-proxy baseline PROMIS scores and self-assessed baseline PROMIS scores up to six weeks post-injury.

**METHODS:** Eligible patients with acute fractures were identified from an orthopedic Trauma Service at one institution for one year. Proxies were first-degree relatives, significant-others, or spouses. The PROMIS Computer Adaptive Technology Bank v2.0 Physical Function and Upper Extremity surveys were administered on tablets. Patients and their proxies completed week-0 baseline PROMIS scores within seven days of injury. Patients completed week-2,6 retrospective baseline PROMIS scores during outpatient visits or via remote mechanism. Patient-specific means with 95% confidence intervals were estimated from a linear mixed-effects model. Intra-class correlations (ICC) were calculated.

**RESULTS:** 169 patients were included, of which 62% had lower extremity (LE) injuries (n=104), 24% (n=41) had upper extremity (UE) injuries, and 14% (n=24) had both. The mean age was 51 years, 59% were male (n=99), and 78% of cases were operative (n=131). Ground level falls were the most common mechanism of injury (n=53, 31%). Mean differences in patient-proxy scores at week-0 were similar for both LE ( $0.1 \pm 3.5$ ) and UE ( $-0.7 \pm 2.8$ ). Patient-proxy agreement was significantly high ( $p < .01$ ) for both the LE (ICC=0.94) and UE (ICC=0.96) scores. Mean differences for self-assessed patient scores were similar for week-0/week-2 in both LE ( $0.6 \pm 3.1$ ) and UE ( $0.3 \pm 2.1$ ), and week-0/week-6 in both LE ( $0.1 \pm 3.8$ ) and UE ( $0.6 \pm 2.3$ ). Pairwise timepoint comparisons of these differences demonstrated significant LE score correlation ( $p < .01$ ) between week-0/week-2 ( $r = .95$ ) and week-0/week-6 ( $r = .93$ ), and significant UE score correlation ( $p < .01$ ) between week-0/week-2 ( $r = .97$ ) and week-0/week-6 ( $r = .93$ ).

**CONCLUSION:** This data demonstrates little variation and high agreement in patient-proxy PROMIS scores and self-assessed PROMIS scores over time. These findings suggest that pre-injury functional status can be obtained via self-assessment up to six weeks post-injury, and via use of a proxy, in a general orthopedic trauma population. Baseline assessment of function may aid in determining patient return to pre-injury functional status.

**Paper 096**

**Can a Prediction Tool that Utilizes Both Clinical and Laboratory Data Increase Accuracy of Septic Nonunion Diagnosis?**

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**OBJECTIVES:** The purpose of this study is to identify clinical risk factors for septic nonunion to develop a prediction tool to improve the diagnosis of infection prior to nonunion surgery.

**METHODS:** This retrospective cohort study was completed at a single tertiary referral level one trauma center. Patients were included if they had surgery to repair a fracture nonunion of the femur, tibia, or humerus after operative initial management. Patient demographics, injury information, and nonunion work-up were collected. Clinical predictors for septic nonunion were determined. Ideal cutoffs for laboratory biomarkers were identified using receiver operating characteristic (ROC) curves. These data were used to create a clinical prediction tool for septic nonunion.

**RESULTS:** 121 patients met inclusion criteria. 32 patients (26.4%) were diagnosed with septic nonunion. Age < 50 ( $p = 0.048$ ), initial fracture surgery performed at outside hospital ( $p = 0.030$ ), early infection requiring debridement within 60 days of initial injury ( $p < 0.001$ ), WBC ( $p = 0.004$ ), and CRP ( $p = 0.003$ ) were independent predictors of infection. Ideal cutoffs based on ROC curves were set to WBC >  $10.0 \times 10^9/L$  and CRP > 1.35 mg/L. The area under the curve of the model was 0.945. With a cutoff of 2.5 points, the sensitivity was 87.5% and the negative predictive value was 95.3%.

**CONCLUSIONS:** This simple prediction system for septic nonunion developed from five specific data points was able to rule out septic nonunion with great accuracy in this initial cohort. This system should be utilized in further studies to assess its validity as a predictive tool in broader populations.

**Paper 097****Significant Loss of Skeletal Muscle Mass Occurs After Femoral Fragility Fracture**

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**PURPOSE:** Femoral fragility fractures in the elderly result in devastating loss of physical function and muscle mass, that is a direct result of immobilization and nutrition deficiencies during the healing phase after trauma. A better understanding of how muscle mass responds to injury is needed to critically evaluate nutrition and rehabilitation interventions designed to prevent muscle loss and optimize function. The purpose of this study was to document sarcopenia, nutrition status, and changes in muscle mass after femoral fragility fractures.

**METHODS:** A two-center prospective observational study enrolled individuals  $\geq 65$  years old admitted for operative fixation of a low-energy femoral fracture. Body composition was assessed within 72 hours of admission (baseline) using multifrequency bioelectrical impedance and repeated 6, 12, and 24 weeks after injury. Sarcopenia was defined by gender specific cutoffs for the appendicular skeletal muscle mass index (ASMI),  $<6.3$  ASMI for females and  $<8.5$  ASMI for males. Malnutrition was defined by Mini Nutritional Assessment<sup>®</sup>. Linear mixed models were used to assess 6, 12, and 24-week change from baseline in lean body mass (LBM) and skeletal muscle mass (SMM). Logistic regression with generalized estimating equations was used to evaluate the association between muscle loss and malnutrition.

**RESULTS:** Forty-four participants (11% male) age  $76.7 \pm 9.0$  years were enrolled. At baseline, 17 (39%) were sarcopenic and 21 (49%) had malnutrition. LBM and SMM decreased  $3.75 \pm 0.68$  kg ( $p < 0.001$ ) and  $2.19 \pm 0.40$  kg ( $p < 0.001$ ) in the first 6 weeks after injury, respectively. By 12 weeks, participants lost  $4.80 \pm 0.80$  kg of LBM ( $p < 0.001$ ) and  $2.75 \pm 0.48$  kg of SMM ( $p < 0.001$ ). LBM and SMM loss persisted through 24 weeks post-injury. At 24 weeks post-injury, participants had  $3.04 \pm 0.95$  kg ( $p = 0.002$ ) less LBM and  $1.73 \pm 0.57$  kg ( $p = 0.003$ ) less SMM compared to baseline. Baseline malnutrition was not significantly associated with muscle loss.

**CONCLUSION:** Femoral fragility fractures result in devastating losses of lean body mass and skeletal muscle mass. These losses occurred early after injury and persisted 24 weeks after injury. Many subjects were classified as malnourished, but malnutrition was not associated with muscle loss, indicating that future investigations of interventions to prevent muscle loss should focus on all fragility fracture patients regardless of nutrition status. These results highlight the need for further investigation into interventions to mitigate muscle loss after injury.



**Paper 098****Subperiosteal Elevation of the Ulnar Nerve is a Safe and Effective Way to Minimize Postoperative Ulnar Neuritis in Distal Humerus Fractures**

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**INTRODUCTION:** Ulnar neuropathy is a common complication following distal humerus fracture typically managed with in situ neurolysis or anterior transposition. We incorporated a lesser-known technique for intraoperative ulnar nerve management, subperiosteal elevation. Our aim is to describe this method and compare postoperative ulnar neuritis rates between the nerve management techniques.

**METHODS:** The study retrospectively reviewed 125 distal humerus fractures that underwent open reduction internal fixation at an urban level 1 trauma center. The presence of preoperative and postoperative nerve injury was identified by deficits documented within the physical exam. The patients were grouped based on intraoperative management of the ulnar nerve. The subperiosteal elevation begins by releasing the ulnar nerve from the triceps. Following release, the nerve remains invested in the brachialis muscle and is elevated subperiosteally with the structures of the cubital tunnel. The nerve is protected and moved anteriorly within the brachialis musculature. Following fixation, the ulnar nerve is returned to its anatomic position and the periosteum is sutured back into place. Comparisons were conducted using Chi-Square and Kruskal Wallis tests at the  $p < 0.05$  significance level, where appropriate.

**RESULTS:** The cohort was comprised of females (52%) with a mean age of 58, who sustained a majority of ground level falls (58%). Ninety-six (77%) were intra-articular fractures. Within the 125 patients, 35 received a subperiosteal elevation, 63 in situ ulnar nerve decompression, and 27 anterior transposition of the ulnar nerve. Twelve patients (34%) receiving subperiosteal decompression had a preoperative ulnar neuropathy. At postoperative evaluation, 100% resolved with 2 (6%) new cases of postoperative ulnar neuritis. For the 63 patients receiving in situ decompression, 13 (21%) had a preoperative ulnar neuropathy. Nine (69%) resolved post-operatively with 5 (8%) cases of new onset postoperative neuritis. Of the 27 patients receiving anterior transposition of the ulnar nerve, 9 had preoperative ulnar neuropathy of which 3 (33%) resolved by postoperative evaluation with 7 (26%) cases of new onset postoperative ulnar neuritis. Compared to anterior transposition, subperiosteal elevation had fewer cases of new postoperative ulnar neuritis ( $p=0.019$ ) and more preoperative symptom resolution ( $p=0.002$ ) while subperiosteal elevation performed similarly in both regards when compared to in situ decompression ( $p > 0.05$ ).

**CONCLUSION:** Intraoperative management of the ulnar nerve with subperiosteal elevation is a safe and effective way to minimize postoperative ulnar neuritis during distal humerus fracture fixation. Anterior transposition of the ulnar nerve should be avoided due to a significant association with postoperative ulnar neuritis.

**Paper 099****3D-Printed One-Third Tubular Plates in an Ankle Fracture Model: A Biomechanical Study**

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**INTRODUCTION:** In environments where orthopedic equipment is scarce, it is imperative to deliver quality care despite lack of access. 3D printing offers a potential solution, but its use has not been fully explored. This study examined the biomechanical properties of 3D-printed one-third tubular plates made from carbon fiber-reinforced polylactic acid (CFR-PLA) and polycarbonate (PC) in a fibula fracture model, and compared results to those of standard stainless steel one-third tubular plates.

**METHODS:** Fibula fracture models were created by cutting composite Sawbones samples to simulate a Danis-Weber Type B fracture pattern. Specimens were fixed with lag screws and 8-hole one-third tubular plates laterally. Stainless steel plates were used as controls. Experimental plates were 3D-printed in CFR-PLA and PC. The plates were secured with three bicortical 3.5mm stainless steel screws proximally, and three unicortical 3.5mm stainless steel screws distally. The control and experimental specimens, and two intact composite Sawbones were mechanically tested for valgus bending strength, torsional strength, and torsional failure strength. A one-way analysis of variance with a least significant difference multiple comparisons post hoc analysis was performed to determine differences between groups with a p-value of 0.05.

**RESULTS:** Under compressive forces, there were no significant differences in flexural rigidity. The stainless steel controls had significantly greater stiffness than PC constructs, but not CFR-PLA constructs. When compressive loads were released, stainless steel controls demonstrated significantly greater stiffness and rigidity compared to both CFR-PLA and PC constructs. Mean peak load measured at 3mm of vertical displacement was significantly greater for stainless steel constructs than all other samples.

Torsion testing displayed superior stiffness and rigidity in CFR-PLA plate constructs, followed by the stainless steel controls, and then the PC plate constructs. Mean peak torque at 10 degrees of external rotation was highest for the carbon fiber group. Torsional failure testing, however, demonstrated superiority of the stainless steel controls over 3D-printed constructs.

**DISCUSSION:** Fracture fixation with the stainless steel control outperformed 3D-printed plates overall, but mechanical ranges for several testing values overlapped with controls. With a 20-minute manufacturing time and material cost under \$1, this study demonstrates the potential of 3D-printed constructs to become a viable option for fracture care at substantially decreased cost, and improve access to orthopedic care in resource-scarce environments. Further studies are needed to evaluate the clinical utility of 3D-printed constructs.

**Paper 100****The Lateral Tibiotalar Line: A Novel Radiographic Marker for Syndesmotic Stability of the Ankle**

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**BACKGROUND:** Radiographic markers such as increased medial clear space and increased tibiofibular clear space have been suggested as the gold-standard radiographic indicators for syndesmotic disruption following an ankle injury. However, without a quality mortise-view or with decreased rotational stress placed on the injured ankle at the time of the radiograph, the sensitivity of the parameter decreases. We propose a novel radiographic marker, the lateral tibiotalar line, and hypothesize it may be a more sensitive indicator for syndesmotic disruption in an injured ankle.

**METHODS:** This cadaveric study utilized 5 ankles that were iatrogenically destabilized. Prior to intervention, AP, mortise, and manual stress radiographs of the ankles were obtained. The syndesmosis of the ankle (AITFL, PITFL, IOM) and Deltoid ligament complex were surgically disrupted and repeat radiographs were obtained. The lateral tibiotalar line was measured via two points: Point A beginning 10 cm from the tibial plafond along the lateral border of the tibia and Point B representing the floor of the incisura fibularis. A straight line was then drawn connecting the two. We defined a specimen as positive for destabilization if there was greater than 0.5mm of the articular surface of the talus lateral to the line. Images were reviewed by 4 independent reviewers.

**RESULTS:** All five specimens had evidence of lateral tibiotalar shift when comparing pre-injury mortise and post-injury stress views. On stress views, Only 40% had evidence of medial clear space widening >5mm and none had evidence of tibiofibular clear space widening >6mm. The sensitivity of the lateral tibiotalar line increases as increased external rotation stress is applied to the ankle, with the sensitivity being 60% at 10 and 20 degrees of external rotation and 100% at 30 degrees of external rotation. Four specimens did not cross the lateral tibiotalar line on our pre or post-intervention mortise views. When an external rotation stress was placed on these specimens the specimens all crossed this line by 1mm to 3mm on average. In the one sample that did cross the line on pre and post-intervention mortise view, there was an increase in lateral talar translation by 2mm. The sensitivity of the lateral tibiotalar line compares to only 40% for medial clear space widening and 0% for tibiofibular clear space widening noted on these specimens at 30 degrees. Sensitivity was 0% for both parameters at 10 and 20 degrees of external rotation.

**CONCLUSION:** The lateral tibiotalar line is a novel radiographic marker that may be useful as an additional tool for orthopedic surgeons when assessing stability in unstressed and stressed ankle injuries. This radiographic marker may be more sensitive than the medial clear space and tibiofibular clear space widening that has typically been used in the past.

**Paper 101****Evaluation of a Multidisciplinary Preoperative Workup Strategy for Geriatric Hip Fractures at a Level III Community Hospital**

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**INTRODUCTION:** Timely management of hip fractures has been shown to decrease length of stay and mortality. A recent study demonstrated reduced time to surgery (TTS) and length of stay (LOS) after implementing a multidisciplinary protocol led by in-house anesthesiologists for preoperative optimization of geriatric hip fracture patients at a level I trauma center. The purpose of this study was to evaluate these measurements after implementation of this approach at a university-affiliated level III community hospital.

**METHODS:** Hospital billing records were retrospectively reviewed to identify patients aged 65 or older who underwent operative fixation for an isolated proximal femur fracture at a level III community hospital before and after the protocol was implemented. Time and date of admission, surgery, and discharge, as well as details of consultations, additional preoperative workup, and both preoperative and postoperative course were collected. Statistical analysis was performed using Student's t-test.

**RESULTS:** 257 patients from the pre-implementation period (Cohort #1) and 107 patients from the post-implementation period (Cohort #2) were included. The average TTS was 26.13 +/- 19.42 and 25.7 +/- 15.1 hours, respectively ( $p>0.05$ ). The average LOS was 138.8 +/- 62.2 and 163.5 +/- 79.7 hours for Cohorts #1 and #2, respectively ( $p=0.005$ ). 41 patients in Cohort #1 and 34 patients in Cohort #2 received additional preoperative cardiac testing. The average TTS for these groups were 34.9 +/- 24.7 and 33.5 +/- 17.6 hours, respectively ( $p>0.05$ ). The average LOS for these groups were 158.4 +/- 71.8 and 191.3 +/- 88.5 hours, respectively ( $p>0.05$ ). The average time from order to result of additional cardiac testing was 11.15 +/- 8.1 hours in Cohort #1 and 4.4 +/- 4.1 hours in Cohort #2 ( $p<0.001$ ).

**DISCUSSION:** Our results show improvement in timeliness of preoperative cardiac testing but no difference in TTS and increased LOS after protocol implementation. These are in contrast to the improved TTS and LOS seen at a level I academic trauma center. It appears there are differences in the potential benefit to patients provided with this strategy depending on the type of hospital in which they are applied. Timely management of operative hip fractures depends on preoperative evaluation, operating room availability, and surgeon availability. All three of these must be addressed to achieve the goal of reduced LOS and TTS.

**Paper 102****Periprosthetic Fractures Following Total Hip Arthroplasty: How Many Have Systemic Osteopenia or Osteoporosis?**

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**INTRODUCTION:** Osteoporosis is underdiagnosed before total hip arthroplasty (THA), or may develop postoperatively, increasing periprosthetic fracture risk. This study characterized the prevalence of osteoporosis and osteopenia diagnoses before and after periprosthetic femur fractures following THA, and how often patients received testing and endocrinology consultation.

**METHODS:** We identified 172 Vancouver B2 (110) and B3 (62) periprosthetic femur fractures treated with a modular fluted tapered stem from 2000 to 2018 at one institution. The mean age was 75 years, 50% were women, and the mean BMI was 29 kg/m<sup>2</sup>. A text search tool identified patients with documented osteoporosis or osteopenia diagnoses, fracture risk assessment tool (FRAX), bone mineral density (BMD) testing, or endocrinology consult by searching clinical notes and radiology reports for keywords. Documentation was reviewed and coded for analysis. Age-appropriate BMD testing was defined as no later than one year after the recommended ages of 65 (females) or 70 years (males). Mean follow-up was 11 years.

**RESULTS:** The prevalence of osteoporosis diagnosis increased from 20% before periprosthetic fracture to 39% after. The prevalence of osteopenia diagnosis increased from 13% before fracture to 24% after. The prevalence of either diagnosis increased from 24% before fracture to 44% after. No patients had documented FRAX scores before fracture, and only 2% had scores after. The prevalence of BMD testing increased from 21% before fracture to 22% after. Only 14% received age-appropriate BMD testing. The proportion with endocrinology consults increased from 6% before fracture to 24% after. The prevalence of either diagnosis was 32% among patients without endocrinology consults compared to 83% of those with consults.

**CONCLUSIONS:** Although many periprosthetic fractures following THA are fragility fractures that qualify patients for osteoporosis diagnoses, there remain significant gaps in diagnosis, testing, and endocrinology follow-up. Like non-arthroplasty fragility fractures, a systematic approach is needed after periprosthetic fractures.

**Paper 103****Results of a Staged Protocol for Total Hip Arthroplasty with Interval Resection and Articulating Antibiotic PMMA Spacer for Failed ORIF of Acetabular Fractures**

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**PURPOSE:** Arthroplasty following failed open reduction and internal fixation (ORIF) of acetabulum fractures demonstrates an increased rate of dislocation, infection, and revision. The purpose of this study is to evaluate the outcomes and complications for a two-staged protocol consisting of interval resection arthroplasty and articulating antibiotic spacer with cultures, and pathology prior to conversion arthroplasty.

**METHODS:** Retrospective chart review from a single Level 1 trauma center was performed on patients from June 2017 to June 2021 who underwent a staged protocol consisting of an initial resection arthroplasty, antibiotic impregnated PMMA articulating spacer (vancomycin and tobramycin), and intraoperative cultures plus pathology, followed conversion to arthroplasty for failed ORIF of acetabulum fracture. Data collection included patient demographics, time interval from ORIF, surgical time, preoperative C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), intraoperative tissue cultures and pathology reports. Patients with postoperative wound infection following ORIF were excluded. Patients were followed for a minimum of six months.

**RESULTS:** Twelve hips in 11 patients were included in this analysis, with the most common indication being avascular necrosis or post-traumatic osteoarthritis. Acetabular and femoral head impaction were present in 83% (n=10) and 42% (n=5) of patients respectively at time of ORIF. Average time from ORIF to resection arthroplasty was 734 days (range 76 days – 8 years), with 75% of failures occurring within nine months. Positive intraoperative cultures and pathology were found in 50% of hips (n=6) with no preoperative or intraoperative clinical signs of infection. Preoperatively, 83% of patients had an elevated ESR, however, all three patients with an elevated CRP had a positive intraoperative culture. Following arthroplasty, one revision (dislocation) occurred in culture/pathology negative patients (16% or 1/6), and three revisions (two dislocations and one infection) occurred the culture/pathology positive patients (50% or 3/6). Elevated CRP has a 100% positive predictive value for culture/pathology consistent with infection.

**CONCLUSION:** Patients need to understand that arthroplasty following failed ORIF has a high complication rate requiring revision surgery – particularly if intraoperative cultures are positive at the time of resection. A two-staged protocol for conversion of failed acetabulum ORIF to arthroplasty with an interval resection and articulating antibiotic spacer allows for detection of occult infection. While ESR is often elevated in these patients, it does not correlate with intraoperative cultures or pathology. However, an elevated CRP correlated highly with intraoperative cultures and should increase the suspicion for occult infection.

**Paper 104****The Association Between Preoperative INR Values and Postoperative Outcomes Including Mortality in Geriatric Femoral Neck Fractures Treated with Hemiarthroplasty**

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**PURPOSE:** Prior studies demonstrated an association between preoperative international normalized ratio (INR) and postoperative complications and mortality for patients with geriatric hip fractures. These were large database studies with limitations. We hypothesized that an increasing preoperative INR would be associated with increased rates of 90-day mortality and postoperative complications in patients undergoing hemiarthroplasty for geriatric femoral neck fracture.

**METHODS:** Our institutional total joint registry (TJR) was used to identify 2,338 patients (2,440 hips) that underwent hemiarthroplasty for femoral neck fracture (OTA 31B) between 2000 and 2019. Patients were excluded for pathologic fracture, age < 55 years, confounding blood dyscrasias, concurrent operations, or lack of a documented preoperative INR within 72 hours of surgery. This left 1,556 patients (1,616 hips) included in our study. Patient demographics, comorbidities, operative details, and postoperative complications were recorded. The 90-day, 30-day, and in-hospital mortality and complication rates were estimated using Kaplan-Meier survival methods. The Cox proportional hazards regression analyses were performed to examine the association of preoperative INR with mortality and postoperative complications while adjusting for potential confounders including age, sex, Charlson Comorbidity Index (CCI), diagnosis of dementia, dialysis, time to surgery > 2 days, preoperative vitamin K, intraoperative tranexamic acid, and preoperative hemoglobin, among others.

**RESULTS:** The overall 90-day mortality rate was 16.3% (95% CI: 14.3 – 18.3%). After adjusting for confounders, the association of preoperative INR and death within 90-days postoperative was not statistically significant (HR: 1.3; 95% CI: 0.97, 1.8; p=0.08). Preoperative dementia (HR: 1.9; 95% CI: 1.4 – 2.6; p<0.001), CCI (HR: 1.1; 95% CI: 1.1 – 1.2; p<0.001), and age per decade (HR: 1.4; 95% CI: 1.1 – 1.8; p=0.002) were significantly associated with 90-day mortality. Additionally, INR was not statistically associated with 30-day mortality (HR: 0.7; 95% CI: 0.5 - 1.2; p=0.19) nor in-hospital mortality (HR: 1.2; 95% CI: 0.7 - 1.8; p=0.5). On multivariate analysis, INR was significantly associated with superficial wound infection (HR: 2.0; 95% CI: 1.1 – 3.7; p=0.02) and non-infected wound complications (HR: 1.6; 95% CI: 1.1 – 2.4; p=0.007). Superficial infection complications may increase above an INR of 1.8.

**CONCLUSION:** When controlling for confounders, preoperative INR was not significantly associated with 90-day, 30-day, or in-hospital mortality following hemiarthroplasty for geriatric femoral neck fracture. Underlying medical conditions seem to contribute to postoperative mortality more than an elevated INR. However, INR is associated with superficial wound complications. This risk becomes statistically significant between an INR of approximately 1.8 and 2.4.

**Paper 105****Impact of COVID-19 on Time to Surgery for Fractures in Orthopedic Trauma**

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**BACKGROUND:** During the pandemic, necessary timely surgical fracture care continued; however, the effects of COVID-19 on time to surgery (TTS) for orthopedic trauma have not been extensively examined. The present study compares TTS and postoperative complication rates during the first year of the COVID-19 pandemic and the preceding non-pandemic year for patients with various non-emergent orthopedic traumatic injuries. This study also examines the rates of new COVID-19 diagnoses in the 90 days postoperatively during the pandemic.

**METHODS:** A retrospective cohort analysis was performed with the PearlDiver database for patients treated operatively for tibial plateau, proximal humerus, or bimalleolar or trimalleolar ankle fractures from 2019 to 2020. Included patients had active records for a minimum of 90 days following their procedures and were sorted into either pre-pandemic (2019) or intra-pandemic (2020) cohorts. TTS was defined as the time between initial diagnosis of the fracture and associated procedure. Independent sample t-tests and Pearson's Chi-Squared tests were performed to analyze quantitative and categorical data, respectively.

**RESULTS:** A total of 30,355 patients were included in the analysis. The cohorts did not significantly differ with respect to gender, age, or common comorbidities, except for the number of diabetic patients with proximal humerus fractures ( $p = 0.008$ ). The intra-pandemic group had a decreased mean TTS for tibial plateau ( $p < 0.021$ ), bimalleolar or trimalleolar ankle fracture ( $p < 0.001$ ), and proximal humerus fracture ( $p < 0.011$ ) procedures. Of the 10,185 patients in the intra-pandemic cohort, 228 (2.2%) had a diagnosis of COVID-19 infection within 90 days of the orthopedic procedure. There were no differences in surgical site infections, pulmonary emboli (PE), and deep vein thrombosis (DVT) between the pre-pandemic and intra-pandemic groups.

**CONCLUSION:** Time to surgery decreased across various non-elective orthopedic fracture-related procedures during the first year of the COVID-19 pandemic relative to the non-pandemic year prior. This may reflect increased operative room availability with the corresponding reduction in elective cases. No differences in rates of surgical complications within the 90-day postoperative period were observed. Fortunately, only 2.2% of patients developed a COVID-19 infection within 90 days of their index procedure in the intra-pandemic cohort. This study suggests that patients may receive both timely and safe orthopedic surgical care during the COVID-19 pandemic.



**Paper 106****What Are the Major Risk Factors for Nonunion in Pilon Fractures?**

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**PURPOSE:** Pilon fractures are difficult injuries to manage as they are typically associated with extensive soft tissue damage. Although staged management of external fixation followed by open reduction and internal fixation is often used to prevent additional soft tissue damage and its associated complications, rates of nonunion remain high in this patient population. The purpose of this study is to evaluate and identify factors associated with increased rates of nonunion following operative fixation of pilon fractures.

**METHODS:** A retrospective review of all operatively managed pilon fractures at a single level 1 trauma center from 2005 to 2019 was performed. Minimum six-month follow-up was required for inclusion. Patients with skeletal immaturity or amputation prior to definitive fixation were excluded. Patients were grouped based on presence or absence of nonunion, which was defined as lack of bridging bone in at least 3 of 4 cortices and the presence of pain with ambulation at six-month follow-up. Demographics, injury and operative characteristics, and surgical outcomes were compared between the two groups.

**RESULTS:** Among the 279 patients meeting inclusion criteria, 48 developed nonunion at 6-month follow-up (17.2%). Average follow-up was 3.2 years. Patients with nonunion had significantly higher rates of open fractures (50.0% vs. 22.1%,  $p < 0.001$ ) and more required skin grafts (14.6% vs. 5.6%,  $p = 0.029$ ), muscle flap coverage (12.5% vs. 2.6%,  $p = 0.002$ ), and bone grafting (25.0% vs. 3.9%,  $p < 0.001$ ) compared to controls. Those who developed nonunion had significantly lower rates of medial column fixation (43.8% vs. 67.5%,  $p = 0.002$ ) and higher rates of surgical site infection (45.8% vs. 7.8%,  $p < 0.001$ ). Rates of AO/OTA 43C fractures (70.8% vs. 52.4%) and fractures treated with plates overlapping the site of external fixation (39.5% vs. 26.6%) were higher in the nonunion group, but did not reach statistical significance ( $p = 0.064$  and  $p = 0.098$ ). There were no significant differences in demographics, mechanism of injury, Gustilo-Anderson classification, associated ipsilateral lower extremity injuries, surgical approach, or type of fixation between the two groups.

**CONCLUSION:** In the present study, pilon fractures were found to have a nonunion rate of 17.2% at six-month follow-up. Nonunion was associated with the presence of open fracture, need for soft tissue coverage or bone grafting, and surgical site infection. Medial column fixation was associated with a lower rate of nonunion in these fractures.

**Paper 107****Presence of Concomitant Scapular Fractures is Associated with Increased Displacement of Clavicle Fractures**

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**INTRODUCTION:** Midshaft clavicle fractures with concomitant ipsilateral rib fractures tend to have an increased amount of displacement on follow-up radiographs than those without. However, the degree of displacement following all types of clavicle fractures, including proximal and distal clavicle fractures, with concomitant rib fractures is not known. Furthermore, the degree of displacement following a clavicle fracture with other chest wall injuries, specifically rib and scapula fractures, is not known. The purpose of this study was to evaluate the effect of other chest wall injuries on the frequency of clavicle fractures being unstable (>100% displacement).

**METHODS:** Patients with a clavicle fracture [OTA 15.1, 15.2, 15.3] from January 2020 to December 2021 were identified. Patients with an initial chest radiograph or computed tomography of the chest were included. Patients without follow-up films taken 1-4 weeks post-injury were excluded. Age, sex, laterality, time to follow-up, displacement, and presence of chest wall injuries (rib and scapula fractures) were recorded. The cohort was subdivided into patients with an isolated clavicle fracture, patients with a clavicle fracture and concomitant scapula fracture, patients with a clavicle fracture and concomitant rib fracture, and patients with a clavicle fracture, rib fracture, and scapula fracture. Statistical analysis was done using Analysis of Variance (ANOVA), Chi-square, and multinomial logistic regression modeling.

**RESULTS:** 157 patients with clavicle fractures were included. 95 patients sustained an isolated clavicle fracture, 5 patients sustained a concomitant scapula fracture, 41 patients sustained concomitant rib fractures, and 16 patients sustained concomitant rib and scapula fractures. Age, sex, laterality, and time of follow-up were similar between the four groups ( $p > 0.05$ ). 36 (37.9%) patients with an isolated clavicle fracture, 3 (60%) patients with a concomitant scapula fracture, 11 (26.8%) patients with concomitant rib fractures, and 6 (37.5%) patients with concomitant rib and scapula fractures had displacement at follow-up ( $p > 0.05$ ). The odds ratio for progression to a displaced clavicle fracture with a concomitant scapula fracture was 11.012 ( $p = 0.057$ ) when compared to the other groups.

**DISCUSSION & CONCLUSION:** Presence of concomitant scapula fractures increases the rate of clavicle fractures being >100% displaced. The involvement of other chest wall injuries did not significantly increase the rate of the clavicle fracture being >100% displaced on early follow-up. Clavicle fractures with associated scapula fractures tend to demonstrate increased displacement on follow-up radiographs compared to clavicle fractures with other chest wall injuries.

**Paper 108****Temporal Relationship of Hardware Removal and Correlation with Postoperative Deep Infections Following Conversion Total Knee Arthroplasty**

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**BACKGROUND:** Conversion total knee arthroplasty (CTKA), or total knee arthroplasty (TKA) performed in the setting of previously instrumented periarticular implants, has been shown to result in consistently greater rates of adverse outcomes. Previous studies have demonstrated an increased risk of periprosthetic joint infection (PJI) in patients undergoing CTKA with retention of implants. The optimal timing of removal of peri-articular implants remains to be determined. The primary aim of this study was to compare infection rates in conversion TKA when hardware removal was performed in either a staged or concurrent manner using a national insurance database.

**METHODS:** We performed a retrospective study using the total knee arthroplasty subset of the Mariner national insurance claims database. Patients who underwent TKA were identified and among this group we selected for patients who underwent removal of hardware either on the same day as the TKA procedure or within a year before the procedure. Patients were stratified into two groups: concurrent and staged hardware removal and propensity matched. The 90-day and 1-year rates of prosthetic joint infection were then calculated for each group.

**RESULTS:** The rates of infection were 1.64% and 3.00% in the staged group and 2.62% and 3.95% in the concomitant group at 90 days and 1 year postoperative, respectively ( $P=0.001$ ,  $P=0.01$ ). Multivariate analysis identified concomitant removal of hardware as independently associated with higher 90-day (OR: 1.61, 95% CI: 1.25-2.11,  $p<0.001$ ) and 1-year infection rate (OR: 1.33, 95% CI: 1.09-1.64,  $p=0.005$ ). Diabetes and tobacco use were also identified as independently associated with increased risk for infection at 90-days and 1-year. Logistic regression analysis demonstrated patients with hardware removal greater than 3 months prior to CTKA had significantly lower odds of infection at one year postop (OR 0.61 95% CI 0.45-0.84;  $p=0.003$ ).

**CONCLUSION:** Our findings suggest removal of hardware performed concurrently or within three months of a TKA is associated with an increased odds of PJI at one year. This is the first study to demonstrate this temporal relationship between timing of hardware removal and infection rate in CTKA.

**Paper 109****Is There a Time-Dependent Contamination Risk to Open Surgical Trays During Total Hip and Knee Arthroplasty?**

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**BACKGROUND:** Periprosthetic joint infection (PJI) after total hip and knee arthroplasty (TJA) is a devastating complication and intraoperative contamination can be a source for acute PJI. Currently, many measures are performed intraoperatively to reduce the risk of contamination. We sought to identify if sterile surgical trays that are left open to air are possible sources for bacterial contamination. The primary purpose of this study was to determine if there was a time-dependent risk to open surgical trays during TJA cases.

**METHODS:** A prospective intraoperative culture swab study was performed. 23 consecutive primary TJA cases in high air turnover rooms were included. Standard sterile operating room trays without instruments were utilized as the experimental trays. These were opened simultaneously with all other surgical instrumentation needed for the procedure. These trays were left on an isolated Mayo stand next to the scrub tech's table and swabbed at 30 minute intervals. The first swab was performed immediately after opening all sets and the last swab performed on closure of the incision. A new section of the grid-lined tray was swabbed for each data point and the culture analysis was conducted by our institutions' microbiology lab for both quantitative and qualitative analysis. Operating suite room temperature and humidity data was also gathered.

**RESULTS:** 13 of the 23 (57%) cases demonstrated culture positive bacterial growth on at least one time point. Of the 109 independent swabs collected, 19 (17%) had bacterial growth. The most common bacterial species isolated was *Staphylococcus epidermidis*. There were no statistically significant associations between time ( $p=0.35$ ), OR temperature ( $p=0.99$ ), and OR humidity ( $p=0.07$ ) and bacterial growth.

**CONCLUSION:** In spite of isolating an organism in 57% of cases, we could not identify a time-dependent increase in bacterial contamination throughout our operative cases. We were unable to associate OR environmental temperature and humidity to bacterial growth.

**LEVEL OF EVIDENCE:** Level 2

**Paper 110**

**Efficacy of Saline Wash Plus Vancomycin/Tobramycin-Doped PVA Composite (PVA-VAN/TOB-P) in a Mouse Pouch Infection Model Implanted with 3D-Printed Porous Titanium Cylinders**

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**OBJECTIVES:** The efficacy of saline irrigation for the treatment of periprosthetic infection (PJI) is limited in the presence of infected implants. This study evaluated the efficacy of vancomycin/tobramycin-doped polyvinyl alcohol (PVA)/ceramic composites (PVA-VAN/TOB-P) after saline irrigation in a mouse pouch infection model.

**METHODS:** 3D printed porous titanium (Ti) cylinders (400, 700 and 1000  $\mu\text{m}$  in pore size) were implanted into mice pouches, then inoculated with *S. aureus* at the amounts of  $1 \times 10^3$  CFU and  $1 \times 10^6$  CFU per pouch, respectively. Mice were randomized into 4 groups (n=6 for each group): 1) no bacteria; 2) bacteria without saline wash; 3) saline wash only, and (4) saline wash+PVA-VAN/TOB-P. After seven days, pouches were washed out alone or with additional injection of 0.2 ml of PVA-VAN/TOB-P. Mice were sacrificed 14 days after pouch wash. Bacteria cultures of collected Ti cylinders and washout fluid and histology of pouch tissues were performed.

**RESULTS:** The low-grade infection ( $1 \times 10^3$  CFU) was more significant in 400  $\mu\text{m}$  Ti cylinders than that in Ti cylinders with larger pore sizes (700 and 1000  $\mu\text{m}$  ( $p < 0.05$ )). A similar pattern of high-grade infection ( $1 \times 10^6$  CFU) was observed ( $p < 0.05$ ). For the end wash, the bacteria burden ( $0.49 \pm 0.02$ ) in saline wash group was completely eradicated by the addition of PVA-VAN/TOB-P ( $0.005 \pm 0.001$ ,  $p < 0.05$ ).

**CONCLUSIONS:** We noticed that 400  $\mu\text{m}$  Ti cylinders have the highest risk of implant infection. Our data supported that the effect of saline irrigation was very limited in the presence of contaminated porous Ti cylinders. PVA-VAN/TOB-P was biodegradable, biocompatible, and was effective in eradicating bacteria retention after saline irrigation in a mouse model of low grade and high-grade infection. We believe that PVA-VAN/TOB-P represents an alternative to reduce the risk of PJI by providing a sustained local delivery of antibiotics.

**Paper 111****Validating a Decision-Making Model for Use of Debridement, Antibiotics, and Implant Retention**

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**INTRODUCTION:** Current treatment algorithms for periprosthetic joint infection (PJI) for total knee arthroplasty (TKA) suggest that patients diagnosed with early postoperative and acute hematogenous infections are candidates for debridement, antibiotics, and implant retention (DAIR). However, success rates of DAIR using these criteria alone are variable. Judicious use of DAIR could help alleviate morbidity associated with failure, namely implant removal and spacer placement. Scoring systems exist, but validation has demonstrated limited utility thus far. The aim of this study was to validate a recently published comprehensive decision-making model (Boyer, et al) for DAIR at our institution.

**METHODS:** TKA patients diagnosed with PJI by MSIS criteria, who subsequently underwent ipsilateral DAIR at our institution were included. Those with any prior infection-related procedure were excluded. Failure was defined as persistent or recurrent infection requiring surgical intervention. Demographic, microbiological, and clinical course data were collected. Analyses of ROC curves and binary classification accuracy statistics were performed in SPSS programming (IBM SPSS Statistics, Version 24.0. Armonk, NY).

**RESULTS:** 113 DAIR procedures were included. Mean follow-up, age, and body mass index (BMI) were  $2.4 \pm 2.2$  years,  $65 \pm 9$  years, and  $33 \pm 7$  kg/m<sup>2</sup>, respectively. Thirty patients (30%) underwent infection-related reoperation following DAIR. The decision-making model was 66.7% accurate in predicting success or failure. Sensitivity was 66.7% (95% CI 55.5-76.6%), specificity was 66.7% (95% CI 47.2-82.7%), and positive predictive value (PPV) was 84.9% (95% CI 76.8-90.5%).

**CONCLUSION:** Currently, there is no comprehensive system that accurately predicts the failure or success of DAIR; however, the high PPV of Boyer, et al's decision model in our patient population warrants further investigation. Future studies should build upon these criteria, incorporating history of infection, BMI, and other potentially influential risk factors. This algorithm shows promising potential to guide PJI treatment.

**Paper 112****Prophylactic Postoperative Oral Antibiotics Reduce 90-Day Infection Rate After Aseptic Tibial Polyethylene Exchange**

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Isolated tibial polyethylene exchange (ITPE) with irrigation and debridement is an accepted treatment for acute PJI postop or instability/aseptic loosening. Despite emerging technologies in detecting periprosthetic infection, latent infections or low-virulence organisms, especially in early stages, present a challenge. Clinical tools such as International Consensus or MSIS criteria can be equivocal in such patients. To date, no guidelines exist for infection prevention after ITPE in presumed aseptic knees. Clearance of PJI after ITPE for known septic knees in literature ranges from 41% to 73% and success is less likely with staph aureus infections (Diermengian C, et al. J Arthroplasty. 2003 Oct).

A previous study at our institution observed increased 90-day infection rate (21.0%) after presumed aseptic ITPE. This was much higher than the rate of infection for primary total knee arthroplasty (TKA). Given the type of organisms isolated in many of these cases, we hypothesized that a portion of patients undergoing ITPE for aseptic indications may have undetected underlying infection and would benefit from an extended course of oral antibiotics. A recent study also demonstrated addition of 14 days postoperative oral antibiotics reduced 1-year PJI in select TKA patients compared to surgical & host-factor optimization alone (Kheir, M et al. J Arthroplasty 2021). We hypothesized that extending postop prophylaxis with 10 days of oral antibiotics starting postop day 1 would similarly reduce PJI after aseptic ITPE.

We conducted a retrospective 2-year (03/2018-03/2020) review of 63 patients who underwent ITPE for aseptic indications by a single surgeon. All patients received 10-days of oral trimethoprim-sulfamethoxazole DS BID or Cephalexin QID if allergic. Patients from our previous study were used as controls. No perioperative protocols changed between study periods. Selection criteria and population comorbidities were comparable. Fisher's exact test and multivariate regression analyses were performed with  $p < 0.05$  as statistical significance. No infections occurred after ITPE with extended antibiotics compared to 17/81 infections in the control group at 90 days ( $P < 0.05$ ).

We observed a statistically significant reduction in PJI after ITPE with 10 days oral extended antibiotics postop. These results support the hypothesis that some patients with presumed aseptic diagnoses may have underlying infection. No major complications were observed from extending antibiotics in our study. Coagulase negative staph, Cutibacterium acnes, and staphylococcus aureus were occasionally isolated in intraop cultures at ITPE. Moreover, some presumed contaminants may be sources of active PJI.

**Paper 113****Cutibacterium Acnes Periprosthetic Joint Infections: Presentation and Treatment Considerations**

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**INTRODUCTION:** Cutibacterium acnes (*C. acnes*; previously known as Propionibacterium acnes or *P. acnes*) periprosthetic hip and knee infections are underreported. While culture contamination with *C. acnes* occurs, true infections are important to recognize and treat. We sought to describe the demographics and treatment outcomes of patients with *C. acnes* hip and knee periprosthetic joint infections (PJIs).

**METHODS:** Patients with *C. acnes* PJI of the hip and knee between 2001 and 2020 were retrospectively reviewed utilizing the institutional total joint registry. Patients with monomicrobial PJI and two positive cultures were considered to have true *C. acnes* PJI. Patients with polymicrobial infection or with *C. acnes* contaminants were excluded. This resulted in 36 PJIs (21 hips and 15 knees) with mean age 62 years and 42% female. Mean follow-up was 5 years.

**RESULTS:** The median time to positive culture was 5 days (range, 3-9) and median synovial fluid cell count was 35,916 (range, 3,200-146,000). The median erythrocyte sedimentation rate (ESR) was 20 mm/hr (range, 1-112), and C-reactive protein (CRP) was 20 mg/L (range, 1-104). Of the 36 PJIs, 18 (50%) were treated with chronic antibiotic suppression without surgery, and the remainder were treated with two-stage exchange arthroplasty. The survivorship free of reoperation for reinfection at two and five years was 92% and 86%, respectively. The survivorship at two years free of revision was 94% and free of reoperation was 88%. The mean Harris Hip Score for THA patients was 79.3 preoperatively and 85.2 at two years. The mean Function component of the Knee Society Score was 58 preoperatively and 64 at two years.

**CONCLUSION:** Laboratory evidence of *C. acnes* infection this cohort was typical compared to more conventional organisms. Cultures grew more quickly than previously thought in patients with *C. acnes* infection. Treatment with surgery or chronic antibiotic suppression alone both resulted in successful outcomes without reoperation at mid-term follow-up.

**LEVEL OF EVIDENCE:** IV



**Paper 114****Functional and Patient Reported Outcomes After Successful DAIR for Periprosthetic Joint Infection of Total Knee Arthroplasty**

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There is active debate regarding the utility of Irrigation and Debridement, Antibiotic therapy, and component Retention (DAIR) as a treatment for acute Periprosthetic Joint Infection (PJI). Variable results have been published regarding DAIR's rate of infection resolution with little data investigating functional outcomes.

A retrospective review was performed to identify patients who underwent DAIR for treatment of acute PJI at a single institution from 2008-2020. Patients were included in the study if they underwent irrigation and debridement of an acutely infected total knee arthroplasty (TKA) with modular component exchange and antibiotic therapy employed. Kaplan Meier survival analyses evaluating durability of DAIR were performed. Patients with successful DAIR procedures were sent Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS-JR) and Patient Reported Outcome Measurement Information System-10 (PROMIS-10) forms to assess functional outcomes. DAIR outcomes were compared to a separate cohort of uncomplicated TKAs with KOOS-JR and PROMIS-10 scores already in the institution record base.

In total, 244 patients had a DAIR procedure. The median follow-up time for all cases was 5.9 years (Range 0.5 - 13 years). Seventy-four percent of patients in the DAIR cohort did not require further surgery for PJI. The rate of survival without subsequent operation for infection was 86% at 0.5 years, 80% at 1 year, 77% at 2 years, and 74% at 5 years. Functional outcome data was obtained from 65 successful DAIR cases. The median follow-up time for this cohort was 4.5 years in comparison to 2.8 years for the control TKA group. Mean functional outcome scores for the DAIR cohort were 71.7 for KOOS-JR, 41.8 for PROMIS-10 Physical Health, and 46.5 for PROMIS-10 Mental Health. The control group had mean values of 66.0 for KOOS-JR, 44.3 for PROMIS-10 Physical Health, and 50.2 for PROMIS-10 Mental Health. No difference was observed in KOOS-JR ( $p=0.23$ ) or PROMIS-10 ( $p=0.11$ ) Physical Health scores. PROMIS-10 Mental Health scores were significantly lower in the DAIR cohort compared to the primary TKA group (46.5 vs.50.2,  $p=0.03$ ).

Our data demonstrates 74% of acute PJI cases treated with DAIR were successful in treating the infection out to 5 years. Additionally, knee function and overall physical health outcomes in successful DAIR procedures can restore knee function to a level similar of a primary, uncomplicated TKA. However, clinicians must consider the psychological impact of patients having PJI treated with DAIR, given patients had significantly lower mental health scores than the primary TKA cohort.

**Paper 115****Synovial Fluid ANC and NLR Are Not Superior to PMN% in Detecting PJI**

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**BACKGROUND:** Periprosthetic joint infection (PJI) is a devastating complication after total joint arthroplasty (TJA) with a high morbidity, mortality, and cost. Serum and synovial biomarkers are currently used in the diagnosis of PJI. Serum neutrophil-to-lymphocyte (NLR) ratio has shown promise as an inexpensive test in diagnosing infection, but there have been no known reports of synovial NLR or absolute neutrophil count (ANC) in the diagnosis of chronic PJI. The purpose of this study is to investigate the diagnostic potential of both markers.

**METHODS:** A retrospective review of 730 patients that had a primary total joint arthroplasty and underwent aspiration for chronic PJI or aseptic reasons. Synovial white blood cell count (WBC), synovial polymorphonuclear percentage (PMN%), synovial NLR, synovial ANC, serum erythrocyte sedimentation rate (ESR), serum C-reactive protein (CRP), serum WBC, serum PMN%, serum NLR, and serum ANC had their utility in diagnosing PJI examined by area under the curve analysis (AUC). The AUCs of serum and synovial markers were compared with the Delong test.

**RESULTS:** The AUCs for synovial WBC, PMN%, NLR, and ANC were 0.835, 0.841, 0.827, and 0.850, respectively. Synovial fluid ANC was a significantly better diagnostic marker than synovial NLR ( $p=0.027$ ) and synovial WBC ( $p=0.003$ ), but not PMN% ( $p=0.365$ ). Synovial NLR was also found to be inferior to PMN% ( $p=0.006$ ), but not different from synovial WBC ( $p=0.510$ ). The AUCs for serum ESR, CRP, WBC, PMN%, NLR, and ANC were 0.695, 0.787, 0.632, 0.724, 0.741, and 0.665, respectively. Serum CRP outperformed all other serum markers ( $p<0.05$ ) except for PMN%, and NLR ( $p=0.051$  and  $p=0.130$ , respectively). Serum PMN% and NLR were similar to serum ESR ( $p=0.471$  and  $p=0.237$ , respectively).

**CONCLUSION:** Both synovial ANC and NLR were not superior to the traditional marker, synovial PMN%. However, synovial ANC had similar performance to PMN% in diagnosing chronic PJI, whereas synovial NLR was a poorer diagnostic marker comparatively. As for serum markers, CRP demonstrated the best performance for detecting PJI. These findings suggest that synovial NLR and ANC have little diagnostic value in the diagnosis of PJI.

**Paper 116****Increased Incidence of MRSA in Knee and Hip Prosthetic Joint Infection**

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**INTRODUCTION:** Limited research exists studying the changes in the microbial profile of knee and hip prosthetic joint infections (PJI). This study sought to analyze the incidence of bacterial pathogens responsible for PJI over three decades, hypothesizing an increased incidence of resistant organisms.

**METHODS:** This is a multi-institutional retrospective review of all patients with a knee or hip prosthetic joint infection from 1990-2020 identified through the electronic medical record. All patients with a known causative organism were included and those with insufficient culture data were excluded. 731 eligible joint infections from 715 patients were identified. For patients with multiple joint infections, only the first infection was included in analysis. Organisms were divided into multiple categories: MRSA, MSSA, coagulase-negative staph, streptococcus, enterococcus, fungi, corynebacterium, pseudomonas, culture-negative, other, and polymicrobial. Five-year increments were used to analyze the 30-year study period (1990-1994, 1995-1999, etc). The Cochran-Armitage Trend Test was used to see if there was a linear trend in microbial profile over time and a p-value <0.05 was considered statistically significant.

**RESULTS:** There was a statistically significant positive linear association between the incidence of MRSA among patients with joint infection over time ( $p=0.0088$ ) with incidence primarily increasing after 2004 compared to before 2004. Before 2004, MRSA infections accounted for 0% to 5.77% of all total infections, whereas after 2004 accounted for 13.64% to 19.20%. There was also a statistically significant negative linear association between the incidence of coagulase-negative staph among patients with joint infection over time ( $p=0.0018$ ). All other studied organisms did not have a statistically significant association over time.

**CONCLUSION:** MRSA knee and hip PJI's are increasing in incidence over time, whereas coagulase-negative staph PJI's are decreasing. Identifying these trends may help with the prevention and treatment of PJI.

**Paper 117****Shelf Life Does Not Impact Antibiotic Efficacy in Premade Calcium Sulfate Beads**

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Antibiotic-laden calcium sulfate beads are gaining popularity in the treatment of orthopedic infections such as fracture-related infection and osteomyelitis. Calcium sulfate beads have several advantages over polymethylmethacrylate (PMMA) beads as they are bioabsorbable, have demonstrated improved elution characteristics, and lower peak polymerization temperatures than seen in PMMA. The ability to make and store antibiotic beads for later use has the potential to decrease operating room times and healthcare costs. This study aims to determine the antibiotic efficacy of premade, antibiotic-laden calcium sulfate beads.

4.8mm calcium sulfate beads were made with vancomycin or tobramycin and stored for shelf-life durations of one week, one month, three months, and six months. A subset of beads was tested immediately after creation. At the appropriate time points, beads were placed into a buffer solution and incubated at 37°C with agitation. Antibiotic eluent was collected at 1 hour, 4 hours, 24 hours, 48 hours, and 1 week timepoints. Eluent concentrations were inferred from a prior experiment using the same model. Eluent was used in a microbroth dilution assay to determine minimum inhibitory concentration (MIC) against *Staphylococcus aureus*.

Baseline MIC experiments for tobramycin and vancomycin against *S. aureus* were within previously reported ranges. MIC assay results across different bead shelf lives also remained consistent without an increase in MIC with increasing shelf life for either antibiotic. The one-month shelf life experiment for vancomycin displayed outliers not seen for other shelf lives.

Shelf life up to six months did not impact the efficacy of tobramycin or vancomycin eluent from calcium sulfate beads in vitro compared to beads made and tested immediately. Several advantages of calcium sulfate beads over PMMA beads for local antibiotic delivery include improved elution characteristics, wider drug selection, and that patients do not require return for surgical removal. Additional experiments to determine the impact of sterilization techniques for premade calcium sulfate beads are necessary prior to considering clinical use.

**Paper 118****Antibiotic Prophylaxis with Alternative Non-Cefazolin Protocol is Associated with Higher Rates of Periprosthetic Joint Infection in Primary Total Hip and Total Knee Arthroplasty**

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**INTRODUCTION:** Prophylactic antibiotic administration of a first or second-generation cephalosporin is standard of care for patients undergoing total joint arthroplasty due to broad-spectrum coverage and minimal side effects. Alternative antibiotic regimens chosen in cases of allergy or intolerance have been associated with higher rates of periprosthetic joint infection (PJI). Potential explanations include lack of broad-spectrum coverage and suboptimal dosing. This has led institutions to develop hospital-specific alternative antibiotic prophylactic regimens based on local antibiograms to minimize the risk of PJI. We aimed to study whether use of a novel institution-specific non-cefazolin antibiotic protocol using vancomycin and aztreonam is associated with significant difference in the rates of PJIs.

**METHODS:** This single institution retrospective cohort study included all patients undergoing primary and/or revision total joint arthroplasty (TJA) from 2018 to 2020 who had at least two years of postoperative follow-up. The study cohort was divided into those who received cefazolin vs. alternative antibiotics (vancomycin/aztreonam) as preoperative antibiotic prophylaxis. Multi-variate logistic regression analyses were used to assess whether use of a non-cefazolin antibiotic was associated with differences in the rates of 90-day rates of PJIs, wound complications, reoperations and readmissions after controlling for demographics, comorbidities, type of TJA, and operative time.

**RESULTS:** A total of 1,689 patients undergoing primary and/or revision TJAs from 2018 to 2020 were included in the study. A total of 119 patients (7.0%) of patients received a non-cefazolin antibiotic prior to surgery. Patients who received a non-cefazolin antibiotic (vanc/aztreonam/vanc+aztreonam) vs. cefazolin did have higher odds of experiencing PJIs (9.2% vs. 1.5%, OR 5.56 [2.47-12.51];  $p < 0.001$ ) and reoperations (8.4% vs. 2.7%, OR 3.08 [95% CI 1.45-6.54];  $p = 0.003$ ). There was no association between use of non-cefazolin antibiotics and rates of wound dehiscence (4.3% vs. 2%;  $p = 0.628$ ), superficial surgical site infection (3.4% vs. 2.5%;  $p = 0.987$ ), and readmissions (16.0% vs. 11.0%;  $p = 0.289$ ).

**CONCLUSION:** Overall, there appears to be a significant difference in odds of experiencing periprosthetic joint infections and reoperation in patients receiving a non-cefazolin antibiotic regimen compared to standard cefazolin prophylaxis. Our institution-specific alternative antibiotic regimen is statistically inferior to cefazolin in preventing periprosthetic joint infection. New institutional standards should be directed toward allergy testing in the setting of a penicillin or cephalosporin allergy to reduce the risk of periprosthetic joint infection.

**Paper 119****Antibiotic Cement in Primary Total Knee Arthroplasty for Osteoarthritis is Associated with Lower Risk of Reoperations and Revisions**

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**INTRODUCTION:** There is no widespread consensus on the routine use of antibiotic-loaded bone cement (ALBC) in primary total knee arthroplasty (TKA) and whether it decreases periprosthetic joint infection (PJI) rates. The goals of this study were to evaluate a single institutional experience of primary TKAs with and without ALBC on the rate of PJI, reoperation for PJI, any revision, and any reoperation.

**PATIENTS & METHODS:** We identified 9,925 primary TKAs performed for osteoarthritis with no prior surgery between 2003-2018 from our total joint registry using PS or CR constructs. 52% of cases received ALBC. Mean age was 70 years, mean BMI was 33.1 k/m<sup>2</sup>, and 61.7% were female. Implant survivorship and PJI rates were assessed with Kaplan-Meier methods as well as a cumulative incidence function test. A multivariate analysis was used. Mean follow up was five years.

**RESULTS:** Accounting for the competing risk of death, the 5-year rate of PJI was 1.2% in the ALBC group vs. 1.3% in the non-ALBC group. There were 56 PJIs in the ALBC group vs. 69 in the non-ALBC group. The 5-year reoperation rate was 4.0% in the ALBC group vs. 6.2% in the non-ALBC group. The 5-year rate of any revision was 1.2% in the ALBC group vs. 2.5% in the non-ALBC group. The 5-year rate of revision for aseptic loosening was 0.3% in the ALBC group vs. 1.1% in the non-ALBC group. On multivariate analysis, the utilization of non-ALBC compared to ALBC was associated with an increased risk of reoperations (HR 1.4, p<0.001), revisions (HR 2.0, p<0.001) and revision for aseptic loosening (HR 4.0, p<0.001), however, there was no significant difference between overall PJI rate (HR 1.2, p = 1.0).

**CONCLUSIONS:** The prophylactic use of ALBC in primary TKA was associated with fewer reoperations and revisions, especially among revisions for aseptic loosening.

**Paper 120****Diagnostic Utility and Thresholds for Commonly Obtained Serum and Synovial Markers Prior to Reimplantation in Periprosthetic Joint Infection**

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**BACKGROUND:** Diagnosis of persistent periprosthetic joint infection (PJI) during two-stage exchange is critical for determining appropriate timing for reimplantation. However, the diagnostic accuracy and threshold values of routine serum and synovial markers prior to reimplantation remains unclear. The purpose of this study was to evaluate the diagnostic performance of several commonly obtained serum and synovial markers including trends in serum markers over time, and to define thresholds for PJI diagnosis to better guide reimplantation.

**METHODS:** This was a retrospective review of 249 patients who underwent two-stage exchange with antibiotic spacers for PJI. Charts were reviewed for most recent synovial and serum aspiration data obtained when patients had spacers but prior to planned reimplantation. Synovial makers included white blood cell count (WBC), polymorphonuclear percentage (PMN%), neutrophil-to-lymphocyte ratio (NLR), and absolute neutrophil count (ANC). Serum markers included erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), WBC, PMN%, NLR, and ANC. Serum ESR and CRP were trended from initial infection diagnosis to prior to reimplantation. The collected markers had their utility in diagnosing PJI examined by area under the curve analysis (AUC). Pairwise comparisons of AUCs were performed for serum and synovial markers.

**RESULTS:** Serum CRP had the highest AUC of all studied markers (0.863). The threshold for serum CRP was 3.1 mg/dL, which provided a sensitivity of 65.3% and specificity of 78.9%. Serum ESR had an “acceptable” AUC of 0.749, however, all other serum markers qualified as “poor” tests. The percentage change in serum CRP and ESR had poor diagnostic value compared to the respective absolute values (AUCs of 0.614 and 0.654 respectively). Synovial ANC had the highest AUC of all synovial makers (0.772), with a cutoff of 3,802 cells/uL, but it did not significantly outperform other synovial markers, which all had acceptable AUCs.

**CONCLUSION:** The results show serum CRP to have excellent diagnostic utility for diagnosis of persistent PJI in revision total joint arthroplasty with antibiotic spacers. Absolute values of serum ESR and CRP have better diagnostic value than trends of these serum markers for guiding reimplantation timing. The study also defines diagnostic thresholds for many commonly obtained synovial and serum markers in spacer arthroplasty. There is no marker that can currently be used alone to diagnose PJI in these patients, but rather a combination of these markers along with the overall clinical picture should be reconciled together to make the final diagnosis.

**Paper 121****Social Vulnerability Index (SVI) Can be Used to Predict Healthcare Resource Utilization and Persistent Opioid Use After Elective Lumbar Spine Surgery**

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**INTRODUCTION:** The national capacity for healthcare expenditures is nearing its limit, having experienced recent exponential growth nearing a total of 17% of US GDP. Optimizing patient-specific traits and to reduce healthcare utilization is essential to clinical practice. The Center for Disease Control (CDC) has harnessed the US Census data to create the Social Vulnerability Index (SVI). This study aims to evaluate the association between social determinants of health and healthcare resource utilization following elective lumbar spine surgery.

**METHODS:** Patients were retrospectively identified who underwent elective spine surgery for lumbar degenerative pathology between November 1, 2013 and September 30, 2018 at a single academic center. The Cook County Social Vulnerability Index (SVI) metrics for each patient were determined based on the ZIP code of their home. The SVI is comprised of separate scores pertaining to socioeconomic status, household compensation, minority status & language, and housing & transportation. Possible scores range from 0 (lowest vulnerability) to 1 (highest vulnerability). Health resource utilization was quantified within 1 year postoperatively (imaging studies, emergency and urgent care visits, opioid prescriptions, and others). These metrics were compared between patients with social vulnerability – defined as a SVI score in the upper quartile (SVI  $\geq$  0.75) and control patients (SVI score  $<$  0.75).

**RESULTS:** A total of 92 patients were included in the final cohort – 33 (35.9%) were considered socially vulnerable based on their SVI metrics. Socially vulnerable patients were more likely to utilize the emergency department within 180 and 365 days postoperatively ( $p=0.028$  and  $p=0.045$ ). Socially vulnerable patients were more than 3x more likely to have persistent opioid use at 180 days postoperatively to controls ( $p=0.005$ ). An overall SVI in the upper quartile was associated with persistent opioid use (OR 4.245; 95% CI: 1.469 – 12.265) and at least one emergency department visit within 180 days postop (OR 4.050; 95% CI: 1.227 – 13.370).

**CONCLUSION:** The social vulnerability index (SVI) was associated with postoperative opioid use and emergency department utilization after surgery. Socially vulnerable patients were more likely to utilize emergency department services and to have persistent opioid use at six months postoperatively from elective lumbar spine surgery.



**Paper 122****Preoperative Serum Albumin Level Predicts Length of Stay and Perioperative Complications Following Vertebral Corpectomy and Posterior Stabilization for Metastatic Spinal Pathology**

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**BACKGROUND:** Low preoperative serum albumin levels have been associated with increased perioperative adverse events (AEs) following elective spine surgeries.

**PURPOSE:** To determine the association between preoperative serum albumin levels and perioperative AEs following vertebral corpectomy and posterior stabilization for metastatic spinal pathology.

**METHODS:** The 2010 to 2019 National Surgical Quality Improvement (NSQIP) database was used to identify all patients from the United States undergoing vertebral corpectomy and posterior stabilization for spine tumor excision. Multiple logistic regression ordinal models were used to examine the relationship between preoperative serum albumin levels on perioperative outcome measures. Receiver operating characteristic (ROC) curve analysis and Youden index were used to determine preoperative serum albumin cut-off values for predicting perioperative AEs. Low preoperative serum albumin was defined as serum albumin below this cut-off value. Perioperative outcomes including operative time, intraoperative blood transfusions, postoperative length of stay (LOS), 30-day reoperation, 30-day readmission, discharge disposition, and perioperative AEs were investigated.

**RESULTS:** A total of 301 patients were included in the study. ROC curve analysis demonstrated serum albumin < 3.25 g/dL as a cut-off value for predicting perioperative complications. 78 patients were in low serum albumin cohort and 223 patients were in the normal serum albumin cohort. The low serum albumin group had a higher overall perioperative AEs (61.5% vs. 39.0%,  $p=0.041$ ), longer postoperative LOS ( $19.5 \pm 15.2$  days vs.  $10.1 \pm 9.8$  days,  $p<0.001$ ), higher 30-day reoperation rate (19.2% vs. 7.6%;  $p=0.014$ ), and a higher in-hospital mortality rate (5.1% vs. 0.9%;  $p=0.046$ ). The most common reason for 30-day re-operation was postoperative infection with 10 patients in the low serum albumin group and 11 in the normal serum albumin group (12.8% vs. 4.9%;  $p=0.036$ ). On multiple logistic regression modeling, a low serum albumin was a risk factor for longer LOS (OR 2.3; 95% CI: 1.8-2.7;  $p<0.001$ ) and postoperative complications (OR 1.9; 95% CI: 1.3-2.7;  $p<0.001$ ).

**CONCLUSIONS:** Low serum albumin levels is associated with higher perioperative AEs, longer postoperative LOS, and higher rates of 30-day reoperation and in-hospital mortality among patients undergoing vertebral corpectomy and posterior stabilization for tumor resection. Strategies to improve preoperative nutritional status in patients undergoing this procedure may improve these perioperative outcome measures.

**Paper 123**

**Time to Improvement for Postoperative Symptoms for Cervical Myelopathy: A Retrospective Analysis**

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**INTRODUCTION:** Cervical myelopathy (CM) is a common, progressive spinal disorder with a wide variety of symptoms that differ among individuals. Common symptoms include numbness, extremity weakness, loss of balance, and gait instability. Decompression surgeries are commonly used for the treatment of cervical myelopathy with varying outcomes. Understanding time to improvement for the symptoms of cervical myelopathy after surgery can help guide clinician care and improve outcomes.

**METHODS:** Study design was a retrospective chart review (n=180). All patients had a clinical presentation of cervical myelopathy and received corrective surgery. The data was collected from one hospital system. Data recorded included age, smoking status, co-morbidities, duration of preoperative symptoms, and post-operative days until improvement in numbness, upper extremity strength, and balance.

**RESULTS:** There was a marginally significant association with time to improvement for numbness ( $p=0.053$ ) after surgery correlated to patient age. The average days until improvement in numbness for patients older than 60 years old is significantly longer than those younger than 60 years old (99.3 days vs. 60.2 days). The mean  $\pm$  standard deviation for days until improvement in numbness, upper extremity strength, and balance was 84.46 days, 50.63 days, and 60.40 days, respectively.

**CONCLUSION:** Longer time to improvement in post-operative numbness is correlated with patient age after surgery for CM. No correlation with strength or balance improvement times were found.

**Paper 124**

**Assessing Treatment of Floating Lateral Mass (FLM) Fractures of the Subaxial Cervical Spine**

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**PURPOSE:** The purpose of the study is to define which surgical approach i.e., multi-level anterior, posterior, or combined anterior-posterior, correlates with the highest treatment success rate for floating lateral mass (FLM) fractures. Furthermore, we hope to determine whether surgical approach to FLM fracture treatment remains superior to nonoperative treatment in terms of clinical outcomes.

**BACKGROUND:** Floating lateral mass fracture of the subaxial cervical spine involves a complete separation of the lateral mass from the vertebrae via a disruption of both the lamina and pedicle, resulting in a disconnection of the superior and inferior articular processes. This subset of cervical spine fractures is highly unstable making proper treatment selection of great importance.

**METHODS:** In an IRB approved, single-center, retrospective study, 330 patients with cervical spine fractures of laminae and/or pedicles were identified. Radiological imaging from the date of injury was reviewed to determine the presence of a FLM fracture. Treatment course was analyzed to determine nonoperative vs. operative treatment. Operative treatment was divided into patients who underwent anterior, posterior, or combined anterior-posterior spinal fusion. Review of postoperative complications was used to determine the most favorable procedure.

**RESULTS:** Forty-five patients were determined to have a FLM fracture over a 10-year span. Nine of these patients were female and 36 were male, with an average age of 40 years. Cervical level 6 was the most common fracture site, representing 21 FLM fractures in our study. The nonoperative group had n = 25, and evidently, there were no patients that crossed over to surgery due to subluxation of the cervical spine after nonoperative treatment. The operative treatment group had n = 20, and consisted of 6 anterior, 12 posterior, and 2 combined approaches. Complications appeared in posterior and combined groups. Two hardware failures were noted in the posterior group, along with two postoperative respiratory complications in the combined group. No complications were observed for the anterior group.

**CONCLUSION:** Of 25 nonoperative patients, none required further operation or management of their injury, indicating nonoperative treatment as satisfactory management for FLM fractures. Despite posterior fusion providing more support, the posterior group had incidences of implant failure. There were no reported complications in the anterior group. This study shows potential for nonoperative treatment of FLM fractures and discusses our results with surgical management of FLM fractures, demonstrating anterior approaches as favorable surgical options.

**Paper 125****Patient Satisfaction with Spine Surgery Telemedicine Visits**

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**INTRODUCTION:** Telemedicine continues to be a rapidly growing factor of the modern healthcare system. Telehealth visits can theoretically improve access to care, minimize costs for both provider and patient, and improve the efficiency of healthcare delivery. The purpose of this study is to assess patient satisfaction with telehealth visits across different orthopedic subspecialties.

**METHODS:** Patients who underwent a telemedicine visit between July 2020 to Jan 2021 were identified and emailed a standardized satisfaction survey within 24 hours of their visit. Patients were instructed to assign a score from 0-10 (0 being worst and 10 being best) for seven different categories: 1) likelihood to recommend location, 2) likelihood to recommend provider, 3) understanding of care plan, 4) spent enough time, 5) care needs met, 6) refer a telehealth visit, 7) easiness to connect with telehealth visit. One-way analysis of variances (ANOVA) was used to compare: a) differences in mean scores between the different individual metrics, b) differences in survey scores between subspecialties, and c) differences in scores between mid-level and physician led encounters. Statistical significance was defined as  $p < 0.05$ .

**RESULTS:** A total of 241 patients completed surveys after telehealth visits across a variety of orthopedic subspecialties. Six of the seven metrics had mean scores  $> 9.0$ . Only one metric – “preference for telehealth visit” – had a mean score of  $6.2 \pm 2.9$ . The “preference for telehealth visit” metric was significantly lower than the other metrics ( $p < 0.05$ ). Between orthopedic subspecialties, spine visits resulted in a greater “understanding of plan” score relative to adult reconstruction ( $p = 0.001$ ) and shoulder & elbow visits ( $p = 0.049$ ). Additionally, spine visits resulted in greater “spent enough time” and “care needs met” scores relative to adult reconstruction visits ( $p = 0.002$  and  $p = 0.020$ ). Patients receiving hand care had the highest preference for telehealth visits. Patients had a greater understanding of their treatment plan and were more likely to recommend a telehealth visit when the encounter was led by a physician compared to a mid-level provider ( $p = 0.011$  and  $p = 0.024$ ).

**CONCLUSION:** Patients exhibited high satisfaction with telehealth visits. However, when given the choice, many still prefer a regular clinic visit. These trends were similar across different orthopedic subspecialties. Patients were more likely to express a greater understanding of their treatment plan and a preference for telehealth visits when the encounter was led by a physician rather than a mid-level provider.

**Paper 126****The Effects of Static and Expandable Cages on Local and Global Lumbar Lordosis (LL) in Transforaminal Lumbar Interbody Fusion (TLIF) Patients: A Minimum One-Year Follow-Up**

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**INTRODUCTION:** Sagittal balance has been established as a very important factor in the functional outcome of lumbar spine fusion surgeries. Lumbar lordosis (LL) is one of the parameters of sagittal balance and its correction has been found to spontaneously correct thoracic curves and sacral slopes. Expandable cages are a relatively new technology that has been marketed on the hypothesis that they offer better correction of lumbar lordosis than static cages. However, the few existing studies of expandable cages have not compared them to static cages, have not examined changes in lordosis, and have not included TLIF procedures. Therefore, the purpose of this study is to: determine if local lordosis and global lordosis is affected by the type of cage used (expandable vs. static), determine if one type of cage is better for one vs. two or more level fusions, and to determine if one type of cage is better depending on the lumbar level fused (upper lumbar vs. lower) in TLIF surgeries.

**METHODS:** A total of 332 patients (40% male) were included from a retrospective institutional data review at the University of Missouri between 2014-2017. Patients had to have radiographs in each of the following time periods: preoperatively, immediate postoperative period, six weeks postoperatively, and at least one year postoperatively. All measurements were made by a board certified radiologist with interobserver reliability evaluated by measurements of a subset of these patients by two orthopedic surgeons. Data analysis was performed with student's T test and ANOVA, with statistical significance achieved when  $p < 0.05$ .

**RESULTS:** Overall, there was no statistically significant change at the final follow-up visit in both local or global LL regardless of the type of cage use. There was a statistically significant decrease in global LL in the expandable cages group compared to the static cages group during the preoperative and immediate postoperative period ( $p < 0.002$ ) as well as the immediate postoperative and final follow-up visit ( $p < 0.05$ ). In both the static and expandable cages groups, neither local nor global LL was statistically different when comparing one vs. two or more level fusions or upper vs. lower lumbar TLIF surgeries accounting for age and previous spinal fusion.

**CONCLUSION:** In this retrospective study, expandable cages do not significantly improve lumbar lordosis compared to static cages on radiographic evaluation. Expandable cages may not be the most cost-effective choice in TLIF surgeries.

**Paper 127**

**Women in Spine**

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**BACKGROUND:** The influences on a female orthopedic surgeon differ from males with the choices they must make regarding work/life balance, pregnancy, and family. Within orthopedic fellowships, spine ranks the lowest among women in orthopedics at 2%. Does the spine specialty come with a different perception of strength or work/life balance compared to other specialties? Is there a difference in this field's influence with mentorship or discrimination?

**Questions/purposes:** To understand why there is such a low percentage of women in spine surgery.

**METHODS:** A 37-question survey was developed and sent to all AO Spine members, all orthopedic spine fellowship programs, and distributed on social media. Male and female orthopedic surgeons and neurosurgeons were included. After 12 weeks the survey was closed and analyzed.

**RESULTS:** 62 male and female spine surgeons both orthopedic and neurosurgeons, completed the survey. 23 men and 39 women. 55 were orthopedic surgeons and 7 neurosurgeons. 72% of the responders completed a spine fellowship, 55% were women. 45% of women completed a pediatrics/oncology fellowship with spine training. 58% of women were influenced by a role model. 8% of women were influenced by a female role model. 9% of men vs. 3% of women were influenced by their families on doing a spine fellowship. 2% of men and none of the women were influenced by family planning. Only 4% of women were influenced negatively by the physical aspects of spine surgery including case duration, posture, or standing. Our survey also brings to light the negative aspect of women pursuing and completing a spine fellowship. 10% of women were discouraged by an attending or program director to pursue spine. 22% of women were discriminated against during their fellowship interview, while none of the men felt they were. 33% of the women were asked negative questions during their interview. These included questions on family planning, pregnancy, or significant other/marital status. 14% of women felt they were discriminated against during their fellowship year. This included being bullied, harassed, or sexually harassed.

**CONCLUSIONS:** This study demonstrates that family influence and physical aspects of spine surgery are not the deciding factor for women. Women are being discouraged by attendings, being asked negative questions, and discriminated against during interviews and throughout their fellowship year. Women need to be encouraged and supported throughout their medical education in all specialties especially spine surgery to improve gender diversity.

**Paper 128****Percutaneous vs. Open Management of Thoracic and Lumbar Hyperostotic Fractures: A Case Control Study**

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**INTRODUCTION:** Hyperostotic spine fractures are associated with hyperextension fracture patterns and displacement. There has been increased interest in percutaneous instrumentation for the management of these fractures due to the hyperostotic phenotype which can lend itself to auto fuse after placement of instrumentation.

**OBJECTIVE:** To compare surgical outcomes and complications following percutaneous vs. open management of hyperostotic spine fractures.

**METHODS:** This is a retrospective study of patients with hyperostotic spine fractures of the thoracic and thoracolumbar spine undergoing surgical intervention at a level 1 center. Fifteen patients undergoing percutaneous (Perc) instrumentation from 2013-2022 were age/sex matched to patients undergoing open management from 2002-2018. The following variables were recorded, age, sex, race/ethnicity, level of fracture, number of levels instrumented, intraop and postop complications.

**RESULTS:** The 15 patients undergoing Perc instrumentation consisted of 3 females and 12 males with an average age of 75.3yrs (51-86). 10 had Diffuse Idiopathic Skeletal Hyperostosis (DISH) and 5 had Ankylosing Spondylitis (AS). The 15 patients undergoing Open management consisted of 4 females and 11 males with an average age of 75.2yrs (49-90), 11 had DISH and 4 had AS. There was no significant difference in age between the groups,  $p=0.48$ . For the Perc group, fracture distribution was [T7-T8 n=3; T9-T10 n= 4; 1 each at T5,T8,T9,T10,T10-T11,T11,T11-T12,L1-L2]. The open group fracture distribution was [T6 n=2; T9 n= 2; T11 n=2; 1 each at T5,T6-T7,T7-T8,T9-T10,T10,T10-T11,T11]. EBL was significantly less for the Perc group (95 ml; range 50-150) as compared to the open group (590ml; range 100 – 1400),  $p<0.001$ . The Perc group did not have statistically significant difference in levels instrumented (5.07) as compared to the open group (5.93),  $p=0.07$ . There was one intraop complication in the Perc group, cardiac arrest secondary to mucous plug. Postop operative infection rates were not significantly different between the two groups,  $p=0.1$  (n=2). Two cases of wound complications occurred within 90-day postop in the Perc group. In the open group, postop DVT occurred in 2 patients, and 2 postop neurologic complications. No patients had postoperative epidural hematomas or needed implant revision in either group.

**CONCLUSIONS:** The percutaneous approach for the management of hyperostotic spine fractures was associated with significantly less EBL and no difference in levels of instrumentation compared to the open approach. There was no significant difference in intraop or postop complications between the groups.

**Paper 129****Retrospective Review of Expandable Meshed Allograft Containment Device for Interbody Fusion in Traumatic Fractures and Osteomyelitis**

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**INTRODUCTION:** The trend towards minimally invasive spine surgery continues across the country with more methods for minimally invasive techniques. Previous literature has supported minimally invasive techniques for interbody fusion using percutaneous vertebral augmentation with a polyethylene terephthalate mesh containing bone allograft. In the setting of abnormal endplates or traumatic injuries, a conforming interbody fusion may have success over non-conforming interbody fusion implants. The purpose of this study is to evaluate the clinical and radiographic outcomes in utilizing a mesh containing interbody fusion implant.

**METHODS:** A retrospective chart review was completed on patients undergoing interbody fusion with associated posterior instrumentation with polyethylene terephthalate mesh containing bone allograft (Optimesh®) at a single institution from 2016 to 2021. All patients were treated by fellowship-trained orthopedic spine surgeons. Patient demographics including age, smoking status, history of diabetes, and associated medical comorbidities were collected. Radiographic parameters were measured, calculated, and averaged by two authors. Radiographic fusion was evaluated by treating surgeon with radiographic or computed topography imaging.

**RESULTS:** A total of 24 patients were identified undergoing 25 interbody fusions (one patient had two operations 2 years apart) that met inclusion criteria during the study time frame. The average age was 61 years  $\pm$  15.74 years. There were 15 males and 9 females. Smoking history was present in 18 patients (6 non-smokers) and seven patients had a history of diabetes with an average A1c of 7.61%. The most common indication for utilization of implant was infection in 12/25 cases, followed by traumatic fracture (7), proximal junctional kyphosis (3), and other (3). At an average follow-up of 16 months ( $\pm$  18 months, range 44 days to 5.5 years), three patients required re-operation for postoperative wound infection (primary indication for interbody fusion was infection) and one patient required revision of posterior instrumentation for compression fracture. There were no operations for revision of fusion or malunion or non-union of interbody fusion.

**DISCUSSION & CONCLUSION:** Interbody fusion in the setting of abnormal vertebral body contour is a challenge when many interbody fusion implants are rigid, non-conforming. In our small retrospective review study, we found the polyethylene terephthalate mesh containing bone allograft (Optimesh®) was effective at allowing for interbody fusion in the setting of traumatic fractures or infection with no need for revision of posterior instrumentation or interbody fusion for malunion or nonunion.



**Paper 130****Cervical Spinal Immobilization: A Head-to-Head Comparison of a One-Step Spray-On Foam Splint vs. SAM Splint Immobilization**

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Cervical spine immobilization in an austere environment is challenging. A structural aluminum malleable (SAM) splint is commonly utilized due to its multipurpose intention. A one-step spray-on foam immobilization technique (Fast Cast) has been shown to be effective in lower extremity splinting. The aim of this study was to demonstrate the ability of the Fast Cast to effectively immobilize the cervical spine in a head-to-head comparison against the SAM splint. We hypothesized that there would be no difference in surgeon scoring between Fast Cast and SAM splints for the immobilization of the cervical spine.

This was a cadaveric experimental comparative study. Five orthopedic surgeons served as graders to independently score each device. 5-point Likert scale based on 10 splinting criteria (50 total points possible) was utilized to evaluate cervical spine immobilization. Each of the three cadaveric specimens had an iatrogenic unstable cervical spine injury. An emergency medicine physician performed all SAM immobilizations, and an orthopedic surgeon performed Fast Cast immobilizations on each cadaver. Fluoroscopic imaging was taken before and after immobilization and after log roll/gravity stress. The lead statistical analyst was blinded to the immobilization groups. Statistical significance between groups was set at  $\alpha < 0.05$ . Inter-rater reliability of the Likert scale results was assessed with the Interclass Correlation Coefficient.

Inter-rater reliability was good (ICC = 0.76). Fast Cast exhibited a higher total score than SAM ( $p < 0.01$ ). Likewise, Fast Cast exhibited greater likelihood of higher Likert scores within each question as compared to SAM ( $p \leq 0.04$ ). 100% of raters indicated that Fast Cast passed the gravity stress examination without intrinsic loss of reduction; whereas, 33% of SAM passed ( $p < 0.01$ ). 100% of raters indicated that Fast Cast passed radiographic alignment following immobilization; whereas, 66% of SAM passed ( $p = 0.04$ ). 100% of raters indicated that Fast Cast passed radiographic alignment after the gravity stress examination; whereas, 47% of SAM passed ( $p < 0.01$ ).

The Fast Cast was rated superior to SAM splint immobilization for the cervical spine. This is clinically significant as the Fast Cast is easy to transport and has multifaceted applications. It also eliminates pressure points and circumferential wrapping, obstruction to airway/vascular access, while immobilizing the cervical spine and allowing for radiographic examination. Further studies are needed for human use and application.

**Paper 131****Outcomes of Elective Lumbar Decompression and Decompression with Fusion Procedures in Octogenarians**

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**INTRODUCTION:** Octogenarians are currently one of the fastest growing demographics in the United States. As the population continues to age and life expectancy increases, more elderly individuals are pursuing elective procedures, including spine surgery. The purpose of this study is to assess the incidence and risk factors for short-term complications in elderly patients undergoing elective posterior lumbar decompression or decompression and fusion procedures.

**METHODS:** Patients that underwent elective, single-level, posterior decompression with or without fusion between January 1, 2015 – December 31, 2017 were identified in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. Exact matching was used to match patients aged 80 years and older to patients between 65-79 years-old based on sex, American Society of Anesthesiologists (ASA) class, body mass index (BMI), functional status, and several medical comorbidities. The rate of various 30-day outcomes – unplanned readmission, reoperation, prolonged length-of-stay, non-home discharge, mortality, surgical and medical complications – were compared between the matched cohorts.

**RESULTS:** A total of 10,434 patients were included in the final analysis with 7,692 patients that underwent decompression alone and 2,742 patients that underwent decompression and fusion. In the decompression alone cohort, octogenarians had with significantly higher rates of readmission, non-home discharge, prolonged length-of-stay, perioperative bleeding, and overall medication complications ( $p < 0.001$ ). Similarly in the fusion cohort, octogenarians had significantly higher rates of non-home discharge, perioperative bleeding, and urinary tract infections ( $p < 0.001$ ). Octogenarians that underwent single-level fusion procedures had a higher rate of readmission, non-home discharge, prolonged length-of-stay, and overall medical and surgical complications compared to octogenarians undergoing decompression alone. Risk factors for readmission for octogenarians undergoing decompression alone included a history of COPD, steroid use, ASA class III, and partially dependent functional status. Risk factors for readmission for octogenarians after fusion included obesity class I or greater.

**DISCUSSION & CONCLUSION:** Octogenarians are at higher risk for postoperative complications following elective lumbar spine surgery than their younger counterparts. Furthermore, octogenarians who undergo decompression and fusion are at higher risk for postoperative complication when compared to those who undergo decompression alone. Several identifiable risk factors were predictive of these poor short-term outcomes. While certain elderly patients may be appropriate candidates for elective spine surgery, these patients should be selected carefully to minimize the morbidity and poor short-term outcomes.

**Paper 132****Does the Use of a Smoke Evacuation Device Reduce Smoke Exposure in the OR? A Prospective Study**

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**BACKGROUND:** As the medical community becomes more aware of the potential health hazards associated with exposure to surgical smoke, increasing emphasis is being placed on the use of surgical smoke evacuation devices. In June 2018, Rhode Island was the first state to enact a law mandating the use of a surgical smoke (SS) evacuation system followed by nine more in 2020. While studies have demonstrated the presence of dangerous compounds in SS, few have investigated the utility of these systems. With increased scrutiny on SS levels, these devices require further study. Our goal was to investigate the efficacy of smoke evacuation systems in reducing smoke levels during spine surgery.

**METHODS:** Consecutive patients undergoing spine surgery at a single institution had SS levels measured utilizing the PCE instruments particle counter (PCE-PCO 2). The device was positioned at the level of the surgical drape and smoke particle levels were measured during the surgical exposure. A cautery evacuator pencil (Medtronic Valleylab), and a smoke evacuation tube (Stryker Neptune tube vacuum system) were used and compared to no evacuation. Statistical analysis examined the effect of room size, age, BMI, and number of operative levels on smoke levels. Bivariate and multivariate analyses were completed with smoke level as the dependent variable and smoke evacuator group as well as patient/surgery characteristics as independent variables.

**RESULTS:** 117 patients at a single institution were included. The cautery evacuator pencil (CEP) was employed in 36 cases, smoke evacuation tube (SET) in 43, and no evacuator in 38. Average and peak levels of smoke particles were measured. Across all particle sizes, both the CEP and SET demonstrated significant smoke level reduction. There was no significant difference between the two devices looking at average smoke level, but the SET significantly reduced peak smoke levels when compared to the CEP. Smoke levels were further significantly influenced by room size, and the number of operative levels. Age, and BMI were not significant.

**CONCLUSIONS:** Our results demonstrate both the cautery evacuation pencil and smoke evacuation tube effectively reduce operating room smoke levels during spine surgery. Furthermore, the smoke evacuation tube shows superiority in reducing peak smoke levels. This study supports the use of a smoke evacuation device to reduce SS levels and thus reduce the potential associated health risk to operating room personnel.

**Paper 133****Experiences with the Treatment of Cervical Spine Infections from a Level-I Trauma Center: A Retrospective Cohort Study**

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**INTRODUCTION:** Cervical spine infections are a rare disease, representing about 1% of skeletal infections, 3-6% of which are cervical spine infections. Despite the rarity of the disease, there has been an increase in incidence in recent years due to the increase in susceptible populations and the increase in accuracy in diagnosing cervical spine infections. The purpose of this study was to report the overall complication rates of patients treated for cervical spine infection at a Level-I trauma center.

**METHODS:** We retrospectively reviewed all patients with a cervical spine infection from 2012 to 2021 at a Level-I trauma center. Patients with infection due to previous spine surgery were excluded. Patients' demographics, comorbidities (Charlson Comorbidity Index), white blood cell count (WBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) at time of presentation, and management (operative vs. nonoperative) were recorded. The incidences of reoperation and recurrent infection were recorded. The change in American Spinal Cord Injury Association (ASIA) motor scores from presentation to final follow-up and length of stay (LOS) were recorded.

**RESULTS:** We identified 163 patients with a spine infection. Forty-seven patients had cervical spine involvement and met the inclusion and exclusion criteria. Thirty-three (70.2%) patients had infections isolated in the cervical region. The mean age was 51.3 [23-76] years old and 30 (63.8%) males. Of the patients that had a WBC (n=41), ESR (n=46), and CRP (n=43) prior to admission, 34 (73.9%) patients had an elevated WBC, 38 (92.7%) patients had an elevated ESR, and 36 (83.7%) had an elevated CRP. From the operative cohort, 5 (12.8%) patients had a reoperation, of which 4 (10.2%) patients had undergone fusion during their index procedure. Of the patients treated operatively, 6 (15.4%) had a recurrent infection compared to no patients treated nonoperatively. The average initial ASIA motor score was 90.5, the average ASIA motor score at follow-up was 96.4, and the average change in ASIA motor score was 8.8. The average LOS was 17.9 [2-55] days.

**CONCLUSION:** Cervical spine infections are rare; however, early diagnosis and treatment are critical considering the morbidity and potential neurologic complications. Elevated inflammatory markers may be elevated in patients with a cervical spine infection; however, patients may still have an infection with normal lab values. Recurrent infections and reoperation are complications to consider when treating patients with cervical spine infections.

**Paper 134****Dual-Mobility vs. Large Femoral Head in Revision Total Hip Arthroplasty: Interim Analysis of a Randomized Controlled Trial**

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**INTRODUCTION:** The purpose of this multicenter randomized controlled trial was to determine if dual-mobility bearings (DM) lower the risk of dislocation compared to large femoral heads ( $\geq 36\text{mm}$ ) for patients undergoing revision total hip arthroplasty (THA).

**METHODS:** 146 patients were randomized to a DM ( $n=76$ ; 46mm median effective head size, range 36-59mm) or a large femoral head ( $n=70$ ; twenty-five 36mm heads, forty-one 40mm heads, four 44mm heads). All procedures were performed via a posterior approach. There were 39 both-component revisions, 78 single-component revisions (60 acetabular-only, 11 stem-only, and 7 isolated head-and-liner exchanges), 24 reimplantation of THA after 2-stage revision, 4 conversions of hemiarthroplasty, and 1 revision of a hip resurfacing. The primary outcome was dislocation. Power analysis determined 161 patients were required in each group (power=0.8, alpha=0.05), assuming a reduction in dislocation rate from 8.4% to 2.2%. Descriptive and univariate statistics were performed, with alpha <0.05.

**RESULTS:** At a mean of 18.2 months (range, 1.4-48.2), there were 3 dislocations in the large femoral head group (all 40mm heads) compared to 2 in the DM cohort ([46mm and 51mm effective heads] 4.3% vs. 2.6%;  $p=0.67$ ) at a mean of 5.0 months postoperatively (range, 0.5-12.5). One patient in the large head group and none in the DM group were successfully treated with closed reduction without subsequent revision (one DM patient required open reduction and was subsequently revised for periprosthetic joint infection; the remaining dislocations received head-and-liner exchanges). The effective head size was larger in the DM cohort vs. large head overall ( $46.0\pm 4.3\text{mm}$  vs.  $38.7\pm 2.2$ ,  $p<0.001$ ) and in those that dislocated ( $48.5\pm 3.5\text{mm}$  vs.  $40.0\pm 0.0\text{mm}$ ,  $p=0.02$ ).

**CONCLUSION:** Interim analysis of a multi-center randomized trial found no difference in the risk of dislocation, although the rate of dislocation was lower than anticipated. Full enrollment and further follow up is required.

**Paper 135****Contemporary Custom Flanged Acetabular Components: Expected Outcomes May Differ for Women and Men**

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**BACKGROUND:** Custom flanged acetabular components (CFAC) are used to address extensive acetabular bone loss. We investigated CFAC survivorship and patient-reported outcomes (PROs) based on patient sex.

**METHODS:** Prospective data on 27 CFACs were retrospectively reviewed.

**RESULTS:** 17 females and 10 males did not differ in mean age (63.7,  $p=.320$ ), BMI (28.3,  $p=.836$ ), ASA-PS classification ( $p=.153$ ), pelvic discontinuity (44.4%,  $p=.424$ ), or Paprosky classification (96.3% = 3B,  $p=.999$ ). Procedures were performed for aseptic loosening (52.9% of females and 80% of males) and infection (47.1% and 20%;  $p=.231$ ).

One revision involving the CFAC occurred at 41.4 months in a female for a mechanical failure rate of 3.7%. Revisions not involving the CFAC were performed for instability, infection, and periprosthetic femoral fracture for an overall reoperation rate of 33.3% (9/27) at mean follow-up of 15.2 (0.4-48.2) months.

Excluding reoperations, 58.8% of females and 80% of males ambulated at latest follow-up ( $\bar{x}$  15.9, 0.7-69.2 months,  $p=.406$ ), with 70% and 37.5% using assistive devices ( $p=.342$ ). Activity level improved for 62.5% of females and 57.1% of males ( $p=.999$ ). Both sexes reported mild average activity levels (limited housework/shopping) at latest follow-up. Females realized mean improvement of  $27.4 \pm 22.7$  points ( $p=.011$ ) in hip health compared to  $6.5 \pm 12.9$  for males ( $p=.272$ ). Females without hip pain during unlevel walking increased by 50% ( $p=.07$ ) after surgery, compared to only 1.6% for males ( $p=.999$ ).

**CONCLUSIONS:** We observed excellent survivorship from mechanical failure at short-term follow-up. Improvements in PROs were modest. Most outcomes were not statistically different with the numbers available but large differences favoring males were observed for postoperative ambulation and walking aids. Paradoxically, females realized significantly more improvement in hip health and pain. Nonetheless, limited activity levels remained the same after surgery for both sexes. Further study is recommended to determine whether expected outcomes after reconstruction with CFACs differ for women and men.

Paper 136

**Do 'Surgeon Champions' and High-Volume Surgeons Have Lower Rates of Periprosthetic Hip Fracture?**

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**BACKGROUND:** Recently the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) identified fracture as a significant cause of hip revision. Of 1,433 revisions, 756 (52.8%) occurred within 6 months with fracture the leading early cause. A QI project was initiated to modify fracture risk. Each MARCQI site has a 'Surgeon Champion' who acts as liaison and advocate. This study evaluated the effect of surgeon volume and role of 'surgeon champion' on fracture rate.

**METHODS:** Cases 2012-2020 were queried. Peri-implant femur fractures were identified (intra- and postoperative). Funnel plots with confidence intervals were generated to compare surgeons based on fracture rate and case volume. Surgeons with a fracture rate below the 80% confidence interval were labeled 'Green' (lower than mean). Within 80% confidence interval were 'Yellow' (no significant difference) and above were 'Red' (significantly higher).

**RESULTS:** 17.2% of 'Surgeon Champions' were Green, 62.1% Yellow, and 20.7% Red. Only 6.2% of 'Non-Champions' were Green, 74.5% Yellow and 19.3% Red. Volume analysis showed no low-volume surgeons (lowest quartile volume (<84 THA cases)) had Green status, 88.3% were Yellow and 11.7% Red. Likewise, no 2nd quartile surgeons (84-180 cases) were Green, 77.3% Yellow, and 22.7% Red. 3rd quartile (181-404 cases) were 4% Green, 73.3% Yellow, and 22.7% Red. Of the highest volume surgeons (>404 cases) 29% were Green, 51.3% Yellow, and 19.7% Red.

**CONCLUSION:** There were significant differences in fracture rate between "Surgeon champions" and "non-champions", particularly for Green status. Likewise, nearly all Green surgeons were high-volume. While these groups populated the Green, the shift was from Yellow to Green without decreasing the amount of Red. Lessons are learned with experience and oversight. "Green" surgeons should mentor colleagues to help reduce fractures by increasing use of cement, altering implants, or technique. The importance of evaluating outcomes to promote quality and decrease perioperative complications cannot be overstated.

**Paper 137****Disproportionate Number of Patients Qualify as "High-Risk" for Arthroplasty from Disadvantaged Areas**

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**INTRODUCTION:** Extended oral antibiotic prophylaxis (EOAP) has been shown to reduce rates periprosthetic joint infection (PJI) in high-risk total joint arthroplasty (TJA) patients. Previous studies have shown extended postop oral antibiotics reduce this risk in that population. This multi-center study aims to classify high-risk hip and knee patients for PJI and explore associated socioeconomic and demographic factors to improve future PJI preventive measures.

**METHODS:** All primary and aseptic revision TJA performed in 2019 at three academic medical centers were retrospectively reviewed. High-risk status was defined as body mass index  $>35\text{kg/m}^2$ , diagnosis of autoimmune disease, diabetes mellitus, chronic kidney disease, active tobacco users, or those colonized with nasal staphylococcus. Area Deprivation Index (ADI) was calculated as a measure of socioeconomic status. This is a zip-code based measure of socioeconomic deprivation with scores ranging from 1 (least disadvantaged) to 100 (most disadvantaged). Data was summarized by risk group as means (SDs) or as precents (N's), then tested for risk-group differences with stratified Wilcoxon rank-sum and Chi-square tests with the institutions as strata.

**RESULTS:** Of the 2,511 patients in our pooled cohort, 73.3% met criteria for high-risk. There was no difference in high-risk designation based on race ( $p=0.53$ ) or age ( $p=0.67$ ); however, a larger proportion of female patients were deemed high risk (75.7% vs. 70.1% males;  $p=0.002$ ). Mean Elixhauser scores for high-risk TJA subjects were significantly greater compared to non-high-risk TJA ( $p<.0001$ ); [3.5 (SD 2.4) vs. 2.2 (SD 1.7)]. The Mean ADI for high-risk patients was higher (more disadvantaged) than the non-high-risk cohort ( $p<.0001$ ); [64.0 (SD 20.8) vs. 59.4 (SD 59.4)].

**DISCUSSION:** Across three regionally diverse centers, 73.3% of hip and knee TJA patients met criteria for high-risk classification and would be given oral antibiotics according to the suggestions of some publications. High-risk patients for PJI were often female, had more comorbid conditions and lived in more socioeconomically disadvantaged areas. Further work is needed to determine if this large percentage of patients are truly at greater risk for PJI or if all patients may benefit from EOAP.



**Paper 138**

**Can the American Joint Replacement Registry Utilize Administrative Claims Data to Accurately Classify Revision THA Surgical Diagnoses?**

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**INTRODUCTION:** The American Joint Replacement Registry (AJRR) is a powerful tool for the study of revision total hip arthroplasty (rTHA). AJRR utilizes International Classification of Diseases-10 (ICD-10) codes for recording surgical diagnoses. The validity of utilizing ICD-10 data in this manner is unknown. We sought to determine the accuracy with which ICD-10 data submitted to AJRR correctly classifies rTHA diagnoses.

**METHODS:** 908 rTHAs performed from 2015-2021 at a single institution were included (13.3% septic). Revision diagnoses were obtained from our institutional total joint registry, in which trained abstractors prospectively record surgical diagnosis independent from ICD-10 data. ICD-10 diagnosis codes, as submitted to AJRR, were also retrieved for the same procedures. The accuracy of AJRR submitted ICD-10 diagnosis codes was assessed using Cohen's Kappa statistic, sensitivity, and specificity. We first assessed the accuracy of classifying septic vs. aseptic revisions and subsequently evaluated the aseptic diagnoses of loosening, periprosthetic fracture, and instability.

**RESULTS:** Concordance between AJRR submitted ICD-10 codes and our institutional database for classifying rTHA as septic or aseptic was excellent (96.9%;  $k=0.87$ ). Agreement for aseptic diagnoses varied from very good for instability ( $k=0.76$ ) and loosening ( $k=0.67$ ) to moderate for periprosthetic fracture ( $k=0.54$ ). The percent agreement for instability, loosening, and periprosthetic fracture between databases was 94%, 85%, and 96%, respectively. Specificity was high (>96%) for all three diagnoses, but sensitivity was lower at 74%, 68%, and 44% for instability, loosening, and periprosthetic fracture, respectively.

**CONCLUSION:** ICD-10 data submitted to AJRR correctly classified rTHA cases as septic or aseptic with remarkable accuracy. However, accuracy decreased when evaluating more granular aseptic diagnoses, and was particularly low for periprosthetic fracture and instability. Reassuringly, the specificity of AJRR diagnoses was high. These data demonstrate the potential for diagnosis specific limitations when utilizing administrative claims data for research and registry reporting.

**Paper 139**

**Medicaid Patients Undergo Total Joint Arthroplasty at Lower Volume Hospitals by Lower Volume Surgeons**

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**INTRODUCTION:** Medicaid insurance coverage amongst total hip (TKA) and knee arthroplasty (THA) patients has been associated with poorer postoperative outcomes compared to non-Medicaid patients. Surgeons and hospitals with lower annual total joint arthroplasty (TJA) volume have also been associated with poorer outcomes. This study seeks to characterize whether Medicaid patients undergoing TJA are more likely to be performed at lower volume facilities by lower volume surgeons, and to assess rates of postoperative complications compared with other payer types.

**METHODS:** The Premier Database was queried for all patients who underwent primary TJA from 2015-2020. Patients were divided based on their insurance status: Medicaid vs. non-Medicaid. The distribution of hospital and surgeon case volumes were assessed for each cohort. Multivariate analyses were performed accounting for patient demographics, comorbidities, surgeon volume, and hospital volume to assess the 90-day risk of postoperative complications.

**RESULTS:** Overall, 1,204,624 TJA patients were identified (64.0% TKA and 34.0% THA), of which 55,021 (4.57%) had Medicaid insurance. In total, 49.4% of Medicaid patients were treated by surgeons doing <100 cases per year compared to 37.3% of non-Medicaid patients. Furthermore, Medicaid patients were more likely to undergo a TJA at lower volume hospitals doing <500 cases per year compared to non-Medicaid patients (51.9% vs. 37.4%,  $p<0.0001$ ). After accounting for differences amongst the two cohorts, Medicaid patients remained at increased risk of postoperative deep venous thrombosis (OR 1.15,  $p=0.022$ ), pulmonary embolism (OR 1.47,  $p=0.001$ ), periprosthetic joint infection (OR 1.53,  $p<0.001$ ), and 90-day readmission (OR 1.37,  $p<0.001$ ).

**CONCLUSION:** Medicaid patients were more likely to undergo TJA by lower volume surgeons at lower volume hospitals and had higher rates of postoperative complications compared to non-Medicaid patients. Further investigation should be done to better understand the effects of hospital and physician volume on postoperative outcomes amongst Medicaid TJA patients.

**Paper 140****Have We Gotten Better Over Time Mitigating Complications in Obese Patients Undergoing THA?**

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**INTRODUCTION:** The prevalence of obesity in the United States is increasing substantially and is considered an epidemic. Elevated BMI increases the risk of complications following total hip arthroplasty (THA). We sought to evaluate trends in BMI and complication rates of obese patients undergoing primary THA over the last 30 years.

**METHODS:** Through our institutional total joint registry, we identified 15,455 primary THAs performed for osteoarthritis from 1990-2019. Patients were categorized according to the World Health Organization (WHO) obesity classification and groups were trended over time. Cox proportional hazards regression analysis controlling for confounders was used to investigate the association between year of surgery and 2-year risk of any reoperation, any revision, dislocation, and periprosthetic joint infection (PJI). Regression was stratified by 3 separate groups: non-obese; WHO Class I and Class II (BMI 30-39 kg/m<sup>2</sup>); and WHO Class III patients (BMI ≥ 40 kg/m<sup>2</sup>).

**RESULTS:** There was an increase in the proportion of all obesity classes from 1990-2019 with a 167% increase in Class II (5% to 14%;p<0.001) and a 420% increase in Class III (2% to 8%;p<0.001). The proportion of non-obese patients decreased over time (68% to 52%;p<0.001). BMI values within each WHO Class significantly increased over time. Risk of any reoperation did not change significantly over time amongst non-obese or WHO Class I/II patients. Risk of any reoperation increased significantly over time for WHO Class III patients (HR 1.04; p=0.044). Risk of any revision did not change significantly over time for any group. Risk of dislocation decreased significantly over time for non-obese (HR 0.96;p<0.001) and WHO Class I/II (HR 0.96;p=0.002) patients, but did not change over time for WHO Class III (HR 0.94;p=0.073) patients. Risk of PJI did not change significantly over time for any group.

**CONCLUSION:** At our institution, the annual proportion of patients undergoing THA who are obese has increased by 50% over the last 30 years. Despite BMI values increasing within all WHO classes over time, the risks of any reoperation, any revision and PJI have remained stable in WHO Class I/II patients, and the risk of dislocation has decreased. Amongst WHO Class III patients, the risk of dislocation has not decreased over time and the risk of any reoperation has increased. Continued efforts directed towards preoperative optimization, operative technique, and implant design will be required to mitigate risks in the heaviest patients.

**Paper 141****Tapered Fluted Titanium Stems in Revision Total Hip Arthroplasty: A Clinical and Radiographic Outcomes Study of Monobloc and Modular Designs**

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Establishing stable femoral component fixation in revision total hip arthroplasty (rTHA) remains a clinical challenge, and consensus on the ideal femoral component is lacking. Nonmodular and modular designs have historically been associated with subsidence and fatigue strength and subsequent junctional fracture, respectively. In an attempt to overcome these concerns, design alterations have been made to nonmodular tapered fluted stems including asymmetric coatings and more aggressive tapers aiming to enhance initial stability and limit subsidence. The aim of our study is to present the clinical, radiographic, and functional results of the most recent iteration of both modular and nonmodular tapered, fluted, grit-blasted, forged titanium revision femoral stems.

**METHODS:** In a retrospective review, all rTHAs performed over a 10-year period at our institution were identified. Patients in which tapered, fluted, grit-blasted, forged titanium revision femoral stems were used, whether modular or monolithic, were included. Femoral stem subsidence was measured and recorded radiographically during postoperative follow-up. Clinical outcomes including Harris Hip (HH) and Western Ontario and McMaster Universities (WOMAC) Scores, and rerevision rates were collected. We examined Kaplan-Meier survivorship for the endpoints for subsidence or rerevision for any reason. Statistical analysis for clinical outcomes was performed using repeated measures analysis of variance, and radiographic outcomes were assessed using Kendall's Tau B rank coefficient.

**RESULTS:** Sixty-nine (50 nonmodular and 19 modular) hips in 65 patients met inclusion criteria with a median follow-up of 29.7 months (Interquartile Range, 14-41). 53 of the 71 (74.6%) met survival criteria at last recorded follow-up, with 11 hips (15.5%) undergoing re-revision during this period. Average femoral stem subsidence was  $2.03 \pm 2.24$  mm, with 56 (81%) subsiding less than 3 mm. Risk of femoral subsidence was significantly lower among the monolithic as compared to modular design ( $p=0.01$ ). HH scores improved in both the nonmodular ( $42.94 \pm 8.07$  to  $88.60 \pm 16.36$ ) and modular ( $48.79 \pm 13.31$  to  $71.9 \pm 10.94$ ). WOMAC scores also improved at final follow-up, but without statistical significance between nonmodular ( $52.11 \pm 7.78$  to  $19.39 \pm 16.37$ ) and modular ( $50.39 \pm 12.83$  to  $28.88 \pm 16.58$ ) femoral stems ( $p=0.80$ ).

**CONCLUSIONS:** Advances in implant design including asymmetric coatings and more aggressive tapers in monolithic titanium, tapered-fluted components offers encouraging clinical outcomes with an overall low risk of clinically significant subsidence, making them a reliable implant option in rTHA.

Paper 142

**If I Had a Hammer: A Randomized Study of Surgeon Exertion During Mallet vs. Automated Impactor THA**

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**INTRODUCTION:** Total hip arthroplasty (THA) is a repetitive and physically taxing surgery which requires stamina on the part of the surgeon and can result in musculoskeletal strain and injury. Here we investigate whether an automated impactor system affects surgeon exertion during THA and subsequent postoperative surgeon sleep quality.

**METHODS:** An orthopedic surgeon (male, age = 48) performed 26 THAs while wearing a biometric shirt that measured physiological indicators of physical stress (heart rate, respiration, and energy expenditure). Patients were randomized to surgery using an automated impactor device (IMPACTOR group) or traditional handheld mallet conditions (MALLET group) to match for age, sex, and body mass index. Press fit implants were used for all THAs. Surgeon sleep data were acquired using a sleep tracking ring.

**RESULTS:** Results revealed that surgeon average heart rate was significantly higher for MALLET THAs (121.2 bpm) than for IMPACTOR THAs (108.8;  $p < 0.0001$ ). Indeed, the maximum heart rate distributions during MALLET (range: 148–172 bpm) vs. IMPACTOR THAs (range: 125–146 bpm) were non-overlapping ( $p < 0.0001$ ). Similarly, breathing rate and energy expenditure was higher for MALLET vs. IMPACTOR THAs (breathing rate: MALLET = 16.5 rpm; IMPACTOR = 14.3 rpm,  $p < 0.0005$ ; energy expenditure: MALLET = 614 watts; IMPACTOR = 492 watts,  $p < 0.0005$ ). We also observed improved postoperative sleep quality and sleep duration following IMPACTOR THAs compared to MALLET THAs (sleep score: IMPACTOR = 87.2, MALLET = 71.0,  $p < 0.0001$ ; sleep duration: IMPACTOR: 7.6 hrs, MALLET: 6.3 hrs,  $p < 0.0005$ ).

**CONCLUSION:** Performing THA with the use of an automated impactor system resulted in reduced surgeon physiologic stress and energy expenditure compared to mallet-based THA. These benefits to surgeon well-being were further realized in the postoperative nightly sleep habits of the surgeon.

Paper 143

**The Fate of a Dislocated Dual Mobility: Intraprosthetic Dissociation Commonly Missed and More than Half Will Require Open Reduction**

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**INTRODUCTION:** Dual mobility (DM) implants reduce the risk of dislocation in total hip arthroplasty (THA). Dislocated DM can present as a true dislocation of the entire modular head from the acetabulum, or as an intraprosthetic dislocation (IPD), where the inner head dissociates from the outer polyethylene bearing. This study reports the incidence of DM dislocations and IPD and evaluates the treatment and long-term outcomes of dislocated DM THA.

**METHODS:** 695 primary and 758 revision DM THA were implanted at our institution from 2010-2021. 54 DM THA in 48 patients sustained at least one dislocation event. Mean time to dislocation was 41 weeks, mean age was 64 years, 54% were female, and mean follow-up was 2.5 years. Patient outcomes were evaluated by retrospective chart review.

**RESULTS:** 44 hips presented with true dislocations (3% incidence) and 10 presented with IPD (0.7% incidence). 9 of 10 IPD were missed at presentation and four additional iatrogenic IPD occurred during reduction attempts, increasing IPD incidence to 1%. Reduction attempts in the emergency department failed in 63% of DM, closed reduction attempts in the operating room failed in 53%, and second attempts at closed reduction failed in 95%. Closed reduction was more successful under anesthesia with paralysis ( $p=0.03$ ). Ultimately 65% required open reduction or revision to treat the dislocation, 33% re-dislocated, and five hips underwent subsequent revision at a mean 1.8 years after dislocation.

**CONCLUSIONS:** The incidence of DM dislocation and IPD remains low; however, 90% of IPD were missed, highlighting the importance of DM identification at presentation. Closed reductions were more successful with paralysis; however, the majority of dislocated DM required open management. Given the high conversion rate to open management and risk of iatrogenic IPD, we recommend attempting closed reduction in the operating room, where one may convert to open management as needed.

**SUMMARY:** Over half of attempted reductions for dislocated dual mobility hips fail and require open reduction, and intraprosthetic dislocations of dual mobility are often missed, therefore, these are best managed in an operative setting.

**Paper 144****Bilateral Total Hip Arthroplasty Staged within Six Weeks Increases Risk of Adverse Events**

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**INTRODUCTION:** The ideal timing for bilateral total hip arthroplasty (THA) to avoid an increased risk of adverse events remains controversial. The purpose of this study was to evaluate 90-day outcomes after simultaneous and staged bilateral THA.

**METHODS:** Laterality-specific International Classification of Disease, 10th Revision codes were used to retrospectively identify 273,281 patients undergoing primary THA in the PearlDiver database during 2015-2020. Of these, 39,905 (14.6%) were bilateral. Patients were divided into cohorts of unilateral THA, simultaneous bilateral THA, and staged bilateral THA at 1-14 days, 15-42 days, 43-90 days, and 91-365 days. Bilateral THA cohorts were matched one-to-one with unilateral THA patients based on age, gender, year, Elixhauser Comorbidity Index (ECI), and a preoperative diagnosis of obesity, tobacco use, and diabetes. Univariate and multivariate analysis were used to compare 90-day outcomes between matched groups with a significance level of  $p < 0.05$ . Outcomes were collected beginning after the second THA in staged bilateral groups.

**RESULTS:** Simultaneous bilateral THA was associated with an increased risk of transfusion (odds ratio [OR] 4.43, 95% confidence interval 2.31-2.63,  $p < 0.001$ ), readmission (OR 2.60, 2.01-3.39,  $p < 0.001$ ), and any complication (OR 1.86, 1.55-2.24,  $p < 0.001$ ) compared to unilateral THA. Bilateral THA staged at 1-14 days increased the risk of readmission (OR 1.83, 1.49-2.24,  $p < 0.001$ ) and any complication (OR 1.45, 1.26-1.66,  $p < 0.001$ ) relative to unilateral THA. Bilateral THA staged at 15-42 days also increased the risk of adverse events, including periprosthetic joint infection (OR 3.15, 1.98-5.19,  $p < 0.001$ ), transfusion (OR 2.90, 1.84-4.70,  $p < 0.001$ ), readmission (OR 1.92, 1.55-2.39,  $p < 0.001$ ), and any complication (OR 1.70, 1.46-1.97,  $p < 0.001$ ). Bilateral THA staged at 43-90 days and 91-365 days resulted in similar or decreased rates of individual complications, reoperation, readmission, and any complication relative to unilateral THA.

**CONCLUSIONS:** Bilateral THA should be staged a minimum of six weeks apart in appropriately selected patients to avoid an increased risk of adverse events.

**Paper 145**

**Why Are Contemporary Acetabular Components Failing Following Primary THA?**

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**BACKGROUND:** Advances in acetabular component and bearing surface technology have resulted in decreased revision rates. Still a subset of cases may require revision. Understanding the cause of contemporary failure may allow for further refinement and improvements in patient care. We describe the incidence and causes of contemporary acetabular component revision after primary THA.

**METHODS:** 20,275 primary THAs performed in 16,849 patients (52% female) between 2000 and 2019 at our institution were included. Acetabular revision was defined as removal of the acetabular component for any reason with a total of 170 revisions identified. The average age and BMI for this cohort was 64 and 31, respectively. The 3 most common acetabular components utilized were Depuy Pinnacle, Zimmer Metal Mesh trilogy, and Zimmer Implex Hedrocel Revision accounting for 66% of all the implants. Individual chart review was completed to identify patient demographic variables and specific indications for revision and failure.

**RESULTS:** 170 acetabular revisions occurred in 20,275 primary THAs (1.1%). Indications for revisions included: infection (n=81, 47%), instability (n=39, 23%), aseptic loosening (n=32, 19%), malpositioned cup (n=5, 3%), iliopsoas impingement (n=4, 2.3%), trunnionosis (n=4, 2.3%), leg length discrepancy (n=2, 1.2%), improved head size at time of femoral revision (1, 0.6%), pain of unknown etiology (n=1, 0.6%), periprosthetic femur fracture (n=1, 0.6%), and periprosthetic acetabular fracture (n=1, 0.6%), poly wear (n=1, 0.6%).

**CONCLUSIONS:** Similar to the most recent AJRR annual report, our institutional registry data demonstrated that infection and instability are the leading causes of revision of contemporary acetabular designs. Notably, modern components have minimized failure from aseptic loosening and osteolysis, while other causes of revision are infrequent.

**SUMMARY:** Incidence of contemporary acetabular component revision is exceedingly low, with the most common indications for revision being infection, instability, and aseptic loosening.



**Paper 146**

**Abdominal Pannus Size Should Not Dictate Surgical Approach in Primary Total Hip Arthroplasty**

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**INTRODUCTION:** Large abdominal pannus size is a risk factor for complications with anterior approach THA. However, it is unclear if changing to a posterior approach mitigates this risk. The purpose of this study was to evaluate whether abdominal pannus size had a differential effect on complication rates comparing anterior vs. posterior THA.

**METHODS:** 1,000 consecutive primary THA patients – 478 anterior, 522 posterior – were retrospectively reviewed for complications, and their abdominal pannus was radiographically measured on an a/p pelvis image and placed into one of four categories based upon its vertical size (no pannus (G0), above symphysis (G1), below symphysis (G2), or below ischial tuberosities (G3)). Age, race, gender, BMI, Charlson Comorbidity Index, smoking, and complications/revisions were collected by manual chart review. Chi squared tests for univariate and logistic regression models with forced entry model building controlling for those potential confounding variables were used for statistical analysis.

**RESULTS:** Comparing wound complications and/or delayed healing with increasing pannus size, anterior vs. posterior: (G0 1.9% vs. 3.9%  $p=0.21$ , G1 7.2% vs. 6.7%  $p=0.08$ , G2 17.9% vs. 11.6%  $p=0.27$ , G3 16.7% vs. 15.5%  $p=0.84$ ). Similar results were found with reoperations: (G0 0.9% vs. 1.1%  $p=0.080$ , G1 1.4% vs. 2%  $p=0.72$ , G2 3.0% vs. 5.8%  $p=0.41$ , G3 1.7% vs. 4.5%  $p=0.33$ ). Additionally, when controlling for BMI, age, race, gender, CCI, and smoking in the logistic regression models there was no statistically significant difference in the odds of wound complications or return to the OR between the approaches at each pannus size.

**CONCLUSION:** In primary anterior THA patients, an abdominal pannus of any size does not independently increase the risk of delayed wound healing or reoperation within 90 postoperative days compared to posterior and should not dictate surgical approach.

**Paper 147****Medial Collar Stem Design Lowers Six Month Periprosthetic Hip Fracture and Subsidence Rate**

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**INTRODUCTION:** Many femur fractures in total hip arthroplasty (THA) occur during advancement of the final stem, especially during a direct anterior approach (DAA). Calcar collars are a re-emerging trend among cementless stem designs which may reduce fracture risk by both preventing subsidence and acting as an intraoperative cue for sufficient stem advancement. We hypothesize that collared femoral stems have lower risk of intraoperative and postop periprosthetic fracture and stem subsidence compared to collarless designs in DAA THA at six months.

**METHODS:** A retrospective review of 348 DAA THAs on a Hana table performed from 2017-2020 by a single surgeon, fellowship trained in arthroplasty, was done. Three cementless stems with similar broach systems were studied: Zimmer ML Taper, Avenir & the Avenir-Complete with a collar. Only patients with Dorr A or B femurs received cementless THA. Incidence of intraoperative fractures and postoperative Vancouver AL/B fractures within six months were recorded. Radiographic stem subsidence was measured and compared at six months by the attending surgeon and two independent observers. Fisher-Exact test was used to compare outcomes between the collared vs. non-collared designs with  $p < 0.05$  considered significant. Subsidence  $> 3\text{mm}$  was deemed clinically significant based on prior studies for similar broached stems.

**RESULTS:** Both groups were comparable in sex, smoking history, diabetes, Dorr type, and BMI. Patients with the collared stem had significantly fewer femur fractures compared to collarless stem designs (0/99 vs. 11/249) ( $p=0.043$ ). Three patients had intraoperative calcar cracks requiring cerclage and eight required revision postop. Radiographic subsidence  $> 3\text{mm}$  was also significantly lower in the collared stem group ( $p < 0.001$ ) at 6 months. No statistically significant differences were observed in infection ( $p=0.55$ ), hematoma formation ( $p=0.10$ ), or wound complications ( $p=0.47$ ).

**CONCLUSION:** The use of collared cementless femoral stems in DAA THA resulted in significant reduction in periprosthetic femur fractures and subsidence compared to collarless stems. This was likely due to the collar acting as an intraoperative and postoperative calcar stop against over-advancement in the canal. There were no cases of early loosening with any of the stems. A prospective multi-surgeon study comparing collared and collarless versions of the Avenir-complete stem would yield stronger data. Subsidence would be more reliably measured with 3D imaging and radiostereometry. Implementing collared femoral stem designs may lead to further cost-savings and lower fracture rate in patients undergoing DAA THA.

Paper 148

**How Do Physician Patients Fare after Primary Total Hip and Total Knee Arthroplasty?**

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**INTRODUCTION:** Physician patients requiring surgery present with occupational exposures and personality traits that might affect outcomes. This study aimed to compare implant survivorship, complications, and clinical outcomes of physician patients undergoing primary total hip arthroplasty (THA) or total knee arthroplasty (TKA).

**METHODS:** A retrospective review of our institutional total joint registry identified 185 physician patients undergoing primary THA (n=94) or TKA (n=91) from 2008 to 2018. Physician patients were then matched 1:2 with non-physician controls according to age, sex, body mass index (BMI), joint (hip or knee), and surgical year. Physician type (medical in 132 vs. surgical in 53) sub analysis was also performed. The mean age at surgery was 73 years, 84% were male, and mean BMI was 29 kg/m<sup>2</sup>. Implant survivorship was assessed via Kaplan-Meier methods. Clinical outcomes were evaluated by Harris hip scores (HHS) and Knee Society scores (KSS). Mean follow-up was four years.

**RESULTS:** There was no significant difference in five-year implant survivorship free of any reoperation ( $p>0.4$ ) or any revision ( $p>0.2$ ) between physician or non-physician patients. Similarly, the 90-day complication risk between physicians and non-physician patients was not significantly different after THA or TKA ( $p>0.6$  for both). Physicians and non-physicians demonstrated similar improvement in HHSs ( $p=0.6$ ) and KSSs ( $p=0.4$ ). There was no difference in implant survivorship ( $p>0.4$ ), complications ( $p>0.6$ ), or patient reported outcomes ( $p>0.1$ ) when comparing physician subtype (medical vs. surgical).

**CONCLUSION:** Physician patients, including surgeons, do not have worse implant survivorship, more complications, or inferior clinical outcomes when compared to non-physicians. In addition, there are no differences between medical vs. surgical physicians.

**SUMMARY:** Physicians undergoing primary total hip or knee arthroplasty have similar implant survivorship, complication rates, and clinical success when compared to controls.

**Paper 149**

**Age, Comorbidities, and Lack of Insurance Are Predictors of In-Hospital Mortality After Periprosthetic Hip Fracture**

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**INTRODUCTION:** Periprosthetic hip fractures (PPHFx) are challenging complications that follow total hip arthroplasty (THA). Identifying factors predictive of increased mortality is key to improving management of high-risk PPHFx patients. The study aims to identify predictors of mortality associated with PPHFx.

**MATERIALS & METHODS:** We conducted a retrospective analysis of the Nationwide Inpatient Sample (NIS) for all patients diagnosed with periprosthetic fracture around the internal prosthetic hip joint (ICD-10, Clinical Modification codes M9701XA and M9702XA) between 2016 and 2019. We used a multivariable logistic regression model to assess predictors of in-hospital mortality. Variables analyzed in the model included age, race/ethnicity, sex, median household income based on zip code, primary payment type, weekend admission, and thirty comorbidity categories in the Elixhauser index. Independent predictors were those that showed significance at  $\alpha=0.05$  in the final model.

**RESULTS:** 15,588 PPHFx encounters met the inclusion criteria. Baseline demographics and hospital characteristics of included patients are described. Of these, 257 patients (1.7%) died. Significant predictors included age greater than 70 ( $p < 0.01$ ), presence of 12 comorbidity categories ( $p < 0.05$ ), and "other" payment source ( $p < 0.01$ ).

**CONCLUSION:** Older patients, patients with comorbidities, and patients paying via methods other than Medicare, Medicaid, private insurance, or self-pay, were all at increased risk of dying following PPHFx. Patients with these high-risk predictors with PPHFx may warrant more thorough preoperative medical optimization.

Paper 150

**Greater Trochanteric Fixation Using Cable Plate Devices in Complex Primary and Revision Total Hip Arthroplasty**

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**BACKGROUND:** Successful fixation of the greater trochanter (GT) in conjunction with total hip arthroplasty (THA) is a challenging task. A wide range of clinical results are reported in the literature despite advancements in fixation technology. Multiple factors may influence successful trochanteric fixation in THA. Previous studies may have lacked adequate sample sizes to detect differences.

**PURPOSE:** With a larger sample size our objective is to evaluate nonunion and reoperation rates and determine factors influencing successful fixation of the GT using current generation cable plate devices.

**METHODS:** A retrospective chart review was performed on all GT fixations in conjunction with THA using current generation cable plate devices. Patients were excluded if there was less than one year of radiographic follow-up. All surgeries were performed by one of three fellowship trained surgeons at one institution. Indications for surgery were: Periprosthetic fracture (n=25), revision THA requiring an Extended Trochanteric Osteotomy (n=30), postoperative GT fracture: (n=3), GT fracture nonunion (n=9), and primary THA requiring an osteotomy (n = 3). The goal of all surgeons was to place the construct in an anatomic position defined as when the claw portion of the plate fully captured the trochanteric fragment, the fragment is reduced to the proximal femur, and the plate was secured flush with the femur. Primary outcomes were: radiographic union and reoperation for plate related complications. Secondary objectives were to determine patient and plate factors influencing radiographic union. For comparison between union and nonunion cases, continuous data were evaluated using an independent samples t-test and frequency based data was analyzed using a Chi-Square test.

**RESULTS:** Seventy-six patients with a mean age of  $66 \pm 11$  years (29 males, 47 females). At a mean radiographic follow-up of 2.5 (1.0-7.5) years radiographic union rate was 73.4% with a nonunion rate of 23.6%. Reoperation rate for plate related complications was 36.8% and indications for reoperation were: painful hardware (n=21), nonunion (n=5), and hardware failure (n=2). Seven patients had cable induced bone loss. Anatomic positioning of the plate/GT ( $p=0.031$ ) and increased number of cables used ( $p=0.0350$ ) were associated with radiographic union.

**CONCLUSION:** Greater trochanteric nonunion remains a persistent problem in THA. Successful fixation using current generation cable plate devices may be influenced by plate positioning and number of cables used. Symptomatic hardware is common and may result in plate removal.

Paper 151

**Outcomes of Total Hip Arthroplasty in Patients with a History of Native Hip Septic Arthritis: A 20-Year Retrospective Review**

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**BACKGROUND:** Septic arthritis of the native hip is a relatively rare but devastating event, especially if not diagnosed promptly. Studies have shown that patients with a prior history of septic arthritis of a native hip often require eventual total hip arthroplasty (THA) and have a higher risk of postoperative complications. This study seeks to evaluate the incidence of patients undergoing THA after being treated for septic arthritis (SA) of the operative hip over a 20-year period.

**METHODS:** Retrospective analysis of 130 adult patients treated for septic arthritis of the hip were reviewed. Medical comorbidities, lab results and intraoperative cultures were collected. Outcomes of patients who underwent eventual THA after resolution of SA were evaluated.

**RESULTS:** Of the 244 patients identified in the query, 126 met inclusion criteria and were included in the final data analysis. At time of infection, the mean age was  $47.7 \pm 17.1$  years. Irrigation and debridement was performed in 103 patients (81.7%) and a girdlestone procedure in 14 patients (11.1%) who were diagnosed with a native septic hip. Two patients (1.5%) underwent a total hip arthroplasty. Of these patients, one (14.3%) required revision surgery, while none suffered postoperative recurrence of septic arthritis anywhere in the body.

**CONCLUSION:** Septic arthritis of the native hip is relatively rare in the healthy adult patient. Prompt diagnosis and intervention leads to a relatively low recurrence rate with the majority of patients not requiring additional surgical intervention. In the small cohort that went on to receive a THA, only one required revision surgery. In summary, the results of this study suggest that THA is a safe option in patients with a prior history of septic arthritis of the native hip.

**Paper 152****Comparative Study Measuring Radiation Exposure in Direct Anterior Total Hip Arthroplasty**

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Multiple studies have shown that fluoroscopic guidance is helpful in component positioning, assessing limb length, and hip offset. The use of fluoroscopy-assisted total hip arthroplasty carries radiation exposure risk, both to the patient and to the members of the surgical team in the operating room. New platforms are now being used to assist in optimizing hip component position as well as limb length and offset. This study assesses radiation exposure with a pinless fluoroscopic-assisted hip navigation system (PHN).

A retrospective chart review was conducted on 174 consecutive patients that underwent THA by a high-volume, fellowship-trained surgeon using PHN. All hips were performed with direct anterior approach (DAA). Dose area product (DAP), reference air kerma (dose), and exposure time were measured in each of these patients. Prior literature standards were used to compare radiation exposure times, DAP, and radiation dose on patients that underwent a DAA THA without the use of hip navigation.

In the 174 patients that underwent a DAA THA with the use of PHN, mean fluoroscopy time was 9 seconds (range 4-28 seconds). This is compared to a 20.15 second average across prior studies. Dose area product was 0.583 Gy $\cdot$ cm<sup>2</sup> (range 0.121-3.251) in the PHN group compared to a dose area product of 0.716 Gy $\cdot$ cm<sup>2</sup> (range 0.251-1.81) in prior studies. In the PHN, mean reference air kerma dose was 2.181mGy (range 0.3-11.6) compared to 2.97mGY from prior studies.

This study shows that fluoroscopic-assisted navigation in DAA THA leads to a decrease in radiation exposure time and dose for patients.

**Paper 153****Large Femoral Heads and Select Dual-Mobility Bearing Use Reduce Instability in Contemporary Posterior Approach THA**

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**INTRODUCTION:** Dislocation remains the drawback of posterior approach total hip arthroplasty (THA). Continued advances in modern highly cross-linked polyethylene allow thinner liners, maximizing femoral head diameter per a given cup size, and can be further enhanced with dual-mobility bearings. This study's purpose was to evaluate dislocation rates as large femoral heads and dual-mobility were introduced into contemporary posterior approach THA.

**METHODS:** 1,512 primary THAs utilizing the posterior approach performed from 2010 to 2021 were retrospectively reviewed. The majority of hips utilized a ceramic head-polyethylene liner or dual-mobility bearing, the latter reserved for high-risk patients. Demographics, femoral head size, acetabular cup size, femoral head-acetabular cup ratio, and dislocation within 90 days were collected from the electronic medical record. Data were evaluated using time series analysis techniques as larger femoral heads and dual-mobility bearings were introduced.

**RESULTS:** 57% of the cohort was female with mean age and BMI of 62 years and 31 kg/m<sup>2</sup>. 90% of cases achieved 90-day clinical follow-up. The overall dislocation rate was 0.9%. Use of femoral head sizes  $\geq 40$ mm increased from 4% from year 2010-2016 to 51% from 2017-2021, correlating to a decrease in dislocation rate (1.4% to 0.7%); however, did not reach statistical significance ( $p=0.279$ ). No dislocations occurred in patients with  $\geq 40$ mm femoral heads ( $p=0.007$ ). Twelve of 14 dislocations occurred in cases with head-cup ratio  $< 0.7$  ( $p=0.013$ ). The other two dislocations with head-cup ratio  $\geq 0.7$  had lumbar spine disease and/or fusion. Thirteen of 14 dislocations were female ( $p=0.005$ ).

**CONCLUSION:** Maximizing the femoral head diameter per given cup size via modern highly cross-linked polyethylene liners and dual-mobility bearings decreases dislocation rates and provides increased stability in contemporary posterior-approach THA. Further, these data suggest that dual-mobility should be reserved for only high-risk patients with stiff lumbar spines or patients where a 40mm diameter femoral head is not possible.



**Paper 154**

**Medicare Coverage and Patient Demographics Predict Discharge to Home After Periprosthetic Hip Fracture**

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**INTRODUCTION:** Periprosthetic hip fractures (PPHFx) are challenging complications that follow total hip arthroplasty (THA) with low rates of discharge to home. No studies have quantified predictors for PPHFx patient disposition with recent data. The study aims to identify predictors of discharge to home in patients with PPHFx.

**MATERIALS & METHODS:** We conducted a retrospective analysis of the Nationwide Inpatient Sample (NIS) for all patients diagnosed with periprosthetic fracture around the internal prosthetic hip joint (ICD-10, Clinical Modification codes M9701XA and M9702XA) between 2016 and 2019. We used a multivariable logistic model to identify independent predictors of discharge to home. Variables analyzed in the model included age, race/ethnicity, sex, median household income based on zip code, primary payment type, weekend admission, and thirty comorbidity categories in the Elixhauser index. Independent predictors were those that showed significance at  $\alpha=0.05$  in the final model.

**RESULTS:** 15,588 PPHFx encounters met the inclusion criteria. Baseline demographics and hospital characteristics of included patients are described. Of these, 1,245 patients (8.0%) were discharged to home. Significant predictors included older age ( $p<0.01$ ), female sex ( $p<0.01$ ), race ( $p<0.05$ ), presence of eight comorbidity categories ( $p<0.05$ ), payment source ( $p<0.01$ ), and admission day ( $p<0.01$ ) and type ( $p<0.01$ ).

**CONCLUSION:** Older patients, female patients, Black patients, patients with certain medical comorbidities, patients admitted on the weekends, and patients admitted non-electively were all less likely to be discharged to home. Patients not paying through Medicare were more likely to be discharged to home. Future investigations are warranted to optimize PPHFx patient discharge to home.

**Paper 155****Computerized Navigation Resection of Simulated Bony Tumors Using Skin Fiducials and K-wires:  
An In Vitro Cadaveric Study**

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**INTRODUCTION:** It is estimated that 3,600 new cases of Primary Bone Cancer (PBC) will be diagnosed in 2021, with 1,720 deaths. Additionally, there are many patients with metastatic bone lesions that require orthopedic intervention for mechanical stabilization and pain reduction. Accurate localization and correlation of surrounding anatomy and clear margins is essential for tumor surgery success. Advancements in computerized navigation has demonstrated to be helpful in multiple areas of orthopedics such as spinal pedicle screw placement and joint replacements. The purpose of this study using cadaveric specimens was to evaluate the agreement between planned and resected margins of simulated bone tumors (SBT) using both skin fiducial markers and 1mm k-wires for navigated registration. We propose that skin fiducials and k-wires can be used for navigation registration to safely localize a SBT and aid in achieving accurate surgical resection margins.

**MATERIALS & METHODS:** Multiplanar skin fiducial markers and k-wires were applied prior to an O-arm scan of cadaveric pelvic specimens with implanted SBT. The k-wires were applied to one side of the cadaver and the skin fiducials were applied to the contralateral side. A navigation pointer was used for registration and to guide resection of the SBT with approximately 10mm planned margins. Resection margins were determined from the cortex to the edge of the simulated tumor. A resection was considered acceptable if it was no more than 2mm inside the planned resection margin.

**RESULTS:** A total of 36 resection margins were measured, 18x with skin fiducials and 18x with k-wires. The planned margin mean was 10.0mm for both sides (Skin fiducial: 95% CI = 8.9 – 10.9mm; K-wire: 95% CI = 8.8 – 10.3mm) and the resected margin mean was 9.6 mm (95% CI = 8.1 – 11.0mm) for the skin fiducials and 9.9 mm (95% CI = 9.0 – 11.0mm) for the k-wires. One of the 18 (5%) k-wire resections was 2mm inside the planned resection margin. None of the skin fiducial resections were inside the planned resection margin.

**CONCLUSIONS:** Skin fiducial and k-wires used for computerized navigation registration shows promising results when comparing planned and resected margins of SBT in cadaveric specimens. With further research advanced image guided bony tumor resection using skin fiducial marker and or k-wires may be an effective method for localizing and aiding in obtaining clear surgical margins in bony tumors in human subjects.

**Paper 156****Comparing Reconstruction Techniques for Proximal Tibia Tumors: Allograft Prosthetic Composites Associated with Higher Reoperation Rate But Longer Survival Than Proximal Tibia Replacements**

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**BACKGROUND:** The proximal tibia is a common location for primary and metastatic bone tumors. Proximal tibial replacement (PTR) prostheses and allograft-prosthetic composites (APC) may be used for reconstruction after oncologic resection. Each method has been individually reviewed in prior work; however, there is a paucity of data comparing the two techniques. This study compares the functional and oncologic outcomes of PTR vs. APC for oncologic proximal tibia reconstruction.

**PATIENTS & METHODS:** 39 patients with proximal tibia tumors underwent tumor resection with APC (n=20) or PTR (n=19) reconstruction between 1988-2020 at our institution. Mean tumor size was  $9.5 \pm 7$  cm, 24 were primary bone tumors, 7 were metastatic, and 8 were locally aggressive giant cell tumors. Eight (21%) patients underwent radiotherapy, and 25 (64%) underwent chemotherapy. 35 patients (90%) required flap coverage. Mean age was 39 years, 54% were female, mean BMI was  $25 \text{ mg/kg}^{2}$ , and mean follow-up was 10 years.

**RESULTS:** APC patients were significantly younger than the PTR group, with a mean age of 32 vs. 48 years, respectively ( $p=0.02$ ). APC patients were significantly more likely to undergo reoperation, with 11 (55%) requiring reoperation compared to 4 (21%) in the PTR cohort (OR 4.6, 95% CI 1.12-18.8). Revision rates in both groups were low, with 4 APC revisions and 1 PTR revision, and no significant difference in revision risk between groups (OR 4.5, 95% CI 0.45-44.5). Only 3 patients (2 APC, 1 PTR) underwent amputation; the APC amputations were for nonunion and infection, respectively, and the PTR amputation was for recurrent component dislocation. Overall, 10-year survival was significantly higher in the APC cohort at 70%, compared to 30% in the PTR group ( $p=0.03$ ). There was no difference in postoperatively knee extension between groups, with a mean  $4^\circ$  extension lag in the APC group and  $2.5^\circ$  lag in the PTR group ( $p=0.45$ ). Two APC patients and one PTR patient had a clinically significant extension lag  $>10^\circ$  postoperatively.

**CONCLUSIONS:** Patients undergoing APC reconstruction were younger and are at increased risk for reoperation compared to PTR patients; however, 10-year overall survival was significantly higher in the APC group. Comparing functional outcomes, postoperative extensor lag was rarely clinically significant, with no statistical difference between groups. Overall, both methods have low revision rates and good functional outcomes.

**Paper 157****Comparison of Fixation Techniques for Rotationplasty**

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**BACKGROUND:** Rotationplasty is a reconstructive, limb-sparing surgery for patients with lower extremity musculoskeletal tumors. The procedure involves rotation of the distal lower extremity to allow the ankle to function as the new knee joint and provide an optimum weight-bearing surface for prosthetic use. Fixation is obtained through multiple techniques including plates and intramedullary nails. There is currently a paucity of data comparing fixation techniques. The purpose of this study is to compare fixation outcomes between intramedullary nailing (IMN) and plating (PS) in patients undergoing rotationplasty.

**METHODS:** We reviewed 25 (16 male: 9 female) patients with a mean age of  $10\pm 4$  years, undergoing a rotationplasty for either a femoral ( $n=17$ , 68%) or tibial ( $n=8$ , 32%) tumor. The most common diagnosis was osteosarcoma ( $n=21$ , 84%). Fixation was obtained with either an IMN ( $n=6$ , 24%) or PS ( $n=19$ , 76%). Outcomes of patients undergoing rotationplasty were compared between the IMN and PS groups.

**RESULTS:** Following surgical resection margins were negative in all patients. The mean time to union was 21 months (range 6-93 months). Patients undergoing fixation with an IMN achieved union at a significantly shorter time compared to patients undergoing fixation with a PS ( $7\pm 1$  vs.  $28\pm 7$  months,  $p=0.02$ ). Eight patients developed a nonunion and patients undergoing fixation with a IMN were less likely to have a nonunion (OR 0.34, 95% CI 0.01-2.74,  $p=0.33$ ). Postoperative fracture of the residual limb occurred in 7 (28%) patients and patients undergoing fixation with a plate were likely to have a fracture ( $n=7$ , 37% vs.  $n=0$ , 0%,  $p=0.13$ ). Following surgery, complications occurred in 13 (52%) patients. Patients undergoing fixation with a plate were more likely to have a postoperative complication (OR 8.6, 95% 0.82-89.1,  $p=0.07$ ). Three patients underwent conversion to a formal amputation secondary to tumor recurrence ( $n=2$ ) and compartment syndrome ( $n=1$ ). All patients were able to be fitted with a prosthesis following their rehabilitation.

**CONCLUSION:** Rotationplasty is an option for limb salvage for young patients with lower extremity tumors. The results of the current study suggest the potential for improved rates of union and a decreased time to union when an intramedullary nail can be used. As such, consideration for IMN fixation should be given to all patients undergoing a rotationplasty.

**Paper 158****Radiotherapy Leads to Improved Overall Survival in Patients Undergoing Resection for Undifferentiated Pleomorphic Sarcoma**

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**BACKGROUND:** Undifferentiated pleomorphic sarcoma (UPS) is a frequent subtype within the heterogeneous group of soft tissue sarcomas (STS). The use of radiotherapy (RT) has become an important component of a multimodal approach to treating STS. Studies have demonstrated that the addition of RT improves margin-negative resection rates and local control in STS, though the effect on overall survival (OS) is less clear. Furthermore, there is limited and conflicting evidence regarding effect of RT on overall survival in UPS. The purposes of this investigation were to examine the association between RT and OS and to determine independent prognostic indicators of OS in UPS patients undergoing surgical resection.

**PATIENTS & METHODS:** This was a retrospective review of patients who underwent surgical treatment for primary UPS from 1993 to 2021. Associations between RT and OS were analyzed with Kaplan-Meier curves and log-rank testing. Cox proportional hazards regression analysis was used to determine independent prognostic factors of OS.

**RESULTS:** One hundred and fourteen patients who underwent surgical resection of primary soft tissue UPS were included in the study. Ninety-six (84.2%) patients received RT perioperatively. Eighteen patients (15.8%) did not receive RT for reasons relating to tumor location, difficulty with follow-up, and amputation as the index procedure. The rate of local recurrence was 17.7% in the RT group and 11.1% in the no RT group. Use of RT was not significantly associated with a lower rate of local recurrence in our cohort ( $p=0.49$ ). Use of RT was associated with improved OS on log-rank testing (hazard ratio (HR) 0.20; 95% confidence interval (CI) 0.11-0.36;  $p<0.001$ ). On multivariate analysis, RT was an independent predictor of improved OS (HR 0.17; 95% CI 0.08-0.35;  $p<0.001$ ) while metastasis at presentation (HR 6.87; 95% CI 3.43-13.76;  $p<0.001$ ) and older age (HR 1.03; 95% CI 1.01-1.05;  $p=0.005$ ) were predictive of decreased OS.

**CONCLUSION:** Use of RT in combination with surgery was an independent prognostic indicator of improved overall survival in UPS patients. Older age and metastasis at presentation were associated with worse OS. Based on this and other available studies, treatment for UPS should involve limb-sparing resection when feasible with RT to ensure optimal survival.

**Paper 159**

**What is the Clinical Impact of Staging and Surveillance PET-CT Scan Findings in Patients with Bone and Soft Tissue Sarcoma?**

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**BACKGROUND & OBJECTIVES:** PET-CTs are becoming increasingly utilized in sarcoma care, workup, and surveillance. This study aimed to describe additional PET-CT findings as well as subsequent workups and changes in clinical course due to those results.

**METHODS:** Patient records were retrospectively reviewed, and the additional workups and evaluations triggered by PET-CT findings were qualitatively analyzed to document their results. Additional changes in clinical course were documented.

**RESULTS:** A total of 183 bone and soft tissue sarcoma patients underwent PET-CT as part of staging or surveillance. Additional workup was performed in 31.5% (n=41 of 130) patients who had positive PET-CT findings. Among these, 36.6% (n=15 of 41) patients had clinically significant findings that altered the clinical course. Overall, 14.8% (n=27 of 183) experienced a change in clinical course due to PET-CT.

**CONCLUSION:** PET-CT often highlights lesions of potential clinical importance. Additional workup as well as change in clinical course were not infrequent. Future, multi-institutional studies should address the value of PET-CT in sarcoma care.

**Paper 160**

**PET Imaging vs. Clinical Examination in Determining Lymph Node Involvement in Merkel Cell Carcinoma of the Extremity**

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**INTRODUCTION:** Merkel cell carcinoma (MCC) is a rare, aggressive non-melanoma skin cancer arising from cutaneous neuroendocrine cells that has a propensity for spread to regional lymph nodes. Identification of nodal involvement is an important aspect of initial staging. Modalities for detection of nodal metastatic disease include clinical examination, positron emission tomography (PET), and sentinel lymph node biopsy (SLNB). To date, there has been little data comparing the utility of PET imaging to clinical examination in detecting nodal involvement for MCC of the extremity.

**PATIENTS & METHODS:** Two-hundred and seventy patients with MCC from a single institution were retrospectively reviewed. Of these, 121 (44.8%) patients had MCC of the extremity, including 65 (53.4%) with upper extremity disease and 56 (46.3%) with lower extremity disease. Staging workup and treatment information including clinical examination, PET imaging, and biopsy results were reviewed. All PET images were interpreted by board-certified radiologists and all histology was confirmed by fellowship-trained dermatopathologists.

**RESULTS:** Sentinel lymph node biopsy was performed in 103/121 (85.1%) patients, of which 96/103 (93.2%) had documented lymph node clinical exams and 53/103 (54.4%) had PET imaging performed prior to SLNB. Histopathologic examination was positive for nodal involvement in 34/103 (33%) cases. Compared to SLNB for detection of lymph node metastases, clinical examination of lymph nodes had a sensitivity of 22%, specificity of 97%, positive predictive value (PPV) of 75%, and negative predictive value (NPV) of 76% whereas PET demonstrated sensitivity of 18%, specificity of 91%, PPV of 50%, and NPV of 69%.

**CONCLUSION:** PET imaging is an unreliable modality for detection of regional lymph node involvement in patients with MCC of the extremity. Clinical examination is more accurate; however, the sensitivity of both modalities is low. Sentinel lymph node biopsy should be performed in all patients with MCC of the extremity for evaluation of micrometastatic disease, regardless of findings on clinical examination or PET imaging.

**Paper 161****The Value the Tip-Apex-Distance in Pathologic Bone: Predicting Failure of Prophylactic Fixation of Impending Peritrochanteric Hip Fractures**

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**INTRODUCTION:** Intramedullary (IM) prophylactic fixation provides pain relief and increased stability in patients with metastatic bone disease, leading to improved mobilization and quality of life. The tip-apex distance (TAD) is the cumulative distance between the tip of the proximal lag screw to the center of the femoral head taken on anteroposterior (AP) and lateral films. Prior literature has associated  $TAD > 25\text{mm}$  with significantly higher risk of implant failure in peritrochanteric hip fractures treated with fixed-angle devices. However, there is limited data to support the prognostic value of TAD in patients undergoing prophylactic fixation of impending pathologic peritrochanteric hip fractures. The purpose of the present study is to examine the prognostic significance of TAD in predicting failure of prophylactic fixation of impending pathologic peritrochanteric femur fractures treated with IM nails.

**METHODS:** Retrospective chart review identified patients undergoing intramedullary nailing for treatment of impending pathologic peritrochanteric femur fractures from 2010 to 2020. Tip-apex distance was measured using the equation:  $TAD = (X_{ap} * D_{true}/D_{ap}) + (X_{lat} * D_{true}/D_{lat})$ , where X represents the distance from the tip of the proximal lag screw to the center of the femoral head and D represents the true and measured diameter of the lag screw on AP and lateral films. The study group was divided into two cohorts (TAD 0-25mm, TAD > 25mm). Pearson-chi square tests were used to compare for differences in baseline demographics, clinical characteristics and study outcomes. Multi-variate logistic regression analyses were used to assess whether a TAD > 25mm was associated with differences in rates of failure of fixation/cut-out.

**RESULTS:** A total of 127 patients met inclusion criteria, of which 45 (35.4%) had a TAD > 25mm. Pearson chi-square tests showed that patients who had a TAD > 25mm vs. 0-25mm, had a slightly higher rate of cut-out or fixation failure (8.9% vs. 6.1%;  $p=0.558$ ), need for revision surgery (13.3% vs. 7.3%;  $p=0.268$ ), and implant failure (11.1% vs. 6.1%;  $p=0.316$ ). Multi-variate analysis showed that higher TAD was not associated with greater odds of failure to fixation (OR 0.79 [95% CI 0.11-5.98];  $p=0.820$ ).

**CONCLUSION:** There is a trend towards a higher rate of fixation failure, revision surgery, and low implant survival with TAD > 25mm, among patients undergoing fixation for pathologic proximal femur fractures. Although the findings do not reach significance, providers should still strive to adhere to orthopedic trauma principles when treating impending pathologic peritrochanteric femur fractures.



**Paper 162****Merkel Cell Carcinoma of the Lower Extremity: Outcomes of Multidisciplinary Treatment**

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**INTRODUCTION:** Merkel cell carcinoma (MCC) is a rare and aggressive non-melanoma skin cancer arising from cutaneous neuroendocrine cells with a predilection for sun-exposed regions. MCC has a propensity for local and distant disease recurrence, although multidisciplinary approaches to treatment have demonstrated improved rates of both recurrence and mortality. Currently there is a paucity of data examining the outcome of MCC arising from the lower extremity. The purpose of the present study was to examine the treatment outcomes of patients with MCC of the lower extremity.

**PATIENTS & METHODS:** A cohort of 270 patients with MCC evaluated at a single institution was retrospectively reviewed. Of these, 56 (20.7%) patients had MCC in the lower extremity. The group included 22 females (39%) and all patients were Caucasian. Mean age at diagnosis was 72±11 years. All histology was confirmed by fellowship-trained dermatopathologists. Primary lesions were located on the thigh (n=17), leg (n=33), ankle (n=6), and foot (n=1). One patient presented with distant metastases at diagnosis. Data was collected on the workup and treatment modalities for each patient along with rate of disease recurrence. Recurrence-free survival and disease-specific survival were evaluated using Kaplan-Meier analysis.

**RESULTS:** Wide local excision (WLE) was performed in 48/56 (85.7%) patients, 1 (1.8%) patient underwent Mohs micrographic surgery, and the remaining 7 (12.5%) patients did not receive surgery beyond excisional biopsy. Forty-six (95.8%) patients received sentinel lymph node biopsy at the time of WLE with evidence of nodal metastases in 19 (41.3%) of cases. Adjuvant radiotherapy was delivered to the primary site in 40/56 (71.4%) patients and additionally to the regional lymph node basin in 25/40 (62.5%) patients. Adjuvant systemic therapy was delivered to 5 patients out of the entire cohort. Recurrence-free survival (RFS) was 67.9% at 1 year, 51.6% at 3 years, and 51.6% at 5 years. There were four instances of local recurrence, all of which occurred in patients who had received wide local excision including two patients who also received adjuvant radiation. Fourteen (25%) patients had regional recurrence, and 19 (33.9%) patients had distant recurrence. Average time to recurrence was 14.3 months (range 3-75 months). Disease-specific survival was 91.0% at 1 year, 86.5% at 3 years, and 80.2% at 5 years.

**CONCLUSION:** Merkel cell carcinoma (MCC) of the lower extremity has a high rate of locoregional and distant recurrence despite multifactorial treatment including margin-negative resection, adjuvant radiotherapy to the primary site and regional nodes, and chemotherapy.

**Paper 163****Sarcopenia in Soft Tissue Sarcoma Population**

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**BACKGROUND:** In recent years, there has been a push towards trying to optimize patient's nutritional status through proper dietary regimens and nutritional supplementation. Previous studies have looked at the best measures to assess nutritional status and the impact of nutritional supplementation on muscle mass, but to our knowledge, there has not been previous research examining the impact of these supplements on wound healing in the sarcoma population.

This is particularly important for sarcoma patients who undergo neoadjuvant radiation therapy. Previous studies have demonstrated wound complications in this population approaching 35%. With this high rate of wound healing issues, finding treatment modalities to minimize these complications is of paramount importance.

**METHODS:** Between June 2020 and May 2021, all extremity sarcoma patients receiving care in our department received two weeks of twice daily amino acid supplementation starting on the first postoperative day. We analyzed their wound healing, the primary outcome, at all follow-up appointments with final-end point being six months after surgery. Non-healing wounds were defined as any wound requiring packing at six months postoperatively, any wound requiring a return visit to the OR for debridement, or any wound requiring IV antibiotics (ABX) for healing concerns. The patient cohort was compared with a similar historical patient cohort using the chi-square test. In a subgroup of participants with body composition measurements, we also compared changes in mean fat mass, lean mass, and psoas index from preoperative baseline to 6 months postoperative using generalized linear models.

**RESULTS:** A total of 33 consecutive patients were supplemented with a branched chain amino acid (BCAA) formulation. The historical cohort included 146 participants from the previous seven years (2010 - 2017). Looking exclusively at patients who underwent neoadjuvant radiation, 26% of patients in the historical cohort experienced wound complications compared to 30% in the supplemented group. This difference was not statistically significant. There were 39 participants in the historical cohort with psoas index data at both baseline and six months postoperative. We found a statistically significant decline in psoas index, but no changes in BMI in the historical cohort.

**CONCLUSION:** In our limited sample size, there was no difference in wound healing complications between sarcoma patients treated with neoadjuvant radiation therapy who received postoperative BCAA supplementation and those who were not supplemented. Patients who did not receive supplementation had a significant decline in postoperative psoas index following operative sarcoma removal.

**Paper 164**

**Bone Marrow Aspiration and Biopsy in the Initial Staging of Extraskeletal Ewing Sarcoma**

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**BACKGROUND:** Extraskeletal Ewing sarcoma (EES) are rare tumors within the Ewing sarcoma (ES) family with a high rate of metastasis. Initial staging studies for EES include imaging and bone marrow aspiration and biopsy (BMAB). Recent studies on osseous-based ES have questioned the utility of BMAB compared to modern imaging modalities in detecting metastatic disease. However, no such investigation has been performed to determine the utility of BMAB in EES.

**METHODS:** A retrospective review of biopsy-confirmed EES patients treated at a single institution between 1994 – 2021 was performed. Initial diagnostic and staging information including the use of PET scan, bone scan, and BMAB was collected. Metastatic disease at the time of presentation or during follow-up was noted. Patients were excluded if adequate records of their initial diagnosis and staging were not available or if the diagnosis of Ewing sarcoma was not definitive.

**RESULTS:** 91 patients met criteria for inclusion. Fifty-four patients (59%) underwent BMAB in addition to PET and/or bone scan during their initial workup. Ten (19%) of these patients were found to have metastatic disease at the time of presentation. Sites of metastasis included lung (n=5), bone (n=4), liver (n=1), bowel (n=1), and distant lymph nodes (n=1). These were detected on PET scan in 5 patients, bone scan in 4 patients, and CT Chest in 2 patients. BMAB was negative for marrow involvement in all 54 patients at presentation including those with metastatic disease. Of the 37 patients with no BMAB during their initial workup, 7 (19%) presented with metastatic disease and an additional 12 (32%) later developed metastatic disease. Two of these patients had a negative BMAB after metastatic disease was detected.

**CONCLUSIONS:** The standard utilization of BMAB in the staging process of EES is of low diagnostic yield. BMAB is unlikely to diagnose metastatic involvement even in patients with known metastases to bone.

**Paper 165****Simulated Subacromial Injection Instruction Improves Accuracy and Skill Level: A Model for Procedural Training**

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**PURPOSE:** Musculoskeletal complaints often present first to primary care physicians, however, providers do not always receive adequate instruction in musculoskeletal procedures. Diagnostic and therapeutic injections are useful tools in orthopedics, but inaccurate injections can lead to unnecessary costs and inadequate treatment. We hypothesized that trainees afforded the opportunity to practice on a cadaver would perform better than those who solely received visual-aided instruction on the subacromial injection procedure.

**METHODS:** 24 participants from Internal Medicine and Family Medicine residency programs were divided randomly into two groups (control and intervention) with demographic data recorded. Both groups received subacromial injection instruction via lecture and video demonstration; the intervention group was then allowed to practice on a cadaveric shoulder under mentored guidance. All subjects participated in a simulated patient encounter culminating in the injection of latex dye into a cadaveric shoulder. Participants were graded by an orthopedic surgeon based on a technique rubric. The accuracy of injections was assessed via dissection of the cadavers.

**RESULTS:** 23 out of 24 participants had performed at least one musculoskeletal injection in practice, while only 8.3% of participants had done more than 10 subacromial injections. No difference was found in technique scores between control (18.4+/-3.65) and intervention (19.2+/-2.33) ( $p=0.54$ ). Dissections revealed 25.0% of control group injections were within the subacromial space, while 66.7% of intervention group injections were within the subacromial space. Chi-Square Analysis revealed that the intervention affected the number of injections that were intra-bursal, peri-bursal and extra-bursal between the two groups with statistical significance ( $p=0.031$ ). The intervention group had a higher self-confidence level in their injection as opposed to controls ( $p=0.04$ ). Previous subacromial injection experience did not affect accuracy regardless of group tested ( $p=0.76$ ).

**CONCLUSION:** Simulation and integrated instruction can significantly improve accuracy and confidence in effective procedures such as subacromial injections. Although primary care providers and surgeons develop experience with musculoskeletal procedures in practice, this study demonstrates a role for improved early integrated instruction and simulation to improve accuracy and confidence. This may decrease costs and avoid unnecessary orthopedic surgery referrals, diagnostic tests, and earlier than desired surgical intervention.

**Paper 166****Effects of the COVID-19 Pandemic on Orthopedic Surgery Residency Program Attractiveness - An Applicant's Perspective**

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**INTRODUCTION:** The onset of the COVID-19 pandemic brought about unprecedented changes to both the 2021 and 2022 orthopedic surgery residency match process. Applicants were limited by away rotations and virtual residency interviews. In a recent study conducted on the orthopedic trauma fellowship match, it was found that only 62% of applicants felt comfortable ranking programs that they did not physically attend. In order to better characterize the impact of the COVID-19 pandemic on the orthopedic residency match process, this cross sectional study investigates applicants selection criteria and program preferences during the COVID-19 pandemic in contrast to prior years.

**METHODS:** This cross sectional study surveyed all US PGY-1 orthopedic interns affected by the COVID-19 pandemic during their match process (2021) and PGY 2 through 5 orthopedic residents who matched before COVID-19 restrictions. The survey questionnaire included applicant demographics, scholastic achievements during medical school, number of away rotations attended, number of programs applied, number of interviews received and attended, perception of their interviews, how they ranked programs, overall match satisfaction, and finally how they perceived a list of program attributes. In order to increase survey responses, gift cards were distributed upon completion of the survey, funded internally by West Virginia University's orthopedic Surgery department. This data was statistically analyzed using T-tests for means between groups.

**RESULTS:** A total of 110 residents (n = 38 PGY1 COVID cohort, n = 72 PGY2-5 non-COVID cohort) responded to the survey. There was a significant difference in the age demographics, number of publications accumulated during medical school, number of abstracts/presentation accumulated during medical school, and the number of away rotations attended between the two groups (p value <0.01 for all variables). All other resident demographics, scholastic achievements during medical school, number of programs applied, number of interviews received and attended showed no statistical difference between the two groups. The COVID cohort was significantly less satisfied with their residency match than the non-COVID cohort (p-value = 0.011). The relative importance of program attributes did not differ between the two groups. Important program attributes identified by residents in both groups included geographic location, program friendliness, resident happiness, operative case load, and faculty mentorship. Least important attributes included program prestige, research emphasis, required research year, more time on call, and social media influence.

**DISCUSSION/CONCLUSION:** Orthopedic surgery residents entering the match under ACGME mandated COVID restrictions were significantly less satisfied with their match compared to residents who were able to attend in person away-rotations and interviews.

**Paper 167****The Student You Know: Orthopedic Surgery Home Program Match Rates and Geographic Relationships Before and After COVID-19**

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**INTRODUCTION:** In March 2020, COVID-19 was declared a pandemic by the World Health Organization. This led to outright cancellation of away rotations and in person residency interviews for the class of 2021. This study aims to report recent geographic relationships in the orthopedic match and further explore COVID-19's effect on these geographic relationships. Furthermore, we aim to compare the home program match rates before and after COVID-19.

**METHODS:** A cross sectional examination of 134 residency programs and corresponding 3,253 residents was performed. Residency websites and social media sites were used to record basic residency information as well as each resident's year, matriculated medical school, and matriculated medical school geographic data. This information was used to evaluate the proportion of orthopedic residents from "home program" medical schools and evaluate the geographic trends of matched orthopedic residents.

**RESULTS:** In the four orthopedic surgery residency classes before the pandemic, (2017-2020), 21.8% of residency slots were filled by home program students. During the pandemic match cycle (2021), this number jumped to 28.2% ( $P < .0006$ ). The increase was seen consistently across residency subgroup analysis: class size, doximity rank, and doximity research rank. Correspondingly, there was a statistically significant increase from 34.7% (2017-2020) to 39.3% (2021) ( $P = .0318$ ) in residencies matching with same state medical students. Regional trends stayed consistent. Our study showed that residency programs matched applicants who went to same region medical schools during the 2020-2021 cycle at nearly the exact same rate as they did pre-pandemic (63.6%, up from 63.3%).

**DISCUSSION:** Our study demonstrates that despite widespread virtual away rotations and virtual open houses, residency programs showed an increased preference for their home program students. This trend was significant and widespread, highlighting the generalized nationwide hesitation of both residency programs and students on the virtual interview process.

**Paper 168****A 20-Year Analysis of Orthopedic Surgery Residency Programs: Trends in Program and Applicant Competitiveness**

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**OBJECTIVE:** This study aimed to use a normalized competitive index over 20 years to analyze trends in orthopedic surgery residency programs.

**METHODS:** A retrospective analysis of orthopedic surgery residency program data from the National Resident Matching Program (NRMP) Main Residency Match data from 2003-2022 and NRMP Charting Outcomes data from 2007-2021 was performed. Applicant metrics included USMLE Step 1 and Step 2 scores, research experiences and output, volunteer experiences, and work experiences. A competitive index (CI) was created by dividing the number of programs ranked per applicant times position available over the match rate for each year. The index was normalized to a value of 1 to create a normalized competitive index (NCI) by dividing the yearly CI by the cumulative CI. Nonlinear regressions were performed to analyze trends.

**RESULTS:** The NCI was significantly different across time ( $R^2 = 0.95$ ,  $p < 0.001$ ) with an upward trending NCI slope. Total applicants have nearly doubled over the past two decades (2003, 830 vs. 2022, 1460;  $p < 0.001$ ). The match rate did not significantly increase over the two decades (2003-2012 vs. 2013-2022; 70% vs. 70%;  $p = 0.76$ ). Similarly, the US-MD match rate remained stable over the two decades (2003-2012 vs. 2013-2022; 80% vs. 80%;  $p = 0.46$ ). However, in 2022, the match rate dropped to 59.5%. The 2022 applicant cycle had 14% more applicants, while positions increased by 0.8% compared to the year prior. The USMLE Step 1 and Step 2 scores of matched applicants increased over time ( $R^2 > 0.83$ ,  $p < 0.001$ ) with mean scores of 247 and 253 in 2021, respectively. Research output quadrupled over the 2007-2021 period (3 vs. 14,  $p < 0.001$ ).

**CONCLUSION:** We demonstrated the increasing competitiveness of orthopedic surgery residency programs over twenty years measured by an NCI, while match rates remained constant over time. Match rates have inherent limitations as a singular metric and should only be used in conjunction with alternative metrics. The limited number of positions compared to growing applicant numbers leads to increased competition among applicants. Additionally, applicant USMLE scores and research output have increased dramatically over time. This study provides insight into the growing competitiveness of orthopedic programs and future applicants by combining a more comprehensive index with applicant metrics.

**Paper 169**

**Resident Case Log Practices and Attitudes Among Orthopedic Surgery Residents and Program Directors**

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**INTRODUCTION:** Orthopedic residents are required to record all surgical procedures performed in the Accreditation Council for Graduate Medical Education (ACGME) Resident Case Log. Due to the self-reported nature of the case log, its accuracy and consistency is uncertain.

In 2013, the ACGME shifted case log guidelines to require the selection of one primary Current Procedural Terminology (CPT) code per procedure. Since implementation, case log practices among orthopedic residency programs have not been well-described. The aims of this study are twofold: 1) assess resident ACGME Case Log CPT code selection and standardization, and 2) to understand current practices and attitudes surrounding case logging.

**METHODS:** Residents and program directors from 18 residency programs received standardized, consensus-built surveys distributed through the Collaborative Orthopedic Educational Research Group (COERG). The survey assessed resident case log training, practices, and attitudes toward case logging. Additionally, residents were presented with scenarios across various subspecialties.

**RESULTS:** One hundred and seven residents (response rate: 26.8%) and 16 program directors (response rate: 88.9%) participated. Formal case log training was reported by 51.4% of residents. 56.3% of program directors report providing formal training. 8.4% of residents rated themselves "excellent" at applying CPT codes for the case log, while 0.0% program directors rated their residents' ability "excellent". 43.0% of residents and 81.3% of program directors responded that it was "extremely important" or "very important" to code case logs accurately. There was a statistically significant difference ( $p = 0.006$ ) in the perceived importance of accurate coding between residents and program directors.

Among residents, 43.0% report logging joint injections/aspirations, 77.6% report logging closed reductions, and 56.1% report logging nailbed lacerations. Among program directors, 31.3% instruct residents to log joint aspirations/injections, 93.8% instruct residents to log closed reductions, and 81.3% instruct residents to log nail bed lacerations. There was no statistically significant difference between resident practices and program director instruction.

**CONCLUSION:** While resident case logging practices and program director instruction align in specific scenarios, no program directors rate their residents' case logging abilities highly and few residents rate their abilities highly. Only half of residents report case log training. Finally, the discrepancy in the perceived importance of accurate case logging between program directors and residents may signal a need for additional resident case log training and standardization at the ACGME or program director level.



**Paper 170**

**The Fate of Orthopedic Surgery Applicants from Medical Schools without an Orthopedic Surgery Residency in the Match**

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**PURPOSE:** This study aimed to provide an analysis and assessment of students from medical schools without a home orthopedic surgery residency program when applying for a residency position in orthopedic surgery.

**SIGNIFICANCE:** Orthopedic surgery remains one of the most challenging specialties for medical students to match into; only 59.52% of applicants who applied successfully matched in 2022. Little information is available on how students from medical schools without an affiliated orthopedic surgery residency fare in the match process. This is the first known study to provide comparisons between medical students with or without a home orthopedic residency program in terms of important factors in the orthopedic residency match such as USMLE Step scores, Alpha Omega Alpha membership, number and quality of letters of recommendations (LORs), clerkship performance, and research productivity.

**METHODS:** A survey was created and sent to graduates from six medical schools without affiliated home orthopedic surgery residency programs that successfully matched into orthopedic surgery over the past six years.

**RESULTS:** 44 total responses were recorded. 61% were elected to AOA. 18% participated in the Couples Match. 61%, 57%, and 66% received Honors in General Surgery, Internal Medicine, and in OB/GYN clinical rotations, respectively. The average USMLE Step 1 and Step 2 CK exam scores were 249 and 257, respectively. The average number of away rotations completed was 2.48. The average number of LORs from away rotations and non-orthopedic surgeons were 1.86 and 0.76, respectively. The average number of programs applied to was 84 and interviews obtained was 13.3. 50% matched at a program where they had performed an away sub-internship rotation. The average number of research publications in orthopedic surgery and total publications overall at time of application were 2.09 and 4.11, respectively and orthopedic research presentations and total presentations at 8.27 and 11.64, respectively.

**CONCLUSION:** This novel study showed that students from medical schools without a home orthopedic surgery residency program scored higher on both USMLE Step 1 and Step 2 CK, had a higher percentage of AOA members, and completed a higher number of research publications and presentations in both orthopedic and non-orthopedic fields. These students were more likely to request a letter of recommendation from a non-orthopedic physician and performed more sub-internship away rotations compared to the overall average matched orthopedic surgery student applicant.

**Paper 171**

**Bullying in Orthopedic Surgery Residency**

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**INTRODUCTION:** Bullying is defined as unwanted or aggressive behaviors with a perceived imbalance of power that may cause harm or distress to the target. Orthopedic residents work in fast paced and high stress environments putting them at risk for bullying. The purpose of this study is to determine the prevalence and risk factors associated with bullying for orthopedic surgery residents in the United States as well as relate bullying to burnout and grit using an anonymous survey.

**METHODS:** An anonymous survey was sent to current orthopedic residents. Demographic data, residency information, suicidal ideation, thoughts of attrition and in-training exam quartile were collected. The survey also consisted of the Short Negative Acts Questionnaire (S-NAQ), a validated instrument to measure workplace bullying, the Abbreviated Maslach Burnout Inventory, a tool to measure emotional exhaustion and depersonalization symptoms, and the Short Grit Scale, a validated questionnaire to which measures trait-level perseverance and passion.

**RESULTS:** 87 surveys were returned. 33.6% of residents indicated that they experience bullying. According to the S-NAQ questionnaire, 33.8% of residents are frequently bullied and 21.2% are occasionally bullied. There are high rates of burnout according to the Abbreviated Maslach Burnout Inventory which divides burnout into three domains: 20% experienced low personal accomplishment, 42.7% high depersonalization, 37.5% high emotional exhaustion. Burnout, suicidal ideation, and thoughts of attrition were significantly related to frequent bullying on the S-NAQ questionnaire.

**CONCLUSION:** Bullying occurs at high rates in orthopedic residency training and is associated with burnout, suicidal ideation, and thoughts of attrition. Further research needs to be done to determine effective interventions to reduce bullying rates in residency training.

**LEVEL OF EVIDENCE:** Level 3

Paper 172

**Orthopedic Surgery First Year Resident Surgical Skills Month Curriculum**

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In 2012 a mandate came to formally teach surgical skills for orthopedic surgery program year one residents. We describe our reasoning and the mechanics behind our one-month surgical skills course that we developed for our first-year orthopedic surgery residents. We include our rationale of design, our monthly and daily format, a discussion of cost, a description and samples of our feedback surveys and results, and thoughts moving forward. We think sharing our thought process and programs will help others refine or create their own orthopedic first year resident educational activities.

**Paper 173****The Crucial Role Program Directors Play in Impacting Diversity in Orthopedic Surgery**

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**INTRODUCTION:** Women and minorities continue to be underrepresented in the orthopedic community and residency training programs, despite an increased focus on and efforts for increased recruitment. This lack of representation extends further into faculty appointments and leadership for underrepresented minorities (URM) and female orthopedic surgeons. In residency training, the program director is a crucial member of the department - representing the program's culture and a role model for trainees. The purpose of this study was to identify whether the presence of URM and/or female program directors influenced the ethnic and gender distribution of orthopedic residency training programs.

**METHODS:** Information on each orthopedic surgery residency program was collected using the Residency Explorer Tool – a source-verified compilation of data collected from Association of American Medical Colleges, National Resident Matching Program (NRMP), USMLE, and ACGME approved residency programs from 2017-2021. Data collected included program details, faculty and resident gender distribution, faculty and resident ethnicity, race, and demographic characteristics. The program director specific gender, ethnicity, and demographic characteristics were collected utilizing residency program web sites. The prevalence of factors in programs with the top quartile of female and underrepresented residents were compared with those with lower percentages.

**RESULTS:** Data were obtained from 153 of 197 programs, with 3,753 residents and 153 program directors identified. Overall, 15.9% residents were female and 27.2% were of underrepresented ethnic minority in the residency programs. The rate of female program directors was 11.8%, female chairs 6.5%, and URM program directors 18.7%. Programs with more female residents were not significantly associated with a female program director ( $p=0.97$ ), however, these programs did have significantly more ethnically diverse program directors ( $p<0.01$ ). Programs with a greater percentage of URM residents had a significantly higher proportion of ethnically diverse program directors ( $p<0.01$ ). No correlation was found with higher percentages of underrepresented residents and female program directors ( $p=0.71$ ).

**CONCLUSION:** Efforts have been established to identify factors that attract URM and female applicants to promote increased diversity in orthopedic residency programs. We are continuing to see increased number of female and URM residents at orthopedic residency programs with more female and URM program directors. National leaders should consider increasing the diversity of their faculty and the program director role, especially when undertaking efforts to recruit and improve interest of female and URM applicants interested in orthopedic surgery as a specialty.

**Paper 174****Wielding the "Strategic Signaling Spear": Medical Student Preference-Signaling During the Orthopedic Surgery Residency Application Process**

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The orthopedic surgery residency selection process has grown more competitive over recent years, with programs receiving an unprecedented number of applications. As an effort to target applications to programs of interest, the American Orthopaedic Association has announced the introduction of a formal preference-signaling program into the 2022-2023 orthopedic surgery residency selection cycle. This system will allow every applicant to assign "signals" to a total of 30 programs to complement other critical forms of preference signaling during the residency application process. The purpose of this study was to 1) investigate the implications of the new preference-signaling program, 2) propose the framework of the "strategic signaling spear" for applicants to conceptualize the power of all methods of preference-signaling to improve their odds of matching, and 3) describe the role of strong mentorship at all stages of the residency application process. We performed a comprehensive literature review to understand how variations of the preference-signaling process have impacted resident selection across other specialties, and we analyzed data from the unprecedented 2021-2022 Match cycle for orthopedic surgery that broke records with 1,737 applicants vying for only 875 positions. We used these findings to develop the "strategic signaling spear". Given the growing competitiveness of the field, we believe that every applicant should strategically shape their own spears guided by strong and active mentorship throughout the application process to help applicants hit the ultimate "target"—a successful match into orthopedic surgery.

**Paper 175**

**Is Height an Unconscious Bias During Orthopedic Residency Selection?**

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**BACKGROUND:** Unconscious bias exists in healthcare, though many steps have been taken to eliminate its existence. Orthopedic surgery has been suggested to be one of the least diverse specialties in medicine. However, it is unknown if implicit bias remains in the Orthopedic Surgery Residency Match in relation to resident height.

**OBJECTIVE:** For the first time in history, orthopedic surgery residency interviews took place on a predominately virtual platform due to COVID-19, thereby blinding admission committees to the height of an applicant. We anticipated that, with a lack of height determination, there would be a statistically significant difference in the average height of the incoming PGY-1 resident class compared to previous matriculants.

**METHODS:** A survey was sent to all ACGME-accredited Orthopedic Surgery Residency Program Directors to be forwarded to their respective orthopedic surgery residents. In order to increase the response rate, the survey was sent a total of five times from June 2021 to December 2021. The survey was constructed to collect information on year in training, interview format, height, age, and consent to participate in the survey.

**RESULTS:** The response rate was 4.5% for residents, totaling 195 respondents. This included four groups: PGY-1 Virtual (57), PGY-1 In-person (6), PGY-2-5 In-person (132), and PGY-1-5 In-person (138). The mean height was 179.98 cm for PGY-1 Virtual, 183.9 cm for PGY-1 In-person, 179.25 cm for PGY-2-5 In-person, and 179.33 cm (SD=8.5) for PGY-1-5 In-person. There was no significant effect of interview format on height after controlling for age ( $p=0.084$ ). The estimated marginal mean heights for PGY-1 Virtual and PGY-1-5 In-person were 181.32 cm and 178.76 cm respectively, with a mean difference of their estimated marginal heights of 2.57 cm.

**CONCLUSION:** This study investigated unconscious height bias in the orthopedic surgery residency admissions process. Our results demonstrate that the virtual interview format used by ACGME Orthopedic Surgery Residency Programs during the COVID-19 pandemic did not have a significant effect on the average height of accepted candidates.

**Paper 176****Cementless Total Knee Arthroplasty is a Risk Factor for Early Aseptic Loosening in a Large National Database**

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**INTRODUCTION:** Despite excellent longevity demonstrated in institutional studies, outcomes after cementless total knee arthroplasty (TKA) on a population level remain unknown. The purpose of this study was to compare short-term outcomes between cemented and cementless TKA using a large national database.

**METHODS:** Using fixation-specific International Classification of Disease, 10th Revision (ICD-10) procedure codes, 294,485 patients undergoing primary TKA between 2015-2018 were identified within the PearlDiver database. Patients with a diagnosis of osteoporosis or inflammatory arthritis were excluded. Cementless TKA patients were matched one-to-one with cemented TKA patients based on age, Elixhauser Comorbidity Index (ECI), gender, and year to yield matched cohorts of 10,580 patients. Outcomes at 90 days, 1 year, and 2 years postoperatively were compared between groups, and Kaplan-Meier analysis was used to evaluate implant survival rates.

**RESULTS:** Cementless TKA was associated with a shorter average length of stay ( $2.94 \pm 2.29$  days vs.  $3.05 \pm 2.57$  days,  $p=0.001$ ) compared to cemented TKA, with no significant differences in 90-day adverse events. At one year postoperatively, cementless TKA was associated with an increased rate of any reoperation (odds ratio [OR] 1.47, 95% confidence interval [CI] 1.12-1.92,  $p=0.005$ ) compared to cemented TKA. At two years postoperatively, there was an increased risk of revision for aseptic loosening (OR 2.34, CI 1.47-3.85,  $p<0.001$ ) and any reoperation (OR 1.29, CI 1.04-1.59,  $p=0.019$ ) after cementless TKA. Two-year revision rates for infection, fracture, and patella resurfacing were similar between cohorts.

**CONCLUSIONS:** In this large national database, cementless fixation is an independent risk factor for aseptic loosening requiring revision and any reoperation within two years after primary TKA. Although associated with a shorter length of stay, the small difference observed is unlikely to be clinically important. While long-term data is needed, surgeons should select implants carefully based on their individual design features and track record.

**Paper 177****Vitamin D3 Supplementation Prior to Total Knee Arthroplasty: A Randomized Controlled Trial**

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**BACKGROUND:** Vitamin D deficiency has been associated with worse outcomes following total knee arthroplasty (TKA). The purpose of this randomized controlled trial was to determine if a one-time dose of vitamin D3 prior to TKA improves function and patient-reported outcomes, while decreasing complications.

**METHODS:** 107 Patients undergoing primary TKA were prospectively randomized to receive 50,000 international units (IU) vitamin D3 (57 patients) or placebo (50 patients) on the morning of surgery. Patients were excluded if already taking vitamin D3. An a priori power analysis determined 45 patients were required in each cohort to detect a minimal clinically important difference of six points in the functional component of the 2012 version of the Knee Society Score (KSS), assuming an alpha of 0.05, power of 80%, and standard deviation of 10 points. The KSS and Timed Up and Go Test (TUGT) were measured preoperatively and at three and six weeks postoperatively. Complications within 90 days postoperatively were recorded. Changes in KSS and TUGT were analyzed using linear mixed effects models, with alpha <0.05.

**RESULTS:** There was no difference in improvement of KSS at three weeks (+4.8 points vitamin D3 vs. +3.0 points placebo; p=0.58) or six weeks (+14.5 points vitamin D3 vs. +12.4 points placebo; p=0.51) from baseline. There was no difference in change in TUGT at three weeks (+1.2 seconds vitamin D3 vs. +0.6 seconds placebo; p=0.55) or six weeks (-0.3 seconds vitamin D3 vs. -0.9 seconds placebo; p=0.61) from baseline. There were four complications in the placebo cohort and five complications in the vitamin D3 cohort (p=1.00).

**CONCLUSION:** Supplementation with 50,000IU vitamin D3 on the morning of TKA failed to demonstrate significant differences in functional KSS, TUGT, or complications in the early postoperative period compared to placebo. Future studies should evaluate different dosing regimens, including larger one-time vitamin D3 doses.



**Paper 178**

**Prior Authorization is Burdensome for Total Joint Arthroplasty Surgeons: A Survey of the American Association of Hip and Knee Surgeons Membership**

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**INTRODUCTION:** The purpose of this study is to survey the impact that prior authorization has on the practices of total joint arthroplasty (TJA) surgeon members of the American Association of Hip and Knee Surgeons (AAHKS).

**METHODS:** A 24 question survey was approved by the AAHKS Advocacy Committee and distributed to all 2,802 board-certified adult reconstruction members of AAHKS in March 2022.

**RESULTS:** There were 353 responses (13%). Ninety-five percent of surgeons noted an increase in prior authorization over the past five years. A majority (71%, 249) of practices employ at least one staff member to exclusively work on prior authorization a mean of 15 hours/week (range 1-125) for a mean of 18 prior authorization claims/week (range, 1-250). Surgery approval (99%), diagnostic imaging (94%), and prescription medications (69%) were the most common reasons for prior authorization. Surgeries were most commonly denied because conservative treatment had not been tried (71%) or had not been attempted for enough time (67%). However, a majority (57%) of authorizations rarely/never changed the treatment provided. Most (56%) indicated that prior authorization rarely/never followed evidence-based guidelines. Prior authorization was very burdensome (93%) and negatively impacted clinical outcomes (87%) leading to delays to access care (96%) at least sometimes.

**CONCLUSIONS:** Prior authorization is burdensome for TJA surgeons and results in negative clinical outcomes including delaying access to care. Prior authorization has increased in the past five years resulting in high administrative burden. Denials were common for TJA surgeries, with the insurer claiming that certain nonoperative treatments were not attempted or not attempted for enough time. Most requests did not cite evidence-based guidelines supporting their decision and most often did not lead to changes in treatment. Prior authorization is detrimental to high value care by generating high physician and patient burden and low cost-effectiveness in TJA.

Paper 179

**Photographic Evidence of Range of Motion Following Total Knee Arthroplasty: Is There an Influence on Early Rehabilitation and Recovery?**

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**INTRODUCTION:** The purpose of this investigation was to assess whether an immediate postoperative photograph of maximal passive knee flexion and extension would accelerate recovery following total knee arthroplasty (TKA). We hypothesized superior postoperative range of motion (ROM) and functional status in patients who received photographic evidence as compared to those who did not.

**MATERIAL & METHODS:** A single-blinded, randomized controlled trial (RCT) was conducted between May 2020 and August 2021. Patients were randomized into two arms: those who received photographic evidence and those who did not. Functional status, quantified by the Knee Injury and Osteoarthritis Outcome Score (KOOS), and ROM were compared at six weeks post-operation. Wilcoxon rank sum tests were used to draw statistical comparisons.

**RESULTS:** 59 TKAs were included in our final cohort, of which 29 were randomized to photographic evidence and 30 were randomized to no photographic evidence. Fewer physical therapy (PT) sessions were completed by those receiving photographic evidence (16 vs. 20;  $p=0.48$ ). At six weeks post-operation, no significant differences were appreciated for achieved knee flexion and KOOS between groups. However, we did note superior range of motion in respect to knee extension in those who received photographic evidence compared to those who did not receive photographic evidence ( $0^\circ$  vs  $3^\circ$ ;  $p=0.01$ ).

**DISCUSSION:** Achieved ROM, functional status, and required PT were superior in patients that received a photograph compared to those that did not. Photographic evidence is an inexpensive modality that can be used by arthroplasty surgeons to reduce patient anxiety and increase confidence in the early postoperative period following knee replacement surgery.

**Paper 180****Changes in Neuraxial Anesthesia Protocols Lead to Improved Efficiency of Same Day Discharge Total Knee Arthroplasty in an Ambulatory Surgery Center**

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**BACKGROUND:** With the exponential rise in outpatient total knee arthroplasty (TKA), improving rapid recovery protocols for same-day discharge (SDD) may help to increase patient satisfaction and provide substantial economic benefit. This study evaluates how bupivacaine vs. mepivacaine spinal anesthesia and preoperative adductor canal blocks (ACB) influence TKA outcomes at a free-standing ambulatory surgery center (ASC).

**METHODS:** Consecutive TKA patients from March 2018 to September 2019 at a free-standing ASC were retrospectively reviewed and grouped by neuraxial anesthetic regimen: bupivacaine with ACB (n=50), bupivacaine without ACB (n=20), and mepivacaine without ACB (n=20). Preoperative ACBs stopped in December 2018 and mepivacaine spinals began in March 2019. All patients received local anesthetic peri-articular injections at time of closure. Time to discharge from post-anesthesia care unit (PACU), controlled void, and ambulation and postoperative pain, milligram morphine equivalents (MME), and 90-day visual analog scale pain and KOOS Jr. scores were compared among mepivacaine and bupivacaine patients without ACB and separately among bupivacaine patients  $\pm$  ACB using Student's t-test and Fisher's exact test. Post-hoc power analyses found 20 patients in each mepivacaine vs. bupivacaine without ACB cohorts could detect a 70-minute difference in time to discharge and bupivacaine with and without ACB cohorts could detect a 1.5-point difference in pain at discharge with 80% power.

**RESULTS:** All patients underwent successful SDD. Mepivacaine spinals decreased minutes to PACU discharge ( $231 \pm 64$  vs.  $324 \pm 95$ ,  $p < 0.001$ ), controlled urinary voiding ( $164 \pm 75$  vs.  $279 \pm 103$ ,  $p < 0.001$ ), successful ambulation ( $183 \pm 62$  vs.  $243 \pm 84$ ,  $p = 0.024$ ), and total facility time ( $428 \pm 117$  vs.  $537 \pm 100$ ,  $p = 0.003$ ), but increased MME ( $13.1 \pm 8.6$  vs.  $7.3 \pm 9.3$  mg,  $p = 0.049$ ) despite similar pain at discharge ( $2.3 \pm 2.6$  vs.  $2.4 \pm 2.8$ ,  $p = 0.908$ ) compared to bupivacaine. Patients receiving bupivacaine with and without ACB, respectively, had statistically similar pain at discharge ( $1.3 \pm 2.1$  vs.  $2.4 \pm 2.8$ ,  $p = 0.100$ ), MME ( $4.5 \pm 8.2$  vs.  $7.3 \pm 9.3$  mg,  $p = 0.214$ ), minutes to ambulation ( $237 \pm 80$  vs.  $243 \pm 84$ ,  $p = 0.793$ ) and PACU discharge ( $302 \pm 94$  vs.  $324 \pm 95$ ,  $p = 0.372$ ). The bupivacaine without ACB cohort had lower VAS pain at 2-weeks compared to those with an ACB ( $3.5 \pm 2.0$  vs.  $4.5 \pm 1.9$ ,  $p = 0.029$ ). The remaining VAS-pain score intervals and all KOOS Jr. scores were similar ( $p \geq 0.17$ ). Patient demographics were similar between cohorts ( $p \geq 0.29$ ).

**CONCLUSION:** Mepivacaine spinals for TKA facilitated quicker SDD via decreased times to void and ambulation with a small increase in morphine equivalent requirement. Discontinuing preoperative ACBs had minimal effect on PACU outcomes.

Paper 181

**The Impact of Social Determinants of Health on Postoperative Outcomes and Complications Following Total Knee Arthroplasty: A Retrospective, Database Study**

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**INTRODUCTION:** Social determinants of health (SDOH) are factors within a patient's environment that ultimately affect health and quality of life outcomes. The purpose of this study was to investigate the impact of specific social determinants of health on outcomes and complications following total knee arthroplasty (TKA).

**METHODS:** A retrospective cohort study was conducted on 8,126 patients who underwent 10,201 consecutive TKA procedures between 2014-2020 at a single multi-center hospital system. Patient data abstraction was done by means of inquiry to the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI). Data points requested include gender, marital status, race, insurance status, perioperative course, and incidence of complications (death, DVT, PE, dislocation, fracture, hardware failure, prosthetic joint infection, any purpose ED visit, and hospital readmission) within three months of surgery. Univariate and subsequent multivariate analyses was conducted between patient groups stratified by various social determinants of health.

**RESULTS:** Female gender demonstrated significantly increased mean hospital stay, rate of same-day discharge (SDD), and rate of discharge to a skilled nursing facility (SNFs) while male gender demonstrated significantly greater rate of periprosthetic joint infection ( $p < 0.001$ ). Single and widowed patients showed significantly greater lengths of stay and rate of discharge to SNFs while married patients had a significantly greater rate of SDD ( $p < 0.001$ ). Caucasian patients had significantly greater rates of SDD and discharge to SNFs compared to non-Caucasian patients. Medicare patients showed greater lengths of stay, rate of SDD, discharge to SNFs, and any purpose ED visit or hospital readmission ( $p < 0.001$ ). All other SDOH group comparisons for postoperative outcomes did not result in significant findings.

**CONCLUSIONS:** Evaluation of patient-specific SDoH is an important consideration for perioperative management and resource utilization in patients undergoing TKA.

Paper 182

**Radiographic Outliers, Revisions, and Functional Outcomes in Fixed-Bearing Medial Unicompartmental Arthroplasty**

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**BACKGROUND:** Unicompartmental knee arthroplasty (UKA) is a technically demanding procedure vulnerable to errors in component positioning. Most consider component malposition a significant contributor to UKA mechanical failure and revision and propose robotic assistance to mitigate risk of malposition. This study evaluated revision rates and functional outcomes of radiographic outliers in manual UKA.

**METHODS:** A retrospective review of 222 consecutive fixed-bearing medial UKAs performed with manual instrumentation was conducted. Implant positioning and alignment were assessed radiographically measuring tibial coronal (TCA), femoral coronal (FCA), tibial sagittal (TSA), and femoral sagittal (FSA) angles and implant overhang. UCLA Activity Level and all-cause survivorship were evaluated with  $\alpha \leq .05$  designating statistical significance.

**RESULTS:** Manual UKAs achieved the following targets: 92% for TCA, 100% for FCA, 88% for TSA, and 100% for FSA. For implant overhang, 100% met medial, anterior, and posterior targets. UKAs in this study achieved alignment and overhang target goals more frequently than previously published manual and robot-assisted success rates. Survivorship free from aseptic revision in this study was 96% at 8.5 years. In contrast to published results for robotic UKAs, manual UKA revision rates did not differ in alignment outliers and non-outliers (2.3% vs. 3.1%  $p = 0.570$ ). There were no differences in UCLA Activity Level or KOOS Jr. improvement scores comparing radiographic outliers and non-outliers ( $p \geq 0.159$ ) with the numbers available.

**CONCLUSION:** This study found no differences in revision rates or functional outcomes between radiographic outliers and non-outliers in manually-instrumented fixed-bearing UKA using previously published targets. For robotic assistance to be cost effective, it must demonstrate improved outcomes or survivorship when compared to manual UKAs. Our results contradict recently published claims that manual alignment outliers and failure rates fail to meet expectations for UKA.

**Paper 183****Did Rapid Expansion of Same-Day Discharge During the COVID-19 Pandemic Increase Early Complications After Total Joint Arthroplasty?**

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**INTRODUCTION:** Due to regulatory pressures and scarcity of hospital resources in the early stages of the COVID-19 pandemic, elective total joint arthroplasty (TJA) were unable to be routinely performed with planned overnight observation status. As a result, many institutions quickly developed programs for same-day discharge (SDD). The purpose of this study was to determine whether expansion of SDD resulted in more early complications following TJA.

**METHODS:** Patients undergoing primary TJA with SDD were identified in the ACS-NSQIP database between 2018 and 2020. SSD was defined as length of stay of 0 days. Patients were stratified based on whether TJA occurred between 2018 Quarter 1 and 2020 Quarter 1 (pre-COVID) or 2020 Quarter 2 and 2020 Quarter 4 (post-COVID), corresponding with widespread restrictions on elective surgery. Patient demographics and 30-day rates of total complication, readmission, and respiratory complications were compared between groups.

**RESULTS:** A total of 26,703 patients underwent TJA, with 17,260 occurring pre-COVID and 9,443 post-COVID. The pre-COVID group was younger (64.7 vs. 63.8 years), had more females (54.9% vs. 50.0%), and lower BMI (30.4 vs. 30.8 kg/m<sup>2</sup>) compared to the post-COVID group ( $p < 0.0001$  for all). The post-COVID group had significantly more patients with an ASA score of 3 or more (34.9% vs. 31.5%,  $p < 0.0001$ ). There was no difference in rates of total complication between the pre-COVID (3.4%) and post-COVID (3.7%) groups ( $p = 0.17$ ). Rates of readmissions for were similar for the pre-COVID (1.8%) and post-COVID (1.8%) groups ( $p = 0.76$ ). Respiratory complications occurred less frequently in the post-COVID group (0.2% vs. 0.3%,  $p = 0.03$ ).

**CONCLUSION:** There was no increase in total complications or readmission related to expansion of SDD after primary TJA due to the COVID-19 pandemic. There were significantly fewer respiratory complications post-COVID, possibly related to increased preoperative screening for underlying respiratory illness.

**Paper 184****Cementless Total Knee Arthroplasty in Patients Over 75: A Single Practice Review Using Statewide Registry Data**

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**INTRODUCTION:** While cemented total knee arthroplasty (TKA) has been the gold standard, newer uncemented implants have yielded positive initial results. However, concerns about early failure in older populations persist. We hypothesized that early outcomes and revision rates would be similar using a modern press-fit implant in older patients, regardless of fixation method. As such, the 90-day outcomes and 2-year revision rates of uncemented TKAs in patients over 75 years were compared to an age-matched cohort of cemented TKAs.

**METHODS:** A statewide arthroplasty registry was queried for all primary TKAs (01/2016-05/2020) performed in patients >75 years by a single practice in a single hospital. This yielded 150 cementless TKAs that were matched to 150 cemented TKAs for age and sex. The same implant was used in all cases regardless of fixation method. Ninety-day ED visits, readmissions, return to the OR and 2-year revision rates were compared. Fisher's exact and Chi squared tests were used for categorical data, and paired t-tests for continuous data. Log-rank was applied for survival analysis.

**RESULTS:** Cementless TKA had significantly less 90-day post operative events (ED visits, medical readmissions, return to OR) vs cemented (123/150 vs. 104/150;  $P = .011$ ). There were more deep vein thromboses in cemented TKAs (0 vs. 5,  $P = .024$ ). There were 5 total revisions in each cohort. The uncemented cohort had 2 fractures requiring revision and 3 periprosthetic joint infections (PJI). The cemented cohort had one TKA revised for pain/stiffness, 3 PJIs, and one TKA revised for unknown reasons. The survival analysis yielded no difference between cohorts at 2 years ( $P = .431$ ).

**CONCLUSION:** Cementless TKAs performed as well or better than matched cemented cohort in patients > 75 years old for 90-day outcomes and 2 year (early) revision rates. The data supports continued investigation regarding optimal indications and patient selection when utilizing uncemented TKA technologies.

**Paper 185****Preoperative Expectations Do Not Predict Contemporary Total Knee Arthroplasty Satisfaction**

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**BACKGROUND:** As many as 15-20% of patients have previously been reported to have dissatisfaction following contemporary total knee arthroplasty (TKA). Lower postoperative patient reported outcome measures (PROMs) and failure to meet preoperative expectations have been associated with patient dissatisfaction with TKA performed 15-20 years ago. We performed this study to determine whether preoperative patient expectation for improvement is associated with postoperative satisfaction with contemporary total knee arthroplasty surgery.

**METHODS:** We evaluated 397 patients (461 TKAs) prospectively enrolled in an institutional joint replacement registry who had reported both preoperative outcome expectations (5-point Likert) and postoperative patient satisfaction (5-point Likert) following their TKA surgery. Patients are routinely counseled before their surgical procedure on a 70-90% expected pain reduction following a clinically successful surgical procedure, with an expectation that only 15% of patients may be completely satisfied. Patients included in this study had preoperative anteroposterior (AP), lateral, and patellofemoral imaging to define osteoarthritis disease severity, preoperative and minimum 1-year postoperative patient reported outcome measures (PROMs) including KOOS-Jr, NIH-Physical and Mental function subscores, and UCLA activity score. Comparative analysis was performed between 257 TKAs (55.6%) performed for patients who expressed a desired 75-99% improvement for a successful TKA (Group 1) with 19 TKAs (4.1%) expecting < 25% improvement (Group 2), 20 TKAs (4.3%) expecting 25-50% improvement (Group 3), 93 TKAs (20.1%) expecting 50-75% improvement (Group 4) and 70 TKAs (15.2%) expecting 100% improvement (Group 5)

**RESULTS:** The overall satisfaction rate was 91.1% with a dissatisfaction rate of 4.5%. There was no difference in mean patient satisfaction score between patients holding surgeon-aligned expectations and those desiring 100% improvement (4.59 vs. 4.60 points,  $p=0.91$ ) or with expectation for 75% or less improvement (4.59 vs. 4.58 points,  $p=0.95$ ). Post-TKA satisfaction was no different among patients with surgeon-aligned expectations or conflicting expectations (91.8% vs. 90.7%,  $p=0.74$ ). Highly satisfied patients were no more likely to have surgeon-aligned expectations (3.73 vs. 3.70 points,  $p=0.82$ ) with no difference in their expectation for 100% improvement (15.0% vs. 15.6%,  $p=0.88$ ), 50-99% improvement (77.0% vs. 75.5%,  $p=0.91$ ), or < 50% improvement (7.9% vs. 8.2%,  $p=1.0$ ).

**CONCLUSION:** Contemporary TKA is associated with lower dissatisfaction rates than previously reported. Preoperative education, medical optimization, improved implant designs, and surgical techniques all likely play a role in these improvements. Additional efforts may be directed toward transitioning modestly satisfied into highly satisfied patients following TKA.



**Paper 186****Comparing the Clinical Performance and Radiographic Observations of Single vs. Multiple Radius Femoral Components in Primary Total Knee Arthroplasty**

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**INTRODUCTION:** Both single-radius (SR) and multi-radius (MR) femoral components have been utilized in total knee arthroplasty (TKA), with each design offering theoretical advantages. However, studies conflict whether one design leads to superior clinical performance. Our study is one of the largest cohorts of either component and aims to compare their clinical efficacy in range of motion, mechanical complications, and radiographic changes.

**METHODS:** An institutional surgical database was reviewed for patients who underwent primary TKA under from 2011 to 2018. Changes in flexion contracture (FC), range of motion (ROM), and subsequent mechanical complications. Anteroposterior (AP) and lateral radiographic images were evaluated at six weeks postoperatively and at most recent follow up to determine radiolucent line (RLL) progression. ANOVA, t-tests, chi-squared, and Fischer's exact tests for proportions through SPSS. (IBM SPSS Statistics, Version 24.0. Armonk, NY)

**RESULTS:** 213 SR and 1,913 MR femoral components were included from 6 companies. ASA score distribution, mean age, BMI, and proportion of varus/valgus tibiofemoral alignment did not differ between cohorts. Mean follow-up was  $2.2 \pm 2$  years for SR and  $3.1 \pm 2.4$  years for MR. Preoperative FC and ROM between each component type, and postoperative FC and ROM between each component type did not differ ( $p = 0.67$ ; 0.12, 0.46, 0.61). Neither SR nor MR had greater likelihood of aseptic loosening (0.5% vs. 0.6%, two-tailed,  $p = 1$ ). SR was associated with increased frequency of tibial radiolucency progression on AP images (29% vs. 23.3%,  $p=0.03$ ), and decreased frequency of radiolucency progression on femoral lateral images (22.3% vs. 14%,  $p=0.003$ ).

**CONCLUSIONS:** MR and SR femoral components are functionally and clinically non-inferior to one another, and both show similar progressions of RLLs.

**Paper 187****Total Joint Arthroplasty in Patients with Lymphedema as Compared to a Propensity Matched Control Cohort**

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**BACKGROUND:** Lymphedema is rare in arthroplasty patients but has been associated with a higher complication rate. Specifically, patients with lymphedema who undergo joint arthroplasty may experience periprosthetic infection, deep venous thrombosis, and subsequent revision at a higher rate. However, there are very few studies on this topic, each with limited numbers of patients. The purpose of this study is to determine the outcomes of total joint arthroplasty in patients with lymphedema as compared to a matched control cohort.

**METHODS:** This was an IRB approved retrospective study that evaluated primary total hip and knee arthroplasty procedures performed at one tertiary academic center between 1/1/2005 and 10/31/2020. Treatment-control propensity score matching was implemented on a sample of patients undergoing total knee arthroplasty to generate unique, 5-patient sets consisting of one patient with pre-surgery lymphedema to four patients without pre-surgery lymphedema, matched on age, sex, and year of surgery. Multivariable generalized estimating equations (GEEs) estimated the adjusted effects of lymphedema on several post-surgical outcomes separately.

**RESULTS:** This analytic sample consisted of 335 unique patients matched into 67 unique sets on age, sex, and year of surgery. In the lymphedema cohort, 1 patient (1.5%) had a DVT within 90 days of their surgery, 36 (53.7%) were discharged to a rehabilitation center, 16 (23.9%) had a re-admission, 14 (20.9%) were admitted to the ER within 90 days, 6 (9.0%) experienced infection, 6 (9.0%) had a revision/reoperation. The lymphedema cohort experienced an average blood loss of 200 mL and 3-day post-surgical length of stay. Pre-surgery lymphedema demonstrated a significant effect on ER admission within 90 days (OR 46.56,  $p = 0.01$ ) and discharge to a rehabilitation center vs. home (OR 4.14,  $p < 0.01$ ), a potential effect on readmission within 90 days (OR 2.21,  $p = 0.09$ ), revision/reoperation (OR 2.82,  $p = 0.09$ ), and no effect on DVT within 90 days (OR .57,  $p = 0.45$ ), post-surgical infection (OR 1.47,  $p = 0.45$ ), length of stay (OR 0.00,  $p = 0.99$ ), operative time (OR 0.04,  $p = 0.38$ ), or estimated blood loss (OR 0.09,  $p = 0.47$ ), after adjusting for BMI, diabetes, age, sex, and year of surgery.

**CONCLUSION:** Preoperative lymphedema is a significant risk factor for patients who are undergoing total joint arthroplasty. Pre- and postoperative modalities should be utilized to help control lymphedema and mitigate these increased risks.

**Paper 188**

**Long-Term Survivorship of Metaphyseal Sleeves in Revision Total Knee Arthroplasty**

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**INTRODUCTION:** The use of metaphyseal sleeve fixation in revision total knee arthroplasty (rTKA) has demonstrated reassuring early and midterm results. However, there are few reports on long-term survivorship of these implants. We investigated long-term survivorship free from re-revision of patients who received metaphyseal sleeve fixation in rTKA.

**METHODS:** We performed a retrospective review on 170 patients who underwent implantation of 245 metaphyseal sleeves (97 femoral, 148 tibial) during rTKA at a single institution from 2005 to 2012. Indications for revision included infection (41%), aseptic loosening (35%), instability (18%), wear/osteolysis (8%), and malalignment (4%). Mean age at surgery was 66 years, mean BMI was 33.2m<sup>2</sup>/kg, and 82 (48%) patients were female. Mean follow-up was 7.5 years, and 83 patients had a minimum of 10-years of follow-up. Sleeves were cemented in 42% of cases (38% femoral, 44% tibial).

**RESULTS:** Intraoperative fracture occurred in 6.5% of cases (3.3% femoral, 2.4% tibial). Revision for aseptic loosening occurred in two cases (1 tibial sleeve at 10 months, 1 femoral sleeve at 9.7 years). There were 12 cases (7.1%) of implant removal for infection (8 resection arthroplasty, 4 above-knee amputations). Sleeve survivorship free from revision for aseptic loosening was 99.4% at 5 years and 98.2% at 10 years. Sleeve survivorship free from removal for any cause was 95.5% at 5 years and 87.6% at 10 years. Overall survivorship free from any reoperation was 88.7% at 5 years and 78.1% at 10 years.

**CONCLUSION:** Metaphyseal sleeves for revision TKA have good long-term survival rates for both tibial and femoral implantation. Reoperation for aseptic loosening in this population is rare, even by 10 years of follow-up.

**Paper 189****Assessing Risk Factors for 90-Day Emergency Department Visits Status-Post Index Total Knee Arthroplasty: A Retrospective Case Control Study**

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**INTRODUCTION:** With the increasing adoption of value-based healthcare initiatives in total knee arthroplasty (TKA), a greater emphasis has been placed on implementing cost-saving measures while maintaining or improving quality of care. One area of interest has been postoperative ED visits. Here we evaluate potential risk factors for 90-day ED visits.

**METHODOLOGY:** This is a case control study from a large, tertiary, private, academic institution. All primary TKAs between 7/1/2013 to 12/31/2017 were obtained retrospectively from a prospective institutional database utilized for contribution to a state-wide joint arthroplasty database. All patient charts were subsequently verified and reviewed for all-cause 90-day ED visits, and divided into two cohorts based on their ED visit. Patients were subsequently compared for differences in their baseline demographics, medical comorbidities, intraoperative factors, and postoperative course. Unpaired t-test and chi-squared tests were performed for continuous and categorical variables, respectively, with  $p < .05$  as statistically significant.

**RESULTS:** 8,554 total knee arthroplasties were included in the study period. 679 patients (7.94%) required an ED visit within 90 days while the remaining 7,875 (92.06%) did not.

Preoperatively, TKAs requiring a 90-day ED visit were significantly younger ( $65.32 \pm 10.12$  vs.  $66.52 \pm 9.62$ ;  $p < 0.01$ ), had higher ASA scores (ASA 3/4: 57.58% vs. 43.98%;  $p < 0.0001$ ), more likely diabetic (21.98% vs. 17.50%;  $p < 0.05$ ), and had positive history of DVT (14.58% vs. 7.72%;  $p < 0.0001$ ). Surgically, these patients were significantly more likely to have received general anesthetic (43.89% vs. 36.01%;  $p < 0.001$ ) and not receive intraoperative tranexamic acid (80.71% vs. 84.86%;  $p < 0.01$ ). Postoperatively, these patients had a longer length of stay ( $2.75 \pm 1.69$  vs.  $2.55 \pm 1.44$ ;  $p < 0.001$ ) and be reported to have a postoperative DVT (3.98% vs. 1.27%;  $p < 0.0001$ ). Other patient demographics, MRSA colonization/decolonization, anesthetics, surgical approach, postoperative transfusion, and discharge disposition were similar between groups.

**CONCLUSION:** Patients undergoing primary total knee arthroplasty have a combination of modifiable and non-modifiable risk factors and surgical variables contributing to postoperative ED visits. Further research is warranted to identify areas of potential quality improvement.

**Paper 190****Revision TKA for Arthrofibrosis and Flexion Instability Compared to Isolated Flexion Instability**

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**INTRODUCTION:** Flexion instability is a leading cause of early revision total knee arthroplasty (TKA), with most symptomatic patients demonstrating rapid postoperative flexion with persistent pain and instability. However, there is a subset of patients with symptomatic flexion instability and arthrofibrosis. This study compared patient outcomes in revision TKA cases performed for traditional isolated flexion instability (FI) to those performed for flexion instability with arthrofibrosis (FI+A).

**METHODS:** 669 consecutive revision TKA cases were retrospectively reviewed to identify those with traditional isolated FI and FI+A. Surgical technique emphasized the established principles of tibial slope reduction, optimizing posterior femoral condylar offset, and modest joint line elevation using varus-valgus stabilizing implants. Demographic, radiographic, and patient-reported outcomes (PROs) were prospectively recorded and analyzed.

**RESULTS:** One hundred fifteen patients with FI were compared to 20 FI+A patients. The two groups did not differ by demographics ( $p \geq 0.207$ ), follow-up ( $p = 0.462$ ), or covariates ( $p \geq 0.073$ ); however, the FI group had a higher prevalence of uncontrolled depression (27.8% vs. 5.0%,  $p = 0.026$ ), although it did not influence outcomes ( $p \geq 0.434$ ). The two groups did not differ by preoperative, postoperative, or the change in radiographic metrics or minimum 1-year PROMs with numbers available ( $p \geq 0.126$ ). The FI+A group had a significantly greater increase in range of motion (ROM) from preoperative baseline compared to the FI only group (26.1 vs. 1.7°,  $p = 0.008$ ). However, the isolated FI group obtained a significantly higher postoperative ROM (116 vs. 103°,  $p = 0.016$ ).

**CONCLUSION:** This study indicates that patients with FI+A obtain comparable outcomes after revision TKA compared to those with FI only. Furthermore, patients with arthrofibrosis potentially caused by flexion instability gained significant postoperative ROM and benefit from revision TKA. Further study is warranted to understand whether FI is causative or merely correlative in patients with concomitant arthrofibrosis.

**Paper 191****Does Optimizing Asymmetric Native Knee Flexion Gap Balance Promote Superior Outcomes in Primary TKA?**

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**INTRODUCTION:** Replicating native knee kinematics remains the ultimate goal of contemporary total knee arthroplasty (TKA). Advanced technology such as robotics and TKA sensors provide greater intraoperative information, without evidence-based targets for improved patient outcomes. Further, some surgeons target a rectangular flexion space in TKA unlike the native knee. This study purpose was to determine the effect of in vivo flexion gap asymmetry on PROMs in contemporary TKA.

**METHODS:** Tibiofemoral joint space dimensions were measured during 129 standardized TKAs by two surgeons using a calibrated tension device at 90-degrees of flexion after complete PCL-resection. Flexion space asymmetry was calculated. Patient-reported outcomes at minimum 1-year related to pain, function, and satisfaction were compared in patients categorized in groups based on gap dimensions at 90-degrees of flexion: 1) equivalent laxity in medial and lateral compartments, 2) greater lateral laxity, and 3) greater medial laxity.

**RESULTS:** The three groups did not differ by age, BMI, gender proportions ( $p \geq 0.429$ ), months of latest follow-up ( $p = 0.134$ ), preoperative tibiofemoral alignment ( $p = 0.498$ ), or preoperative PROM scores ( $p \geq 0.093$ ). Knee Society Score (KSS) pain with stair climbing and a knee "always" feeling normal were significantly superior (exceeding MCID) for patients with equal or lateral laxity compared to those with medial laxity ( $p \leq 0.064$ ) at minimum 1-year follow-up. KSS level walking pain, UCLA Activity level, KOOS JR total, and satisfaction scores were also superior for patients with symmetric or lateral laxity compared to those with medial laxity at 90-degrees although lacked statistical significance with numbers available ( $p \geq 0.111$ ).

**CONCLUSION:** Results of this study suggest patients with either an equally tensioned rectangular flexion space, or with moderate later flexion laxity have superior clinical outcomes. These findings support the clinical benefit of facilitating posterolateral femoral rollback in flexion which mimics native knee kinematics and helps us further define targets for robotic and advanced technology.

**Paper 192****Resurfacing the Thin Native Patella: Is It Safe?**

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**INTRODUCTION:** Whether to resurface the patella during total knee arthroplasty (TKA) remains debated. One often cited reason for not resurfacing is inadequate patellar thickness. However, when left un-resurfaced, this cohort has known relatively high revision rates. The aim of this study is to describe the implant survivorships, reoperations, complications, and clinical outcomes in patients who underwent patellar resurfacing of a thin native patella.

**METHODS:** Our institutional total joint registry was used to identify patients undergoing primary TKA with patellar resurfacing from 2000 to 2010. Of the 11,333 identified patients, 200 (1.8%) had a pre-resection patellar thickness of  $\leq 19$ mm. Pre-resection and post-resection patella thickness was measured intraoperatively using calipers. Median pre-resection and post-resection thickness was 19 (range 12-19) and 12.5 (range 10-17), respectively. Mean age was 69 years, mean BMI 31 kg/m<sup>2</sup>, and 93% were female. Indications for surgery included: osteoarthritis (n=153), rheumatoid arthritis (n=33), post-traumatic arthritis (n=14). Median follow-up was 10 years (range 2-20).

**RESULTS:** At 10 years, survivorships free of any patella revision, patella-related reoperation, periprosthetic patella fracture, and patella-related complication were 98%, 98%, 99%, and 97%, respectively. There were 2 patella revisions: 1 for aseptic loosening and 1 for PJI. There were 2 additional patella-related reoperations, both arthroscopic synovectomies for patellar clunk. Two patients underwent MUA. There were 3 periprosthetic patella fractures managed nonoperatively, all with well-fixed components and intact extensor mechanisms. Radiographically, the patella appeared well fixed in all non-revised knees. Knee society scores improved from mean 36 preoperatively to mean 81 at 10-years postoperatively.

**DISCUSSION:** Resurfacing the thin native patella was associated with high survivorship free of patellar revision at 10-year follow-up. None-the-less there was one case of patellar loosening and 3 periprosthetic patella fractures. These risks must be weighed against the known higher incidence of revision when the thin native patella is left un-resurfaced.

**SUMMARY:** Resurfacing of thin native patellas ( $\leq 19$ mm) is associated with high survivorship free of patella revision but was associated with a 1.5% rate of periprosthetic patella fracture.

**Paper 193**

**Porous Tantalum Tibial Metaphyseal Cones in Revision TKA: Excellent 10-Year Survivorship**

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**INTRODUCTION:** Tibial metaphyseal cones (TMCs) are commonly utilized in revision total knee arthroplasty (TKA) to address bone loss and obtain biologic fixation. Mid-term studies have demonstrated excellent survivorship and high rates of radiographic osseointegration, but longer-term studies are lacking. We aimed to assess longer-term implant survivorship and clinical outcomes after revision TKA with TMCs.

**METHODS:** Between 2004-2011, 228 consecutive revision TKAs utilizing porous tantalum TMCs were retrospectively reviewed from a single institution. Mean age was 65 years, mean BMI was 33 kg/m<sup>2</sup>, and 52% were female. Implant constraint was 28% rotating hinged, 64% varus-valgus constrained, and 7% posterior stabilized. All TKAs had cemented tibial stems. Implant survivorship, complications and clinical outcomes were assessed at a minimum of 10-year potential follow-up.

**RESULTS:** 10-year survivorship free of aseptic loosening leading to TMC removal was 97%, free of TMC removal for any reason was 88%, free of re-revision for any reason was 66%, and free of reoperation for any reason was 58%. Three TMCs were grossly loose at the time of re-revision with intraoperative stress testing. The most common indications for re-revision were periprosthetic joint infection (PJI), instability, and aseptic femoral component loosening. Index revisions due to periprosthetic fractures or reimplantation after PJI had higher re-revision rates compared to cases indicated for aseptic loosening, osteolysis or instability. The 10-year nonoperative complication rate was 24%. Knee society function scores increased from a mean of 43 preoperatively to 57 at 10 years.

**CONCLUSIONS:** Porous tantalum TMCs demonstrate excellent longer-term survivorship with a low rate of implant removal. PJI, instability, and aseptic femoral component loosening continue to pose considerable challenges to long term re-revision-free survival. Porous tantalum TMCs provide an excellent tool to effectively address tibial bone loss and achieve solid fixation in revision TKA.



**Paper 194****Cementless TKA Over the Past Decade: Excellent Survivorship in Contemporary Designs**

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**INTRODUCTION:** Cementless fixation in total knee arthroplasty (TKA) is increasing due to improvements in biomaterials, surgical technique, and implant design. Albeit rare, failure of osseointegration typically occurs within the first two years, and limited data exist on survivorship of the various modern uncemented TKA designs. This study purpose was to evaluate clinical survivorship of contemporary cementless TKA designs at mid-term out to 10 years.

**METHODS:** 589 consecutive primary cementless TKAs with a consistent contemporary design were performed between 2011 and 2022. 339 TKAs performed up to May 2020 for 2-year follow-up were reviewed. Indications centered around bone quality and involved predominantly younger and more active patients. The two designs were comprised of a tibia component with a highly porous titanium ingrowth surface, a central keel, and peripheral cruciform pegs with a porous cobalt chrome femur. Demographics, revisions, and re-operations within a statewide healthcare system were recorded. Survivorship estimates were calculated using right-censored non-parametric Kaplan-Meier methodology.

**RESULTS:** The cohort was 60% male and 55% ASA classification 1-2 with mean age and BMI of 57 years and 35 kg/m<sup>2</sup>. 226 TKAs obtained minimum 2-year follow-up with a mean of 3.6 years (range 2-10). All-cause Kaplan-Meier survivorship free from revision was 91% (95% CI 83-100) and Kaplan-Meier survivorship free from aseptic loosening was 99% (95% CI 98-100) at a maximum of 10 years. The revision rate due to aseptic loosening was 0.6% (2/339) consisting of two femoral components. No tibial components were revised for aseptic loosening.

**CONCLUSION:** These results demonstrate encouraging mid-term survivorship of cementless fixation in primary TKA with use of contemporary ingrowth biomaterials and modern implant designs. This particular tibial implant design with a highly-porous titanium fixation surface, central keel, and peripheral cruciform pegs demonstrated excellent osseointegration without failure in the mid-term, which portends superior long-term fixation. Longer-term follow-up remains warranted.

**Paper 195**

**Impact of Resident Involvement on Complication Rates in Revision Total Knee Arthroplasty**

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**INTRODUCTION:** The number of revision total knee arthroplasty (TKA) procedures continues to rise, a direct consequence of the increase in primary TKA. The number of arthroplasty-trained orthopedic surgeons has failed to increase at a corresponding rate, and the increased burden will ultimately fall on non-specialized orthopedists. Resident involvement in primary TKA does not increase postoperative complications, but revision TKA is more complex and the impact of resident involvement has not been well studied.

**METHODS:** Using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, this study identified 1,834 revision TKA procedures between the years 2008-2012. Of these procedures, 863 included residents. Demographic information, postoperative complications, comorbidities, operative times, and length of stay (LOS) were stratified by resident and non-resident involvement and analyzed.

**RESULTS:** Resident involvement was not associated with a significant increase in complications, despite a significant increase operative times (147.50 minutes with resident involvement vs. 124.55 minutes without a resident,  $p < 0.001$ ). Resident involvement did produce increased length of stay by 0.34 days, but this did not reach significance ( $p = 0.061$ ).

**CONCLUSION:** Resident involvement in revision total knee arthroplasty was associated with a significant increase in operative time; however, there were no significant increases in postoperative complication rates within 30 days. These findings support continued resident involvement in revision total knee arthroplasty cases and postoperative management.

**Paper 196**

**Uni- Or Not Uni-?: Long-Term Survivorship of Unicompartmental Knee Arthroplasty**

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**BACKGROUND:** There has been a recent surge of interest in UKA due to its purported advantages over TKA such as preserved bone stock, retained cruciate driven kinematics, earlier recovery, and improved functional outcomes. However, the reported revision rate is classically higher when compared to TKAs. Despite previously higher revision rates, UKAs performed under the right conditions may have survivorship comparable to that of primary TKAs.

**METHODS:** This is a non-controlled, retrospective cohort study. Data was collected from a prospectively maintained, single institution database. All patients over 18 years of age undergoing primary UKA between 01/01/2001 and 12/31/2016 were included. All surgeries were performed by a single, fellowship-trained surgeon. The primary outcome analyzed was implant survivorship at final follow-up.

**RESULTS:** There were a total of 363 UKAs. 62 were staged bilateral with a single simultaneous bilateral procedure. 8 patients were excluded due to unrelated deaths during the study period. Mean age was 61.97 (38.32-92.58). Average follow-up for these patients was 10.62 years (4.18-20.61). 18 revision procedures were performed for an average revision rate of 5.1%.

**CONCLUSION:** UKA is an attractive treatment option in select patients with isolated, unicompartmental OA. This large, single surgeon study demonstrates that, in the hands of an experienced surgeon, UKA is a viable treatment option with low revision rates comparable to those catalogued for TKA in current registries.

**Paper 197****When Intravenous Vancomycin Prophylaxis is Needed in Shoulder Arthroplasty, Incomplete Administration is Associated with Increased Infectious Complications**

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**INTRODUCTION:** Vancomycin is often used as antimicrobial prophylaxis for shoulder arthroplasty (SA) either when first generation cephalosporins are contraindicated or colonization with resistant bacteria is anticipated. In general, vancomycin necessitates longer infusion times to mitigate potential side effects. When infusion is started too close to the time of the incision, administration may not be complete during surgery. This study evaluated whether incomplete administration of intravenous (IV) vancomycin prior to shoulder arthroplasty (SA) affects the rate of infectious complications.

**METHODS:** Between 2000 to 2019, all primary SA types (hemiarthroplasty, anatomic total shoulder arthroplasty, reverse shoulder arthroplasty) performed at a single institution for elective and trauma indications using IV vancomycin as the primary antibiotic prophylaxis and a minimum follow-up of 2 years were identified. The time between the initiation of vancomycin and skin incision was calculated. Complete administration was defined as at least 30 minutes of infusion prior to incision. Demographic characteristics and infectious complications including survival free of prosthetic joint infection (PJI) were generated. Multivariable analyses were conducted to evaluate the association between vancomycin timing and the development of PJI.

**RESULTS:** A total of 461 primary SA were included. Infusion was complete (>30 minutes preoperatively) for 163 [35.4%] and incomplete (< 30 minutes preoperatively) for 298 [64.6%] SA. The incomplete group demonstrated higher rates of any infectious complication (8% vs. 2.3%;  $P = .005$ ), PJI (5.5% vs. 1%;  $P = .004$ ), and reoperation inclusive of revision due to infectious complications (4.9% vs. 1%;  $P = .009$ ). Survivorship free of PJI was worse in SA with incomplete compared to those with complete vancomycin administration. Survival rates for incomplete and complete administration were 97.6% and 99.3% at 1 month, 95.7% and 99.0% at 2 years, 95.1% and 99.0% at 5 years, and 93.9% and 99.0% at 20 years, respectively ( $P = .006$ ). Multivariable analyses confirmed that incomplete vancomycin administration was an independent risk factor for PJI compared with complete administration (hazard ratio [HR], 4.22 [95% confidence interval (CI), 1.12 to 15.90];  $P = .033$ ), even when other independent predictors of PJI (age, male sex, prior surgery, MRSA colonization, and follow-up) were considered.

**CONCLUSIONS:** When vancomycin is the primary prophylactic agent used at the time of primary shoulder arthroplasty, incomplete administration (infusion to incision time under 30 minutes) seems to adversely increase the rates of infectious complications and PJI. Prophylaxis protocols should ensure that complete vancomycin administration is achieved to minimize infection after SA.

**Paper 198****Teres Minor Deficiency Does Not Predict Clinically Inferior External Rotation After Reverse Total Shoulder Arthroplasty: A Two-Year Matched Cohort Study**

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**BACKGROUND:** Current teaching maintains that reverse total shoulder arthroplasty (RTSA) is unlikely to restore external rotation (ER) in those without a functional posterior rotator cuff, specifically the teres minor (TM). We hypothesized that patients with TM deficiency (TMD) would have inferior ER outcome parameters to those with intact TM (TMI).

**METHODS:** A single institution database was used to identify all patients between January 2014 and July 2020 that underwent lateralized RTSA, had 2-year (Y2) follow-up, and did not undergo adjunct tendon transfer procedures. Pre-op imaging was reviewed to identify patients with TMD and propensity score matching was used to construct a control group (CG) of equal size. TMD was defined and divided into three subgroups: 1) Atrophy (n=15): CTA/OA/RCT with Grade III/IV TM atrophy on pre-op MRI [CG: similar diagnosis with intact TM]; 2) Fracture (n=14): Proximal humerus fracture/nonunion treated with RTSA with failed greater tuberosity (GT) repair on follow-up XR [CG: fracture with healed GT repair]; 3) Endoprosthesis (n=10): Any endoprosthesis reconstruction where all rotator cuff tissue was resected [CG: large three tendon RCT and intact TM without atrophy]. Primary outcome measures were active ER-ROM measured at the side,  $\Delta$ ER-ROM from baseline, ER strength, and ASES Subscore question "can you reach back of head."

**RESULTS:** 39 TMD patients were successfully matched with 39 TMI patients. Although TMD was associated with reduced baseline ER-ROM [13.6 vs. 28.8; p=0.004], TMD achieved greater  $\Delta$ ER-ROM 2 years after RTSA [24.6 vs. 10.3; p=0.014] and demonstrated comparable Y2 ER-ROM [38.6 vs. 40.7; p=0.484]. TMD had a higher rate of ER weakness [12% vs. 0%; p=0.044], however, this did not lead to clinically significant differences in ability to reach back of head [Unable: 24% vs. 20%; p=0.686] or patient reported functional scores [Y2 ASES: 76.2 vs. 74.8; p=0.793]. Subgroup analysis showed significantly improved  $\Delta$ ER-ROM for TMD patients in the Atrophy group [28.2 vs. 8.3; p=0.036] and reduced Y2 ER-ROM in the endoprosthesis group [34.5 vs. 41.7; p=0.029]. There otherwise were no significant subgroup differences in Y2 ER-ROM,  $\Delta$ ER-ROM, ER weakness, or ability to reach back of head.

**CONCLUSION:** Our study, representing one of the largest cohorts of TMD patients to date, suggests that patients with an insufficient or absent TM can achieve satisfactory ER-ROM and function after RTSA. Future study will seek to identify muscle activation patterns of the shoulder girdle which allow TMD patients to functionally overcome this insufficiency to perform activities requiring ER.

**Paper 199****Association of Superior Humeral Head Osteophyte with Rotator Cuff Pathology in Patients with Glenohumeral Osteoarthritis**

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**BACKGROUND:** Glenohumeral osteoarthritis (OA) is associated with development of peripheral osteophytes. The significance of a superior humeral head osteophyte (SHO), which directly abuts the superior rotator cuff, is not well understood. The purpose of this study was to determine if a relationship exists between the size of a SHO and the incidence of concomitant RCT or rotator cuff insufficiency. A secondary goal was to determine if there were differences in measurement of SHO between plain radiographs and MRI.

**MATERIALS & METHODS:** Patients >18 years of age with radiographic glenohumeral OA and a concurrent shoulder MRI within 1 year of plain radiographs from two institutions were identified for retrospective review. Plain radiographs were reviewed to determine: the Samilson and Prieto OA grade and measure the size of the SHO. MRIs were reviewed for SHO measurement and to determine the presence, type, and size of RCT, thickness of the supraspinatus tendon, and degree of FI of the rotator cuff musculature.

**RESULTS:** The study included 461 patients. The mean size of the SHO was 1.93 mm (95% CI: 1.75, 2.10) on radiographs and 2.13 mm (95% CI: 1.96, 2.30) on MRI. The risk ratio for the incidence of RCT was 1.14 (95% CI: 0.91, 1.43) for SHO presence on radiograph and 1.26 (95% CI: 0.96, 1.63) on MRI. Each 1-mm increase size of the SHO on X-ray and MRI, was associated with a 0.20 mm (95% CI: 0.12, 0.28) and 0.17 mm (95% CI: 0.08, 0.26) decrease in supraspinatus tendon thickness, respectively. The presence of a SHO was associated with moderate-to-severe FI of the supraspinatus with a risk ratio of 3.16 (95% CI: 1.67, 5.98) when present on radiograph and 3.47 (95% CI: 1.63, 7.35) when present on MRI.

**DISCUSSION:** The degree of osteoarthritis was associated with larger SHOs and radiographs tended to slightly underestimate the size of the SHO compared to MRI. The presence and size of the SHO was not associated with the presence of concomitant full or partial thickness RCTs. However, there was an association with the presence of a SHO and decreased thickness of the supraspinatus tendon and moderate-to-severe FI, indicating potential rotator cuff insufficiency. Therefore, the presence of a large SHO may be an indication for MRI prior to considering anatomic total shoulder arthroplasty to evaluate the health of the superior rotator cuff.

**Paper 200****Muscle Activation Patterns During Active External Rotation After Reverse Total Shoulder Arthroplasty**

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**INTRODUCTION:** Reverse total shoulder arthroplasty (RTSA) reliably restores forward elevation; however, return of functional external rotation (ER) has been less predictable. Preoperative teres minor insufficiency has been demonstrated as a predictor of unsatisfactory ER following RTSA. However, there has been little investigation of the muscle activation patterns that generate ER postoperatively. We proposed to determine the timing and relative activation levels of the shoulder girdle musculature during external rotation in patients who have a well-functioning RTSA.

**METHODS:** This prospective study included patients from a single institution at least 1-year postoperative from a RTSA performed for superior rotator cuff deficiency with intact functional ER and an intact teres minor using a medial glenoid/lateral humerus design. Electrophysiological and kinematic analyses of their shoulder was performed during external rotation using dynamometry, seven surface EMGs and 3 needle EMGs (teres minor, teres major, posterior deltoid) placed along the upper extremity. Visual 3D was used to identify external rotation time series. Custom software (MATLAB, 2021a) was utilized to determine EMG onset and offset from which muscle fiber recruitment strategies were calculated.

**RESULTS:** Sixteen patients were included in the study with an average age of 71.9 years at an average postoperative period of 24.8 months. The average ASES score was 87.7, ASES subscore for ER 2.75 out of 3, and VAS 0.5. The sequence of muscle activation from IR to ER began predominantly with the upper trapezius, middle trapezius, and latissimus dorsi, followed by the anterior deltoid, which activated until the arm reached neutral rotation. As the arm continued to externally rotate past neutral, the teres major initiated external rotation against gravity followed by the teres minor and then the posterior deltoid. The teres major, teres minor, and posterior deltoid worked as equivalent contributors to ER.

**DISCUSSION:** The results of this study establish a sequence of muscle activation for external rotation in a well-functioning RTSA. The upper trapezius, middle trapezius and latissimus dorsi are likely initial scapular stabilizers, with the anterior deltoid powering external rotation towards neutral. Beyond neutral, the teres major, teres minor, and posterior deltoid function equally and sequentially to power maximal external rotation.

**Paper 201**

**Complications After Reverse Shoulder Arthroplasty for Proximal Humerus Nonunion**

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**INTRODUCTION:** Previous literature has shown a high complication profile in patients who undergo reverse shoulder arthroplasty after proximal humerus nonunion. However, this was at a single institution and the numbers may therefore be limited. The purpose of this study is to evaluate the outcomes of primary reverse shoulder arthroplasty (RSA) for nonunion of the proximal humerus.

**METHODS:** All patients at a single institution who underwent reverse shoulder arthroplasty for proximal humerus nonunion between 2014 and 2019 were included in this study. Inclusion criteria included 90 days or greater from injury to surgery and exclusion criteria included less than 1 year follow-up. Charts were retrospectively reviewed for demographic information, intraoperative information, postoperative complications, and reoperations. Postoperative radiographs were reviewed for evidence of tuberosity healing.

**RESULTS:** A total of 41 shoulders were included in this study. The mean follow-up time was 5 years (range: 1-11 years). The average patient age at time of arthroplasty was 71 years (range: 54-86). Thirty-one shoulders (76%) had been initially treated conservatively for their proximal humerus fracture and 10 shoulders (24%) were treated initially with open reduction internal fixation. Patients who were initially treated nonoperatively were more likely to show evidence of greater tuberosity healing on postoperative radiographs ( $p=0.0298$ ). The overall rate of complications was 29% (12/41 shoulders). The most common complication was dislocation (5 shoulders, 12%), and 4 of the 5 shoulders that sustained a dislocation required reoperation. The overall rate of reoperation was 22% (9/41 shoulders).

**CONCLUSION:** Reverse shoulder arthroplasty continues to be associated with a significant rate of complications and reoperations, nearly 30% in the current study. While this number is slightly decreased from prior study (41%), it is still clinically important. This information should be taken into account when counseling patients regarding treatment options. More data regarding risk factors for failure may be useful for optimizing successful surgical outcomes.



**Paper 202****Does Implant Innovation Optimize the Rates of Recovery After Reverse Shoulder Arthroplasty?**

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**INTRODUCTION:** In recent years, reverse shoulder arthroplasty (RSA) has seen an increase in utilization to treat a wide range of various shoulder pathologies. However, glenoid wear is a common obstacle for patients that undergo shoulder arthroplasty, resulting in higher failure rates and poor outcomes. To address this issue, augmented RSA glenoid components were introduced to treat patients with glenoid wear. Despite the increase in use of augmented RSA (aRSA), there has been limited literature on these new implants. The purpose of this study was to quantify the rate of recovery after aRSA compared to standard RSA.

**METHODS:** A retrospective review of 2,089 patients who were treated with primary RSA from 2007 - 2020 with both augmented and standard RSA was performed. The demographic variables, Constant-Murley score (CMS), and range of motion were collected preoperatively and at latest follow-up appointment. Change (delta) in clinical and functional outcomes were calculated from the pre- to postoperative period and compared. Time to recovery was compared between groups and recovery was defined as a Constant-Murley Score  $\geq 70$ . Statistical analysis included t-test with significance defined as  $p < 0.05$ .

**RESULTS:** The augmented group had less males (341) than standard group (381) ( $p = 0.002$ ). All other demographic variables and preoperative patient reported outcome metrics were comparable ( $p > 0.05$ ). Patients who underwent augmented RSA experienced significantly greater postoperative Constant score (63) ( $p < 0.001$ ) compared to Constant score of 59 in standard RSA, greater active forward elevation improvements (73 in aRSA vs. 58 in RSA), improvements in active abduction (aRSA=63 in AG vs. 51 for RSA), and improvement in active external rotation (aRSA=20 compared to 14 in RSA) ( $p < 0.05$ ). The rate of recovery for patients that had fully recovered was significantly shorter in the augmented RSA group with an average of 13 (+ 16) months following surgery compared to an average of 15 (+ 18) months for standard RSA patients ( $p = 0.03$ ).

**CONCLUSION:** Our results demonstrate that augmented baseplates more reliably improve rate of recovery, outcome scores and range of motion for RSA patients. This study is helpful for patients and orthopedic surgeons to understand that implant selection may significantly impact a patient's rate of recovery and outcome after RSA.

**Paper 203****Functional Outcomes and Complications Following Superior Humeral Head Resurfacing for Treatment of Compensated Cuff Arthropathy**

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Massive, irreparable rotator cuff tears remain a significant problem for orthopedic surgeons. Some of these patients develop compensated cuff arthropathy (CCA). In patients with CCA, contact between the humeral head and acromion is a known pain generator (PG). One surgical technique to address this PG is superior humeral head resurfacing (SHHR) with a stemless shoulder inlay implant. Patients who developed CCA with humero-acromial arthrosis and otherwise normal glenohumeral joint anatomy are ideal candidates. By targeting the PG, shoulder function may improve. The purpose of this study is to evaluate functional outcomes and complications of SHHR used to treat CCA without glenohumeral arthritis.

A retrospective study of patients who underwent SHHR between November 2014–May 2020 by a single community-hospital based surgeon was conducted. Patients who failed nonoperative treatment underwent diagnostic arthroscopy followed by glenohumeral joint inspection to confirm an irreparable rotator cuff. Subacromial decompression and minimal acromioplasty were also accomplished. Then, a mini-open, deltoid-splitting approach was performed to visualize the greater tuberosity, and a resurfacing implant was placed at the supraspinatus insertion lateral to the articular surface. Patients started active and passive range of motion on postoperative day 1. Range-of-motion, American Shoulder and Elbow Surgeons (ASES) assessment form, Pennsylvania Shoulder Score (PENN), and satisfaction scores were collected postoperatively. Complications were recorded.

Of the initial 21 patients (15 males), 19 were included in the final analysis as 1 patient died and one underwent conversion to reverse total shoulder arthroplasty. Mean age was 71 (range, 52–78). Mean follow-up was 36 months (12–64). Postoperatively, forward flexion increased (+19°), external rotation decreased (-9°), and abduction increased (+15°), but these were not statistically significant. Mean postoperative ASES and PENN were 81.0 and 77.6, respectively. Sixteen patients (84.2%) were satisfied with the procedure and 12 (63.3%) were very satisfied. Eighteen patients (94.7%) stated they would recommend the procedure to a family member.

SHHR for CCA showed good short-term functional outcomes and low revision rates with few complications. SHHR improved pain while preserving bone stock and the glenohumeral joint. This was achieved by minimizing contact between the acromion and greater tuberosity, a known PG. To our knowledge, no study has reported on pain and functional outcomes of the SHHR technique. We believe SHHR is a beneficial treatment option to reduce pain in patients with CCA and minimal glenohumeral arthritis.

**Paper 204****Evaluating the Utility of Perioperative Laboratory Tests in Primary Shoulder Arthroplasty**

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**BACKGROUND:** The rising incidence of primary shoulder arthroplasty (TSA) is associated with a \$4 billion increase in cost associated with this procedure by 2030. Studies have evaluated sources of cost containment, including inpatient services, namely routine perioperative laboratory tests. This study evaluates the utility of routine perioperative complete blood count (CBC) and basic metabolic panel (BMP) in TSA and identifies predictors of abnormal postoperative laboratory results and the need for medical intervention (NMI).

**METHODS:** All patients undergoing primary TSA from 2013 to 2020 at a single institution were included. Demographics, comorbidities, procedural details, pre- and postoperative CBC and BMP values were recorded. Abnormal values were identified for each laboratory marker. NMI was defined as postoperative blood transfusion, electrolyte repletion, fluid resuscitation, and inpatient medical consultation. Univariate and multivariate analyses were performed to determine independent predictors for abnormal postoperative CBC (AbCBC) and BMP (AbBMP) results and NMI. A p-value < 0.05 was considered statistically significant.

**RESULTS:** Of the 328 total patients, 202 (61.6%) subjects were female patients and median age was 70.5 years. Medical intervention was required in 115 (35.1%). There were no differences in rates of NMI based on patient demographics, comorbidities, and preoperative CBC and BMP results although there was a significant difference in rates of NMI when comparing postoperative serum potassium (4.1mmol/L no NMI group; 3.9mmol/L NMI group; p=0.039). Ultimately, there were no preoperative demographic, surgical or laboratory factors associated with postoperative NMI on regression modeling. Increasing BMI (odds ratio [OR] 1.08, 95% confidence interval [95%CI] 1.01-1.15, p < 0.03), preoperative serum glucose (OR 1.05, 95%CI 1.02-1.08, p=0.003), and preoperative serum BUN (OR 1.12, 95%CI 1.05-1.12, p=0.01) are associated with 8.0%, 5.0%, and 12% increases in odds of an AbBMP, respectively. Preoperative K is inversely correlated with AbBMP (OR 0.19, 95%CI 0.05-0.67, p=0.01).

**CONCLUSION:** AbCBC and AbBMP are not associated with NMI. Postoperative BMP tests should be considered in patients with elevated BMI, elevated preoperative serum glucose, elevated preoperative serum BUN, and those with preoperative serum hypokalemia. Postoperative CBC tests are not necessary after routine primary shoulder arthroplasty.

**Paper 206****Can Making Skin Incision with Electrocautery Eliminate C. acnes from Surgical Wound During Shoulder Arthroplasty? A Prospective Randomized Clinical Trial**

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**BACKGROUND:** C. acnes remains a challenging problem in shoulder arthroplasty. This prospective randomized clinical trial sought to test if making skin incision using electrocautery would decrease C. acnes contamination during shoulder arthroplasty. Our hypothesis was that making skin incision with electrocautery would result in significantly lower positive rates for C. acnes culture taken from the dermis of incised skin, surgeon's gloves, and forceps during shoulder arthroplasty compared to scalpels.

**MATERIALS & METHODS:** Patients undergoing primary anatomic or reverse total shoulder arthroplasty were randomized into two groups. Cefazolin or Vancomycin was administered intravenously within one hour of skin incision. Standard prep of the shoulder was undertaken. Standard deltopectoral incision was used in both groups. A swab culture from the dermis of the incised skin was obtained in both groups immediately after incision. Swab cultures of surgeon's gloves and forceps were taken immediately prior to humeral component implantation. Anerobic culture medium was used, and the samples were held for 14 days. Negative control culture (swab culture exposed to the operating room air for 5 minutes) was obtained in the first 23 patients. The primary outcome of the study is the proportions of positive C. acnes cultures from the dermis of incised skin.

**RESULTS:** 58 patients were enrolled with 29 in each group. The mean age was 69 years. There were 16 females with 8 in each group. In dermis swabs, 7 patients in the Scalpel group (24%) were positive for C. acnes, whereas no patients in the Electro group (0%) were positive ( $p < 0.001$ ). In glove cultures, both groups had 6 patients (20%) with positive cultures. Forceps cultures, both groups had 4 positive patients (13%). All positive cultures male patients, whereas not a single female patient had positive cultures for C. acnes. there was no significant difference in positive conversion time between groups or between different cultures ( $p > 0.05$ ).

**DISCUSSION:** Making skin incision with electrocautery resulted in zero positive dermis culture for C. acnes, compared to 24% in the scalpel group. C. acnes did grow in cultures taken later during surgery from surgeon's gloves and forceps in both groups. The source of C. acnes that grew in surgeon's gloves and forceps is unclear at this point. In conclusion, this study showed a potential antibacterial effect of electrocautery skin incision against C. acnes, but the problem of delayed C. acnes contamination of the surgical field remains and is yet to be addressed through future research.

Paper 207

**Reverse vs. Anatomical Total Shoulder Arthroplasty: A Comparison Study Evaluating Postoperative Range of Motion and Pain Over 24 months**

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**INTRODUCTION:** To date, there have been variable results comparing range of motion (ROM) and pain control between patients who undergo reverse total shoulder arthroplasty (rTSA) and those who undergo anatomical total shoulder arthroplasty (aTSA). Therefore, the primary purpose of this investigation was to compare these outcomes over 24 months. We hypothesized that patients who undergo aTSA will achieve significantly better ROM and pain control as compared to rTSA.

**MATERIAL & METHODS:** Following Institutional Review Board (IRB) approval, a retrospective review of all TSAs was conducted from January 2011 to June 2020. Patient descriptive characteristics, comorbidities, and preoperative Visual Analog Scale (VAS) score as well as active forward flexion (FF) and external rotation (ER) were queried from the electronic medical record. Postoperative VAS score and shoulder ROM were recorded at 2 months, 6 months, 12 months, and 24 months following surgery. In addition to frequency and descriptive statistics, independent samples t-tests as well as chi-square tests were used for statistical analysis.

**RESULTS:** After exclusions, 473 TSAs were included in our final analysis. Of these, 35% of cases were aTSA, while 65% were rTSA. When comparing VAS scores at 2 months, 6 months, 12 months, and 24 months, postoperatively, no differences were seen between aTSA and rTSA ( $p > 0.100$ ). Regarding ROM, aTSA cases achieved greater degree of active FF and ER at 2 months, 6 months, 12 months, and 24 months, postoperatively. Excluding active FF at 24 months, all mean differences in achieved ROM were statistically significant ( $p < 0.001$ ).

**DISCUSSION:** We observed superior ROM in patients who had aTSA as compared to those who had rTSA. This was true for all follow-up time points and was statistically significant. Pain control, however, was similar across 24 months. Our findings are on par with other available literature that has described superior ROM following aTSA. Our data can serve as a useful reference to shoulder and elbow surgeons while counseling patients for shoulder replacement surgery.

**Paper 208****Hemiarthroplasty for Non-Traumatic Avascular Necrosis of the Humeral Head is Associated with Low Complications and Reoperation Rates**

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**INTRODUCTION:** This was a retrospectively review of clinical and radiographic outcomes of patients who underwent hemiarthroplasty for non-traumatic avascular necrosis (AVN) of the humeral head and to review demographic and clinical factors that might affect patient outcomes.

**MATERIALS & METHODS:** Between 2009 and 2019, 68 hemiarthroplasties were performed for non-traumatic AVN at our institution with an average follow-up time of 6.5 years. 34 patients (50%) had underlying steroid and/or chemotherapy use, 17 (25%) were considered idiopathic, 9 (13.2%) had a hematologic or coagulopathic condition, 6 (8.8%) had radiation, and 2 (2.9%) had a history of alcohol abuse. Outcomes including revisions, re-operations, and complications were recorded. Range of motion (ROM) data and functional outcome scores were evaluated. Preoperative radiographs were reviewed for degree of AVN. Postoperative radiographs were reviewed to assess for stem loosening, humeral head subluxation, and glenoid erosion.

**RESULTS:** Postoperative ASES Scores were 74.5 and SST Scores were 75.3. Overall satisfaction with the operation was rated as 7.3 on a scale of 0-10. Average external rotation was 62 degrees and average active elevation was 163 degrees. No differences in outcomes scores or ROM were noted based on preoperative etiology, although the idiopathic group trended towards lower forward flexion compared to the steroid/chemotherapy group ( $p=0.07$ ). 3/68 (4.4%) patients suffered postoperative complications. The overall revision rate was 2/68 (2.9%), both involving conversion to anatomic total shoulder arthroplasty for progressive painful glenoid erosion. Radiographically, no patients had evidence of loosening. One patient (2.3%) had mild, two had moderate (4.5%), and one had severe (2.3%) subluxation of the humeral implant. 3 patients had mild (6.8%), 4 had moderate (9.1%), and 3 had severe (6.8%) glenoid erosion.

**DISCUSSION:** Hemiarthroplasty for non-traumatic AVN of the humeral head appeared to be better than those reported in the literature for post-traumatic AVN. Within the non-traumatic AVN cohort, those with an idiopathic underlying etiology may be prone to worse forward flexion. Postoperative glenoid erosion was generally well tolerated and did not appear to increase revision rates in the intermediate term follow-up.

**Paper 209****The Effect of Humeral Component Retroversion on External Rotation and Shoulder Function Outcomes in Patients Undergoing Reverse Total Shoulder Arthroplasty**

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**BACKGROUND:** Deficits in shoulder external rotation create significant limitations in activities of daily living, including eating and reaching the top of the head. Reverse total shoulder arthroplasty (rTSA) changes the mechanics of the shoulder and improves forward elevation reliably, but external rotation deficits frequently persist. There is currently a wealth of information regarding the impact of glenoid component lateralization, neck shaft angle, angulation of the glenoid component, and joint surface material on external rotation. However, the impact of humeral component retroversion is less understood. The purpose of this study was to compare strength and range of motion (ROM) in external rotation of patients undergoing rTSA at different degrees of humeral retroversion. We hypothesized that humeral retroversion at 30 degrees would result in more ROM and external rotation strength postoperatively than 0 degrees of retroversion.

**METHODS:** This is a retrospective study on patients who underwent rTSA with either 0 or 30 degrees of humeral component retroversion between November 2016 to 2018. A 36 mm sized-glenosphere with a system that lateralizes off the glenoid was utilized in all patients. Patient demographic information and postoperative outcomes at 3 months, 6 months, and latest follow-up including degree of external rotation, strength in external rotation, Visual Analog Scale for pain, Simple Shoulder Test score, and the American Shoulder & Elbow Surgeons score were recorded.

**RESULTS:** Outcomes for 38 patients were included (18 0-degree and 20 30-degree). No preoperative difference was observed between the two cohorts. There was no significant interaction between time and retroversion for any variable ( $p \geq 0.156$ ). Time had a significant effect on all outcomes ( $p \leq 0.002$ ) except for internal rotation ( $p = 0.166$ ). Retroversion did not have a significant effect on outcomes at any time point ( $p \geq 0.068$ ), though there was a trend towards significance for external rotation strength ( $p = 0.068$ ). External rotation at the side (ERS) increased from 25.0 to 35.3 degrees and external rotation in abduction (ERA) increased from 39.2 to 63.4 degrees from 3 months postoperative to final follow-up. ERS strength increased from 2.45 to 3.88 lbs, and ERA strength increased from 1.59 to 3.72 lbs from 3 months postoperative to final follow-up.

**CONCLUSION:** No difference in outcomes were observed between 0 and 30 degrees of humeral component retroversion. Strength in external rotation abduction may be impacted by humeral component retroversion. Further clinical studies with larger sample sizes are needed to study the impact of humeral component retroversion on external rotation abduction strength.

**Paper 210****Gait Abnormalities in Elderly Patients Undergoing Elective Shoulder Surgery**

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**INTRODUCTION:** Elderly patients undergoing elective shoulder arthroplasty or rotator cuff repair are at increased risk for falls. Sling immobilization and various gait parameters have been implicated in increased fall risk, namely gait velocity, stride length variability, and stride time variability. We aimed to determine how these parameters change postoperatively compared to preoperative levels. Additionally, if sling wear had any impact on these gait parameters. We hypothesized that in comparison to the preoperative time point, these gait variables would be negatively impacted postoperatively and by sling wear.

**METHODS:** A prospective cohort study of 38 patients older than 65 was designed. Patients underwent total shoulder arthroplasty or shoulder arthroscopy with rotator cuff repair. Postoperatively patients were immobilized in a sling and were formally evaluated at the 2 week, 6 week, and 3 month timepoints. Preoperatively and at each postoperative timepoint patients underwent walking trials on a gait analysis mat. Velocity, stride length variability, and stride time variability were compared. Preoperative gait with and without a sling was also compared. Statistical significance was determined via one-way analysis of variance testing with post hoc Bonferroni analysis.

**RESULTS:** Stride length variability between preoperative and all postoperative timepoints did not change significantly ( $p=0.184$ ). Stride time variability did not change across preoperative and all postoperative timepoints ( $p=0.433$ ). Lastly, velocity did not change between preoperative and all postoperative timepoints ( $p=0.745$ ). No differences were found in post hoc analysis between all gait parameters and timepoints as well ( $p>0.13$ ). Notably, there were no significant differences in the aforementioned gait parameters as a function of sling wear.

**DISCUSSION:** Postoperatively elderly patients are at a higher risk of falls after elective shoulder surgery. In our study velocity, stride length variability, and stride time variability were not found to change significantly within the first three postoperative months. Sling wear did not appear to affect these parameters. Our data suggests that these gait mechanics may not be the primary contributors to increased fall risk postoperatively. Rather, fall risk is likely multifactorial and further study is needed to identify potentially modifiable risk factors to decrease falls postoperatively.



**Paper 211****Effect of Steroid Injections on Preoperative Pain and Function Prior to Shoulder Arthroplasty**

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**BACKGROUND:** Subacromial and intraarticular corticosteroid injections are well-known short-term treatments used with the intent of reducing pain and improving function as a first line treatment for patients with shoulder pathology. However, little is known about the preoperative effect of steroid injections in patients who eventually undergo surgical shoulder replacement surgery. The purpose of this study was to determine the correlation of ipsilateral steroid injection on preoperative function and pain scores preoperatively for patients who eventually undergo shoulder arthroplasty.

**METHODS:** A retrospective chart review was performed on 347 patients who underwent shoulder arthroplasty by a single fellowship-trained orthopedic surgeon from 2017-2020. Patients were divided into two groups: non-injection SA group (NG) vs. injection SA group (IG), using criteria of at least one injection within one year prior to surgery. Patient demographics, range of motion (ROM), patient reported pain, and American Shoulder and Elbow Surgeons Score (ASES) were collected from latest preoperative visit and analyzed between groups.

**RESULTS:** The overall cohort had 54% females with an average age of 70.5 years and BMI of 29.7. There were 268 patients in the OG group and 75 patients in the IG group with a mean time from injection to surgery of 6.5 months. The IG had significantly more females (72% vs. 49%;  $p < 0.01$ ) and older average age 73.3 vs. 69.9;  $p = 0.016$ ). The IG had significantly greater ROM for active forward flexion ( $83.6^\circ$  vs.  $73.6^\circ$ ;  $p = 0.04$ ) and active abduction ( $74.3^\circ$  vs.  $62.3^\circ$ ;  $p < 0.01$ ). There was no significant difference in patient reported pain ( $p = 0.21$ ) or ASES score ( $p = 0.42$ ).

**CONCLUSIONS:** The results of our study indicate that patients who receive steroid injections within one year of shoulder arthroplasty have better ROM compared to patients who did not receive injections. The comparable pain, satisfaction, and ASES at the time of preoperative visit suggests no negative impact of steroid injections as first line treatment for shoulder arthritis, however, more research needs to be done to further elucidate which patients might benefit from a steroid injection vs. who will ultimately fail and proceed to surgical shoulder arthroplasty.

**Paper 212****Rate of Incidental Findings on Routine Preoperative Computed Tomography for Shoulder Arthroplasty**

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**BACKGROUND:** Incidental findings are commonly noted on advanced imaging studies. Little data exists regarding the rate of incidental findings on computed tomography (CT) obtained for preoperative planning prior to shoulder arthroplasty. This study aims to identify the incidence of these findings and the rate at which they warrant further work-up to guide orthopedic surgeons in counseling patients.

**METHODS:** A retrospective review was performed to identify patients with a preoperative shoulder CT and subsequently underwent anatomic total shoulder arthroplasty (TSA), reverse total shoulder arthroplasty (RSA), or shoulder hemiarthroplasty (HA) at a single institution between 2015-2021. Electronic medical records were reviewed to obtain demographic data including age, sex, and smoking status. Radiology reports for CTs were reviewed for incidental findings and were categorized based on location, tissue type, and/or body system. The rate of incidental findings was determined as well as the rate at which further work-up or follow-up is recommended by the radiologist.

**RESULTS:** A total of 617 patients were identified to have undergone TSA, RSA, or HA and received preoperative shoulder CT in the defined timeframe. Average age did not differ significantly between patients with incidental findings and those without ( $66.3 \pm 10.3$  years vs.  $64.9 \pm 10.1$  years;  $p = 0.152$ ). Sex also did not differ significantly between patients with and without incidental findings (43.8% female vs. 51.4% female;  $p = 0.111$ ). Smoking status did differ significantly between these groups with 22.6% of patients with incidental findings reporting that they were current smokers at the time of indication vs. 14.0% of patients without incidental findings ( $p = 0.021$ ). There were 173 incidental findings noted in 146 patients (23.7%) of our 617 patient cohort. These 173 findings ranged from pulmonary (59%), skin/soft tissue (16%), thyroid (13%), vascular (9%), spinal (2%), and abdominal (1%) findings. Of the pulmonary findings, 50% were pulmonary nodules and 47% were granulomatous disease. Overall, the final radiology report recommended further work-up or imaging for 50% of the patients with incidental findings.

**DISCUSSION:** Incidental findings are relatively common in preoperative CTs obtained for shoulder arthroplasty, occurring in up to a quarter of patients. The majority of findings are pulmonary in nature and are largely comprised of pulmonary nodules. Overall, half of the patients noted to have incidental findings were recommended further work-up. These results establish population data to guide orthopedic surgeons in patient counseling.

**Paper 213****Impact of Sickle Cell Disease in Shoulder Arthroplasty: A Matched Cohort Analysis**

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**BACKGROUND:** Sickle cell disease (SCD) is a genetic disorder of abnormal hemoglobin synthesis that is known to cause glenohumeral avascular necrosis (AVN). Little has been published on the use of shoulder arthroplasty (SA) for the treatment of glenohumeral AVN in SCD. We report on the clinical and radiographic results, and postoperative complications following SA in the patient cohort.

**METHODS:** A retrospective review was performed identifying 17 primary SA (9 hemiarthroplasty [HA], 7 anatomic total shoulder arthroplasty [aTSA], and 1 reverse total shoulder arthroplasty [RSA]) in patients with a confirmed diagnosis of SCD and a minimum of 2-year follow-up. This cohort was matched (1:2) according to age, sex, body mass index, type of prosthesis, and year of surgery with patients who had undergone HA or TSA for OA or RSA for cuff tear arthropathy. Outcomes included the visual analog scale for pain (VAS), American Shoulder and Elbow Surgeons score (ASES), range of motion (ROM) and strength measurements in forward elevation (FE), external rotation (ER), and internal rotation (IR).

**RESULTS:** Our cohort included 9 (52.9%) men with a mean age of 43 years. The average follow-up time was 5.9 years. In patients with SCD, SA provided significant improvements in VAS pain (9.1 to 3.8;  $P < .001$ ), FE (95° to 128°;  $P < .001$ ), ER (24° to 38°;  $P < .001$ ), IR score (3.2 to 5.2;  $P < .001$ ), FE strength (4.2 to 4.8;  $P < .001$ ), ER strength (4.1 to 4.7;  $P < .001$ ), IR strength (4.1 to 4.7;  $P < .001$ ), and ASES scores (48.6 to 73.5;  $P < .001$ ). When compared to the matched cohort, the SCD group demonstrated higher preoperative (9.1 vs. 3.8;  $P < .001$ ) and postoperative VAS scores (3.8 vs. 1.3;  $P < .001$ ). Other clinical outcomes demonstrated no significant differences. There were 5 (29%) complications, 2 (11.8%) episodes of sickle cell crisis, and 3 (18%) reoperations in the SCD cohort. When compared to the matched cohort, there were no statistical differences with respect to complications (29% vs. 12%;  $P = .140$ ) or reoperations (18% vs. 12%;  $P = .387$ ).

**CONCLUSIONS:** SA is an effective treatment modality for glenohumeral AVN in patients with SCD. Patients may expect improvements in pain, function, motion, and strength. However, final postoperative pain relief may be less than those treated with SA without SCD. Unique perioperative management is necessary to mitigate the risk of postoperative sickle cell crises.

**Paper 214****Risk Factors that Predispose Patients to Failure After Augmented Reverse Shoulder Arthroplasty**

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**INTRODUCTION:** Glenoid bone loss is a complex and difficult pathology to treat in the setting of total shoulder arthroplasty, resulting in higher failure rates and worse outcomes. To address this issue, augmented glenoid components were introduced, such as augmented glenoid baseplates in reverse shoulder arthroplasty (RSA). Despite the increase in use of augmented RSA (aRSA), there has been limited literature on these new implant innovations. The purpose of this study was to investigate risk factors that predispose aRSA patients to underperform. By quantifying shoulder outcome measures, the Minimal Clinical Important Difference (MCID) can assist in establishing a minimum threshold of improvement that defines aRSA performance.

**METHODS:** A retrospective review of 148 patients treated with aRSA from 2007-2020 by a single fellowship-trained orthopedic surgeon was conducted. Demographics, diagnoses, comorbidities, and clinical outcomes following aRSA were collected preoperatively and postoperatively at 3, 6, 12, and 24-month follow-ups. Risk factors associated with aRSA inability to achieve MCID were determined by comparing outcomes assessed by American Shoulder and Elbow Surgeons (ASES) scores across the collected patient characteristics at each time point. Underperformance based on MCID criteria (determined by the anchor-based method) was defined as a postoperative ASES score in the bottom 10% of the cohort and chi-square statistical analyses were performed.

**RESULTS:** At 3 months 10.7%, 6 months 2.4%, 12 months 2%, and 24 months 1.5% of patients met the MCID criteria for underperformance. Additionally, female patients and patients with rotator cuff arthropathy were more likely to underperform following aRSA at 3 months ( $p < 0.05$ ). There was no significant association between aRSA underperformance and ethnicity, BMI, arm dominance, implant device, previous shoulder surgery, preoperative and postoperative narcotic use, tobacco use, injections, and postoperative physical therapy. Additionally, no significance was seen with other comorbid conditions including hypertension, diabetes mellitus, inflammatory arthritis, cardiovascular disease, diagnoses of osteoarthritis, and rotator cuff tear.

**CONCLUSION:** Overall, aRSA has a high success rate with less than 10% of patients underperforming throughout the postoperative recovery period and only 1.5% of patients underperforming at 24 months. These results can provide surgeons with insight on the overall success rates of RSA and into how risk factors impact patient outcomes in the postoperative period. This can be used in practice to help counsel and tailor patient care to provide a more robust follow-up in these patient populations.

**Paper 215****Volume Distribution of Shoulder Arthroplasty Among Low and High-Volume Surgeons in the State of Iowa**

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**INTRODUCTION:** Repetition is a key component in the development of surgical skills. While repetition is important for enhancing a surgeon's proficiency and comfortability, care from high volume surgeons has also been shown to improve patient outcomes including lower complication rates, shorter hospital stays, and lower revision rates. Given the growing demand for joint arthroplasty in the United States, and the substantial increase in shoulder arthroplasties performed, it is important for patients and referring providers to recognize who is offering shoulder arthroplasty, their practice volume, and the implications of that volume on patients' outcomes. Prior research has shown that the majority of shoulder arthroplasty procedures tend to be performed by lower volume surgeons. However, much of this data is outdated, and there is no existing literature assessing these practice volumes in rural states. Therefore, the purpose of this study is to identify and compare shoulder arthroplasty practice patterns and volume distributions in the state of Iowa.

**MATERIALS & METHODS:** The Iowa Hospital Association Databank, a web-based database that collects information from 119 hospitals and health system members across the state of Iowa, was searched for total shoulder arthroplasty procedures. Using ICD-10 Procedure codes, total shoulder arthroplasty cases were identified. The database was queried for all shoulder arthroplasty cases during 2019 to limit the potential impact of the COVID-19 pandemic on volume distributions. Patient demographics, as well as surgeon and hospital identifiers were collected. Low volume surgeons were defined as those who performed less than 15 primary shoulder arthroplasty cases per year. Medium volume was defined as between 15 and 49 shoulder arthroplasty procedures per year. Surgeons were considered high volume if they performed 50 or more primary shoulder arthroplasty procedures per year. Similarly, low volume hospitals were defined as institutions where less than 15 arthroplasties were performed yearly, while medium volume was defined as between 15 and 49 per year. High volume hospitals were those that performed 50 or more primary shoulder arthroplasty procedures per year. The proportion of low, medium, and high volume surgeons and hospitals were assessed, as well as the number of primary shoulder arthroplasty procedures performed by low, medium, and high volume surgeons during the year 2019.

**RESULTS:** In 2019, a total of 1,926 primary shoulder arthroplasties were performed across the state of Iowa. These procedures were performed by 144 distinct surgeons, across 49 different institutions. In 2019, 74% (106/144) of surgeons were considered low volume, 20% (29/144) were considered medium volume, and only 6% (9/144) were considered high volume surgeons. However, during that same year, 44% (843/1926) of shoulder arthroplasty procedures were performed by high volume surgeons, 39% (742/1926) were performed by medium volume surgeons, and only 18% (341/1926) of shoulder arthroplasties were performed by low volume surgeons. Regarding hospital volume, only 20% (10/49) of institutions were considered high volume and 43% (21/49) were considered low volume. Similar trends were seen in the volume of shoulder arthroplasty

## **BREAKOUT SESSION #14 | ADULT RECONSTRUCTION: SHOULDER**

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procedures performed, in that 68% (1308/1926) were performed at high volume institutions, and only 5% (105/1926) were performed at low volume hospitals .

DISCUSSION: In the state of Iowa, while most surgeons performing shoulder arthroplasty are considered "low volume," and only a small portion are considered "high volume", almost half of all primary shoulder arthroplasty cases are ultimately performed by high volume surgeons. Additionally, the majority primary shoulder arthroplasties are performed at high volume hospitals. A considerably lower proportion of shoulder arthroplasty cases are being performed by low volume surgeons in low volume hospital settings. This data suggests a shift in the perception that most shoulder arthroplasty procedures are performed by low volume surgeons. Furthermore, this data may provide a glimpse into the evolution of practice patterns in shoulder arthroplasty.

**Paper 216****Utility of PACU vs. Postoperative Day 1 Radiographs Following Shoulder Arthroplasty**

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**INTRODUCTION:** Postoperative radiographs may be performed at different timelines after shoulder arthroplasty. Radiographs obtained in the postoperative recovery unit (PACU) are often of poor and do not alter patient care. The purpose of this study was to determine if PACU radiographs differed in quality from radiographs performed in the radiology suite at postoperative Day 1 (POD1) following shoulder arthroplasty.

**METHODS:** We retrospectively reviewed 392 consecutive shoulder arthroplasties performed between January 2020 and July 2021. There are two shoulder surgeons performing shoulder arthroplasty at our institution. One of our surgeons prefers to obtain postoperative radiographs in the PACU and at two weeks postoperatively, while the other surgeon prefers to obtain postoperative radiographs in the radiology suite on postoperative day (POD) 1 that are meant to serve as baseline. Our series included 50 consecutive anatomic total shoulder arthroplasties (TSA) and 50 consecutive reverse total shoulder arthroplasties (RSA) for which postoperative radiographs were obtained in the PACU. We also included 50 consecutive TSA and 50 consecutive RSA for which post-operative radiographs were obtained in the radiology suite on POD 1 prior to discharge. TSA radiographs were blinded and reviewed by 3 authors and graded on their quality using criteria described by Alolabi et al. RSA radiographs were reviewed for evidence of fracture or dislocation. The weighted kappa was used to describe the intra-rater agreement and inter-rater agreement between two raters.

**RESULTS:** There was no statistical difference in age, sex, BMI, and number of comorbidities between all groups. Intra-observer reliability was moderate to substantial with weighted kappa values of  $0.65 \pm 0.07$  (95% CI 0.51-0.80,  $p < 0.001$ ),  $0.58 \pm 0.09$  (95% CI 0.41-0.75,  $p < 0.001$ ), and  $0.67 \pm 0.07$  (95% CI 0.53-0.82),  $p < 0.001$ ). Inter-observer reliability was moderate to substantial with weighted kappa values of  $0.605 \pm 0.07$  (95% CI 0.46-0.75,  $p < 0.001$ ),  $0.66 \pm 0.07$  (95% CI 0.52-0.81,  $p < 0.001$ ), and  $0.65 \pm 0.08$  (95% CI 0.50-0.80,  $p < 0.001$ ). When assessing quality of radiographs, 30% of radiographs obtained in the PACU deemed of high quality while 57% of radiographs obtained in the radiology suite were deemed of high quality, which was statistically significant ( $p < 0.001$ ). 59% of two week postoperative radiographs were deemed quality. There were no changes in patient's post-operative courses based on imaging findings.

**CONCLUSION:** Postoperative radiographs in the PACU do not alter patient management and are often inadequate to serve as baseline radiographs.

**Paper 217****The Return to Activity for Patients Undergoing Revision RSA**

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**BACKGROUND:** Reverse shoulder arthroplasty (RSA) is becoming an increasingly common procedure with expanded indications. Previous studies indicate the survival rate of RSA is 58%-76% at 10 years postoperative and it is suspected that as the incidence of RSA rises, revision rates will rise as well. With this in mind, it is crucial for orthopedic surgeons to accurately estimate functional return and restoration of normal activities for patients undergoing revision RSA.

**METHODS:** This was a retrospective review of 41 patients who underwent revision RSA by a single fellowship-trained orthopedic surgeon. Patients were included in the analysis if they had a minimum of three follow-up visits and data was collected from pre- and postoperative visits at 3, 6, and 12-months. The mean American Shoulder and Elbow Surgeons (ASES) Score was calculated for each time point, with recovery being defined as an ASES score of 70 or greater. Statistical analyses were performed, via chi-squared tests, to compare overall ASES scores and to compare the proportion of patients who recovered between consecutive visits.

**RESULTS:** The mean age of our cohort was 66.85 with an average BMI of 28.75 kg/m<sup>2</sup>. Regarding gender and race, 70.7% were female and 87.8% Caucasian. The mean ASES score at pre-op was 34.27 and the mean postoperative score at 3 months 58.52, 65.74 at 6 months post-op, and 70.87 at 12 months post-op. The percentage of patients who reached an ASES score of 70 or greater at 3 months was 34.78%, 43.48% at 6 months, and 60.87% at 1 year. The only statistically significant difference between the proportions of recovered patients at consecutive time points was between pre-op and 3 months post-op ( $p < 0.05$ ).

**CONCLUSION:** Our results indicate that most patients will reach recovery by one-year postoperative after revision RSA. The most substantial improvements in ASES score and recovery rates was from six months to one year with improvements after that persisting at a much slower rate. This information is important for surgeons to help guide follow up and to better set expectations for when patients can expect to have the most improvement and ultimately recover after revision RSA.



**Paper 218****Oral Ketorolac as an Adjuvant Agent for Postoperative Pain Control Following Arthroscopic Anterior Cruciate Ligament Reconstruction: A Prospective, Randomized, Controlled Study**

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**INTRODUCTION:** Successful outpatient anterior cruciate ligament (ACL) reconstruction hinges on effective analgesia. Traditionally, oral narcotic agents have been the preferred analgesic postoperatively in orthopedic surgery. However, these agents have several known side effects and are associated with a potential for abuse. This study evaluates the efficacy of ketorolac, a non-steroidal anti-inflammatory drug with analgesic properties, as an adjuvant agent for postoperative pain control following ACL reconstruction.

**METHODS:** Adult patients undergoing primary ACL reconstruction were prospectively enrolled. Exclusion criteria involved patients with a history of bleeding diathesis, renal dysfunction, chronic analgesia use, or alcohol abuse. Eligible patients were randomized into one of two groups. The control group received a standard of care pain protocol involving oxycodone-acetaminophen 5-325 on discharge. The ketorolac group additionally received intravenous ketorolac postoperatively and three days of oral ketorolac on discharge. Pain levels and total narcotic utilization were recorded three times per day for the first five days after surgery. Pain and functional outcomes were obtained at two and six weeks postoperatively.

**RESULTS:** The final analysis included 48 patients; the mean age of the cohort was  $32 \pm 11.6$  years and 60.4% of patients were female. There were no differences in preoperative demographics, comorbidities, and preoperative functional scores between the two groups. Over the first five days after surgery, patients in the ketorolac group consumed a mean of 45.4% fewer narcotic pills than the control group ( $p < 0.001$ ) (Fig 1). Additionally, mean postoperative pain scores were 22.36 points lower for patients in the ketorolac group ( $p < 0.001$ ) (Fig 2). There was no difference in functional outcome scores at up to six weeks postoperatively or adverse events between the two groups with no reported cases of gastrointestinal bleeding.

**CONCLUSION:** The use of adjunctive intravenous and short-term oral ketorolac substantially reduces narcotic utilization and pain levels following anterior cruciate ligament reconstruction.

**Paper 219****Mid-Term Results of Particulate Articular Cartilage Implantation**

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**INTRODUCTION:** Articular cartilage injury is a devastating problem in patients of all ages, but particularly in the younger population. One traditional method of treatment is Autologous Chondrocyte Implantation (ACI), which has been upgraded to Matrix-Induced Autologous Chondrocyte Implantation (MACI). Both ACI and MACI require two surgeries. Emerging research and product development have proposed a one-stage particulate articular cartilage implantation (PACI). This study was conducted to evaluate the mid-term results of the one-stage PACI concept.

**METHODS:** A cohort of patients was prospectively evaluated following a one-stage PACI procedure of the knee. All patients suffering an articular cartilage injury large enough to require cartilage replacement ( $> 1\text{cm}^2$ ) and a candidate for traditional ACI were considered for the one-stage procedure. Minimum two-year follow-up was required. Outcomes were assessed through patient-reported questionnaires and MRI at one year postoperatively. Patient-reported outcomes including KOOS, IKDC, Lysholm, and SANE scores were collected. Data on previous surgery, concurrent surgery, and subsequent surgery were also recorded.

**RESULTS:** A total of 38 patients, involving 43 knees, underwent one-stage PACI; 17 were female and 21 male. The average patient age was 17 (Range: 13 - 33). Follow-up duration averaged 48 months. The average lesion size was  $2.6\text{ cm}^2$  (Range: 1 -  $7.5\text{ cm}^2$ ). There were 19 patellar lesions, 8 medial and lateral femoral condyle lesions, 6 trochlear groove lesions, and 2 tibial plateau lesions. Twenty-one knees had surgery prior to the PACI procedure. Thirty-one knees had simultaneous surgery and 11 knees underwent subsequent surgery.

KOOS pain, symptoms, ADL and QOL all decreased from their 2 to 4 year follow-up but only by one or two points. The KOOS Sport/Rec score improved by four points. The IKDC and Lysholm scores both decreased by two points, but the SANE increased by two. None of these changes were statistically significant. Follow-up MRI demonstrated cartilage incorporation in all patients. There was resolution of preoperative bony edema under the cartilage lesion and there was no undermining fluid signal beneath the new cartilage implantation. One patient developed some cartilage overgrowth.

**DISCUSSION/CONCLUSIONS:** This study reports the mid-term results of a one-stage particulate articular cartilage implantation. MRIs demonstrated cartilage incorporation and resolution of preoperative bony edema. Based on this series, at an average of four years, the one-stage PACI procedure maintains the previously reported significant improvement in patient-reported outcomes.

**Paper 220****Outcomes Following Arthroscopic Intervention for Arthrofibrosis After Anterior Cruciate Ligament Reconstruction**

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**INTRODUCTION:** Development of arthrofibrosis following anterior cruciate ligament reconstruction (ACLR) remains a clinical challenge. Though risk factors such as decreased preoperative range of motion, graft malposition, and unsatisfactory physical therapy are modifiable, a small percentage of patients developing arthrofibrosis ultimately require surgical or procedural intervention. Despite this, there remains a paucity of data following arthroscopic intervention for arthrofibrosis after ACLR. The purpose of this study was to 1) describe the patient demographics, injury and surgical characteristics, and patient reported outcomes (PROs) for those requiring arthroscopic intervention for loss of motion after ACLR, and 2) to compare outcomes between patients undergoing early intervention within three months vs. those undergoing late intervention after three months.

**METHODS:** All patients with a history of an ACLR and a subsequent operative procedure for postoperative arthrofibrosis at a single institution between 2000 and 2018 were retrospectively identified. Arthroscopic interventions included a lysis of adhesions (LoA), cyclops excision, or capsular resection with or without manipulation under anesthesia. Patients were excluded if they had knee dislocation, trauma with fracture, or less than two years of clinical follow-up. PROs including Tegner activity score, VAS, and IKDC scores were collected at final follow-up and comparisons made between groups receiving intervention before (early) or after three months (delayed) from the primary procedure.

**RESULTS:** A total of 40 patients were included with a mean age of 27.2 years and mean follow-up of 8.8 years. Following arthroscopic intervention, the mean arc of motion improved from 93° preoperatively to 131° postoperatively ( $p < 0.001$ ), and VAS improved from 3.0 to 1.2 ( $p = 0.001$ ). Thirteen patients (32.5%) underwent arthroscopic intervention within 3 months of index operation, while 27 (67.5%) interventions occurred after 3 months. The early cohort had higher post-intervention IKDC scores (86.8 vs. 71.7;  $p = 0.035$ ) compared to the delayed group. Compared to their pre-injury baseline, Patients with delayed intervention were more likely to require cyclops debridement (53.8% vs. 7.7%;  $p = 0.005$ ) and demonstrated a more significant drop in Tegner activity score (-2.4 vs. -0.3;  $p = 0.030$ ) from their preoperative baseline.

**CONCLUSION:** Arthroscopic intervention for loss of motion after ACLR successfully improves ROM and pain. Patients with both early and late intervention managed to obtain satisfactory knee ROM and functional outcomes, though improved IKDC scores were seen when intervention occurred within three months of the primary procedure.

**Paper 221****Hypermobile Lateral Meniscus: A Clinical Case Series Describing Diagnosis and Surgical Outcomes**

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**BACKGROUND:** Despite first appearing in the literature in the early 1990's, hypermobile lateral meniscus (HLM) remains a minimally defined and oft missed diagnosis. Although more mobile than its medial counterpart, disruption of key attachments of the lateral meniscus, such as the popliteomeniscal fascicles, may lead to extrusion-- causing episodes of pain and locking without true meniscus tear. There has been little study into the optimal methods for diagnosis and treatment. Thus, the purpose of this study was to elucidate the demographics, clinical presentation, radiographic features, and surgical outcomes for HLM.

**METHODS:** Natural language processing and text-searching tools were utilized to query medical records at an academic medical institution. Searches were focused on clinic and operative notes with the terms "hypermobile", "hyper mobile", and "lateral meniscus". Results were restricted to two campuses between January 1, 2000 to January 1, 2020. Records were excluded if patients were treated nonoperatively, had evidence of meniscus tear, multiligamentous knee pathology, or lacked two-year follow-up. Data collection and analysis were done in Excel and JMP, respectively.

**RESULTS:** Seventeen patients representing 18 knees met inclusion criteria. The mean age was 24.1 (range 6-61) years. Mean follow-up was 62.5 months (3 months - 151 months). There were more male knees (56%, 10/18) and mean BMI was 26.3 (range 19.5-36.1). The majority of the cohort participated in sport (72.2%, 13/18) and had hypermobility of the left meniscus (72.2%, 13/18). All eighteen knees had pain symptoms, while 94% (17/18) experienced mechanical symptoms. Two-thirds had been evaluated by at least one orthopedic surgeon for symptoms before referral to this institution. All knees had preoperative MRIs, but only seven knees were noted to have clear fascicle tears by senior surgeons, and only one knee had the correct diagnosis via MSK-trained radiologist interpretation. Most repairs were performed with an all-inside technique (61%, 11/18). Postoperatively, 78% (14/18) knees had complete resolution of pain and 67% (12/18) had resolution of mechanical symptoms. Only one (5.6%, 1/18) knee required meniscus revision surgery.

**CONCLUSION:** HLM continues to be a diagnostic dilemma. These patients may see multiple providers, have incorrectly interpreted imaging, and undergo various treatments prior to successful diagnosis. This case series demonstrates the strong possibility of identifiable trends in patient presentation; recognition of these factors may lead to a timely, accurate diagnosis and appropriate intervention. Moreover, it highlights the role of surgery as a reliable solution for mechanical symptoms and pain for patients with HLM.

**Paper 222****Anterior Cruciate Ligament Tears in the Adolescent Population: Injury Demographics and Risk of Re-Injury Amongst High School Athletes**

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**INTRODUCTION:** Anterior cruciate ligament (ACL) injuries are becoming increasingly common in adolescents due to increased participation in organized sports and year-round training regimens. There is a lack of literature specifically investigating the impact of type of sport played and mechanism of injury on primary and recurrent ACL tears and surgical management amongst high school athletes. The purpose of this study is to characterize recent epidemiologic trends of ACL injuries, ACL reconstruction, and re-tear rates in high school adolescents based on age, participating sport, and mechanism of injury.

**METHODS:** A prospectively maintained institutional database was retrospectively reviewed for all patients 18 or younger who underwent primary ACL reconstruction between 2015 to 2020. Electronic medical records (EMR) were reviewed for patient demographic information and documentation review from prior injury/surgery. Odds ratios were calculated for baseline patient characteristics and their association with risk of re-tear. Multivariate regression (MVR) analysis was also performed to identify the relationship between re-tear and specific categorical variables.

**RESULTS:** A total of 482 patients were included in analysis. Patients were an average age of  $16.0 \pm 1.36$  (range: 13-18) at injury presentation for initial ACL tear. Adolescents who played soccer, and patients who underwent ACL reconstruction with hamstring autograft had increased risk of re-tear. Black adolescents participating in sports had a decreased risk of ACL re-tear compared to White adolescents. When adjusting for multiple variables, (including age, sex BMI, primary graft choice, sport, follow-up), odds of re-tear in 13 and 14-year-olds and 18-year-olds, patients who received hamstring autograft or participated in contact sports, was increased. Patients who were Black or had a BMI of 30 or higher had lower adjusted odds of re-tear.

**DISCUSSION & CONCLUSION:** Initial presentation of ACL injuries in high school athletes often occurs at 16 or 17 years old, with similar distribution based on participating sport (predominantly football, soccer, and basketball). Based on age, high school seniors are found to have an increased risk of ACL re-tear and freshman also have increased risks of ACL re-tear. However, the overall rate of ACL re-tear in high school athletes of all ages is low. High school athletes must take caution when initiating sport participation (underclassman) and when playing at high level intensity (upperclassman), as susceptibility for ACL re-tear is elevated.

**Paper 223****Social Determinants of Health Influence Outcomes and Health Care Utilization Following Anterior Cruciate Ligament Reconstruction**

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**BACKGROUND:** Social Determinants of Health (SDOH) refer to social and economic factors that influence a patient's health status. The effects of SDOH on National Institutes of Health (NIH) Patient-Reported Outcomes Measurement Information System (PROMIS) Computer Adaptive Test (CAT) scores and on postoperative resource utilization in anterior cruciate ligament reconstruction (ACLR) patients have yet to be thoroughly investigated.

**PURPOSE:** To investigate the impact of SDOH on PROMIS CAT outcomes and postoperative resource utilization in ACLR patients.

**METHODS:** Patients who underwent ACLR between July 2017 and April 2020 were included. The electronic medical record was used to identify SDOH for each patient. PROMIS Computer Adaptive Test (CAT) measures of Physical Function ("PROMIS PF"), Pain Interference ("PROMIS PI"), and Depression ("PROMIS D") were completed preoperatively and postoperatively (6-months and 12-months). Postoperative health care utilization (clinical visits, virtual encounters, imaging encounters, and physical therapy visits) were recorded as well. Independent two-group t-tests and Wilcoxon rank-sum tests were used to analyze mean differences between patient groups based on SDOH.

**RESULTS:** 230 ACLR patients were included with a mean age of 27.1 years and a male predominance (59.1%). Black patients were represented more frequently in the lowest MHI Quartile (62.9% vs. 22.9%, respectively;  $p < 0.001$ ), while also having a higher Area Deprivation Index (ADI) (70.1 vs. 45.9, respectively;  $p < 0.001$ ) when compared to white patients. Black patients, patients in lower MHI quartiles, patients with higher ADI indexes, employed patients, patients with public healthcare coverage, female patients, and smokers reported significantly worse PROMIS PF, PI, and D scores at preoperative, 6m, and 1y postoperative timepoints when compared to their respective counterparts. Black and unemployed patients attended significantly fewer postoperative PT visits when compared to their respective counterparts. Patients with public healthcare coverage attended fewer postoperative PT visits compared to privately insured patients, although these findings only approached significance. Patients in lower MHI quartiles and retired patients had significantly more postoperative imaging encounters compared to their respective counterparts. Female patients had more postoperative virtual encounters than male patients.

**CONCLUSION:** SDOH variables that reflect racial and socioeconomic disparities are associated with differences in postoperative health care utilization and ACLR outcomes as measured by PROMIS CAT domains. Taking into account an ACLR patient's SDOH may help in improving outcomes and adherence to postoperative management.

**Paper 224****Influence of Femoral Tunnel Interference Screw Diameter on Pull-Out Strength and Failure Mode During Anterior Cruciate Ligament Reconstruction: A Biomechanical Study**

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**INTRODUCTION:** Anterior Cruciate Ligament reconstruction (ACLR) can be performed with a variety of options. Bone-patellar tendon-bone (BTB) autograft is considered by many to be the gold standard. Prior studies support the use of 7mm or larger interference screws for femoral tunnel fixation. However, with modern materials and fixation techniques may allow for adequate fixation with smaller interference screw size. The use of a smaller screw for femoral sided fixation leads to preservation of the native bone and a larger surface-area to volume ratio for graft incorporation to improve biologic healing. The purpose of this study was to determine the effect of interference screw diameter on the pull-out strength and failure mode of femoral tunnel fixation in ACLR at time zero fixation.

**METHODS:** Twenty-four fresh-frozen cadaveric knees were obtained from 17 different donors (United Tissue Network, Phoenix, AZ). Specimens were allocated to three different treatment groups (n=8 per group) based on interference screw diameter: 6mm, 7mm, or 8mm biointerference screw (Arthrex, Naples, FL). All specimens underwent DEXA scanning prior to allocation to ensure no difference in bone mineral density among groups (p=0.99). All specimens underwent femoral-sided ACLR with bone-patellar tendon-bone (BTB) autograft. Specimens subsequently underwent mechanical testing under monotonic loading conditions to failure. The load to failure and failure mechanism were recorded. One-way analysis of variance was performed to assess for differences in load to failure. Chi-squared test was performed to assess for difference in failure mechanism. A priori power analysis was performed to ensure 90% power. Data are reported as mean (standard deviation). Significance was set at p=0.05.

**RESULTS:** Load to failure (N) for each group was 308.6 (213.3), 518 (313), and 541 (267) for 6mm, 7mm, and 8mm diameter screws, respectively. There was no difference in pull out strength among the three groups (p=0.228). One specimen in the 6mm group, 2 specimens in the 7mm group, and one specimen in the 8mm group failed by screw pullout, the remainder in each group failed by ligament failure. There was no difference in failure mode observed among the three groups (p=-0.74).

**DISCUSSION:** No difference in pull out strength or failure mode was observed among interference screw diameters. These findings suggest that there is no difference in ACL femoral tunnel BTB pull-out strength and failure mechanism among 6mm, 7mm, and 8mm biointerference screws at time zero fixation.

**Paper 225****Predicting Risk Factors for All Cause Reoperation After Anterior Cruciate Ligament Reconstruction: A Machine Learning Approach**

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**INTRODUCTION:** Although a typically successful procedure, reoperations do occur after anterior cruciate ligament reconstruction (ACLR). Identifying predictive factors of all cause reoperation after ACLR can inform clinical decision making, improve risk mitigation, and enhance patient education. The purpose of this study was to determine incidence of reoperation after ACLR and develop an interpretable machine learning model to identify predictors of all cause reoperation after ACLR.

**METHODS:** A longitudinal geographical database was utilized to identify patients with a diagnosis of new anterior cruciate ligament injury between 1990 and 2016 with minimum 2-year follow-up. Patients were reviewed and those who underwent reoperation after ACLR were selected and analyzed. Eight machine learning models were appraised on their ability to predict all cause reoperation after ACLR. Model performance was evaluated via discrimination using area under the receiver operating characteristics curve (AUROC) and calibration plots. To explore modeling interpretability and radiomic feature influence on the predictions, we utilized a game-theory-based method through SHapley Additive exPlanations (SHAP).

**RESULTS:** A total of 1,400 patients underwent ACLR with a mean postoperative follow-up of 107 months. Of these, 218 (16%) experienced a reoperation after ACLR. GradientBooster was the best performing model for predicting all cause reoperation after ACLR (AUROC = 0.73) and outperformed logistic regression in this regard. SHAP plots identified the following risk factors (in order of relative influence) predictive for all cause reoperation: distal tear location, diagnosis of systemic inflammatory disease, malalignment of the knee, Workers' Compensation (WC) claims, tibial fixation via an expansion mechanism (bulging of the graft), higher VAS score prior to surgery, current smokers, and concomitant meniscal repair.

**CONCLUSION:** While outperforming traditional statistics, machine learning models identified distal tear location, diagnosis of systemic inflammatory disease, malalignment of the knee, WC claims, tibial fixation via an expansion mechanism (bulging of the graft), higher VAS prior to surgery, current smokers, and concomitant meniscal repair as predictive risk factors for all cause reoperation after ACLR. After further generalization, these models may provide information for surgeons which could increase their ability to risk mitigate and educate patients on their potential risk factors prior to ACLR.



**Paper 226****Improved Return to Weight-Bearing After Implantable Shock Absorber (ISA) Compared to HTO for Medial Compartment Knee OA**

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**PURPOSE:** After exhausting non-surgical treatments, patients with moderate medial knee OA who are not candidates for arthroplasty because of age, disease severity, or desired activity level have limited options. For this working-age population, recovery from surgery is an important factor in the decision to select treatment. A surgically implantable shock absorber (ISA) has been developed to address this clinical need. The device is implanted subcutaneously in the medial extra-capsular space and allows immediate range of motion and weightbearing. This study compared recovery after ISA implantation to HTO.

**METHODS:** Eighty-one patients were prospectively enrolled in an international, multicenter trial of the ISA and compared to a previously enrolled control group of 81 patients who underwent HTO. The two groups had similar baseline characteristics for KL grade, BMI, symptom duration, opioid usage, and patient sex and age. The ISA was implanted through a single incision and placed using procedure-specific instrumentation, fluoroscopic guidance, and surgical techniques familiar to sports medicine surgeons. Patients returned for post-treatment follow-up visits at 6 weeks and 3, 6, 12, 18 (ISA only), and 24 months. Return to partial and full weightbearing and safety events were compared between the ISA and HTO groups through two-year follow-up visits.

**RESULTS:** The operative time was 70.7 minutes for the ISA arm and 65.4 minutes for the HTO control arm ( $p > 0.05$ ). The estimated blood loss was 4.6 cc for the treatment arm and 42.4 cc for the control arm ( $p < 0.001$ ). 90.5% of ISA patients treated in the US were treated on an outpatient basis, with a 9.6 hour length of stay. HTO patients reported a 40.7 hour length of stay. ISA patients achieved partial weight bearing at 3.8 days compared to 28.2 days in the HTO group ( $p < 0.001$ ). The trend was repeated for return to full weightbearing, with ISA patients reporting 13.4 days compared to HTO patients reporting 58.0 days ( $p < 0.001$ ). There were zero mechanical device malfunctions in either study arm. One patient in each group underwent elective joint-modifying surgery through two years.

**CONCLUSION:** This study demonstrates a favorable procedure and recovery profile for the ISA compared to HTO. With no weightbearing or study-imposed limitations on return to activity and the availability to be performed in an outpatient setting, the ISA has potential to offer patients an attractive alternative for the treatment of moderate medial knee OA.

**Paper 227****Outcomes of Surgical Stabilization for Recurrent Patellar Instability in Competitive Wrestlers: Outcomes, Reoperations, and Return to Play at Six Years Mean Follow-Up**

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**INTRODUCTION:** Wrestling is a physically demanding sport with athletes prone to knee injuries and lateral patellar dislocations. However, there is a paucity of data evaluating the results of patellofemoral stabilization surgeries (PSS) for recurrent patellar instability (RPI) in this cohort. The purpose of this study was to assess return to play (RTP), patient-reported outcomes (PRO), and reoperation rates following PSS for RPI in a cohort of competitive wrestlers.

**METHODS:** All competitive wrestlers with a history of an RPI and subsequent PSS at a single institution between 2000 and 2020 were identified. Primary PSS ranged from MPFL reconstruction (n = 31; 50%) or reconstruction (n = 22; 33.5%), and other (n = 9; 14.5%) in the form of tibial tubercle osteotomy (TTO), lateral retinaculum release (LRR), and medial retinaculum reefing (MRR). Exclusion criteria included revision PSS, or concomitant anterior cruciate ligament reconstruction or multi ligament knee injury. All patients were contacted for determination of reinjury rates, current sport status, and PROs.

**RESULTS:** Ultimately, 62 knees in 56 wrestlers were included at a mean follow-up time of 6.6 years (range, 2.0 – 18.8 years). RTP occurred in 55.3% of wrestlers at a mean of  $8.8 \pm 6.7$  months. Among the PSS no differences were observed between rates of RTP (P = .676), postoperative pain (P = .176), Tegner activity level (P = .801), International Knee Documentation Committee (P = .378), Lysholm (P = .402), or Kujala scores (P = .370). Complications were observed in 29% of knees with RPI as the most common complication (n = 13, 21%). Among PSS types, MPFL reconstruction had the lowest rate of complications (9.7% vs. 40.9% vs. 66.7%; P < .001), RPI (6.5% vs. 27.3% vs. 55.6%; P = .005), and surgical failure (9.7% vs. 31.8% vs. 55.6%; P = .008). Kaplan-Meier survivorship free from surgical failure of the entire cohort was 91.9% at 1 year, 77.7% at 5 years, and 65.7% at 15 years. MPFL reconstruction had the highest survivorship when compared to MPFL repair and other PSS up to 10 years after the index surgery (90.3% vs. 64.1% vs. 27.8%; P = .048).

**CONCLUSIONS:** Return to competitive wrestling was observed in 55.4% of athletes after ACLR, with 21% of wrestlers experiencing RPI despite PSS. MPFL reconstruction may serve as a more durable graft for competitive wrestlers with lower rates of RPI and failure when compared to other PSS up to 10 years after surgery.

**Paper 228**

**Use of Fantasy Points in Evaluating Professional Athlete Performance After ACL Reconstruction**

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**INTRODUCTION:** Our aim in performing this study was to evaluate whether fantasy and wins above replacement (WAR) scores of athletes undergoing ACL reconstructive surgery in NFL, NBA, NHL, and MLB players could be utilized in evaluating their performance post-surgery.

**METHODS:** We identified publicly accessible data from a cohort of professional players who underwent ACL reconstruction. Data was obtained through newspaper archives, injury reports, player profiles, and press releases between 1992 and 2015. Fantasy and Wins Above Replacement (WAR) scores were calculated for each player.

**RESULTS:** A total of 81 professional players met inclusion criteria. Decreased fantasy scores ranged from 50-60% across the four leagues after the index operation. NHL players had the lowest RTP at 11/14 (79%) and MLB players had the highest RTP at 14/15 (93%). RTP for NBA and NFL were comparable at 22/26 (85%) and 23/26 (88%), respectively. NFL players had the lowest average career length after surgery at 26 months, while NBA players had the longest average career length at 64 months. MLB players on average required the longest time to return to pre-surgical level of performance (21 months). NHL players had the shortest average recovery time (8 months) and NBA players had the longest average recovery time at 13 months.

**DISCUSSION & CONCLUSION:** Approximately, half of all the players studied exhibited a decline in fantasy score or WAR. In addition, NFL players had the lowest average career length and NBA players enjoyed the longest average career length after surgery. NHL players had the lowest recovery time, while the NBA players had the longest recovery time. This may be a reflection in the relative physical demands of each sport and differences in medical adherence protocol or differences in medical clearance protocols. The strength of this study is the utilization of fantasy points and WAR as a single unifying measure of a player's performance. Based on these study

**RESULTS:** The average performance of an elite athlete tends to decrease after undergoing ACL reconstruction. Although it appears that performance peaks in the initial years after the operation for some players, there is an overall long-term performance decline. More studies are needed to better understand the effects of ACL reconstruction in elite athletes; however, the use of fantasy scores may be an objective tool in measuring the success rate of ACL reconstruction.

Paper 229

**Return to Sport Following Anterior Cruciate Ligament (ACL) Reconstruction in Athletes Using Hamstring Tendon vs. Quadriceps Tendon Autograft**

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ACL tears are common among athletes. While research has been conducted comparing bone-patellar tendon-bone (BPTB) and hamstring tendon (HT) grafts in return to sport (RTS), less research has been done comparing quadriceps tendon (QT) grafts.

**PURPOSE:** To determine whether QT autografts have superior RTS results compared to HT autografts.

**METHODS:** 217 recreational and competitive athletes ages 13-24 who underwent ACL reconstruction between 2017 and 2022 were included in the study, of which 103 had HT autografts and 114 had QT autografts. RTS rates, RTS testing results, RTS clearance time, and reinjury occurrence were collected. RTS testing consisted of isokinetic testing quadriceps and hamstrings muscles and jump testing.

Chi-square statistics and Wilcoxon rank-sum tests were used to detect differences between the HT and QT groups on categorical and continuous variables, respectively. Statistical significance level was set to  $p < 0.05$ .

**RESULTS:** The median age of patients undergoing HT and QT autograft repairs were 18 and 16, respectively ( $p = 0.0008$ ).

Of 28 HT athletes, 26 returned to competition (92.86%), and 31/33 (93.94%) QT athletes returned to competition ( $p = 0.8649$ ). Of 30 HT athletes, 26 returned to previous level of play (86.67%), and 34/44 (77.27%) QT athletes returned to previous level of play ( $p = 0.3111$ ).

Median isokinetic quadriceps testing at 60 degrees/second among 23 HT athletes was 95% ( $p = 0.0603$ ) and 84% among 75 QT athletes. Median hamstring isokinetic testing at 60 degrees per second was 88% ( $p = 0.0011$ ) for 21 HT athletes and 102% among 75 QT athletes. HT athletes had a median of 3 tuck jump errors among 20 athletes ( $p = 0.308$ ), and QT athletes had a median of 2 errors among 73 athletes. Median time to initial RTS testing was 29.30 weeks ( $p = 0.0733$ ) for 25 HT athletes and 25.89 weeks for 75 QT athletes.

Time to physician clearance was 28.51 weeks among 54 HT athletes ( $p = 0.0003$ ) and 35.48 weeks among 66 QT athletes. There was a 9.90% ACL graft re-tear rate in the HT group and 5.31% rate in the QT group ( $p = 0.2024$ ).

**CONCLUSION:** Return to sport rates were high for HT and QT autograft ACL reconstructions. QT athletes were tested about three weeks sooner. HT athletes performed better on isokinetic quadriceps testing, while QT athletes performed better on isokinetic hamstring testing and functional testing. HT athletes were more likely to suffer a subsequent ACL tear.

**Paper 230****Improved Biomechanical Performance and Excellent Clinical Outcomes with the Use of Suture Anchors for Patellar Tendon Repair: A Scoping Review**

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**INTRODUCTION:** Patellar tendon rupture is an uncommon, but significant injury of the knee extensor mechanism with an increasing incidence. Transosseous repair (TO) has been considered the gold standard technique for patellar tendon repair, however, the use of suture anchors (SA) has been suggested to have potential biomechanical advantages. The purpose of this systematic review is to summarize the literature reporting on SA usage for patellar tendon repairs.

**METHODS:** A systematic literature review utilizing the Preferred Reporting Items for Systematic and Meta-Analyses (PRISMA) guidelines was performed using the electronic databases PubMed, Embase, and the Cochrane Library. Inclusion criteria consisted of studies with suture anchor usage for patellar tendon repair, cadaver and animal biomechanical studies, technical studies, and clinical studies.

**RESULTS:** Our study identified 107 eligible studies for full-text review with 25 studies meeting inclusion criteria.

**Human Cadaver Biomechanical** - A total of 6 studies were included with 129 cadaveric specimens that underwent patellar tendon repair with 66 receiving a suture anchor repair. Three studies found significantly less gap formation in SA cohorts compared to TO cohorts at various cycles ( $p=0.009$ ,  $p<0.05$ ,  $p=0.03$ ). One study found significantly increased load to failure in the SA cohorts compared to the TO cohort ( $p<0.05$ ).

**Animal Biomechanical Studies** - Three studies were included with 128 animal model specimens with 54 receiving SA repair. One study found significantly less gap formation with SA repair compared to TO ( $p<0.001$ ). One study showed significantly increased load to failure with SA repair compared to TO ( $p<0.001$ ).

**Technical studies** - Seven technical studies were included with a total of 11 patients undergoing a patellar tendon repair with SA for fixation. Five studies reported acceptable outcomes.

**Clinical Studies** - Nine clinical studies were included with a total of 405 patients with 419 knees. One study found a statistically significant reduction in re-rupture rate in the SA group compared to the TO group (0% vs. 7.5%;  $p=0.034$ ). Four studies reported excellent return to activities of daily living and return to sport. Six studies reported excellent return of knee range of motion.

**CONCLUSION:** We found that SA repair is a viable option for patellar tendon repair. Multiple studies indicate that it provides a biomechanically superior repair option within human cadaver and animal models. Patient outcomes seen in these articles indicated effective strength, good range of motion, appropriate return to activities, and decreased rate of re-rupture.

**Paper 231****Association of Long Distance Running with Hip and Knee Arthritis**

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**INTRODUCTION:** Long-distance running is a popular form of cardiovascular exercise with many well-described health benefits, from improving heart health to the management of obesity, diabetes, and mental illness. The impact of long-distance running on joint health in recreational runners, however, remains inconclusive. The goal of this project was to examine the cumulative effect of long-distance running over a lifetime and the presence of hip and knee osteoarthritis.

**METHODS:** A survey was distributed to all participants registered for the 2019 or 2021 Chicago marathon (n=37,917). Surveys collected runner demographics and assessed for hip/knee pain, osteoarthritis, family history, surgical history, and running-related history. Running history included the number of marathons run, number of years running, average running pace, and average weekly mileage. The overall prevalence of osteoarthritis was identified, and a multivariable logistic regression model was used to identify variables associated with the presence of hip and/or knee osteoarthritis.

**RESULTS:** Surveys were completed by 3,804 participants. The mean age was 43.9 (range, 18-83) and participants completed on average 9.5 marathons (median 5, range, 1-664), ran an average of 27.9 miles per week (median 25, range 0-180), and had been running for a mean of 14.7 years (range, 1-67). Hip and/or knee pain over the prior year was reported by 36.3% of participants and the prevalence of hip and/or knee arthritis was 7.3%. A history of hip/knee injuries or surgery, advancing age, family history, and BMI were risk factors for arthritis. Cumulative number of years running, number of marathons completed, weekly mileage, and mean running pace were not significant predictors for arthritis. The majority (94.2%) of runners planned to run another marathon, despite 24.2% of all participants being recommended by a physician to reduce their running volume or stop all together.

**CONCLUSION:** From this largest surveyed group of marathon runners, the most significant risk factors for developing hip or knee arthritis were age, BMI, previous injury or surgery, and family history. There was no identified association between cumulative running history and the risk for arthritis. Healthcare providers should consider these results before advising their patients reduce or eliminate running as a form of exercise to reduce arthritic risk.

**Paper 232**

**Predicting the Risk of Post-Traumatic Osteoarthritis Following Anterior Cruciate Ligament Reconstruction: A Machine Learning Time to Event Analysis**

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**BACKGROUND:** There is long-term risk of post-traumatic osteoarthritis (PTOA) after anterior cruciate ligament reconstruction (ACLR). Elucidating the risk factors and identifying at-risk patients is challenging.

**PURPOSE:** To produce machine learning survival models that predict 1) patients at risk of symptomatic PTOA and 2) patients who are treated with total knee arthroplasty (TKA) following ACLR. We hypothesize these models will outperform traditional Kaplan-Meier (KM) estimators.

**METHODS:** A geographic database identified patients undergoing ACLR between 1990 and 2016 with minimum 7.5-year follow-up. Models analyzed various factors to predict the rate and time to 1) symptomatic osteoarthritis and 2) TKA using random survival forest (RSF) algorithms. Performance was measured using Out-of-bag (OOB) c-statistic, calibration, and Brier score. Predictive performance of the RSF models were compared to KM estimators.

**RESULTS:** 974 ACLR patients with a minimum follow up of 7.5 years were included, among these 215 (22.1%) developed symptomatic osteoarthritis, and 25 progressed to TKA (2.6%). The RSF algorithms achieved good to excellent predictive performance for symptomatic arthritis (OOB c-statistic 0.76, Brier score: 0.128) and progression to TKA (OOB c-statistic 0.89, Brier score: 0.026), respectively. Significant predictors of symptomatic PTOA included increased pain scores, older age, increased BMI, increased time to ACLR, number of arthroscopic surgeries before the diagnosis of arthritis, positive pivot-shift after reconstruction, concomitant chondral injury, secondary meniscus tear, inappropriate return to full activity, and use of allograft. Significant predictors for TKA included older age, increased pains scores, number of arthroscopic surgeries, high-demand activity/occupation, hypermobility, higher BMI, systemic inflammatory disease, increased time to surgery, return to full activity before one-year, and mid-substance tears. Brier score over time revealed that RSF models outperformed Kaplan-Meier estimators.

**CONCLUSION:** Machine learning survival models reliably identified patients at risk of developing symptomatic PTOA and consistently outperformed traditional Kaplan-Meier estimators.

**Paper 233****Coronal Plane Alignment Does Not Affect Outcomes After Transtibial Meniscus Root Repair**

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**OBJECTIVES:** Meniscal root tears, defined as a radial tear occurring within 1 cm of meniscal attachment or an avulsion of the meniscus attachment site to bone. Previous studies have identified patient demographics and lower extremity coronal plane alignment as important factors that can impact postoperative clinical outcomes. However, there is no standardized set of guidelines to identify proper surgical candidates for meniscal root repair based on coronal plane alignment. The purpose of this study was to evaluate the impact of coronal plane alignment on outcomes of root repair. We hypothesized that patients with lateral root repairs performed in a valgus knee or medial root repairs performed in a varus knee ("at-risk" group) would report worse patient-reported outcomes.

**METHODS:** Patient demographic and surgical data were retrieved from chart review between 2006 and 2018. Patients between 18 and 65 years old with adequate full length weight bearing radiographs for measuring the mechanical axis were included. Patients were contacted to complete patient-reported outcome measures (PROM): Knee Injury and Osteoarthritis Outcome Score (KOOS) and International Knee Documentation Committee subjective score (IKDC). Patients with varus alignment (> 3 degrees) and a medial root repair, or valgus alignment (>3 degrees) and a lateral root repair were considered "at-risk". PROMs were compared between at-risk groups vs. patients within 3 degrees of neutral mechanical axis. Independent t-tests for continuous variables and chi-squared test for categorical variables were utilized to analyze relationships among body mass index subgroups, level of malalignment, PROMs, and complications.

**RESULTS:** A total of 62 patients who underwent transtibial meniscus root repair were identified. Twenty patients met inclusion criteria, of which 9 patients (45%) were considered "at-risk" with varus-aligned knees with medial root tears. Patients at-risk of failure had a greater absolute mean mechanical axis (-6.8 degrees) when compared to patients not at-risk of failure (-0.091 degrees) ( $p < 0.001$ ). Additionally, patients at-risk of failure had a shorter length of mean follow-up time (13.0 months) when compared to patients not at-risk of failure (15.3 months) ( $p = 0.005$ ). No significant differences were noted between the groups in patient age, sex, BMI, or PROMs.

**CONCLUSION:** This study assesses the implications of demographic variables and coronal plane alignment on outcomes of meniscal root repair and provides additional guidelines to the literature to appropriately identify proper surgical candidates. Although more studies are needed to confirm these findings, this study demonstrates no associated differences in outcome of root repair based on coronal plane alignment.



**Paper 234****Return to Sport After Knee Injuries in Collegiate Wrestling**

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**BACKGROUND:** Wrestling is known to be a sport of relatively high injury incidence, and knee injuries account for a large percentage of those injuries. Treatment of these injuries varies considerably depending on injury and wrestler characteristics, leading to variability in complete recovery and return to sport (RTS). The purpose of this study was to evaluate injury trends, treatment strategies, and RTS characteristics after knee injuries in competitive collegiate wrestling.

**METHODS:** NCAA Division I collegiate wrestlers who sustained knee injuries between January 2010 and May 2020 were identified using an institutional Sports Injury Management System (SIMS). Wrestling-related knee, meniscus, and patella injuries were identified, and treatment strategies were documented to investigate potential recurrent injury trends. Descriptive statistics were used to quantify the number of days, practices, and competitions missed, return to sport times, and recurrent injuries among wrestlers.

**RESULTS:** Overall, 184 knee injuries were identified. After excluding non-wrestling injuries ( $n=11$ ), 173 injuries remained (77 wrestlers). The mean age at time of injury was  $20.8 \pm 1.4$  years, and the mean BMI was  $25.9 \pm 3.8$  kg/m<sup>2</sup>. There were 135 primary injuries (74 wrestlers), which consisted of 72 (53%) ligamentous injuries, 30 (22%) meniscus injuries, 14 patellar injuries (10%), and 19 other injuries (14%). The majority of ligamentous injuries (93%) and patellar injuries (79%) were treated nonoperatively, while the majority of meniscus tears (60%) underwent surgery. Twenty-three wrestlers (22%) sustained recurrent knee injuries, of which 76% were treated nonoperatively after their initial injury. Recurrent injuries consisted of 12 (32%) ligamentous injuries, 14 (37%) meniscus injuries, eight (21%) patellar injuries, and four (11%) other injuries. Fifty percent of recurrent injuries were treated operatively. When comparing recurrent injuries to primary injuries, recurrent injuries had a significantly longer return to sport time (Recurrent  $68.3 \pm 96.0$  days vs. Primary  $26.0 \pm 56.4$  days,  $p=0.01$ ).

**CONCLUSIONS:** The majority of NCAA Division I collegiate wrestlers who sustained knee injuries were initially treated nonoperatively, and approximately one in five wrestlers sustained recurrent injuries. Return to sport time was significantly increased after a recurrent injury.

**LEVEL OF EVIDENCE:** IV

**Paper 235****Achilles Tendon Ultrasound Characteristics in NCAA Division I Gymnasts**

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**INTRODUCTION:** Achilles tendon injury risk is ten-fold higher in Division 1 collegiate gymnasts than any other NCAA sport. These can be career-ending injuries. There has been minimal research relating symptoms to ultrasound characteristics of otherwise healthy collegiate gymnasts' Achilles tendons. The purpose of this study was to use ultrasound imaging to determine the appearance and characteristics of Achilles tendons along with questionnaires to elicit symptoms and specific risk factors in collegiate gymnasts.

**METHODS:** This IRB-approved study was carried out at a university with a Division 1 collegiate women's gymnastics program. Inclusion criteria included all gymnasts who were part of the team in the 2021-2022 season. This study took place three weeks after the end of the season. For those athletes who agreed to participate, a survey collecting information about the gymnasts' backgrounds was filled out. The gymnasts also completed the VISA-A questionnaire, a validated and reliable outcome measure for patients with Achilles tendinopathy. They then underwent ultrasound of their bilateral Achilles tendons. These ultrasounds were performed by a sports medicine fellowship-trained primary care physician who is certified in musculoskeletal ultrasound.

**RESULTS:** Eighteen of 21 (86%) gymnasts agreed to participate, filled out the surveys, and underwent bilateral Achilles tendon ultrasounds. Thirty-five Achilles tendons were included, with one excluded for prior repair. Although only two gymnasts complained of current Achilles tendon pain (three tendons), eight gymnasts scored <90 on the VISA-A questionnaire. A perfect score is a 100, and the minimally clinical significant difference in this questionnaire has been shown to be >10 points, so these eight gymnasts demonstrate symptomatic Achilles tendinopathy. On ultrasound imaging, the majority of the Achilles tendons looked normal. In fact, all recorded values were considered normal except for one single tendon that was mildly hypoechoic (2%).

**DISCUSSION & CONCLUSION:** This study demonstrates that despite nearly 50% of the gymnasts endorsing symptoms consistent with Achilles tendinopathy, the majority of these athletes' Achilles tendons appeared normal on ultrasound examination. This is in contrast to a prior study demonstrating ultrasound abnormality in elite male and female gymnasts tendons, although the abnormalities were not correlated with tendinopathy symptoms. Prospective follow-up of the gymnasts in this study will determine if any of the collected data is prognostic for Achilles tendon injury. Further studies investigating Achilles tendons in collegiate gymnasts are necessary given the high rates of ruptures in these athletes.

**Paper 236****Negative Pain Thoughts Questionnaire Scores and Outcomes After Orthopedic Sports Medicine Procedures**

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**INTRODUCTION:** Pain is multifactorial and can be heavily influenced by cognitive biases. A (4-item) Negative Pain Thoughts Questionnaire (NPTQsf) was previously developed to assess an individual's attitudes toward pain. To our knowledge, there are no published studies evaluating how patients' attitudes toward pain impact outcomes following shoulder or knee surgery. The purpose of this study was to evaluate the relationship between patients' perceptions of pain and patient reported outcomes following shoulder or knee surgery.

**METHODS:** Patients receiving rotator cuff or meniscal surgery were prospectively enrolled. Patient demographics were collected preoperatively. Patient reported outcomes surveys (SF-12, VAS Pain Scale, and ASES for shoulder patients or IKDC for knee patients) were administered preoperatively and at follow-up. Data was analyzed using Pearson correlation and Student's t-test.

**RESULTS:** A total of 63 rotator cuff patients and 56 meniscus patients had complete preoperative and follow-up assessments. There was no correlation between preoperative NPQTsf scores and net change in ASES or IKDC (Pearson=0.113 and -0.122,  $p > 0.05$ ), or postoperative ASES or IKDC scores (Pearson=-0.164 and -0.264,  $p < 0.05$ ). There was a moderate negative correlation between preoperative NPQTsf scores and preoperative and postoperative SF-12 scores in shoulder surgery patients (Pearson= -0.450, -0.316, -0.358, -0.347,  $p < 0.05$ ). There was a moderate negative correlation between preoperative NPQTsf scores and preoperative and postoperative SF-12 scores in knee surgery patients (Pearson= -0.449, -0.292, -0.350, -0.400,  $p < 0.05$ ). Postoperative NPTQsf scores had a large negative correlation with postoperative ASES and IKDC scores, as well as the net change in both scores (ASES: Pearson=-0.694 and -0.569,  $p < 0.001$ ; IKDC: Pearson= -0.606 and -0.635,  $p < 0.001$ ).

**DISCUSSION & CONCLUSION:** These results do not demonstrate a relationship between perceptions of pain preoperatively and outcomes in either shoulder or knee surgery. While there is not a relationship between preoperative NPTQsf scores and patient-reported outcomes, there is a strong relationship between outcomes and postoperative perceptions of pain. These results indicate that a patient's cognitive biases preoperatively may not affect surgical outcomes, but patients with more negative cognitive biases related to pain postoperatively are more likely to have worse outcomes. The moderate relationship seen between preoperative NPTQsf scores and SF-12 scores shows that patients with more cognitive biases related to pain are more likely to have worse physical and mental health overall.

**Paper 237****Relation Between Anterior Cruciate Ligament Return to Sport After Injury Scale and Physical Functioning Tests**

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**INTRODUCTION:** The Anterior Cruciate Ligament Return to Sport After Injury (ACL-RSI) scale quantifies psychological readiness to return to sport (RTS) after ACL reconstruction (ACLR), with low ACL-RSI scores associated with poor prognoses. Physical functioning tests (PFTs), like the single-legged triple-hop, are also used to determine readiness to RTS. This study assessed the relation between ACL-RSI and single-legged triple-hop performance. It was hypothesized that triple-hop distance and ACL-RSI would be positively correlated, but that the triple-hop limb symmetry index (LSI) would not be correlated.

**METHODS:** An honest broker provided anonymous data from our institution's ACLR return-to-play (RTP) data repository, which contains data from RTP assessments conducted as part of standard patient care. Primary ACLR patients were included in the analysis if they were 12-30 years old at the time of ACLR, received an autograft, completed an RTP assessment 6-12 months post-ACLR, and had the ACL-RSI and triple-hop measured (n=290). The distance hopped on the involved and uninvolved limb was allometrically scaled to the patient's height. LSI was calculated as the ratio of the involved to uninvolved. Linear regression was used to explore the relation between ACL-RSI and triple-hop performance. Significance was set to  $p < 0.05$ .

**RESULTS:** On the involved leg, triple-hop distance and ACL-RSI were positively correlated ( $p=0.023$ ,  $R^2=0.095$ ) and for every additional increment of the patient's height hopped, ACL-RSI increased by 8.7% ( $p=0.231$ ). On the uninvolved leg, triple-hop distance and ACL-RSI were not correlated ( $p=0.081$ ,  $R^2=0.048$ ) and for every additional increment of the patient's height hopped, ACL-RSI did not change (6.6%,  $p=0.081$ ). Finally, triple-hop LSI and ACL-RSI were not correlated ( $p=0.115$ ,  $R^2=0.033$ ) and for every 10% improvement in LSI, ACL-RSI did not change (4.8%,  $p=0.116$ ).

**DISCUSSION:** There is currently a lack of standardized criteria to inform when it is safe for athletes to RTS. Psychological readiness has been shown to be strongly related to successful RTS and reinjury, while PFTs are less often related. This study suggests that involved leg triple-hop distance, but not the uninvolved or triple-hop LSI, may be related to psychological readiness to RTS, albeit weakly. Therefore, involved leg triple-hop distance may be a more useful metric for successful RTS than LSI. Isolating PFTs that are related to effective indicators for successful RTS, like ACL-RSI, could inform the standardization of rehabilitation programs for ACLR patients and improve ACLR outcomes.

**Paper 238****Novel Anti-Inflammatory Benefits of Aquatic Treadmill Use with Considerations for Rehabilitation**

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**BACKGROUND:** Aquatic treadmill (ATM) exercise is often utilized in rehabilitation as a form of low-impact activity and has been shown to enhance vascular function and muscular hypertrophy/strength when combined with resistance training (RT). Recently, exercise modulation of systemic pro- and anti-inflammatory biomarkers (cytokines) has been observed to influence recovery/adaptation (of interest for populations experiencing acute or chronic inflammation).

**PURPOSE:** To analyze serum cytokine (pro-inflammatory, anti-inflammatory, metabolic) concentrations and post-exercise soreness before and after 12 weeks of RT, combined RT-ATM, or combined RT-LTM (land treadmill) training in previously sedentary adults.

**METHODS:** Following informed consent, healthy volunteers ( $n=47$  |  $\sigma n=23$ ,  $37\pm 11$ yr |  $\rho n=24$ ,  $38\pm 12$ yr) were screened to assess  $VO_{2max}$ , body composition (DEXA), and total body strength. Subjects were then randomized into 3 groups: RT ( $\sigma n=7$ ,  $\rho n=8$ ), RT-LTM ( $\sigma n=8$ ,  $\rho n=8$ ), RT-ATM ( $\sigma n=8$ ,  $\rho n=8$ ). Each performed progressive RT (2/wk, 3 x 8-12 reps, 7 exercises, @60%~80%1RM) for 12 wks. In addition, the RT-LTM and RT-ATM groups also performed 12wks of aerobic LTM or ATM (3/wk, 60→85% $VO_{2max}$ , 250→500 kcal/session). Blood samples were obtained at rest and 24h following acute exercise before and after training. Serum concentrations of interleukin (IL) 6 (metabolic/inflammatory), 8 (inflammatory), 10 (anti-inflammatory) and tumor necrosis factor alpha (TNF- $\alpha$ , inflammatory) were analyzed (Luminex®, Millipore®). 24h-post exercise soreness was also recorded following acute exercise (VAS 0-10). A mixed-model ANOVA was used to compare acute and chronic changes in serum cytokines and 24h post-exercise soreness.

**RESULTS:** Serum Cytokine Responses to Acute Exercise: Following acute exercise in the untrained and trained state, IL-6 was significantly increased in the RT-LTM group only ( $P=0.027$ ,  $P=0.049$ ). Significant acute increases in IL-10 were observed following both bouts of exercise in the RT-ATM group only ( $P=0.033$ ,  $P=0.020$ ). Chronic Basal Cytokine Changes: Significant reductions in systemic IL6 ( $P=0.026$ ) and TNF- $\alpha$  ( $p<0.001$ ) were observed following RT-ATM training only. Post-Exercise Pain & Soreness: In the untrained state, the RT-ATM group was observed to have reduced soreness compared to the RT-LTM group for the arms ( $P=0.011$ ), legs ( $P=0.033$ ), and chest ( $P=0.019$ ). In the trained state, the RT-ATM group was observed to have reduced soreness compared to the RT-LTM group for the arms ( $P=0.009$ ), back ( $P=0.035$ ), chest ( $P=0.040$ ), abdomen ( $P=0.048$ ), and overall ( $P=0.040$ ).

**CONCLUSION:** The addition of ATM to a standardized RT protocol acutely and chronically modulates various cytokines in an anti-inflammatory manner compared to RT-LTM or RT indicating a potential "pro-growth/recovery" benefit while also reducing post-exercise soreness. These findings hold promise for rehabilitation for attenuating post-surgery pain, muscle loss, and inflammation. ATM exercise may also help facilitate recovery in populations suffering from chronic inflammation.

Poster 001

**Highlighting the Utility of Ultrasound Guidance in Achilles Paratenon Injections: A Cadaver Study**

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**INTRODUCTION:** The rise of ultrasound guidance has touched every corner of medicine, with applications ranging from arterial line placement to pre-procedural vascular mapping. Ultrasound application in the orthopedic setting has numerous functions including injection therapy in the peritenon space for treatment of Achilles tendinopathy. Accuracy during injection is important in maximizing the efficacy of treatment. The aim of this study is to investigate whether utilization of ultrasound guidance improves the accuracy of the injection compared to the traditional freehand technique.

**METHODS:** Six fresh-frozen, below-the-knee cadaver specimens were utilized in the study. Specimens were thawed 24 hours prior to the procedure and marked 40mm superior to the border to the calcaneus. Specimens were divided into an ultrasound guided and a free hand group. Confirmation of injection into the peritenon space was confirmed real-time with the ultrasound guided approach and was confirmed following injection in the freehand approach. During the ultrasound guided approach, the ultrasound probe was held transversely relative to the Achilles tendon at the marked site and was used to visualize the needle entering the peritenon space. In both approaches, the needle was inserted medially to the Achilles. Injections were performed by a fellowship-trained foot and ankle orthopedic surgeon.

**RESULTS:** Accurate placement of the injection was achieved in all three (100%) of the specimens in the ultrasound guided experimental group. One of three injections in the freehand group was injected into the appropriate space (33%).

**CONCLUSIONS:** Achilles tendinopathy is a common pathology treated with injection therapy when first-line treatments such as NSAIDs and elevated heel orthotics have failed. Accurate placement of the injections is critical in achieving optimal therapeutic results. This study illustrates the utility of ultrasound guidance in maximizing the accuracy of injections and provides early evidence that highlights the importance of reproducible injection techniques that may change the perceived "efficacy" of injection therapy.

**SUMMARY:** This cadaveric study intends to highlight the benefits of ultrasound guidance when performing achilles tendon injection therapy, with the hopes of laying the groundwork for future prospective studies that may change the way the "efficacy" of this management is viewed.

Poster 002

**Analysis of Patient-Reported Outcomes Following Triple Arthrodesis: A Minimum Two-Year Followup**

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**INTRODUCTION:** Adult acquired flatfoot deformity (AAFD) is a debilitating condition that is common in the United States. Triple arthrodesis (TA) is a treatment option reserved for advanced disease. Evidence on patient outcomes following this procedure remains limited. This study aims to report patient-reported outcomes following TA via patient-reported outcome measurement information systems (PROMIS). Secondary aims are to delineate any demographics or patient characteristics that significantly impact PROMIS scoring.

**METHODS:** In this single institution study, we identified all patients who underwent triple arthrodesis between 2014 and 2021 based on CPT coding. Patients who underwent a TA procedure for AAFD with a minimum of 24 months follow-up were eligible for inclusion in this study. Patients under the age of 18, those undergoing revision surgeries, or those with pathologies other than AAFD were excluded from this study. Patient demographics and surgical complications were collected through chart review. The Patient Reported Outcomes Measurement Information System (PROMIS) survey and Foot Function Index (FFI) scores were collected via telephone interview. PROMIS scores were analyzed with a Type III "SS" ANOVA test to stratify independent risk factors and account for confounding variables.

**RESULTS:** 115 patients met our inclusion criteria. 49 patients (43%) submitted responses to the survey. Patient outcomes were collected at an average of 5.50 years postoperatively. There were no significant differences in the rates of complications among any of the variables analyzed. The average PROMIS physical function score was 38.35, the average pain interference score was 61.52, and the average depression score was 49.82. Males and patients with prior foot and ankle procedures had significant increases in PROMIS physical function scores ( $p < .05$ ). The mean FFI scores were 58.56 for pain, 60.07 for disability, and 48.07 for activity limitation. Patients > 50 years old had significantly higher FFI pain, disability, and total scores ( $p < .05$ ). VAS scores decreased preoperatively to postoperatively from 5.4 to 2.6. The presence of Type 2 DM and tobacco usage were associated with a significant increase in preoperative VAS pain scores.

**CONCLUSIONS:** Our study is the first to examine variables significantly impacting PROMIS, FFI, and VAS scores for patients undergoing TA for AAFD. Treatment of AAFD with TA appears to be beneficial in long-term reduction of pain. This study is one of the largest to date involving patient reported outcomes following TA and can serve as a prognostic tool for physicians to use when counseling patients prior to this procedure.

Poster 003

Understanding Human Motor Endplate Degeneration After Peripheral Nerve Injury

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There is often limited functional recovery after peripheral nerve injury (PNI) despite optimal surgical intervention. One of the reasons for these poor outcomes is a time-dependent degeneration of denervated motor endplates (MEPs) at neuromuscular junctions (NMJs). Prior studies have demonstrated that human MEPs have different morphology, size, and density than murine MEPs. Moreover, our recent studies indicate that unlike mouse and rat models, some MEPs in humans persist even >6 months post-PNI. These results suggest that degeneration of denervated human MEP may not be analogous to murine MEP degradation. Here, we use a new methodology for NMJ visualization to assess human NMJ degeneration in PNI patients. Denervated and innervated muscle samples were obtained in patients undergoing standard of care surgery 3-6 months post-PNI. Samples were prepared either (1) by immunostaining sections for  $\alpha$ -BTX, neurofilament (NF) and synaptophysin (SYN) or (2) clearing the whole muscle sample with CUBIC R1 solution and immunostaining with NF, SYN, and acetylcholine receptor (AChR)- $\alpha$ . Muscle samples were imaged with a Keyence BZ-X810 microscope and MEPs in denervated tissue exhibited morphological degenerative changes when compared to innervated muscle including a mix of abnormal morphologies ranging from pretzel to fragmented. At similar time points post-injury, some patients had greater NMJ degeneration with a higher proportion of plaque MEPs compared to others. MEP morphology was better defined in samples immunostained for AChR- $\alpha$  than with  $\alpha$ -BTX. CUBIC-clearing prior to immunostaining allowed for excellent antibody penetration, enabling 3D reconstruction and morphometric quantification of MEP integrity in biopsied muscle. Our data indicate that (1) human NMJ degeneration is species specific and (2) preserved MEPs in humans predict greater functional recovery with nerve repair surgery. Because human NMJ degeneration shows tremendous variation, some patients have the potential for recovery with surgery even if performed >6 months post-injury. These data suggest a role for preoperative muscle biopsy prior to reconstructive surgery after a significant nerve injury.



Poster 004

Retrospective Review of Corticosteroid Injection for Management of Lacertus Syndrome

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**INTRODUCTION:** Lacertus syndrome is a proximal median nerve compression neuropathy characterized by weakness of flexor pollicis longus (FPL), flexor digitorum profundus (FDP) to the index finger, and flexor carpi radialis (FCR); and pain with compression of the median nerve at the lacertus fibrosus. Lacertus syndrome is a clinical diagnosis, as electromyography/nerve conduction studies and imaging often show no abnormalities. Treatment includes surgical release of the lacertus fibrosus which has been shown to improve mean DASH and patient satisfaction scores.

Corticosteroid injections (CSI) have been used for diagnostic and therapeutic purposes in compression neuropathies such as carpal tunnel, radial tunnel, and pronator syndromes. To our knowledge, the role of CSI in lacertus syndrome has not been evaluated. The purpose of this study was to investigate the efficacy of CSI for symptom management in lacertus syndrome and secondarily to describe characteristics of lacertus syndrome.

**METHODS:** A retrospective review of all patients who underwent CSI at the lacertus fibrosus by a single surgeon for lacertus syndrome between 2016-2021 was performed. Patient demographics, co-morbidities, history and physical examination was collected at the time of CSI. Follow-up measurements included subjective improvement in symptoms, physical examination, and repeat injection or subsequent lacertus fibrosus release.

**RESULTS:** A total of 73 patients met inclusion criteria. Chief complaint included hand and/or forearm pain in 50 patients (68%), median nerve paresthesias in 54 (74%), and hand weakness in 11 (15%). On exam, 72 (99%) had pain at the lacertus fibrosus and 63 (86%) had weakness in 1 or more of FCR, FPL, and/or FDP index. Following CSI, 9 patients were lost to follow-up. Of the remaining 64, 48 (75%) had subjective improvement in symptoms following CSI. 13 (20%) had repeat steroid injection (1-3 more steroid injections). 19 patients (30%) underwent lacertus fibrosus surgical release, of which 17 (89%) had improvement to their symptoms.

**DISCUSSION:** Overall, we found that 75% of patients who underwent CSI at the lacertus fibrosus for lacertus syndrome experienced subjective symptomatic relief and a relatively small percentage of patients had repeat CSI (20%) or subsequent surgical release (30%) suggesting a potential long lasting therapeutic response to CSI. This is similar to other compression neuropathies in the upper extremity that can be managed with CSI alone or subsequent surgical release. This study provides evidence that CSI can provide symptomatic relief in lacertus syndrome, although further research is needed to better characterize those who may benefit.

Poster 005

**Surgical Management of Peroneal Nerve Injuries**

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**INTRODUCTION:** Traumatic peroneal nerve injuries are rare, troublesome injuries typically associated with proximal tibia and fibula fractures or knee dislocations. The purpose of this study was to evaluate the demographics, treatment options, and outcomes following surgical management of peroneal nerve injuries.

**METHODS:** Patients evaluated at a single institution for peroneal nerve injuries from 2001-2022 were retrospectively reviewed. Mechanism of injury, time to surgery, pre- and postoperative examinations, and operative reports were recorded. Satisfactory outcome, defined as the ability to achieve anti-gravity dorsiflexion strength or stronger following surgery, was compared between nerve grafting and nerve transfers in patients with at least nine months of postoperative follow-up using Fisher's exact test.

**RESULTS:** Thirty-seven patients underwent surgical management for their peroneal nerve injury at an average of 177.5 days after injury. Average age was 30.3 years, and 86.5% were male. Eight patients (21.6%) underwent posterior tibial tendon transfer to the lateral cuneiform in addition to nerve surgery. Most common mechanism of injury was sporting events resulting in knee dislocation (n=11), with football being the most common sport (n=6). The majority of patients sustained a traumatic knee dislocation at the time of injury (n=28; 75.7%). Twenty-nine patients had follow-up greater than 9 months after surgery, with an average follow-up of 4.3 years. Surgeries included neurolysis (n=4), direct repair (n=1), tibial motor nerve transfer (n=16), or nerve grafting using allograft (n=2) or sural nerve autograft (n=6). At last follow-up, 58.6% (n=17) of patients had antigravity strength or stronger dorsiflexion. Thirteen (41.4%) patients used an ankle foot orthosis during all or some activities. In patients that underwent nerve grafting across the peroneal nerve defect, 75% (n=6) were able to achieve anti-gravity strength or stronger dorsiflexion. In patients that had a tibial nerve motor unit transfer to the peroneal nerve, 43.75% (n=7) were able to achieve anti-gravity strength or stronger dorsiflexion at last follow-up. However, there was no statistical difference between nerve transfers and nerve grafting in postoperative dorsiflexion strength ( $p = 0.21$ ).

**CONCLUSION:** Peroneal nerve injuries frequently occur in the setting of knee dislocations and similar high energy injuries. Treatment is not universally successful in restoration of ankle dorsiflexion, and over one-third of patients require an ankle foot orthosis at mid-term follow-up. Patients should be properly counseled on the treatment challenges and variable outcomes following peroneal nerve injuries.

Poster 006

Menstrual Hormone-Induced Cyclic Thumb CMC Instability and Degeneration in Women: A Systematic Review

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**HYPOTHESIS:** Relaxin is a hormone which peaks during the luteal phase of the menstrual cycle, and a known collagenolytic promoter that has been shown to avidly bind tissues supporting the trapeziometacarpal (TMC) joint in women. We hypothesize a causal linkage between cyclic binding of relaxin to female TMC joint supporting tissues, and the early onset of severe TMC osteoarthritis (OA) commonly seen in women.

**METHODS:** A systematic literature review was performed per PRISMA guidelines, qualitatively and quantitatively assessing papers regarding relaxin-TMC joint stability interactions. The primary outcome variable was TMC joint degeneration/loss of function; the “late stage” consequences of relaxin-induced instability. The secondary outcome variable, the “early stage” consequences of relaxin-induced instability, was asymptomatic TMC joint laxity in young women.

**RESULTS:** In healthy young women, menstrual cycle relaxin peaks corresponded with asymptomatic TMC joint instability. Immunohistochemical studies of TMC arthroplasty patients showed increased relaxin binding to TMC joint supporting tissues in women compared to men. Demographic analysis of patients from the TMC arthroplasty studies show a predominantly female cohort, who were on average significantly younger than the male surgical patients.

**DISCUSSION & CONCLUSION:** Each relaxin peak during the menstrual cycle causes instability in the soft tissues supporting the TMC joint, including—critically—the main stabilizing ligament: the anterior oblique. The cyclic instability is typically asymptomatic for years after menarche with accumulating damage due to repetitive microtrauma. This likely causes the early-onset high severity TMC joint OA clinically pervasive among female orthopedic hand clinic patients. Further research is indicated to develop risk assessment strategies and potential interventional options.

Poster 007

Return to Sport and Performance After Thumb Metacarpophalangeal Joint Collateral Ligament Surgery in the National Basketball Association

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**BACKGROUND:** Injuries to the thumb represent 2.7% of all National Basketball Association (NBA) game-related injuries. Thumb metacarpophalangeal ligament injuries are commonly characterized as ulnar collateral ligament (UCL) or radial collateral ligament (RCL) sprains or tears. Thumb collateral ligament injuries occur from a variety of mechanisms.

**PURPOSE:** Evaluate NBA players undergoing thumb collateral ligament surgery (UCL or RCL): Time to return to sport; Post-injury career length compared to matched controls; Preoperative performance compared to postoperative performance; and Post-injury performance compared to matched controls.

**METHODS:** NBA players who underwent confirmed thumb collateral ligament surgery between 1992 and 2021 were identified using publicly available data. Exclusion criteria: nonoperative management, revision surgery, players with less than one full pre-index season. Players with less than one year of post-index NBA experience/performance statistics were excluded from data analysis. Performance statistics, ligament injuries (UCL or RCL), return to sport (RTS) time, laterality, and injury dates were recorded. Cases were matched 1:1 with controls based on age ( $\pm 1$  year), BMI, NBA experience ( $\pm 1$  year), and performance statistics prior to the index date; and position. RTS evaluation and performance evaluation were conducted. Successful RTS required a player to participate in at least one post-injury game in the NBA or another professional basketball league. Performance analysis included players who had one NBA season of postoperative performance statistics available to maintain comparability and match to a control. Career survival was evaluated with a Kaplan-Meier career survival curve using a player's retirement as the endpoint.

**RESULTS:** RTS rate was 100% (44/44). Thirty-three players had at least one year of postoperative statistics in the NBA (33/44, 75%) with an average age of  $26.9 \pm 3.0$  years. Post-index career length (Case:  $5.5 \pm 3.5$  seasons, Control:  $4.9 \pm 3.7$  seasons,  $p=0.515$ ) was not significantly different from controls. Same season time to RTS ( $n=20$ ) was  $7.1 \pm 2.4$  weeks. Off-season or season-ending surgery ( $n=13$ ) RTS time was  $28.4 \pm 18.7$  weeks. There was no difference when evaluating career length when stratified by RCL vs. UCL. Post-index performance statistics and league adjusted shooting statistics did not differ from matched controls.

**CONCLUSIONS:** RTS rate is high in NBA athletes undergoing thumb collateral ligament surgery. Players that do return for at least one full postoperative season do not experience decreased performance or career length due to thumb collateral ligament surgery, regardless of injury to the dominant or non-dominant thumb.

Poster 008

Every Painful Lesion in the Upper Extremity is Not a Neuroma: An Algorithmic Approach for Diagnosing Painful Benign Forearm Lesions

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**INTRODUCTION:** Painful forearm lesions (PFLs) are one of the most common complaints for an upper extremity surgeon to treat. Patients usually have dealt with their forearm pain for years, have been evaluated or treated without resolution, and often have concerns for something more sinister. The forearm is a frequent location for many painful soft tissue tumors, most of which are benign. Glomus tumors are among the less common PFLs; however, it is important for the upper extremity surgeon to be familiar with and regularly consider this entity. Glomus tumors are small, benign, neurovascular tumors that account for only 1-2% of soft tissue tumors and can be exquisitely painful and temperature sensitive. Traditionally found subungually, extradigital manifestations of glomus tumors in the forearm can present with atypical symptoms and are often misdiagnosed as neuromas. In practice, we have recently seen several PFLs ultimately identified by surgical pathology as glomus tumors. This raises the questions: are extradigital glomus tumors in the forearm truly rare and are we missing/misdiagnosing them more than we think? Although historically considered a relatively uncommon soft tissue tumor, there may be an opportunity to reconsider glomus tumors in your initial differential for PFLs. We propose a new approach to the diagnosis of glomus tumors and other PFLs.

**METHODS:** Literature review of typical and atypical etiologies of painful benign masses of the forearm. Creation of algorithmic diagnostic approaches.

**RESULTS:** After thorough review of the literature, we have compiled a list of PFLs. We have constructed an algorithm to serve as a guide for differential diagnoses to consider, including common tumors and rarities alike. Primary diagnoses included neuromas, schwannomas, glomus tumors, angioliipomas, fibromas, and ganglion cysts.

**CONCLUSION:** Glomus tumors may present as PFLs, but as they are historically considered rare, they are frequently not considered in the initial differential and are subsequently misdiagnosed. With the overlap of symptomatology between extradigital glomus tumors and other common PFLs, glomus tumors should be included in your initial differential. The diagnosis of a glomus tumor can be accomplished by conducting an inclusive history and physical exam, including appropriate imaging. Definitive diagnosis and treatment for many of these tumors is excisional biopsy; however, preoperative planning, establishing postoperative expectations, and overall quality of patient care depends upon a thoughtful and comprehensive initial differential.

Poster 009

**Inhibition of Inflammation and Mitochondrial ROS Attenuates Post-Traumatic Osteoarthritis in a Rabbit Model of Ligamentous Instability**

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**BACKGROUND:** Aberrant loading of the joint surfaces leads to chondrocyte apoptosis, mitochondrial reactive oxygen species (ROS) production, and release of inflammatory mediators that lead to enhanced matrix degradation. Our lab has provided evidence of calcium/calmodulin dependent protein kinase kinase 2 (CaMKK2) involvement in proinflammatory processes of post-traumatic osteoarthritis (PTOA) in a murine meniscal destabilization model. In addition, inhibition of mitochondrial ROS production following blunt joint trauma prevented PTOA in minipigs.

We hypothesize that inhibiting inflammatory processes by blocking CaMKK2 and mitochondrial ROS production alone or in combination will attenuate PTOA in a rabbit knee destabilization model.

**METHODS:** This study was approved by institutional IACUC and DoD ACURO. Adult male New Zealand White rabbits (3.5 kg average weight) were acquired and allowed to acclimate to new singles housing for of 1 week. Rabbits then underwent surgical ACL transection and were separated into 4 treatment groups: saline, CaMKK2 inhibitor STO-609, Ros inhibitor amobarbital (AMO), or STO-609+AMO (N=15/group). Rabbits assigned to the AMO group were treated with an immediate intra-articular injection of AMO delivered in a reverse hydrogel. The remaining groups received subcutaneous injections of either saline or 77  $\mu$ M STO-609 three times weekly for 16 weeks, or one intra-articular dose of AMO followed by injections of STO-609. After euthanasia, both knees were harvested. Five pairs of knees per group were flash frozen for RNA isolation. mRNA expression of Camkk2, Mmp-13, Col2a1, Acan, Cox2 and Il-6 were determined using qRT-PCR. Ten pairs of knees per group were placed in formalin for fixation and evaluated by microcomputed tomography (micro-CT) for alterations in the subchondral bone. After micro-CT, the knees processed for histology. Safranin O-stained coronal sections of the knee joints were staged using the Osteoarthritis Research Society International (OARSI) scoring system to determine PTOA severity. Sections were also immunostained to determine CaMKK2, Col2, and Mmp-13 protein levels.

**RESULTS:** Destabilized rabbit knees demonstrated increased PTOA severity by OARSI scoring. Treatment with STO-609, AMO, and AMO+STO-609 resulted in lower OARSI scores. Untreated cartilage specimens had higher levels of Camkk2, Mmp13, Il-6 and Cox2; and decreased expression Acan and Col2a1 compared to those treated with either STO-609, AMO, or AMO+STO-609. STO-609, AMO, and AMO+STO-609 treatments showed protection against osteophyte formation, and subchondral bone remodeling in destabilized knee joints.

**CONCLUSIONS:** The results of this study suggest that blockade of CaMKK2 and/or mitochondrial ROS mitigates the development of PTOA in a preclinical model of ligamentous instability. STO-609, a CaMKK2 inhibitor, and AMO, a reversible complex 1 inhibitor, are novel therapeutics for preventing and mitigating ligamentous injury-initiated PTOA.

Poster 010

**A Coronoid-Centric Classification System of Proximal Trans-Ulnar Fracture Dislocations Has Almost Perfect Intraobserver and Interobserver Agreement**

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**INTRODUCTION:** Complex fractures of the proximal ulna encompass a number of distinct injuries that require different treatment principles. However, classification systems reported to date oftentimes blur the distinction between Monteggia injury patterns and trans-olecranon fracture-dislocations, particularly when the fracture involves the coronoid.

The Mayo classification of proximal trans-ulnar fracture-dislocations categorizes these fractures in three types according to what the coronoid is separated from: Trans-olecranon fracture-dislocations (the coronoid is separated from the olecranon, but still attached to the ulnar metaphysis); Trans-ulnar basal coronoid fracture-dislocations (the coronoid is separate from both the olecranon and the ulnar metaphysis); and Monteggia fracture-dislocations (the coronoid is separated from the ulnar metaphysis, but still attached to the olecranon). The purpose of this study was to evaluate the intraobserver and interobserver agreement of this proposed classification system when assessing all injuries with both radiographs (xR) and computed tomography (CT).

**METHODS:** Three fellowship-trained Shoulder and Elbow surgeons and 2 fellowship-trained Orthopedic Trauma Surgeons blindly and independently evaluated the xR's and CT's of 90 consecutive proximal ulnar fracture-dislocations treated at a level I trauma center. Inclusion criteria included a subluxation or dislocation of the elbow and/or radio-ulnar joints with a complete fracture through the proximal ulna. Each surgeon classified all fractures according to the Mayo classification, which is based on what the coronoid is separated from (ulnar metaphysis, olecranon, or both). Intraobserver reliability was determined by scrambling the order of the fractures and having each observer classify all the fractures again after a washout period of at least six weeks. Interobserver reliabilities were obtained to assess the overall agreement between observers. Kappa values were calculated for intraobserver and interobserver reliabilities.

**RESULTS:** The average intraobserver agreement was 0.87 (almost perfect, range 0.76-0.91). Interobserver agreement was 0.80 (substantial agreement; range 0.70-0.90) for the first reading session and 0.89 (almost perfect; range 0.85-0.93) for the second reading session. The overall average interobserver agreement was 0.85 (almost perfect; range 0.79-0.91).

**CONCLUSION:** Classifying proximal trans-ulnar fracture-dislocations based on whether the coronoid is separated from the olecranon, the ulnar metaphysis, or both was associated with almost perfect intraobserver and interobserver agreement, whether the surgeons were fellowship trained in trauma or elbow and shoulder. Further research is needed to determine whether the use of this classification system leads to the application of principles specific to the management of these injuries and translates into better outcomes.

Poster 011

Periprosthetic Fracture: A Missed Opportunity for Diagnosis and Intervention

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**PURPOSE:** Many arthroplasty patients have low BMD preoperatively. Periprosthetic fractures (PPFx) result in significant morbidity, mortality and cost but are underappreciated by osteoporosis clinicians. Osteoporosis diagnosis and treatment reduces PPFx risk. The purpose of this study is to describe osteoporosis-related data available at the time of PPFx in a university-based orthopedic practice.

**METHODS:** The EMR of PPFx patients over a five-year period was reviewed. Demographic data and parameters relevant to osteoporosis were recorded. Prior BMD studies including DXA and opportunistic CT scans were reviewed, if available. L1 Hounsfield Unit (HU) measurements were obtained on CT scans performed within two years of the index PPFx.

**RESULTS:** 156 patients (115 F/41M) of mean (SD) age 75.4 (11.9) were reviewed. Almost all, 153/156 (98%) fractures were femoral (32 proximal, 26 mid, 95 distal). Falls caused 139 fractures (89%), and 12 (8%) were spontaneous. Mean time from arthroplasty to fracture was 7.9 (6.3) years. Prior fragility fracture(s) had occurred in 76 (49%). Osteoporosis had been diagnosed in 42 (27%) and pharmacologic treatment prescribed in 38 (24%). L1 HU data were available in 44; mean (SD) HU was 79.4 (29.6) with 34 (77%) < 100, consistent with osteoporosis. Evidence of osteoporosis based upon prior diagnosis, treatment or fracture, or low HU was present in 105 (67%) at the time of PPFx.

**CONCLUSION:** PPFx are often osteoporosis related. Data available at the time of fracture frequently allows diagnosis of osteoporosis which should prompt evaluation and pharmacologic treatment consideration. Increased identification of osteoporosis in total joint arthroplasty patients, pre- and postoperatively, is needed to reduce PPFx.



Poster 012

The Impact of Tranexamic Acid in Postoperative Outcomes of Pelvic and/or Acetabular Fracture: A Systematic Review and Meta-Analysis

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**BACKGROUND:** Tranexamic acid (TXA) is a plasminogen inhibitor that prevents fibrinolysis and has been shown to be a safe, cost-effective way to decrease operative blood loss in arthroplasty patients. Orthopedic pelvic trauma is associated with high volume blood loss, but the use of TXA in pelvic and/or acetabular fractures (PAF) remains controversial. We hypothesized that there would be no difference in transfusion rates or blood loss in these patients.

**METHODS:** This systematic review and meta-analysis was performed using PRIMSA guidelines. Retrospective and prospective cohort studies and randomized control trials that reported the use of TXA in PAF were included. Variables abstracted were time to TXA delivery, dosages, number of doses given preoperatively, drug delivery mode, estimated blood loss, transfusion rates, and number of venous thromboembolic events (VTE). Meta-analysis was performed using a random-effect model.

**RESULTS:** 8 studies (925 patients) were included in the qualitative systematic review and 5 studies (627 patients) were included in the statistical analysis. TXA was commonly administered intravenously (87.5% of the studies), with 1-gram doses given in 50% of the studies. There was no significant difference in transfusion rate (Relative Risk: -0.19; 95% CI -0.65, 0.27; I<sup>2</sup> = 81.7%, p = 0.42), operative duration (Mean Difference: -4.8 minutes; 95% CI -33.12, 23.51; I<sup>2</sup> = 82.0%), and estimated blood loss (Mean Difference: -93.77 mL; 95% CI: -239.36, 105.83, I<sup>2</sup> = 82.8%, p=0.36). There were no differences in the VTE rate (Relative Risk: -0.06, 95% CI: -1.06, 0.95; I<sup>2</sup> = 0% p =0.91). Funnel plot did not show significant asymmetry. Heterogeneity was documented.

**CONCLUSION:** Our systematic review revealed that TXA does not reduce the transfusion rate or estimated blood loss in PAF fixations and does not pose an increased risk of VTE. However, given the moderate heterogeneity in the data, further investigation is essential to better understand the role of TXA in PAF management.

Poster 013

Racial Disparities in a Fascia Iliaca Block Program at a Level 1 Trauma Center

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**INTRODUCTION:** The use of multimodal analgesia and regional nerve blocks have become of increasing interest as an alternative to opioids for pain control in hip fracture patients. Previously, we have reported on the success of fascia iliaca blocks (FIB) performed in the emergency department for pain control in hip fractures at our institution. The purpose of this study was to identify possible disparities in care provided to these patients based on their race.

**METHODS:** Our institution instituted an initiative to perform fascia iliaca blocks in the emergency department on hip fracture patients on January 1, 2020. After IRB approval, prospectively collected data was gathered on hip fracture patients from January 1, 2020 to May 31, 2022. Patients were excluded if contraindications to undergoing fascia iliaca block. Patients race was self-reported during intake to the emergency department. Patients were grouped based on self-reported race. Receipt of fascia iliaca block and time from diagnosis to undergoing block were compared between groups. Student t test and chi-square tests were used for analysis with  $p < 0.05$  indicating statistical significance.

**RESULTS:** During the study period 421 patients with hip fractures presented to our institution. One hundred and sixty-one patients had contraindication to FIB. Two hundred and twenty-nine of 260 patients (88%) without contraindications to undergoing FIB identified as White/Caucasian. Patients eligible for FIB who identified as White were more likely to receive FIB (42% vs. 22%). Amongst patients who received FIB, White patients had shorter time from diagnosis of fracture to undergoing FIB compared to non-White patients (182 vs. 224 minutes).

**DISCUSSION/CONCLUSION:** Our previous study demonstrated the benefits related to decreased opioid consumption associated with undergoing a fascia iliaca block in the emergency department. In this study, we found that when FI block was indicated non-White patients were less likely to receive the FI block. Additionally, we found that non-White patients waited longer to undergo FI block than White patients when they did receive FIB. In conclusion, institutions should remain aware of disparities in care provided to their patients and enact changes to provide equitable care to all patients.

Poster 014

**Does In-Situ Sterilization of the External Fixator for Maintenance of Reduction During Definitive Fixation of High-Energy Tibial Plateau Fractures Impact Rates of Postoperative Stiffness?**

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**INTRODUCTION:** High energy proximal tibia fractures are commonly treated using staged management protocols to allow for soft tissue healing and limit complications. Recent studies have shown that the external fixator device may be prepped into the surgical field in-situ during definitive fixation surgery without increased infection risk. This study aims to determine if prepping in the external fixator leads to differences in rates of postoperative stiffness of the knee after staged definitive fixation of a high energy tibial plateau fracture.

**METHODS:** This retrospective cohort study was conducted at two academic level 1 trauma centers. Patients were divided into prepped and non-prepped groups based on sterilization and inclusion of the external fixator prior to definitive fixation. The primary outcome was rate of postoperative stiffness defined as need for manipulation under anesthesia. Other confounding variables were investigated to evaluate their impact on postoperative stiffness as well.

**RESULTS:** 244 patients were included in the study: 162 in the prepped group and 82 in the non-prepped group. There were no differences between non-prepped and prepped groups with respect to age, gender, BMI, or Orthopedic Trauma Association fracture classification. Average follow-up was 14.6 months (range 3 months to 60 months). The overall rate of postoperative stiffness was 11.6% (26/244). Patients in the non-prepped group had an increased risk of stiffness postoperatively (18.3% non-prepped vs. 6.8% prepped;  $p = 0.006$ ). There was no difference in postoperative stiffness after stratification based on the entire fixator frame or just the fixator pins (6.9% pins only vs. 6.7% entire frame,  $p = 0.998$ ). Prep status was a significant predictor of postoperative stiffness on multiple binary logistic regression (relative risk 2.23, 95% CI 1.07-3.96,  $p = 0.032$ ), independent of OTA classification ( $p = 0.243$ ), days in the external fixator ( $p = 0.223$ ), and operative time ( $p = 0.073$ ).

**CONCLUSIONS:** The results of the present study indicate that removal of the external fixator prior to definitive fixation of high energy tibial plateau fractures may be associated with increased postoperative stiffness independent of possible confounding variables. It is hypothesized that the transient loss of reduction associated with external fixator removal may lead to additional inflammatory insult and articular trauma. Maintenance of the temporary fixator may be considered to assist in definitive surgery and decrease complication postoperatively.

Poster 015

Risk Factors for Surgical Site Infection After Operative Management of Pilon Fractures

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**PURPOSE:** Pilon fractures result from high-energy trauma, leading to extensive fracture comminution and soft tissue damage. Current operative management prioritizes initial soft tissue protection with subsequent definitive fixation. Despite concerted efforts, extensive soft tissue damage remains a serious concern as it is associated with postoperative complications such as wound dehiscence and infection. The purpose of this study is to identify risk factors associated with surgical site infection (SSI) following operative management of pilon fractures.

**METHODS:** A retrospective review of all operatively managed pilon fractures at a single level 1 trauma center from 2014 to 2019 was performed. Minimum six-month follow-up and skeletal maturity was required for inclusion. Patients with amputation prior to definitive fixation were excluded. Patients were grouped based on presence of surgical site infection or no infection. SSI consisted of superficial and/or deep infections (defined as return to the operating room for debridement with positive cultures). Patients were grouped based on presence or absence of SSI. Demographics, injury and operative characteristics, and surgical outcomes were compared between the two groups.

**RESULTS:** A total of 279 patients met inclusion criteria for the study, with 40 patients developing SSI (14.3%). Average follow-up was 3.2 years. A total of 95.4% (228/267) patients suffered high-energy injury. Patients that developed SSI had a significantly higher proportion of open fractures (47.5% vs. 23.4%,  $p=0.003$ ); however, there were no significant differences in Gustilo-Anderson classification or open wound location compared to controls. The SSI group required significantly higher rates of skin grafts (25.00% vs. 4.18%,  $p<0.001$ ) and muscle flap coverage (20.0% vs. 1.7%,  $p<0.001$ ). Operative time was significantly longer in the SSI group (283.1 vs. 222.3 minutes,  $p=0.002$ ). Patients with SSI displayed significantly higher rates of nonunion at 6-month follow-up when compared to those without SSI (55.0% vs. 10.9%,  $p<0.001$ ). There were no significant differences in mechanism of injury, AO/OTA fracture classification, associated ipsilateral lower extremity injuries, bone grafting, surgical approach, or presence of medial column fixation between the two groups.

**CONCLUSION:** The present study shows that SSI after pilon fractures has a devastating prognosis, with 55% of patients developing nonunion at 6 months. Risk factors for SSI in these patients included open fracture, receiving soft tissue coverage, and longer operative times. Future multicenter studies are needed to further investigate risk factors for SSI after operative management of pilon fractures.

Poster 016

Cost-Analysis of Revision Amputations: A Single Center Retrospective Study

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**BACKGROUND:** The number of lower extremity amputations that performed in the United States has been increased in proportion to the rising incidence of diabetes mellitus and peripheral vascular disease. It has been noted in the literature that 150,000 amputations are performed yearly.<sup>1</sup> These revisions can represent a high yearly cost to our health systems, understanding risk factors and probability of revision can facilitate preoperative discussion.

**METHODS:** Operative cases from 2015-17 of a single center Veterans Integrated Service Network 19 (VISN 19) were reviewed for amputations including revisions. The prevalence of amputations, return trips to OR including washouts and revision amputation, OR time and inpatient cost were analyzed. Furthermore, revision and non-revision groups respective age, gender, BMI, amputation level, surgical time, and preoperative A1c were evaluated. Our local center average OR time (\$35/minute) and average inpatient stay (\$1,360/day) were used for cost analysis.

**RESULTS:** In our study population (n=153), 41% patients returned to the OR for either washout (16%) or revision amputation (34%) encompassing an average OR and inpatient cost of \$16,465 per patient. Risk for revision included preoperative A1c (7.57 vs. 8.33; p=0.41) and amputations at the level of ankle (1 vs. 12; p=.04). In our population, BMI, age, and gender were not significant differences in risk for revision. The revision population had an increased average hospital stay compared to the non-revision group (15.25 days vs. 5.82 days; p<.001).

**CONCLUSION:** This study illustrates the likelihood of revision amputation and consideration in preoperative planning for level and patient understanding and expectations. This information can benefit Orthopedic surgeons and practitioners in pre- and postoperative planning and counseling the patients. Furthermore, this study may provide information in the cost of amputation/revision and expectation of further surgery, especially with those at the level of ankle.

Poster 017

**Evaluation of a Novel Multidisciplinary Pre-Operative Workup Strategy for Geriatric Hip Fractures**

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**OBJECTIVE:** To determine the financial and clinical impact of a standardized, multidisciplinary team for surgical clearance and optimization in geriatric hip fracture patients.

**DESIGN:** Retrospective Case Series

**SETTING:** Level 1 Trauma Center

**PATIENTS:** One-hundred and twenty-four geriatric patients (age >65 years old) in the pre-protocol group (Cohort 1; January 2017-December 2018) and 98 geriatric patients in the post-protocol group (Cohort 2; October 2019-January 2021) with operative hip fractures.

**INTERVENTION:** Implementation of a multi-disciplinary team protocol consisting of Anesthesiology, Internal Medicine, and Orthopedic Surgery departments for assessment of medical readiness and optimization for surgical intervention in geriatric hip fractures.

**MAIN OUTCOME MEASUREMENTS:** Rate of cardiology consultation, need for cardiac workup (echocardiography stress testing, heath catheterization), time to medical readiness (TTMR), time to surgery (TTS), case-cancellation rate, length of stay (LOS), and total hospitalization charges.

**RESULTS:** Following implementation of the new protocol, there were significant ( $p < 0.001$ ) decreases in TTMR (19 hours vs. 11 hours), LOS (149 hours 120 hours), case cancellation rate and total hospital charges (\$84,000 vs. \$62,000). There were no significant differences with respect to in-hospital complications or re-admission rates/mortality rates at one year.

**CONCLUSIONS:** Following implementation of a protocolized, multi-disciplinary approach to optimizing geriatric fracture patients, we were able to demonstrate a reduction in unnecessary preoperative testing, time to medical readiness for surgery, case cancellation rate, length of stay and total hospitalization charge – without a concomitant increase in complications or mortality. This study highlights that standardization of the perioperative care for geriatric hip fracture patients can provide effective patient care while also lowering financial and logistical burden in care for these injuries.

**LEVEL OF EVIDENCE:** Level III

Poster 019

**Tranexamic Acid Administered at Time of Hospital Admission Does Not Decrease Transfusion Rates or Blood Loss for Extracapsular Hip Fractures: A Double-Blinded Randomized Clinical Trial**

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**INTRODUCTION:** Tranexamic acid (TXA) has demonstrated efficacy in the management of blood loss perioperatively in hip fracture surgery and has demonstrated benefits if given upon hospital admission in the trauma population at large. As peritrochanteric fractures are extracapsular, much of the blood loss may be “hidden” and occur in the initial period of time after fracture, but prior to surgery. The aim of the present study was to evaluate the efficacy of TXA when administered immediately upon hospital presentation in patients with AO/OTA 31-A fracture patterns to determine its effect on (1) transfusion rates (2) estimated blood loss, and (3) postoperative complications.

**METHODS:** A prospective, double-blinded, randomized clinical trial was performed from 2018 – 2022. 129 patients with AO/OTA 31-A fractures were included: 64 patients were randomized to intravenous (IV) TXA and 65 patients to placebo (IV normal saline). Study drug was administered in the emergency department at time of presentation according to a protocol previously published in the CRASH-2 trial (1-gram bolus over 10 minutes followed by a 1-gram infusion over 8 hours). Perioperative TXA was not administered in either cohort. The mean age was 79 years, 71% were female, and mean body mass index was 26 kg/m<sup>2</sup>. The primary outcome was the rate of red blood cell (RBC) transfusion hospital day #0 – #3. Secondary outcomes included estimated blood loss (as determined by hemoglobin balance method) and complications including venous thromboembolic events, stroke, myocardial infarction, all-cause 90-day readmissions, and death. Patients were followed for 6 months following the index surgery. Continuous variables were analyzed using Student’s t-test and categorical variables using Chi-squared test.

**RESULTS:** There was no difference in the rate of RBC transfusion between treatment arms between hospital day #0 – #3 (TXA: 27% vs. Placebo: 29% , p=0.74). There was no difference in the estimated blood loss between hospital day #0 – #3. There was no difference in the incidence of postoperative complications including deep vein thrombosis, pulmonary embolism, stroke, myocardial infarction, 90-day readmission, or death.

**CONCLUSIONS:** The current study did not demonstrate a decrease in the need for RBC transfusion when administering TXA at time of presentation for patients with extracapsular hip fractures. Importantly, there was no increased rate of complications in the TXA cohort suggesting early administration is safe. The results of the current study do not support the use of TXA at time of hospital presentation for reducing “hidden” blood loss for patients with extracapsular hip fractures.

Poster 020

**The Incidence and Diagnosis of Intra-Articular Extension with Spiral Distal Third Humerus Fractures**

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**PURPOSE:** Many orthopedic injuries have associated fracture patterns that require specific diagnostic tests to provide the appropriate treatment. For example, femoral shaft fractures can be associated with femoral neck fractures and distal third tibia fractures can be associated with posterior malleolus fractures. Prior to the identification of these relationships and the optimal means of diagnosis, treatment of these injuries could be difficult. The relationship between spiral distal humeral shaft fractures and intra-articular extension has not been previously assessed. Knowledge of this association will help guide treatment and dictate whether advanced imaging is warranted in this population. The purpose of this study is to identify if there is an association between spiral distal humeral shaft fractures and intra-articular extension.

**METHODS:** We conducted a retrospective review of patients who presented with spiral distal third humeral shaft fractures from 2016-2021 at a single institution. We queried our electronic medical record utilizing CPT codes (24500, 24505, 24515, 24516) and ICD10 codes (S42.3, S42.4). Inclusion criteria consisted of patients older than 17 years old, spiral distal third humeral shaft fractures, and patients with appropriate radiographic imaging. Patients were excluded if they had an associated periprosthetic fracture or pathologic fracture. For each patient we recorded OTA fracture classification, presence of CT scan, and presence of intra-articular extension. The results were analyzed using descriptive statistics.

**RESULTS:** Nine hundred and seventeen patients were identified with humeral shaft fractures. Of those, 146 had distal humeral shaft fractures. From the distal humeral shaft cohort, 57 patients were included in the study with spiral distal third humerus fractures, of which 1 (1.8%) fracture had intra-articular extension. Thirty patients had CT scans of the distal humerus, and none of these scans identified additional patients with intra-articular extension.

**CONCLUSION:** Distal third humeral shaft fractures infrequently have intra-articular extension. One patient out of 57 had intra-articular extension seen on radiographs and CT scan (1.75%). Based on our results with our cohort, distal third humeral shaft fractures do not routinely require CT scans to evaluate for intra-articular extension.



Poster 021

**Intramedullary Reaming Biopsy in Diagnosing Metastatic Long Bone Disease**

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**PURPOSE:** Prior studies have shown that intramedullary reamings sent to pathology for analysis were sufficient to diagnose metastatic long bone disease in 40-60% of cases. The objective of our study was to further describe the diagnostic accuracy of intramedullary reaming biopsy in cancer patients with long bone lesions or suspected pathologic fractures in determining the presence of metastatic disease. We hypothesized that intramedullary reaming biopsy would have a higher than previously reported sensitivity.

**METHODS:** Electronic medical records, including demographics and operative/pathology reports, were reviewed for adult femur, humerus, and tibia (AO/OTA types 31-33, 11-13, and 41-43, respectively) intramedullary nail fixation cases performed between January 2013 and October 2021 at a single academic institution. Cases in which reamings from cancer patients were sent to pathology were included. Cases involving open biopsy were excluded. Statistical analysis was performed using Pearson's chi-squared test for categorical variables and Student's t-test for continuous variables.

**RESULTS:** Of the 46 reamings from 44 patients sent to pathology, 32 (69.6%) were able to establish a diagnosis of metastatic disease. The majority of reaming biopsies were from the femur (42/46, 91.3%), followed by humerus (3/46, 6.5%), and tibia (1/46, 2.2%). Only five samples (10.9%) were crushed or necrotic. Average patient age was  $69.2 \pm 11.7$  years, with reamings from older patients having a lower diagnostic yield ( $p = 0.021$ ). Most reamings were from female (76.1%) and white (73.9%) patients. Approximately half of cases were therapeutic (52.2%) vs. prophylactic (47.8%) in nature. The most common diagnoses were breast (37.0%) and lung (21.7%) carcinoma and multiple myeloma (21.7%).

**CONCLUSION:** Our study found that intramedullary reaming biopsy in cancer patients with long bone lesions or suspected pathologic fractures has a higher than previously reported sensitivity for diagnosing metastatic disease. Only a small proportion of samples were crushed or necrotic, suggesting that intramedullary reaming may be a less destructive biopsy method than previously described.

**SUMMARY:** Intramedullary reaming biopsy in patients with long bone lesions or suspected pathologic fractures has a relatively high diagnostic yield and is a less destructive method than previously described.

Poster 022

**Does Achieving PROMIS MCID Influence Healthcare Resource Utilization After Cervical Spine Surgery?**

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**INTRODUCTION:** Patient-reported outcome measures are important metrics for quality of care, patient satisfaction, and efficacy of surgical intervention. However, there is a lack of literature assessing how these outcome measures are associated with how patients utilize healthcare resources in the postoperative period. The purpose of this study is to compare healthcare utilization metrics between patients obtaining minimally clinically important difference (MCID) in after elective cervical spine surgery.

**MATERIALS/METHODS:** Patients undergoing elective spine surgery between November 1, 2013 and September 30, 2018 at a single, tertiary academic center were prospectively followed for 12 months after surgery. Two PROMIS computer adaptive testing (CAT) outcomes – physical function (PF) and pain interference (PI) – were assessed at baseline, 6 weeks, 3 months, and 12 months postoperatively. A MCID of 8 was selected for PF and PI scores based on prior literature. Patients were split into two groups, those with and without achievement of MCID at 365 days postoperatively. Healthcare resource utilization metrics were compared between the two groups. Healthcare resource metrics included cervical imaging studies, emergency department visits, urgent care visits, postoperative opioid prescriptions, epidural or other spinal injections, and pain management referrals at 90-, 180-, and 365-days postoperatively. Utilization was divided into three groups based on tertiles – low, moderate, and high resource utilization.

**RESULTS:** 139 patients were included in the final cohort. Fifty-five (39.6%) patients achieved MCID of the PI and/or PF score at 12 months postoperatively. Patient variables were similar between the two groups, including sex, age, body mass index (BMI), Charlson comorbidity index, American Society of Anesthesiologists (ASA) class, and baseline (e.g. preoperative) PI and PF scores. However, patients that achieved MCID had a lower number of vertebral levels fused ( $p=0.007$ ). There were no significant differences in healthcare resource utilization at 365 days postoperatively between patients that achieved or did not achieve MCID after surgery.

**CONCLUSION:** Patients that failed to achieve minimally clinically important differences in PI and PF scores after elective cervical spine surgery did not have a higher rate of healthcare resource utilization in the first year postoperatively.

Poster 023

**Accuracy of Non-Invasive Hemoglobin (nHgb) Monitoring in an AIS Population**

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**SUMMARY:** nHgb monitoring moderately correlates (0.6) with invasive hemoglobin (iHgb) in pediatric AIS patients undergoing PSFI. Surgeons could consider screening AIS patients postoperatively with nHgb monitoring and only order iHgb measurement if the nHgb value is <10.8 g/dL.

**HYPOTHESIS:** nHgb monitoring would accurately correlate with iHgb measures in AIS patients undergoing PSFI.

**STUDY DESIGN:** retrospective review of prospective data.

**INTRODUCTION:** Needle phobia and fear of blood draws is very common in children and adolescents. Noninvasive hemoglobin (nHgb) monitoring in children was first introduced in the Intensive Care Unit (ICU) setting. Later, our total joint arthroplasty colleagues demonstrated that nHgb monitoring was more efficient, less expensive, and preferred by patients compared into invasive hemoglobin (iHgb) monitoring. The purpose of this study is to identify the correlation between nHgb and iHgb monitoring which would allow a nHgb threshold to be determined. Patients with a nHgb level above that threshold would no longer require a blood draw, thus minimizing resource utilization, blood draw related anxiety, and pain during the postoperative period.

**METHODS:** We enrolled 60 consecutive patients undergoing posterior spine fusion/instrumentation (PSFI) for AIS. Average EBL was 415cc, and 189 cc was returned via cell saver. 2/60 (3.3%) patients required an allogenic blood transfusion perioperatively. nHgb and iHgb values were obtained within 60 minutes of each other at three separate time points (preoperative, in Post-Anesthesia Care Unit (PACU), and POD 1 at 0700) iHgb and nHgb values were recorded. The results were retrospectively reviewed and analyzed. Paired t tests were utilized to compare mean (n/i)Hgb values. Pearson correlation coefficients were calculated at all three time points. ROC analysis was performed on the postoperative values to determine a threshold.

**RESULTS:** There was a moderate positive correlation at all three time points (0.4, 0.59, 0.6) ( $p= 0.005, <0.001, <0.001$ ). At all three timepoints, the mean nHgb value was 1-2 g/dL higher than the mean iHgb value, and this was statistically significant. At 0700 on POD1, a patient with a nHgb value of  $\geq 10.8$  g/dL had an iHgb value of  $>9.0$  g/dL with 87% sensitivity.

**CONCLUSIONS:** Noninvasive Hgb monitoring was found to correlated with iHgb in pediatric AIS patients undergoing PSFI. Surgeons could consider screening AIS patients postoperatively with nHgb monitoring and only order iHgb measurement if the nHgb value is <10.8 g/dL resulting improvement in the patient experience. **TAKE HOME MESSAGE:** nHgb correlates moderately with iHgb measurements. A nHgb value of  $\geq 10.8$  g/dL demonstrated an iHgb value of  $>9.0$  g/dL with 87% sensitivity.

Poster 024

Elevated HbA1c Values Predispose Medical Complications After Lumbar Fusion

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**INTRODUCTION:** Hemoglobin A1c (HbA1c) levels are indicative of glycemic control. In the perioperative setting, glycemic control has been linked to increased risk of surgical complications. This study intends to assess the predictive value of HbA1c levels on medical complications following lumbar fusion.

**METHODS:** Subjects consisted of individuals  $\geq 18$  years who underwent lumbar fusion surgery between 2002-2021 at a multi-site academic center. HbA1c levels recorded within three months of surgery, demographic information, and clinical factors were abstracted. Major medical complications were defined as experiencing  $\geq 1$  of the following: myocardial infarction, cardiac arrest, deep vein thrombosis, pulmonary embolism, respiratory distress, pneumonia, sepsis, and/or stroke within 90 days of surgery. A similar outcome for minor medical complications considered anemia, delirium, dysphagia, nausea/vomiting, and/or urinary retention. Univariate analyses were performed using independent, two-tailed Welch's t-tests. Significant outcomes were further evaluated via multivariate logistic regression. Outcomes significant on multivariate analysis were analyzed with Receiver Operating Characteristic (ROC) curves to identify predictive thresholds. ROC curves were assessed using Area under the ROC Curve (AUC) measurements and Mann-Whitney U tests.

**RESULTS:** The patient cohort was composed of 384 patients (49% males, average age: 62.03, average HbA1c: 6.28). 19% and 57% of patients experienced major and minor medical complications, respectively. Univariate analysis showed a significantly higher HbA1c in patients who experienced major medical complications ( $p=0.030$ ) whereas minor medical complications showed no significance. Upon logistic regression, unit increases in HbA1c significantly increased odds of major medical complications (OR:1.604; CI: 1.161-2.215,  $p=0.004$ ). ROC analysis identified a cutoff HbA1c of  $\geq 7.0\%$  predictive of major medical complications (AUC: 0.59  $\pm$  0.07,  $p=0.024$ ).

**CONCLUSION:** Higher HbA1c levels were significantly associated with increased odds of medical complications in patients following lumbar fusion. A clinically useful HbA1c threshold was identified that can inform preoperative care.

Poster 025

Using Machine Learning Techniques to Predict Healthcare Utilization After ACDF

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**BACKGROUND:** Health service overutilization contributes to substantial postoperative expenses. The current study applies ML modeling to patients who underwent anterior cervical discectomy and fusion (ACDF) to predict postoperative healthcare use.

**METHODS:** We included patients who underwent single or multilevel ACDF from 2002 – 2021 at a multi-site academic center. Variables (64) spanned demographic and clinical data, including preoperative complete blood count and basic metabolic panel values. Outcomes were 90-day and 1-year reoperation, 90-day readmission, 90-day Emergency Department (ED) or Urgent Care visits, and 90-day outpatient resource use (invasive procedures, non-routine testing, non-routine imaging). A random forest (RF), elastic-net regression (ENet), and neural network (NN) were created. Performance was assessed using Area Under the Receiver Operating Curve or Mean Absolute Error statistics and compared to a null benchmark. Feature importances for highest performing models were computed.

**RESULTS:** A total of 1,032 patients (47.2% males; average age 55.1 [SD: 12.1]) were included. A subset (19.1%) had at least one 90-day ED/UC visit, and the readmission rate within 90-days was 9.6%. Average outpatient resource use was 4.8 (SD: 2.6).

All models outperformed the benchmark model. ENet was best for ED/UC visits, with top predictors being history of cervical fusion and lumbar decompression. RF was best performing for 90-day readmission and outpatient resource use. Top predictors of readmission were history of endocrine (non-diabetes) disorders and psychiatric conditions. Outpatient resource use was best predicted by BMI and OR duration hours.

**CONCLUSIONS:** ML and deep learning models were created with high performance to predict postoperative health utilization. This approach may allow physicians to counsel at-risk patients.

Poster 026

**Percutaneous Stabilization of Traumatic Lumbar and Thoracic Spine Fractures: A Retrospective Review**

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STUDY DESIGN: Retrospective cohort, Fracture, lumbar, thoracic

OBJECTIVE: Percutaneous fixation of spine fractures has been increasing in popularity over the past decade. The objective of our study was to assess cases of percutaneous and open treatment of spinal fractures in a trauma population and evaluate outcomes and indications for surgery.

METHODS: Data was collected from patients that underwent percutaneous or open spinal fixation over the past 10 years at our institution with greater than 3 months follow-up. Patients were divided into two groups. Demographic and complications data was collected.

RESULTS: Seventy-eight patients underwent percutaneous spine fixation for thoracic or lumbar spine fractures and 73 patients underwent open instrumented posterior spinal fusion (IPSF). There were no significant differences when demographic, age, gender, BMI, smoking status, or comorbidities was compared between the two groups. The open IPSF procedure was significantly longer ( $206.88 \pm 56.1$  vs.  $130.79 \pm 47.6$  minutes,  $p < 0.01$ ) and had a higher estimated blood loss ( $543.77 \pm 431.84$  vs.  $71.22 \pm 61.83$  mL,  $p < 0.01$ ). There were significantly more complications that required return to the operating room in the open IPSF group (11 patients) vs. the percutaneous group (3 patients,  $p = 0.018$ ). The length of stay of patients in the percutaneous group ( $11.38 \pm 7.74$  days) and open IPSF group ( $14.01 \pm 10.55$  days) was not significantly different ( $p = 0.08$ ).

CONCLUSIONS: The role of percutaneous spinal fracture still remains controversial, but this study shows promising results in the correct patient group. This study shows decreased blood loss and length of stay in the percutaneous group, but may also have increased nonoperative complication rates.

Poster 027

**Transforaminal vs. Lateral Interbody Fusion for Treatment of Adjacent Segment Disease in the Lumbar Spine**

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**INTRODUCTION:** There is a paucity of literature that compares revision lumbar adjacent segment disease (ASD) outcomes based on surgical approach. This study aimed to compare posterior vs. lateral approaches for treatment of ASD by comparing the perioperative and postoperative outcomes in patients who received a posterior lumbar interbody fusion (PLIF)/transforaminal lumbar interbody fusion (TLIF) and lateral lumbar interbody fusion (LLIF)/oblique lateral interbody fusion (OLIF).

**METHODS:** A retrospective review was performed of consecutive patients who underwent a single-level PLIF/TLIF, LLIF, or OLIF for symptomatic ASD at a single tertiary care academic medical center between January 2010 and December 2021. All surgeries were performed by fellowship-trained orthopedic and neurosurgeons. Exclusion criteria included skeletal immaturity (age <18 years old), multi-level fusions, and surgery indication for malignancy or infection. Patient demographics, medical comorbidities, operative details, postoperative complications, and revision surgery profiles were collected for all patients.

**RESULTS:** 152 consecutive patients (mean age  $65 \pm 10$  years) were included in the analysis. 123 (81%) of patients underwent a PLIF/TLIF, 18 (12%) underwent an LLIF, and 11 (7%) underwent an OLIF. There was no difference in rate of intraoperative complications between procedural cohorts. The PLIF/TLIF cohort experienced a significantly greater mean operative time and blood loss ( $210 \pm 62$  min;  $414 \pm 254$  ml) as compared to OLIF ( $184 \pm 80$  min;  $49 \pm 29$  ml) and LLIF ( $105 \pm 64$  min;  $36 \pm 33$  ml) ( $p < .001$ ,  $p < .001$ ). Overall, there was no difference in rate of 30-day ( $p = 0.25$ ) or 90-day ( $p = 0.14$ ) readmission, 30-day ( $p = 0.62$ ) or 90-day ( $p = 0.745$ ) return to OR, 90-day ED utilization ( $p = 0.964$ ), nor reoperation within 13 months ( $p = .873$ ) between procedural cohorts. Common postoperative complaints were radicular pain (19.7%), transient neurological deficit (9.9%), and hip flexor pain (5.3%). There was a significantly greater rate of radicular pain for the OLIF cohort (63.6%) as compared to LLIF (38.9%) and PLIF/TLIF (13%) ( $p < .001$ ). There was a significantly greater rate of DVT/PE in the OLIF cohort (9%) as compared to the PLIF/TLIF (2.4%) and LLIF (0%) cohorts ( $p = .03$ ). Complication rates were otherwise comparable between procedural cohorts.

**DISCUSSION:** Posterior (TLIF/PLIF) and lateral (OLIF/LLIF) approaches to the lumbar spine demonstrated similar risk profiles with regards to intraoperative complications, postoperative health-care utilization, and postoperative complications. Posterior approaches demonstrated greater mean operative time and blood loss, whereas lateral based approaches, particularly OLIF, demonstrated greater rate of postoperative radicular pain and DVT/PE.

Poster 028

The Role of Clinical Comorbidities and Social Determinants of Health on 90-Day Readmission Rates Following ACDF

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Social determinants of health (SDH) are communal and environmental factors that affect the wellbeing of a person. SDH has become increasingly important across various fields of medicine, yet it remains understudied within spine surgery. Machine learning (ML) algorithms are well suited to glean insights from clinical databases. This study aims to apply ML to understand relationships between SDH and 90-day readmission rates in ACDF patients.

Patients that underwent single or multi-level ACDF at a multi-center academic health system between 2002 – 2020 were acquired from Northwestern Medicine Electronic Data Warehouse. More than 60 clinical variables including demographics, past medical and surgical history were included. Each patient was assessed SDH characteristics using the Social Deprivation Index (SDI), which was retrieved from the American Community Survey. The primary endpoint was 90-day readmission. Several ML models were run using custom R scripts and were validated by Area Under the Curve (AUC). The data was split into training/testing (80/20) sets. Validation was performed on withheld test data following optimization. The best performing model was determined by AUC; variable importance was calculated for the best model and ranked by impact on output prediction.

A total of 2,957 patients and 63 variables were included in the final sample. Of all patients undergoing ACDF, the 30-day and 90-day readmission rates were 3.4% (n=101) and 6.8% (n=202), respectively. Additionally, the 90-day and 1-year reoperation rates were 1.0% (n=29) and 1.8% (n=53), respectively. Of the 4 models, Boosted Tree performed the best with an AUC of 0.734. Variable Importance scores showed that other cardiovascular disorders (other than history of arrhythmias, MI, or heart failure), hypertension, and BMI were found to be most impactful.

Results from this study indicated that cardiovascular disorders, hypertension, and BMI are most predictive of 90-day readmission following ACDF. Out of all the SDH variables studied, only the presence of Managed Care insurance and federal county poverty score were found to be in the top 10. Further studies are needed to clarify the interplay between social determinants of health and patient outcomes.



Poster 030

Retaining a Well-Fixed Cone During Revision Total Knee Arthroplasty: Surgical Technique and Outcome

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**INTRODUCTION:** Metaphyseal cones with cemented stems are frequently used in revision total knee arthroplasties (TKA). However, during subsequent aseptic re-revisions, removing a well-fixed cone can be difficult. One innovative option is to retain the well-fixed cone and cement a new revision component with stem through the retained cone, yet minimal data exist. As such, we report the implant survivorship, re-revision rates, radiographic outcomes, and postoperative complications of this technique in a series of patients.

**METHODS:** Between 2005 and 2019, we identified 9 patients with 10 well-fixed metaphyseal cones (6 femoral and 4 tibial) who underwent revision of the femoral or tibial component with a stem extender through a well-fixed and maintained cone through our institutional total joint registry. Mean age at re-revision TKA was 65 years and 44% of patients were female. Patients had a mean of 4 prior knee arthroplasty procedures. Indications for re-revision TKA were aseptic loosening (n=3), instability (n=3), extensor mechanism disruption (n=2), heterotopic ossification (n=1), and prosthesis fracture (n=1). Mean follow-up was three years.

**RESULTS:** At final follow-up, no retained cones with a new femoral or tibial component with stems were revised. Two knees required revisions for other reasons: one for a failed hinge mechanism and one for infection. There was one additional reoperation for tibial stem cortical perforation. Radiographically, there was no evidence of aseptic loosening at most recent follow-up. One patient had postoperative anemia, deep vein thrombosis, and atrial fibrillation within 90-days of their re-revision TKA; no other patients experienced early postoperative complications.

**CONCLUSION:** When re-revising a TKA within a well-fixed metaphyseal cone, these early data suggest the cone can be safely retained to minimize morbidity associated with cone removal. While long-term follow-up is needed, retaining a well-fixed metaphyseal cone provides an excellent option in difficult re-revision TKAs.

**SUMMARY STATEMENT:** Retaining a well-fixed metaphyseal cone during re-revision TKA may be an effective technique for minimizing unnecessary morbidity during the procedure.

Poster 032

The Differential Effect of COVID-19 on Total Joint Arthroplasty Between Hospital and ASC/HOPD - A MARCQI Analysis

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INTRODUCTION: COVID-19 created unprecedented challenges for healthcare, especially for high volume elective case sub-specialties like total joint arthroplasty (TJA). Conservation of resources and limited inpatient capacity led to new patterns of clinical workflow such as changes in preoperative selection for outpatient surgery, a push for same day discharge and changes in site of service. This study examined demographic changes and short-term complications associated with TJA pre- and post-COVID and analyzed differential effects between hospitals and ASC/HOPDs.

METHODS: Using a statewide TJA registry, case volumes, patient demographics, and 90-day complications of primary TJA performed at hospitals and ASC/HOPDs between 07/2019-12/2019 and 07/2020-12/2020 were compared. Propensity scoring was used to create a matched hospital cohort for complication comparisons.

RESULTS: When comparing 2020 to 2019, there was a 9% and 17% decrease in hospitals for THA and TKA volume respectively. In contrast, these increased 84% and 125% in ASC/HOPDs. Entering 2020: ASC/HOPD patients became older ( $p=0.0031$ ,  $p<0.0001$ ; hips, knees), more ASA>2 ( $p=0.0105$ ,  $p=0.0021$ ), less attended joint class ( $p<0.0001$ ,  $p<0.0001$ ), and more hips were women ( $p=0.023$ ). Hospitals had higher preoperative pain scores ( $p=0.0117$ ,  $p<0.0001$ ; hips, knees), less joint education attendance ( $p<0.0001$ ,  $p<0.0001$ ), had younger knees ( $p=0.0169$ ), and more ASA>2 (0.0009). After propensity matching, there were no significant differences for 90-day fractures, DVT/PE, infection, or hip dislocations in either setting. Hospital hips had higher readmissions ( $p=0.0003$ ), and knees higher 30-day ED visits ( $p=0.005$ ). In the ASC/HOPD both THAs and TKAs were prescribed higher OMEs ( $p<0.0001$ ,  $p<0.0001$ ).

CONCLUSION: COVID shifted TJAs to the ambulatory setting. The care pattern change negatively affected preoperative education and increased the number of less healthy patients in outpatient settings. However, aside from increased discharge OMEs, short-term complications post-COVID were not increased in ASC/HOPDs in this propensity matched cohort. The COVID induced push for site of service change appeared safe and efficacious.

Poster 033

**Outcomes After Primary Below-Knee Amputation for Vascular vs. Diabetic Indications**

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**INTRODUCTION:** End-stage peripheral artery disease and diabetes-related complications are two of the most common indications for below-knee amputation (BKA). However, there is a lack of large population data comparing short-term outcomes following primary BKA for vascular versus diabetic related indications. The aim of this study is to compare the incidence of various 30-day complications after primary BKA for vascular vs. diabetic indications.

**METHODS:** The ACS NSQIP database was queried to identify primary BKA cases between 1/1/2015 and 12/31/2017. ICD-10 codes were used to determine surgical indication. Baseline demographics, surgical indications, and various 30-day outcome measures were extracted. Patients undergoing BKA for diabetes/infection and vascular indications were isolated. Exact matching was used to match these two groups on a variety of patient variables, including age, sex, BMI, ASA class, and several medical comorbidities. The incidence of various 30-day outcome measures were compared between groups. Binary logistic regression was used to identify independent risk factors for various 30-day complications.

**RESULTS:** 1,522 patients were included in the final matched cohort. After exact matching, patients undergoing BKA for vascular disease were more likely to experience an unplanned hospital readmission (19.5% vs. 14.2%,  $p=0.009$ ) and an unplanned reoperation (9.8% vs. 6.1%,  $p=0.012$ ). The two groups had similar rates of mortality, non-home discharge, surgical complications, and medical complications ( $p>0.05$ ). Total hospital length of stay was also comparable between the two groups ( $p>0.05$ ). Multivariate analysis demonstrated that undergoing BKA for a vascular indication was an independent predictor of unplanned readmission and reoperation within 30 days of surgery. Advanced age, ASA class 4, obesity, and a history of COPD or dialysis use were also predictors of various 30-day complications.

**CONCLUSION:** Patients undergoing primary BKA for vascular indications are at a higher risk of poor 30-day outcomes relative to those with diabetic-related indications. Specifically, vascular patients are more likely to experience an unplanned hospital readmission and reoperation.

Poster 034

Greater Improvement in PROMs in Patients with Body Mass Index  $\geq 40$  Following Primary TKA

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**INTRODUCTION:** Body mass index (BMI) cutoffs have been established at some institutions for total knee arthroplasty (TKA) patients due to increased risk of medical complications in obese patients. However, evidence-based medical optimization may mitigate risk in obese patients. This study examined the influence of the 40 kg/m<sup>2</sup> BMI cutoff on patient-reported outcomes measures (PROMs) following primary TKA with specialized perioperative optimization.

**METHODS:** 1,329 primary TKAs with standardized surgical techniques, identical congruent bearings, and standardized perioperative optimization and management protocols were retrospectively reviewed. Demographics and covariates related to PROMs were compiled. Patients were categorized into two groups based on BMI  $\geq 40$  or  $< 40$  kg/m<sup>2</sup>. Outcomes were revision status and prospectively collected PROMs related to activity level, pain, function, and satisfaction.

**RESULTS:** 22.9% of patients had a BMI  $\geq 40$ . The  $\geq 40$  BMI group had significantly lower age, more females, worse ASA-PS classification; a higher prevalence of depression and preoperative narcotic use ( $p \leq 0.008$ ); and significantly lower preoperative PROM scores ( $p < 0.001$ ) compared to the  $< 40$  BMI group. Despite these differences, the  $\geq 40$  BMI group was associated with greater improvement in Knee Society pain with level walking and stair climbing ( $p \leq 0.001$ ), KOOS JR score ( $p = 0.001$ ), and greater satisfaction (92% vs. 82%,  $p = 0.002$ ) at minimum 1-year follow-up. In multivariate analysis, BMI  $> 40$  was the largest standardized effect on improvement in PROM scores. No cases in the  $\geq 40$  BMI group were revised for aseptic loosening, and cases revised for periprosthetic joint infection were not different between groups ( $p = 0.800$ ).

**CONCLUSION:** Despite being more debilitated preoperatively, patients with BMI  $\geq 40$  experienced greater improvement in PROMs compared to BMI  $< 40$ . Given the significant improvements in PROMs and quality of life in morbidly obese patients with BMI  $\geq 40$ , with appropriate perioperative optimization and risk mitigation, these patients should not be prohibited by payers or surgeons from having TKA when appropriately indicated.

Poster 036

**Conversion Total Knee Arthroplasty After Failed Osteochondral Allograft Reconstruction - Similar Functional Performance with Lower Satisfaction**

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**BACKGROUND:** Large structural osteochondral allograft reconstruction has been introduced to treat osteoarthritis and post-traumatic arthritis in younger patients. While this approach has been successful for most patients, some may require an early conversion to total knee arthroplasty (TKA). We performed this study to characterize conversion TKA indications and to compare postoperative conversion TKA and primary TKA outcomes.

**METHODS:** We identified 26 consecutive conversion TKA (25 patients) performed following failed biological reconstruction at 33.7 month mean follow-up (range 18-52 months). Patient demographic characteristics (age, sex, BMI, ASA), allografts utilized, surgical procedures performed concurrent with the biological reconstruction, procedures performed before conversion TKA, and timing between index biological reconstruction and subsequent procedures were obtained from the electronic medical record. Preoperative conversion TKA expectation (5-point Likert) and patient reported outcome scores reported before and after conversion TKA (VAS Pain score, KOOS-Jr, UCLA activity) were compared between the primary treatment cohort and an age-gender-BMI matched cohort of 55 primary TKA (50 patients) with mean 29.0 months follow-up (range 17-56 months).

**RESULTS:** Articular cartilage loss was the primary indication for conversion TKA in 25 cases (96.2%) with associated failure modes (instability, joint stiffness, graft nonunion, or osteonecrosis) present in 12 cases (46.2%). Mean time to TKA conversion was 23.8 months (7.5 - 48 months) and patients had a median 2 additional procedures between biological reconstruction and conversion TKA (range 0-7). Primary TKA components were used for 17 patients (65.5%) including 3 TKAs utilizing a cemented stem extension (11.5%). Nine TKA conversion procedures (35.5%) were performed using revision femoral TKA components and metal augments were used to manage tibial or femoral bone deficiency in 4 cases (5.4%). A constrained-condylar insert was used for 3 cases (11.5%). There were no significant differences in preoperative expectation ( $p=0.95$ ), health literacy ( $p=0.47$ ), or preoperative opioid use ( $p=0.98$ ) between cohorts. Primary TKA patients reported greater contralateral joint pain ( $p<0.001$ ) and back pain ( $p=0.001$ ) and higher VAS knee pain (6.1 vs. 4.2 points,  $p<0.05$ ) before surgery. Similar postoperative KOOS-Jr scores were reported (77.5 vs. 77.1 points,  $p=0.98$ ) and UCLA activity scores were higher in the conversion TKA cohort (6.4 vs. 5.6 points,  $p<0.05$ ), but patient reported satisfaction was significantly lower (4.4 vs. 4.8 points,  $p=0.01$ ). Two patients who underwent conversion TKA were dissatisfied with their outcome, compared with no patients undergoing primary TKA (4% vs. 0%,  $p=0.11$ ).

**CONCLUSION:** While conversion TKA following failed biological joint replacement provides similar or better clinical performance than primary TKA in younger patients, procedural satisfaction is less certain. Patients undergoing biological joint reconstruction should not anticipate that a conversion TKA will necessarily allow return to frequent, high impact activity.

Poster 037

Examining Appropriate Knee Magnetic Resonance Imaging at a Tertiary Care Center

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**INTRODUCTION:** Inappropriate imaging adds cost burdens on the healthcare system, particularly at institutions that may serve high proportions of underserved and public aid patients. The American College of Radiology (ACR) recommends radiographs as the first-line diagnostic test for knee pain prior to ordering an MRI, however, there is a lack of information regarding institutional compliance with these guidelines. We analyzed the use of MRI for knee pain at an outpatient urban, tertiary care center by providers from different specialties.

**METHODS:** A retrospective study of all knee MRIs ordered between 1/1/2010 and 12/31/19 was done. For each MRI, the indication, ordering provider specialty, presence of previous radiographs, and prior diagnosis of osteoarthritis were recorded. Indications for MRI were categorized as nonspecific knee pain, suspected soft tissue injury (meniscus, ligamentous, tendinous), and other. Pearson's chi square test was used to compare the MRI ordering rates.

**RESULTS:** The sample totaled 5,462 outpatient knee MRIs. 2,182 (40%) were ordered without a prior radiograph. PCPs (55%) and other providers (40%) were less likely to have a previous knee radiograph prior to ordering an MRI as compared to orthopedic surgeons (66%) ( $p < 0.001$ ). PCPs and other providers were also less likely to order MRIs with a history of having a knee radiograph as compared to orthopedic surgeons in patients presenting with nonspecific knee pain and those with soft tissue injuries ( $p < 0.001$ ). Orthopedic surgeons (59%) ordered MRIs less commonly in patients with a history of osteoarthritis as compared to PCPs (63%) or other providers (62%) ( $p = 0.010$ ).

**DISCUSSION:** Advanced imaging represents a significant cost in healthcare. Orthopedic surgeons are less likely to order an MRI without first having a knee radiograph when compared to PCPs and other providers for all indications including nonspecific knee pain and soft tissue injuries. Additionally, orthopedic surgeons are also less likely to order an MRI when a patient has a history of osteoarthritis in comparison to all other providers. Despite this gap, about 4 in 10 MRIs ordered at our institution were completed without prior radiographs. Educational initiatives should be established to improve understanding of MRI appropriateness guidelines and ultimately reduce hospital costs, particularly at institutions with a high percentage of public aid patients.

Poster 038

The Ability of MRI to Predict Capsulolabral Adhesions at Revision Hip Arthroscopy

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**BACKGROUND:** Capsulolabral adhesions are known to cause persistent pain after hip arthroscopy often leading to revision surgery. The diagnosis of adhesions in patients with persistent postoperative pain can be difficult to make.

**PURPOSE:** To determine the accuracy of preoperative MR arthrogram in evaluating for capsulolabral adhesions.

**METHODS:** We retrospectively reviewed revision hip arthroscopies performed by a single surgeon between 2019 and 2022. MSK Radiologists blinded to surgical variables assessed preoperative axial T1 FS MR arthrograms for adhesions and graded adhesions as mild (length <5 mm), moderate (5-10 mm), or severe (> 10mm). Paralabral sulcus effacement increased the grade one level beyond adhesion length. Intraoperative arthroscopy images were evaluated for the incidence and severity of adhesions. Adhesions were graded intraoperatively as mild (rare, small adhesions), moderate (multiple or large adhesions), or severe (many adhesions disrupting labral function). A grade of 0 was assigned if no adhesions were present. Graders were blinded to each other, and Wilcoxon signed-rank test compared diagnosis methods. Sensitivity, specificity, and predictive values (PPV, NPV) were also calculated.

**RESULTS:** We identified 45 patients with preoperative MR arthrograms undergoing revision hip arthroscopy. On MRI grading, there were 41 adhesion cases (93%) of which 14 were considered severe (33%), 22 moderate (52%), and 6 mild (14%). On intraoperative grading (ICC 0.73, Kappa 0.35), there were 32 cases (71%) with 14 classified as severe (31%), 10 moderate (22%), and 8 mild (18%). There was no difference in severity assessment between the two diagnosis methods ( $p < 0.001$ ). Preoperative MRI was moderately able to predict intraoperative adhesions (sensitivity 90.6%, PPV 69%).

**CONCLUSION:** Axial T1 FS MR arthrogram is a sensitive tool to assess for capsulolabral adhesions in the revision arthroscopy setting. MR arthrograms best predict severe adhesions and are moderately predictive of mild and moderate adhesions. Further assessment of less invasive detection measures may be warranted.

Poster 039

Identifying Racial Disparity in Utilization and Outcomes of Hip Arthroscopy Using Machine Learning

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**BACKGROUND:** Advancements in the diagnosis and arthroscopic treatment of femoroacetabular pathology have resulted in improved hip function and delayed progression to hip arthroplasty. Unfortunately, previous investigations have observed decreased rates of access, utilization of, and outcomes following orthopedic interventions such as hip arthroplasty in underrepresented patients. The purpose of this study is to examine racial differences in procedural rates, outcomes, and complications in patients undergoing hip arthroscopy.

**METHODS:** The State Ambulatory Surgery and Services Database (SASD) and State Emergency Department Database (SEDD) of New York were queried for patients undergoing hip arthroscopy from 2011 to 2017. The primary outcomes investigated were utilization over time, total charges billed per encounter, 90-day emergency department visits following hip arthroscopy, and revision hip arthroscopy. Patients were stratified into White and non-White race. Subgroup analysis, temporal trends with Poisson regression modeling, and targeted maximum likelihood estimation (TMLE) were all performed.

**RESULTS:** A total of 9,745 patients underwent hip arthroscopy during the study period, with 1,081 patients of non-White race (11.9%). Poisson regression demonstrated an annual increase of 1.11 in the incidence rate of hip arthroscopy among White patients, compared to 1.03 for non-White patients ( $p < 0.001$ ), with this disparity projected to increase by 2040 (Figure 1). Based on TMLE, non-White patients were significantly more likely to incur higher costs (OR: 1.30, 95% CI: 1.24-1.37,  $p < 0.001$ ) and visit the emergency department within 90-days after surgery (OR: 1.09, 95% CI: 1.01, 1.18,  $p = 0.05$ ), but had negligible differences in reoperation rates at 90 days to 2 years (OR: 1.13, 95% CI: 0.78-1.63,  $p = 0.53$ ). Subgroup analysis identified higher likelihood for 90-day emergency department admissions among non-White patients compared to White patients, which were significantly compounded by Medicare insurance (OR: 2.95, 95% CI 1.46-5.95,  $p = 0.002$ ), median income in the lowest quartile (OR: 1.84, 95% CI: 1.2-2.61,  $p = 0.012$ ), and residence in low-income neighborhoods (OR: 2.05, 95% CI: 1.31-3.2,  $p = 0.006$ ). Subgroup analysis for charges billed and reoperation did not identify significant findings.

**CONCLUSION:** Irrespective of insurance status, non-White patients undergo hip arthroscopy at a lower rate, incur higher costs, and more frequently experience unexpected returns to the emergency department. Improved initiatives to improve the disparity in access to and outcomes following hip arthroscopy must be addressed to further its utility for all patients.



Poster 040

**Association Between Computerized Tomography Measurements and Stryker HipMap Data In Patients with Femoroacetabular Impingement**

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**INTRODUCTION:** Stryker's HipMap is a 3-D imaging application that uses computer-based analytics on imaging studies to deliver a visual report with cam and pincer analysis, indications for instability and other metrics. It is designed to assist with preoperative surgical planning for patients with femoroacetabular impingement (FAI). After incorporating HipMap into clinical practice, inconsistencies were noted between HipMap reports and imaging studies read by the orthopedic surgeon and radiologists regarding cam and pincer lesions. This pilot study aimed to determine the level of agreement between clinical observations and the automated HipMap, to evaluate the utility of Stryker's 3-D hip-mapping technology as a means for surgical planning.

**METHODS:** This work was determined to be a quality study and non-human subjects work by our IRB. Sixteen patients with indications of FAI underwent CT imaging and 3-D hip-mapping of the affected lower extremity as part of standard clinical care. Lower extremity CT studies were interpreted by an orthopedic surgeon and radiologist. Their reports provided qualitative descriptions of hip anatomy that identified cam and pincer lesions. The HipMap report was considered positive for a cam lesion if one or more of the four alpha angles reported by the application was greater than the upper normal limit of 55°. It was considered positive for a pincer lesion if either the lateral center edge angle or acetabular coverage values were greater than upper normal limits of 40° and 55%, respectively. A Fisher exact test was performed on these data to determine whether differences between the two groups in rate of cam and pincer lesions identified were significant.

**RESULTS & DISCUSSION:** The radiologists' reports identified cam and pincer lesions in 13/16 and 10/16 patients, respectively. The HipMap identified cam and pincer lesions in 7/16 and 1/16 patients, respectively. The difference between numbers of cam lesions identified was non-significant ( $p=0.0659$ ). While this difference was not statistically significant, 6/16 patients had different outcomes between the two groups (37.5%) which could have clinically meaningful impact. The difference between numbers of pincer lesions identified was significant ( $p=0.0021$ ). These data suggest that differences may exist between the rate of cam and pincer lesions identified in patients with FAI by radiologists and surgeons, and by the Stryker HipMap. While this pilot quality study is limited in sample size, further investigation into these differences and resulting clinical significance is warranted.

Poster 041

**Concomitant Hip Arthroscopy and Periacetabular Osteotomy: Systematic Review and Meta-Analysis of Contemporary Outcomes, Survivorship, and Complications with Comparison to Isolated Periacetabular Osteotomy**

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**INTRODUCTION:** While symptomatic acetabular dysplasia is traditionally managed with periacetabular osteotomy (PAO), performing concomitant hip arthroscopy has the potential to address both the intra- and extra-articular contributing pathologies in a single surgical episode.

**PURPOSE:** This systematic review and meta-analysis sought to evaluate outcomes, survivorship, and complication rates among patients who underwent concomitant PAO and hip arthroscopy reported in the current literature. Additionally, we sought to evaluate how these outcomes compared to patients undergoing isolated PAO.

**METHODS:** A comprehensive literature review of the electronic databases PubMed, Medline, EBSCO host, and Google Scholar was performed to identify all studies of PAO and concomitant hip arthroscopy up to July 2021. Following the application of pre-determined inclusion and exclusion criteria, 12 studies reporting on a total of 647 patients (666 hips) undergoing PAO with concomitant hip arthroscopy were included. Pooled analyses were conducted if more than two articles reported on the same outcome measure.

**RESULTS:** Significant improvements in patient reported outcome measures (PROMs) and radiographic measures were demonstrated for a large majority of included studies. Pooled analyses demonstrated significant improvements in postoperative modified Harris Hip Score (mHHS) (mean difference (MD): -25.65, 95% CI: -29.79 to -21.50;  $p < 0.001$ ) and lateral-center edge angle (LCEA; MD: -12.88, 95% CI: -16.04 to -9.72;  $p < 0.00001$ ) values. Patients undergoing these combined procedures experienced 131 complications for 627 hips (20.89%) with 28 (21.37%) classified as major. There were 25 re-operations for 551 hips (4.54%), and postoperative survivorship estimated at minimum to be 85% after 3.5 years follow-up. However, for most outcome measures, there were no differences noted between concomitant procedures and isolated PAO. Complication rates were additionally comparable (OR: 3.15, 95% CI: 0.71-13.85;  $p = 0.13$ ).

**CONCLUSIONS:** Based on the currently available literature, patients undergoing concomitant PAO and hip arthroscopy experience excellent outcomes. However, there is limited evidence to indicate that performing both procedures results in different outcomes compared to PAO alone.

Poster 042

Radiographic Measures of Hip Dysplasia Correlate with Joint Contact Stress Computed with Discrete Element Analysis

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**BACKGROUND:** Hip dysplasia results in altered joint contact mechanics and premature osteoarthritis. Periacetabular Osteotomy (PAO) is a well-established treatment for pre-arthritis hip dysplasia in young adults. Joint contact stresses computed using discrete element analysis (DEA) are associated with long-term outcomes in individuals with hip dysplasia before and after treatment with PAO. The objective of this study was to determine if common radiographic measures of hip dysplasia are associated with joint contact stress computed with DEA before and after PAO.

**METHODS:** A retrospective cohort study identified subjects with hip dysplasia treated with PAO who had preoperative and postoperative CT scans. Radiographic measurements of hip dysplasia, including lateral center edge angle (LCEA), Tönnis angle, extrusion index (EI), and anterior center edge angle (ACEA), were assessed using standing anterior-posterior pelvis and false profile radiographs. Preoperative and postoperative hip models were generated from patient CT scans, and DEA was used to predict the mean and peak stress in the joint during walking. To account for the duration of time an individual's joint was subjected to that particular contact pattern, mean and peak cumulative exposure were also computed for each patient. Spearman's correlation was used to describe associations between radiographic measures and joint contact stress measures.

**RESULTS:** Of the 77 subjects (89 hips) enrolled, 85.4% (n=76) were female, and the median age at surgery was 30 years (range 19-40 years). Preoperatively, the strongest radiographic correlates with mean cumulative contact stress exposure were LCEA ( $r=-0.52$ ,  $p<0.0001$ ), Tönnis angle ( $r=0.44$ ,  $p<0.0001$ ), and EI ( $r=0.44$ ,  $p<0.0001$ ). Preoperative LCEA and EI also demonstrated moderate correlation with mean contact stress ( $r=-0.43$ ,  $p<0.0001$  and  $r=0.43$ ,  $p<0.0001$ , respectively). Preoperative radiographic correlations with peak contact stress and peak cumulative exposure were weak. Postoperatively, radiographic measures were significantly, but weakly correlated with mean cumulative exposure: LCEA ( $r=-0.22$ ,  $p=0.036$ ), Tönnis Angle ( $r=0.27$ ,  $p=0.011$ ), EI ( $r=-0.26$ ,  $p=0.04$ ), and ACEA ( $r=-0.26$ ,  $p=0.014$ ).

**CONCLUSION:** Radiographic measures of hip dysplasia correlate with joint contact stress, but to a lesser extent than expected. Preoperatively, LCEA demonstrated the strongest correlation with mean joint contact stress metrics. Postoperative correlations were not as strong. While advanced techniques beyond current 2D radiographic assessment of hip dysplasia may improve the assessment of dysplastic hips and quality of deformity correction with PAO, it will be challenging to use existing evaluation techniques as reliable surrogates for those more complicated approaches.

Poster 043

**Outcomes of Glenohumeral Arthrodesis in Patients with Brachial Plexus Injuries Using Reamer Irrigator Aspirator Bone Grafting**

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**HYPOTHESIS:** Adult traumatic brachial plexus injuries (BPI) can result in irreversible loss of shoulder girdle musculature resulting in mechanical pain with subluxation/dislocation, however, glenohumeral arthrodesis in this population has a high complication rate secondary to disuse osteopenia, fixation failure, and failure of fusion. This study sought to evaluate the outcomes of a novel reamer-irrigator-aspirator (RIA) harvested bone graft approach in glenohumeral arthrodesis in this specific subset of patients.

**METHODS:** This study retrospectively reviewed 8 patients with a history of BPI who underwent glenohumeral arthrodesis using autologous bone graft harvested via the RIA system from 2019 to 2021. Primary outcome was radiographic evidence glenohumeral arthrodesis. Secondary outcomes included time to union, resolution of shoulder pain, and complications including nonunion, hardware failure, transfusion requirement, donor-site morbidity, and reoperations. Kaplan-Meier was performed to analyze survivorship free of reoperation and complications.

**RESULTS:** The majority of patients were male (75%), with a mean age of 37 and mean BMI of 30 kg/m<sup>2</sup>. Mean follow-up was 7 months. Mean time from injury to glenohumeral arthrodesis was 2.3 years. The mean amount of autograft obtained was 45-cc. A 14 hole 4.5-mm narrow large fragment plate was utilized with a mean of 12 screws. Two patients (25%) reported complications, including prominent hardware (n=1) and traumatic humerus fracture below the fusion plate following a car accident (n=1). There were no postoperative transfusions, infections, hematomas, femur fractures, or significant lower extremity weakness noted. Only one patient required reoperation (12.5%) for fixation of the periprosthetic humerus fracture mentioned previously. At last follow-up, 75% (n=6) of patients did not report pain in the leg or shoulder. Six patients had radiographic follow up, and 100% of those achieved union by 11 weeks postoperatively (5 assessed via CT and 1 via plain radiographs). These radiographs showed complete bone bridging between the acromion and superior glenoid.

**CONCLUSION:** Union was achieved in all (100%) patients who underwent glenohumeral arthrodesis using the RIA system, with a mean time to union of 11 weeks. Most patients experienced an improvement or complete resolution of shoulder pain, and there were no complications involving the donor-site.

Poster 044

Is Ankle Fracture Healing Rate Decreased by NSAIDs? A Multicenter Retrospective Study of Weber B and C Fractures

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**INTRODUCTION:** Ankle fractures are a common orthopedic injury representing approximately 10% of all bone injuries. While NSAIDs ability to reduce pain and avoid the negative sedative and addictive effects of opioids, the negative effects on bone healing found in some of the animal studies may give pause to orthopedic surgeons who are concerned it may result in a higher nonunion rate for their patients. The purpose of this study was to compare the time-to-union for Weber B and C ankle fractures between two cohorts given either opioids or only nonsteroidal anti-inflammatory (NSAID) drugs for their postoperative pain control. We hypothesized that there would be no statistically significant difference in the mean time-to-union between these two cohorts.

**MATERIALS & METHODS:** Ankle fractures presenting at two level I trauma centers, US and Chile, between the dates of January 1, 2015 and January 1, 2019 were retrospectively screened for enrollment in the study. Weber B or C ankle fractures with confirmed radiographic union were included in the study. The US cohort was prescribed opioid based analgesic while the Chilean-based patients were prescribed NSAID analgesic for postoperative pain control. Union was defined as cortical bridging in 3/4 cortices as seen on AP and lateral radiographs. Primary outcome measures were the confirmed time-to-union.

**RESULTS:** The mean time to union in the US cohort was 124.5 days while the mean time to union in the Chilean cohort was 137.6 days. There was no significant difference between the mean time to union between the two cohorts ( $p=0.159$ ). There was a significant difference in the mean age (49 years US vs. 43 years Chilean), the proportion of smokers (46% US vs. 5% Chilean  $\chi^2 < 0.005$ ), and proportion of open fractures (22% US vs. 6% Chilean  $\chi^2 < 0.005$ )

**CONCLUSION:** The mean time to union between the two groups was not statistically significant despite the use of different analgesics for postoperative pain management. Although there have been animal studies that have found that there are significant negative effects on bone healing with NSAID usage, this study suggests that this finding may be more nuanced than originally proposed. This study found that NSAID's may be used for some patients for postoperative pain relief without significantly compromising the time-to-union in ankle fractures.

Poster 045

**Leg Length Discrepancy After Hip Fracture Repair is Associated with Reduced Gait Speed**

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**INTRODUCTION:** Previous studies have shown a negative correlation between functional outcomes and leg length discrepancy (LLD) following hip fracture repair. We have assessed the effects of LLD following hip fracture repair in elderly patients on gait time, standing time, activities of daily living (ADL), and instrumental activities of daily living (IADL) in a randomized clinical trial to evaluate delirium after surgery.

**METHODS:** One hundred sixty-nine patients with femoral neck, intertrochanteric, and subtrochanteric fractures treated with partial hip replacement, total hip replacement, cannulated screws, or intramedullary nail were selected from among 200 patients who participated in the STRIDE randomized clinical trial. Baseline patient characteristics recorded included age, sex, BMI, and Charlson comorbidity index (CCI) score. Activities of Daily living (ADL), IADL, grip strength, sit-to-stand time, gait time, and return to ambulation status were measured at one year after surgery. LLD was measured on final follow-up radiographs as either 1) sliding screw telescoping distance or 2) the difference from a trans-ischial line to the lesser trochanters, and was analyzed as a continuous variable using regression analysis.

**RESULTS:** 88 patients had LLD < 5 mm, 55 between 5-10 mm and 26 subjects > 10 mm. Age, sex, BMI, Charlson score, and ambulation status had no significant impact on LLD occurrence. Type of procedure and fracture did not correlate with severity of LLD. Having a larger LLD was found to have no significant impact on postoperative ADL ( $p=0.60$ ), IADL ( $p=0.08$ ), sit-to-stand time ( $p=0.90$ ), grip strength ( $p=0.14$ ) and return to former ambulation status ( $p=0.60$ ), but did have a statistically significant impact on gait time ( $p=0.006$ ).

**DISCUSSION:** LLD after hip fracture did not affect many parameters associated with recovery, but did have an association with reduced gait speed. Continued efforts to restore leg length after hip fracture repair are likely beneficial.

Poster 046

**Modular Proximal Body Exchange for Re-Revision Total Hip Arthroplasty: Rarely Utilized and Moderately Successful**

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**BACKGROUND:** Modular fluted tapered stems (MFTSs) are commonly used in revision total hip arthroplasty (THA) and provide the option of exchanging the proximal modular portion to address future surgical problems without requiring complete femoral revision. We are unaware of any data documenting the frequency, indications, and outcomes of modular proximal body exchange in re-revision total hip arthroplasty.

**METHODS:** Between 1997–2019, we performed 1,375 MFTS revision THAs at our institution. Among those patients, we identified 47 re-revisions with modular proximal body exchange of a MFTS. During the same time period, 10 additional modular proximal body exchanges with MFTSs previously implanted elsewhere were identified. Indications and outcomes were documented at a mean follow-up of 3.4 years.

**RESULTS:** Modular proximal body exchanges were performed on 47/1375 (3%) MFTSs at final follow-up. The indications for all 57 modular proximal body exchanges performed during the study period were dislocation in 30 (53%), partial resection for periprosthetic joint infection (PJI) in 13 (23%), modular junction failure in 8 (14%), surgical exposure in 4 (7%), and concurrently with trochanteric osteotomy nonunion fixation in 2 (4%). Concomitant acetabular revision was performed in 10/57 (18%) and isolated modular component exchange in the remainder. Among modular proximal body exchanges indicated for dislocation, 10/30 (33%) were re-revised at final follow-up. Among those indicated for PJI, 5/13 (39%) were re-revised at final follow-up. One modular junction subsequently fractured after modular proximal body exchange.

**CONCLUSIONS:** Modular proximal body exchange of a MFTS is an uncommon procedure most often performed for treatment of hip dislocation or PJI. It is moderately successful with approximately one-third of cases requiring subsequent re-revision. This procedure is often performed with modular component exchange alone but can also be helpful to facilitate exposure during complex acetabular revision. These data provide useful information to surgeons considering performing this operation.

**LEVEL OF EVIDENCE:** IV

Poster 047

**Instability in Patients with Lumbar Spine Disease Undergoing Posterior vs. Lateral Approach THA**

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**INTRODUCTION:** Dislocation rates after total hip arthroplasty (THA) in patients with fixed spinopelvic motion due to lumbar spine disease or fusion have been reported as high as 20%. Few studies compare dislocation rates in patients with spine pathology undergoing THA via different surgical approaches. The purpose of this study was to compare postoperative dislocation rates in patients with lumbar spine disease or fusion in primary THA using a posterior vs. direct lateral surgical approach.

**METHODS:** With IRB approval, 1,205 primary THAs performed by two surgeons were retrospectively reviewed. One surgeon routinely performs THAs with a posterior approach while the other surgeon routinely uses a direct lateral approach. Chart review from the electronic medical record was conducted to identify patients who have lumbar spine disease or a lumbar spine fusion. Dislocations for patients with and without lumbar spine disease were compared by posterior approach and direct lateral approach.

**RESULTS:** 767 posterior approach and 431 direct lateral approach THAs were available for analysis. 43.6% of all THAs had lumbar spine pathology (337/767 posterior and 185/431 direct lateral). The overall dislocation rate was 1.26% (15/1,195). The main predictors of dislocation in binary logistic regression were the presence of lumbar spine pathology (OR 5.24, 95% CI: 1.47–18.69,  $p=0.018$ ) and posterior surgical approach (OR 7.93, 95% CI: 1.04–60.6,  $p=0.046$ ). The dislocation rate for direct lateral approach THAs with lumbar spine pathology was significantly lower compared to posterior approach THAs with lumbar spine pathology (0.0% vs. 3.6%,  $p=0.011$ ).

**CONCLUSION:** Although there were few dislocations, the study results suggest a direct lateral approach for primary THA may be beneficial to reduce postoperative dislocation for patients with limited spinopelvic motion due to lumbar spine pathology. Further, surgeons utilizing the posterior approach might consider alternative bearings such as dual-mobility in high-risk patients with lumbar spine disease.



Poster 048

**The Association Between Perioperative Blood Transfusions and Venous Thromboembolism Risk Following Surgical Management of Hip Fractures**

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**INTRODUCTION:** Venous thromboembolism (VTE) is a serious complication experienced by patients suffering from hip fractures. In the current literature, there remains limited evidence regarding the relationship between perioperative blood transfusions and VTE risk among this population. The aim of this paper was to identify the association between perioperative blood transfusion and increased risk for 1) deep vein thrombosis (DVT) and 2) pulmonary embolism (PE) after hip fracture surgery in a large, multi-institutional population.

**METHODS:** Data for all patients undergoing surgical management of hip fractures between 2016 and 2019 were collected from the Targeted Hip Fracture Database of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). A multivariable logistic regression was conducted to identify the variables that were associated with significantly increased DVT and PE risk. All variables collected were included in this analysis to minimize confounding effects. Afterwards, nearest neighbor propensity score matching (PSM) between patients that did and did not receive blood transfusions of any type (1:1) was performed to further evaluate the impact of blood transfusions on postoperative VTE.

**RESULTS:** A total of 46,274 patients were included in our analysis. Of the 11,273 patients who underwent perioperative transfusion, 156 (1.4%) experienced DVT and 93 (0.8%) experienced PE. Following propensity score matching, a total of 12,121 patients that did not receive transfusions were included in our analysis. Preoperative (OR: 1.29, 95% CI: 0.67 to 2.25; p=0.4) and intraoperative/postoperative (OR: 1.17, 95% CI: 0.92 to 1.49; p=0.2) transfusion receipt individually were not associated with an increased risk of DVT following our PSM. No transfusion categories were associated with PE incidence (all p-values >0.05).

**CONCLUSION:** The present analysis sought to better characterize the relationship between perioperative transfusions and the risk of postoperative PE and DVT. While controlling for various patient demographics, comorbidity burden, and fracture pattern, we found intraoperative/postoperative transfusion receipt were associated with the incidence of 30-day DVT. Additionally, we found that the receipt of both preoperative and intraoperative/postoperative transfusions was associated with a significantly higher risk of DVT. Our findings emphasize the importance of perioperative blood management strategies among patients undergoing surgical repair of hip fracture. Specifically, orthopedic surgeons should aim to optimize hip fracture patients prior to surgical intervention as well as intraoperatively to reduce transfusion incidence.

Poster 049

**Novel Identification of Common Genetic Variants in Musculoskeletal Pathways Implicated in Familial Femoroacetabular Impingement**

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**BACKGROUND:** Femoroacetabular impingement (FAI) of the hip results from altered morphology of the proximal femur and/or acetabulum, creating abnormal contact between these structures during normal hip range of motion. A previous report demonstrated increased risk of FAI in siblings of patients with FAI, suggesting a potential genetic predisposition for disease. Nevertheless, a study has yet to be performed investigating the genetic basis or mechanism leading to this familial predisposition. The purpose of this study was to identify single nucleotide polymorphisms (SNPs) and insertions or deletions (indels) that are associated with biologically-relevant genes modulating FAI risk.

**METHODS:** This study commenced after identification of a family with four generations of pincer-type FAI in females leading to premature total hip arthroplasty or hip preservation procedures. Blood samples were collected from each of the four affected women as well as the great-grandfather to serve as a control. Whole exome sequencing was performed followed by variant calling to identify significant SNPs and indels present in all four FAI subjects and absent in the control patient. Subsequent bioinformatics analysis was conducted to identify common transcriptional networks and/or developmental processes that may be impacted by these variants. Additionally, RNA-sequencing of human bone, cartilage, growth plate, and muscle was used to further assess the impact these variants may have on normal development.

**RESULTS:** Whole exome sequencing and variant calling revealed 43 genes harboring mutations that were present in all four FAI patients and absent in the control. Subsequent functional annotation analysis revealed significant enrichment of terms involved in skeletal development (e.g. Notch Signaling). Protein-protein interaction analysis demonstrated networks implicated in the development of bone, articular cartilage, and growth plates. These networks included several genes that are highly expressed in bone tissue and known to be critical for bone morphogenesis and homeostasis (e.g. NOTCH4, COL7A1, MIA3, KAT2B).

**CONCLUSIONS:** Analysis of multigenerational FAI in a single family revealed mutations in several genes involved in skeletal development and actively expressed in bone. Together, these findings suggest that FAI may indeed have a strong genetic etiology and is in part driven by mutations to genes required for bone development or homeostasis. Our findings provide initial insight into disease pathophysiology and may potentially inform diagnostic and prognostic tools.

**SUMMARY:** Genetic analysis of a family with four generations of FAI revealed genetic variations in genes regulating musculoskeletal development, with several being critical local regulators of bone morphogenesis.

Poster 050

Dual-Mobility vs. Conventional Bearings in Patients at High Risk of Dislocation: Interim Analysis of A Randomized Controlled Trial

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**BACKGROUND:** The purpose of this multicenter randomized controlled trial was to determine if dual-mobility bearings (DM) reduce the risk of dislocation in high-risk patients undergoing primary total hip arthroplasty (THA) compared to conventional bearings.

**METHODS:** 248 Patients undergoing primary, posterior approach THA were randomized to a DM (n=120; 42mm median effective head, range 32-53mm) or a conventional bearing (n=128; two 28mm heads, twenty-three 32mm, seventy-seven 36mm, twenty-two 40mm, and four 44mm femoral heads). Three patients randomized to DM incorrectly received a conventional bearing. High-risk inclusion were: prior lumbar fusion, neuromuscular disorder, dementia, substance abuse, age  $\geq 75$ , inflammatory arthritis, or preoperative combined flexion, adduction, and internal rotation  $\geq 115^\circ$ . Stratified randomization was performed: 1) patients with a history of spinal fusion (n=70) and 2) other inclusion criteria (n=178). The primary outcome was dislocation. Patient-reported outcome measures (PROMs) were collected at six weeks, one year, and two years. Power analysis determined 206 patients were required in each group (power=0.80, alpha=0.05), assuming a reduction in dislocation from 8% to 2%. Descriptive and univariate statistics (intention-to-treat and per-protocol) were performed, with alpha <0.05.

**RESULTS:** There was one dislocation in the conventional cohort (0.8%; 36mm head) compared to none in the DM cohort (p=1.00) at mean follow-up of 15.5 months (range, 1.4-47.7). Revision surgery for any reason occurred in five patients in the conventional group (all for infection) vs. one DM patient (periprosthetic femur fracture; 3.9% vs. 0.8%; p=0.22). PROMs were not significantly different at all time points (p=0.10-0.96). There was no difference in intention-to-treat or per-protocol analyses. The effective head size was larger in the DM cohort vs. conventional (41.2 $\pm$ 3.9mm vs. 36.0 $\pm$ 3.0, p<0.001).

**CONCLUSION:** At interim analysis, DM did not decrease dislocation rates in high-risk patients undergoing primary THA, although the overall rate of dislocation was lower than expected. Continued enrollment and follow-up are required.

Poster 051

Acute vs. Delayed Total Hip Arthroplasty After Acetabular Fracture

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**INTRODUCTION:** Acetabular fractures can be devastating injuries to the hip and optimal treatment is often unclear. The risk of posttraumatic arthritis and conversion to total hip arthroplasty (THA) remains high despite advances in operative techniques. Immediate THA for treatment of acetabular fractures has become more common, however, data regarding survivorship is limited. The purpose of this study is to evaluate survivorship of acute vs. delayed THA after acetabular fracture, and identify correlates as they relate to patient demographics and fracture pattern.

**METHODS:** Retrospective review identified 165 patients who had THA for acetabular fracture performed at our institution. Patients were categorized as acute (THA <30 days from initial fracture) or delayed (>30 days from initial fracture). Basic demographics, fracture pattern, initial treatment, THA complications and revisions were recorded. Statistical analysis was performed using logistic regression, chi-square, and Wilcoxon testing.

**RESULTS:** 165 patients met inclusion criteria (50 acute, 115 delayed). Mean follow-up for the acute cohort was 29.3 months, and 43.5 months in the delayed group. Patients who underwent acute THA were older at time of injury (66.2 vs. 45.3 years,  $p < 0.001$ ). The most common fracture pattern was isolated posterior wall ( $n=70$ , 42%). Revision rates between acute and delayed groups were not statistically significant. There was no statistically significant difference between fracture pattern and revision rate. Eighteen (10.9%) patients underwent revision arthroplasty with most undergoing revision for periprosthetic joint infection ( $n=9$ , 0% acute THA;).

**DISCUSSION & CONCLUSION:** Overall revision rate in our cohort was 10.9% (6% acute, 13% delayed). Revision rates did not differ with regard to fracture pattern, age at time of injury or THA. We did observe a higher rate of periprosthetic joint infections in the delayed cohort. Future studies evaluating long term survivorship and patient reported outcomes may provide insight for treatment that may benefit from acute vs. delayed total hip arthroplasty for acetabular fractures.

Poster 052

Wear Analysis of Marathon Crosslinked Polyethylene in Total Hip Arthroplasty

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**INTRODUCTION:** Osteolysis induced from ultra-high molecular weight polyethylene wear has remained an important clinical problem that can limit the longevity of total hip arthroplasties (THAs). Crosslinked polyethylene formulations have been developed to reduce wear, and they have been shown to reduce the development of osteolysis. The wear rate of Marathon crosslinked polyethylene varies with literature reports of 0.01 to 0.07 millimeters per year. The purpose of our study was to analyze a consecutive series of THAs using Marathon crosslinked polyethylene and determine the annual linear wear rate and presence of radiographically apparent osteolysis.

**METHODS:** A retrospective review was conducted to identify patients who received a Marathon crosslinked polyethylene liner during a primary THA surgery by a single surgeon at a single institution from 2009 to 2018. All patients had greater than three years of follow-up. Anteroposterior (AP) pelvis radiographs for all patients performed at routine one year follow-up visit and most recent follow-up were analyzed to evaluate for the presence or absence of osteolysis. The median and range of annualized wear rate (mm/year) were determined.

**RESULTS:** Thirty-nine patients were included in our analyses. Mean age was  $69.7 \pm 7.5$  years old. The median wear rate for all patients was 0.054 mm/year (range: 0-0.487 mm/year). Fourteen (35.9%) patients had a linear wear rate above the accepted osteolysis threshold of 0.1mm/yr. Three patients (7.7%) had radiographically apparent osteolysis on most recent follow-up with wear rates above the osteolysis threshold. Length of follow-up and head diameter for patients who developed osteolysis was not significantly different compared to patients who did not develop osteolysis. There was no difference in age, BMI, or length of follow-up between patients who had a wear rate above or below the osteolysis threshold.

**CONCLUSION:** The mean linear wear rate in this study was comparable to previously reported studies evaluating the wear performance of Marathon. However, we observed an annualized linear wear rate above the osteolysis threshold in 35% of our patients. This fact and its lack of association with age, BMI, and length of follow-up, is worrisome for potential development of osteolysis in these patients. Post-market surveillance and monitoring of the performance of these materials with contemporary methods of wear measurement is recommended to further our understanding of the performance of XLPE and minimize the impact of wear induced osteolysis in patients undergoing THA.

Poster 053

**Inconsistency and Ambiguity within the ICD-10 Procedure Coding System for Hip Fractures**

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**INTRODUCTION:** The International Statistical Classification of Diseases, 10th Revision Procedure Coding System (ICD-10-PCS) was created to increase granularity of procedures and standardize disease tracking. PCS codes are entered by hospital coders using the medical record. Concern exists that this increase in complexity could lead to inaccurate data.

**METHODS:** Medical records and ICD-10 PCS codes for operatively treated femoral neck and pertrochanteric fractures from 2016-2019 at a tertiary-referral medical center were reviewed. Each figure of the 7-unit ICD-10-PCS code was recorded. Definitions for each figure from the 2022 American Medical Association's ICD-10 PCS Official Codebook were compared to the medical record, operative report, and implant record for each surgery.

**RESULTS:** 56.0% (135/241) of PCS codes had ambiguous, partially correct, or incorrect figures within the code. 72.0% (72/100) of fractures treated with arthroplasty compared to 44.7% (63/141) treated with fixation had one or more inaccurate figures ( $p < 0.01$ ). 9.5% (23/241) of codes contained at least one frankly incorrect figure. Approach was coded ambiguously for 24.8% (29/117) of pertrochanteric fractures. Device/implant codes were partially correct in 34.9% (84/241) of PCS codes and in 78.4% (58/74) and 30.8% (8/26) of hemi (HA) and total hip arthroplasties (THA). 69.4% (86/124) of femoral neck fractures and 41.9% (49/117) of pertrochanteric fractures had one or more incorrect or partially correct figures ( $p < 0.01$ ). 13.6% (3/22) of dynamic hip screws, 78.4% (58/74) HAs, 49.0% (47/96) of intramedullary nails (IMN), 63.6% (14/22) of percutaneous cannulated screws, and 46.2% (12/26) of THAs had at least one inaccurate figure within the PCS code.

**CONCLUSION:** Despite the increased granularity of ICD-10 PCS codes, this system is inconsistent and often incorrect. The definitions of the PCS system are difficult to understand and utilize by coders. The poor validity of this system may impact clinical and research conclusion obtained from these codes.

Poster 054

Length of Stay and Postoperative Outcomes Following Hip Fracture Fixation and Elective Total Hip Arthroplasty During the Covid-19 Pandemic

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**INTRODUCTION:** During the COVID-19 pandemic, hospitals limited non-essential services and procedures. Despite these protocols, there are multiple reasons that orthopedic procedures continued during the pandemic. We sought to compare hip-based procedures, both elective and non-elective, during the pandemic to understand trends across similarly invasive procedures during this period. The study aims to profile changes in patient populations who received surgery for hip fractures or underwent elective total hip arthroplasty (THA), as well as compare postoperative lengths of stay (LOS) and rate of complications before and during the COVID-19 pandemic.

**METHODS:** A national insurance claims database was queried to identify patients with operatively managed hip fractures (HF) or those who underwent elective THA. These groups were then divided based on the date of procedure into two further cohorts: pre-pandemic (2016, 2017) and pandemic (2020) cohorts. Cohorts were compared for comorbidities including: diabetes, tobacco, obesity, female, age > 60 years old, and Elixhauser Comorbidity Index (ECI) score, postoperative LOS, and rates of postoperative complications: hemorrhage, wound complication, thromboembolism, infection, and prosthetic joint infection (PJI). Continuous variables were compared using independent sample t-tests and dichotomous variables using chi-squared tests. Univariate analysis of patient risk factors for all complications was performed, followed by multivariate logistic regression analysis.

**RESULTS:** 10,360 HF patients (8,386 pre-pandemic; 2,366 pandemic) and 98,756 THA patients (82,241 pre-pandemic; 16,515 pandemic) were identified. HF and THA pandemic cohorts had increased rates of all comorbidities analyzed as well as significantly increased lengths of stay (LOS) (HF: 4.51 vs. 4.30 days; THA: 2.89 vs. 2.78 days) compared to pre-pandemic cohorts. In the multivariate analysis, hip fracture fixation performed during the pandemic was not found to be associated with significant changes in complications, while THA performed during the pandemic was associated with an improvement in the rates of postoperative hemorrhage ( $p < 0.001$ ), however, did confer an increased risk for wound complication ( $p < 0.001$ ), infection ( $p = 0.001$ ), and PJI ( $p < 0.001$ ).

**CONCLUSION:** Overall, patients seeking orthopedic care for their hip pathology, either hip fracture fixation or THA, during the pandemic appear to be significantly sicker. Despite a global pandemic, patients continued to require management of their hip fracture despite restrictions on medical services. Fortunately, this did not appear to confer a change in the complications following HF surgery when controlling for comorbidities. Conversely, the continuation of elective THA procedures during the pandemic does appear to be associated with longer LOS, and significantly increased surgical complications.

Poster 055

**Efficacy of Root Repair, Partial Meniscectomy, and Nonoperative Management of Meniscus Root Tear on Degenerative Progression of the Knee: A Systematic Review and Meta-Regression**

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**BACKGROUND:** The current literature is lacking on clearly described evidence for meniscus root tear (MRT) treatment. The purpose of this study is to compile and analyze the structural outcomes (progression of osteoarthritis, meniscus extrusion, and rate of arthroplasty) after MRT treatment as currently described in the literature.

**METHODS:** A review was conducted to identify studies published since 2011 on the efficacy of repair, meniscectomy, and nonoperative management in the treatment of MRTs. Risk of bias (ROB) was assessed utilizing the MINORS criteria. Structural outcomes of each intervention, including joint space width (JSW), degree of medial meniscal extrusion (MME), and progression to total knee arthroplasty (TKA), were analyzed utilizing a mix-effects meta-analysis. Subgroup analysis of head-to-head comparisons were similarly analyzed.

**RESULTS:** A total of 56 studies with 3,191 patients (68.5% female) were included. Based on available evidence, JSW was -0.30 mm (95% CI: -0.75 – -0.15) following root repair (n=295) and -0.99 mm (95% CI: -1.73 – -0.24) following meniscectomy (n=186); MME was 1.91 (95% CI: 0.95-2.87) following repair (n=521) and 2.21 (95% CI: -23.20-27.62) following meniscectomy (n=66); and event rate for TKA was 0.03 (95% CI: 0.00-0.029) after repair (n=205), 0.49 (95% CI: 0.23-0.76) after meniscectomy (n=53), and 0.31 (95% CI: 0.15-0.54) after nonoperative treatment (n=93). Direct comparisons demonstrated a relative risk (RR) of 9.40 (95% CI: 0.80-982.4) for TKA following meniscectomy compared to repair and an RR of 2.73 (95% CI: 0.06-120.4) compared to nonoperative treatment.

**CONCLUSIONS:** The literature reporting on the treatment of MRTs is heterogenous and limited to level III and IV studies. Current evidence suggests root repair may be the most effective treatment strategy in delaying degenerative progression of the knee. Comparative studies suggest patients undergoing meniscectomy are almost three times more likely to progress to TKA compared to those undergoing nonoperative treatment and nine times more likely compared to those undergoing repair. Future high quality, prospective studies are warranted.



Poster 056

Lower Extremity Return to Sport Testing: A Systematic Review

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**PURPOSE/HYPOTHESIS:** The purpose of this systematic review is to review current literature for joint-specific and global lower extremity testing to determine the most valid functional test that can be utilized to reduce the risk of re-injury as athletes return to sport (RTS).

**METHODS:** A systematic search of PubMed, PubMed Central, Cochrane Library, OVID, and Embase databases was conducted to identify clinical studies that included evaluation of a return to sport test or functional test for the lower extremities. Both operative and nonoperative treatments were included in this review.

**RESULTS:** Of 8,705 studies, 65 (0.7%) studies published through October 2021 met inclusion criteria and were analyzed. Eighty percent (52/65) of articles discussed RTS for the knee. Furthermore, 96% (50/52) specifically analyzed RTS following ACLR. The most common RTS test was isokinetic dynamometry testing which is seen in 73% (38/52) of studies. Unfortunately, only 6.2% (4/65) studies analyzed RTS for the hip and only one study looked at ankle RTS. The remaining studies analyzed healthy participants only.

**CONCLUSION:** More research is clearly required to identify the most valid functional test batteries for joint-specific RTS lower extremity testing. Even with the enormous amount of literature that exists regarding ACL injuries and testing there is no standardized criterion for RTS clearance. As seen in this review, the research available for the hip and ankle RTS is severely lacking. We hope that the suggested test batteries from this review can serve as a framework for future research and validation for joint-specific RTS functional testing.

**CLINICAL RELEVANCE:** To help healthcare providers and researchers identify which RTS tests provide the most insightful preparation for an athlete to RTS safely.

Poster 057

**Risk Factors for Athletic Pubalgia in Collegiate Football Players: A Retrospective Cohort Study**

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**INTRODUCTION:** Athletic Pubalgia (AP) is an increasingly recognized injury among young athletes. The aim of this study was to evaluate the effect of Olympic weightlifting (OLW), primary position (skill position vs. non-skill position), and body mass index (BMI) in collegiate football players with respect to development of AP.

**METHODS:** Football student-athletes at a single Division 1 collegiate institution from January 2010 to December 2019 were included in the study. OLW training was universally instituted for team conditioning in January 2015. Therefore, all student-athletes from the 2015 roster onward were exposed to OLW training. The primary outcome measure was surgery for AP. The odds of AP were determined using logistic regression, with the dependent variable being whether or not the student-athlete received AP surgery. Independent variables included OLW exposure, primary position (skill position vs. non-skill position), and BMI.

**RESULTS:** A total of 1,154 total student-athlete exposures were included. Of the 576 student-athletes exposed to OLW, 20 developed AP, whereas seven student-athletes not exposed to OLW developed AP. Student-athletes exposed to OLW had a 2.86 (95% CI, 1.25-7.35; P value = 0.018) times higher odds of AP than players not exposed after controlling for primary position and BMI. Skill position players had a 9.32 (95% CI, 1.71-63.96; P value = 0.014) times higher odds of AP than non-skill position players when controlling for BMI and OLW training.

**DISCUSSION & CONCLUSION:** The cause of AP is multifactorial and poorly understood. Modifiable factors that increase exposure to repetitive explosive activities, such as OLW and playing a skill position, are important considerations in the development of AP.

**SUMMARY:** Factors that increase exposure to repetitive explosive activities, such as Olympic weightlifting and playing a skill position, are important considerations in the development of athletic pubalgia.

Poster 059

**Incidence of Injuries in WNBA Players Participating in Olympic and Professional Play**

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**BACKGROUND:** Prior research has shown that Women's National Basketball Association (WNBA) players have up to 60% more injuries than their NBA counterparts. While numerous studies have documented injury statistics and outcomes of NBA athletes, few studies have focused on the WNBA. During the Summer Olympics, WNBA participants compete for their countries during a break in the regular season. This includes at least six additional games prior to returning to professional competition, unlike the Men's Olympics that occur in the NBA offseason. To date, no known reports have evaluated the injury and statistical impact on WNBA season performance following Olympic participation.

**HYPOTHESIS/PURPOSE:** Assess WNBA player performance and injury frequency before and after Olympic participation. We hypothesize that no difference exists within statistical performance or injury frequency for WNBA players before and after participation in Olympic play.

**STUDY DESIGN:** Cross-sectional study

**METHODS:** A public database review of WNBA player profiles (<https://www.basketball-reference.com>) between 2000 and 2016 was performed to identify 47 unique WNBA players (66 seasons) who played for their respective Olympic national teams. Participation statistics were gathered including games played (GP), games started (GS), games missed (GM), total games, and minutes per game (MPG). Statistical performance data were gathered including field goals (FG), field goal attempts (FGA), rebounds, assists, steals, blocks, and turnovers from both before and after the Olympics. Statistical analysis was performed using a two-tailed paired sample t-test with a significance level alpha of 0.05.

**RESULTS:** Of the 66 player profiles analyzed, 11 players (17%) were injured in the pre-Olympics season, but continued participating. Four additional players (7%) were injured during the Olympics, of which 2 players could not continue the WNBA season. Five additional players (12%) were injured in the post-Olympic half of the season. In terms of performance, there was no significant difference in GP, points, FG, FGA, rebounds, steals, or blocks per game. There was a significantly decreased percentage of GS after the Olympics (87% to 79%,  $p < 0.05$ ), MPG (28.15 to 25.62,  $p = 0.01$ ), assists per game (2.76 to 2.55,  $p = 0.04$ ), and turnovers per game (2.16 to 1.9,  $p = 0.004$ ).

**CONCLUSION:** Our study demonstrates that participation in the Olympics may have a negative impact on WNBA player performance in the post-Olympic season. Additional research on interventions such as continuous monitoring of athlete workload across a season to effectively assess risk of injury may improve outcomes.

Poster 060

Comparison of Operative Fixation of Loose Fragments from Osteochondral Defects of the Trochlea in Mature vs. Skeletally Immature Patients

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**PURPOSE:** To compare outcomes between mature and skeletally immature patients following ORIF of loose fragments.

**METHODS:** Retrospective chart review of osteochondral defect (OCD) fixation surgeries by the senior author occurring between 2010 and 2021 was completed yielding 134 patients. Patients were screened based on fixation type and location yielding 15 patients who underwent ORIF of a trochlear defect. Demographics, relevant patient history (activity level, previous knee surgeries or injuries, other knee treatments), findings on imaging (including skeletal maturity, Iwano arthritis score, Caton-Deschamps Index, Dejour classification for trochlear dysplasia, TT-TG distance), and surgical factors including osteochondral defect size and specific location were collected. Failure or subsequent surgery performed on the index knee were evaluated and compared based on skeletal maturity. Comparative statistics were calculated using a Fischer's exact test  $p=0.05$ .

**RESULTS:** Sixteen knees across 15 patients were identified. Eleven skeletally immature on radiographic findings and 5 skeletally mature knees with average follow-up 39.2 months (range, 6 – 108) were included for analysis. In surgeries conducted prior to June 2012 (3 knees), fixation was achieved with Lactosorb nails, after that date all fixations were achieved with ConMed Smartnails (13 knees). Long-term success rates were similar between skeletally immature and mature groups, 90.9% vs. 80% ( $p=0.46$ ), respectively. Average size of the trochlear OCD lesion was  $2.97\text{ cm}^2$  (range, 1.80-4.16) in mature patients and  $3.75\text{ cm}^2$  (range, 1.69-7.50) in skeletally immature patients. There appears to be no significant difference between outcomes between groups. There were two complications; one of which was a hardware failure (Lactosorb nail) in a skeletally immature patient at 18 months postoperatively due to an athletic trauma, and the other was a recurrence of symptoms at 6 years postoperatively, both of which led to revision surgery with microfracture technique.

**CONCLUSION:** Patients who underwent ORIF of loose OCD lesions of the trochlea yield favorable outcomes with low failure rate. No difference between success rates based on skeletal maturity was appreciated. ORIF of loose OCD lesions may be an effective treatment for trochlear fragments amenable to fixation regardless of age.

Poster 061

**Predicting Risk of Secondary Meniscus Tears Following Anterior Cruciate Ligament Reconstruction: A Machine Learning Analysis of 1,369 Patients with a Median Follow-Up of 9 Years**

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**INTRODUCTION:** Surgical management of anterior cruciate ligament (ACL) injury seeks to improve stability and decrease risk of secondary injury, including meniscus tears. Quantification of the risk for meniscus tear can inform clinical decision making and optimize prevention. This study sought to develop and internally validate a machine learning (ML) model to identify risk factors and quantify risk of a secondary meniscus injury following ACL reconstruction (ACLR).

**METHODS:** In this retrospective cohort study, a longitudinal geographical database was used to identify patients with a diagnosis of new ACL injury between 1990 and 2016 with minimum 2-year follow-up. Patients were followed for a new injury of the meniscus following ACLR. Four ML algorithms were evaluated in the prediction of secondary meniscus tears. Performance of the algorithms was assessed through discrimination using area under the receiver operating characteristics curve (AUROC), calibration, and decision curve analysis. Model interpretability was enhanced utilizing global variable importance plots and partial dependence curves.

**RESULTS:** 1,369 patients underwent ACLR with a median follow up of 9 years. 196 (14.3%) experienced a secondary meniscus tear at an average of 65 months following ACLR. The best performing model was the random forest (AUROC = 0.763, (95% CI: 0.761-0.765); calibration intercept = 0.006, (0.005-0.007), calibration slope = 0.961 (0.956-0.965), Brier's score = 0.119 (0.106-0.131)). All four ML algorithms outperformed traditional logistic regression. The following risk factors were identified: shorter time to return to sport (RTS), lower VAS at time of injury, increased time to surgery, older age at injury, and proximal ACL tear location.

**CONCLUSION:** ML models outperformed traditional prediction models and identified shorter time to RTS, lower VAS at time of injury, increased time to surgery, proximal ACL tear location, and age > 30 at time of injury as risk factors for secondary meniscus tears after ACLR. Following external validation, these models can be deployed in the clinical space to provide real-time, quantifiable risk for counseling and intervention.

Poster 062

Impact of ACLR Graft Choice on Meniscal Repair Outcomes

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**INTRODUCTION:** The menisci play a critical role in knee joint stability and mobility. Meniscal tears are one of the most common orthopedic injuries, often occurring simultaneously with an anterior cruciate ligament tear. Despite the clinical importance of preserving the meniscus, repair failure rates are significant, especially in the context of a concomitant anterior cruciate ligament reconstruction (ACLR). The purpose of this study was to evaluate the relationship between ACLR graft choice and meniscal repair outcomes. It was hypothesized that patients receiving a hamstring autograft would have a lower incidence of meniscal repair failure and yield better patient-reported outcome measures (PROMs) than patients who received an allograft.

**METHODS:** A retrospective chart review identified patients who underwent concomitant ACLR and meniscal repair during the study period. Patients who received either an allograft or hamstring autograft during the ACLR and with a minimum of 1 year follow up were included. Data collection included demographic information, smoking status, meniscus repair failure, time to failure, and PROMs, which consisted of Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC), and Marx Activity. Repair failure was defined as the need for a revision repair or meniscectomy. Patients were grouped by the type of ACL graft used; statistical analysis was used to compare data between groups.

**RESULTS:** Of the 677 meniscus repairs performed, 241 patients met the inclusion criteria. Patients who received an allograft were older (35.2 vs 25.9 years old,  $p=1.6e-05$ ) and had a higher BMI (30.3 vs 27.0,  $p=0.006$ ). While allograft patients reported a lower failure rate than hamstring autograft patients (16.7% vs 27.1%,  $p=0.221$ ), analysis demonstrated a trend of lower PROMs and a faster time to failure. Marx activity score was the only statistically significant PROM difference.

**CONCLUSION:** ACLR graft choice does not appear to influence the rate of meniscal repair failures. However, this study demonstrated that hamstring autografts may result in higher PROMs and thus, better quality of life. Further study with larger numbers is required to confirm these findings.

Poster 063

**MRI Prediction of Autograft Size Using Posterior Hamstring Harvest for ACL Reconstruction**

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**INTRODUCTION:** The effectiveness of preoperative MRI in predicting anterior cruciate ligament (ACL) graft diameters for autografts using posterior hamstring harvest has not been evaluated. Accordingly, the purpose of this study is to perform a retrospective review to determine the effectiveness of preoperative MRI measurements of the cross-sectional area (CSA) of the semitendinosus tendon in predicting the intraoperative graft diameter. It is hypothesized that MRI measurement of the CSA of the semitendinosus will accurately predict the intraoperative graft diameter.

**METHODS:** 221 patients who underwent ACL reconstruction with autograft using a posterior hamstring harvest from 2017 through April 2021 by a single surgeon were included. Patient demographics, operative reports were reviewed. Measurements of the CSA of the semitendinosus on MRI were performed by the attending surgeon and a fellow. Interclass correlation was used to analyze the CSA measurements. Multiple linear regression was used to analyze the predictors for graft diameter. A p-value <.05 was considered statistically significant.

**RESULTS:** Patient height ( $p < .0001$ ), and CSA of the semitendinosus ( $p < .0001$ ) were found to be statistically significant. The adjusted  $R^2$  for the combined model was 0.5620, which was greater than models using only height (adjusted  $R^2 = .4092$ ) or only CSA of the semitendinosus (adjusted  $R^2 = .3932$ ). None of the interaction terms between covariates (height, weight, age, gender, etc) were significant. Age ( $p = 0.6400$ ), weight ( $p = 0.9970$ ), and gender ( $p = 0.6700$ ) were not significant predictors. Both intraclass (ICC = 0.864, 95% CI=[0.791, 0.912]) and interclass correlation (ICC=0.827, 95% CI=[0.715, 0.894]) showed good reliability.

**CONCLUSION:** CSA of the semitendinosus tendon and patient height independently perform similarly as predictors of graft diameter. When used together, CSA and height accurately predict the graft diameter ( $R^2 = .6044$ ). Accordingly, this model may be used for preoperative planning of patients intending to undergo ACL reconstruction with posterior hamstring harvest.

Poster 064

Early Results of ACL Reconstruction with Quad Tendon Autograft All-Inside Technique

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**PURPOSE:** To evaluate clinical outcomes for quadriceps tendon autograft after primary anterior cruciate ligament (ACLR).

**METHODS:** A retrospective chart review was conducted to identify patients who underwent ACLR with quadriceps tendon (QT) autograft at a single institution between January 2019 and May 2020. Patients were included who underwent primary ACL reconstruction and had adequate follow-up available in the chart. Patients were excluded if they underwent multiligament reconstruction. Patient demographics, relevant patient history (activity level, previous knee surgeries or injuries, other knee treatment), and surgical factors (diameter of graft, concurrent meniscal or cartilage repair) data was collected. Further review was performed to determine whether any graft failure occurred, or subsequent surgery was performed on the subject knee and the maximum length of follow-up in the chart was recorded.

**RESULTS:** Forty-one patients were identified who underwent primary QT autograft ACLR and 36 met inclusion criteria. Nineteen were male (52.78%), 31 were not Hispanic or Latino (86.11%), 21 were white (58.33%), and 30 were never smokers (83.33%). The average age at time of surgery was  $24.53 \pm 7.02$  years with an average BMI of  $26.75 \pm 5.22$  Kg/m<sup>2</sup>. All surgeries were performed using an adjustable loop suspensory button for femoral fixation and a similar adjustable loop suspensory button for tibial fixation for an "all-inside" technique. The average graft diameter was  $9.42 \pm 0.53$  mm. Nine patients had a concurrent medial and lateral meniscus tear, 8 patients had only a medial meniscus tear, 12 had only a lateral meniscus tear, and 7 had no meniscal tear. When looking at follow-up post-surgery, 34 patients (94.44%) had no complications noted in their chart with a mean follow-up time of  $1.73 \pm 0.8$  years. There was one patient (2.7%) with a complication, who developed postoperative arthrofibrosis requiring re-operation. One patient (2.7%) also sustained a graft re-tear based on physical examination and magnetic resonance imaging, though elected to not undergo revision surgery and returned to modified activities.

**CONCLUSION:** Patients who underwent primary ACLR with QT autograft yield favorable outcomes with a low rate of failure or complications within a two-year follow-up period. QT autografts can be viewed as a viable approach for primary ACLR at two years follow-up. Larger studies are needed to provide comparative outcomes data with other graft options.



Poster 065

**Injection of Bone Marrow Aspirate Concentrate and Demineralized Bone Matrix for the Treatment of Bone Marrow Edema Lesions Provides Excellent Clinical Outcomes in Patients with Mild to Severe Osteoarthritis**

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**INTRODUCTION:** Bone marrow edema (BME) is a known cause of significant knee pain. Patients with Osteoarthritis (OA) who have BME have been shown to have more pain and are more likely to progress to Total Knee Arthroplasty (TKR). Treatment of BME with nonbiological means have failed and injection of bone marrow aspirate concentrate (BMAC) with demineralized bone matrix, known as Intraosseous Bioplasty (IOBP), has shown positive short-term results in some studies. The aim of this study was to evaluate the clinical outcome of IOBP of BME in patients undergoing arthroscopic meniscectomy and debridement in patients with underlying mild to severe OA at a minimum two-year follow-up.

**METHODS:** We prospectively followed our first 31 patients who underwent IOBP for BME lesions concurrently with arthroscopic partial meniscectomy and had underlying mild to severe OA. Patients with meniscus tears and BME lesions were rated by Kellgren-Lawrence Classification of OA (Grade 1:3 pts., Grade 2:6 pts., Grade 3:11 pts., Grade 4:10 pts.). All patients had bone marrow aspiration from Posterior Superior Iliac Spine (PSIS), which was concentrated, and the BMAC was combined with demineralized bone matrix and injected into BME with fluoroscopic guidance following arthroscopic partial meniscectomy and debridement. Results were followed with WOMAC and VAS scores.

**RESULTS:** The mean age of the patients was 59.3 years (range: 36 – 75). There were 13 males and 18 females. The mean preoperative WOMAC score was 69.3 (range: 29 – 96). The mean preoperative VAS score was 7.5 (range: 2 – 10). The mean WOMAC score at 6 months was 13.8 (range: 0 – 48), at 1 year was 14.4 (range: 10 – 78), and at final follow-up was 20.3 (range: 0 – 70). The mean VAS score at 6 months was 1.4 (range: 0 – 6), at 1 year was 1.4 (range: 0 – 8), and at final follow-up was 2.0 (range: 0 – 7). Compared to the preop. values the improvement in VAS scores was significant at all intervals ( $p < 0.00001$ ), and improvement in WOMAC scores was significant at all intervals ( $p < 0.00001$ ). Of the 31 patients, 4 underwent either partial or total knee replacement in the first 2 years. One out of 9 patients with Grade 1 or 2 OA underwent replacement and 3 out of 21 patients with Grade 3 or 4 OA underwent replacement in the first 2 years.

**DISCUSSION & CONCLUSION:** Non-biologic treatments of BME have not produced consistent results, but the use of IOBP with BMAC offers a biologic alternative with successful clinical outcome based on WOMAC and VAS scores at a minimum follow-up of 2 years with only 13% needing joint replacement. Arthroscopic meniscectomy in the presence of symptomatic knee OA has historically not been beneficial, but based on our results, the concurrent treatment of BME lesions with BMAC may contribute to our improved outcomes.

Poster 066

**Anatomic and Reverse Total Shoulder Arthroplasty Amongst Medicare Patients in the Ambulatory Surgery Center: A Retrospective Review on 90-Day Complications**

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**BACKGROUND:** Outpatient shoulder procedures in the ambulatory surgery center (ASC) including anatomic (aTSA) and reverse (rTSA) total shoulder arthroplasty have been proven safe; however, no study has looked at Medicare patients undergoing shoulder arthroplasty. Until recently, all TSA procedures among Medicare patients were required to be completed in a hospital setting. The purpose of this study was to determine the intraoperative and within 90-day postoperative complication risk amongst Medicare patients undergoing aTSA or rTSA at a freestanding ambulatory surgery center.

**METHODS:** All patients undergoing aTSA or rTSA from January 2018 to January 2022 at our institution were identified and 257 patients met inclusion criteria. Three cohorts of patients undergoing shoulder arthroplasty were identified: Medicare patients in an ASC, an age and ASA matched cohort of Medicare in a hospital, and all commercially insured patients in an ASC. Surgical and postoperative complications, hospital re-admissions, and revisions were identified during the 90-day postoperative period. The risk ratio for complications within 90 days among Medicare ASC patients compared to other cohorts.

**RESULTS:** Overall, there were 20 (7.78%) within 90-day postoperative complications. There were no urgent hospital transfers in either ASC cohort and no hospital admissions within 90 days in the Medicare ASC cohort. The incidence of within 90-day complications was 8% for Medicare ASC patients, 10.67% for Medicare inpatients, and 6.37% for commercially insured ASC patients. The incidence of re-operation was 4% for Medicare ASC patients, 1.33% for Medicare inpatients, and 1.27% for commercially insured ASC patients. The incidence of within 90-day hospital re-admissions was 2.67% for Medicare inpatients and within 90-day hospital admissions was 0.637% for commercially insured ASC patients. The risk ratio for incidence of within 90-day complications for the Medicare ASC patient was 0.89 compared to Medicare inpatients, and 1.33 compared to commercially insured ASC patients. None of these risk ratio values were statistically significant, thus, no increase in risk of complications within 90 days amongst the Medicare ASC patients compared to either cohort regardless of surgical age, sex, race, BMI, or ASA score was identified.

**CONCLUSION:** Medicare ASC patients undergoing aTSA or rTSA had a similar within 90-days complication risk compared to Medicare inpatients and commercially insured ASC patients. Our findings suggest that shoulder arthroplasty for Medicare patients can be implemented safely in ASC settings.

Poster 067

**Shoulder Arthroplasty After Prior External Beam Radiation Therapy: A Matched Cohort Analysis**

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**INTRODUCTION:** External beam radiation therapy (XRT) is a commonly used therapeutic modality for the treatment of various chest wall and axillary malignancies. Despite the known risk of local soft tissue dysfunction, and possibly compromised bone ingrowth for cementless implants, there remains limited data on the impact of prior XRT in a shoulder arthroplasty (SA) cohort. This study evaluated the outcomes of primary SA in patients with prior XRT compared to a matched cohort (MC).

**METHODS:** Over a 27-year time period (1993 – 2020), 80 primary SA (7 hemiarthroplasties [HA], 44 anatomic total shoulder arthroplasties [aTSA], and 29 reverse shoulder arthroplasties [rTSA] with previous XRT to the upper chest or axillary region and a minimum of 2-year follow-up were included. This cohort was matched (1:2) according to age, sex, body mass index (BMI), implant, and year of surgery with patients who had undergone HA or TSA for OA or RSA for cuff tear arthropathy. Clinical outcomes including pain, active shoulder range of motion (ROM), strength, complications, and reoperations inclusive of revision surgery were assessed.

**RESULTS:** The XRT cohort consisted of 71 (88.8%) women with a mean age of 70.9 (range, 43 – 87) years, BMI of  $30.9 \pm 7.6$ , and follow-up period of 6.6 years (range, 2.0 – 28.2). In these patients, SA led to substantial improvements in pain, ROM, and strength across the entire cohort. When compared to the MC, the XRT group demonstrated a lower final postoperative forward elevation (FE) ( $111^\circ$  vs.  $126^\circ$ ;  $P = .013$ ) and less improvements in pain (5.3 vs. 6.2;  $P = .002$ ), FE ( $34^\circ$  vs.  $54^\circ$ ;  $P = .002$ ), and external rotation ( $13^\circ$  vs.  $24^\circ$ ;  $P < .001$ ). There were 14 (17.5%) complications and 7 reoperations in the XRT group, with rotator cuff failure after HA or TSA ( $n = 4$ ; 5.0%) as the most common complication and no instances of loose humeral components. The XRT group had a higher rate of complications (17.5% vs. 8.1%;  $P = .03$ ), but not reoperations (8.8% vs. 3.1%;  $P = .059$ ). When evaluated by implant, rTSA demonstrated the lowest rate of reoperations followed by aTSA and HA (2.3% vs. 10.3% vs. 42.9%;  $P = .002$ ).

**CONCLUSIONS:** Primary shoulder arthroplasty is an effective treatment modality for the improvement of pain, motion, and strength in patients with a history of prior XRT. However, when compared to patients without prior XRT, less clinical improvement and a higher rate of postoperative complications were observed.

Poster 068

**Analysis of 90-Day Complications in Total Shoulder Arthroplasty Performed in the Ambulatory Setting**

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**INTRODUCTION:** There is limited data documenting the safety and clinical outcomes following outpatient total shoulder arthroplasty (TSA) and reverse TSA (RTSA) compared to inpatient shoulder arthroplasty. The primary purpose of this study was to evaluate the 90-day complication and readmission rates in patients undergoing outpatient TSA and RTSA. Additionally, we aim to identify to any significant predictors of complications in the entire outpatient cohort. It was hypothesized that there would be no significant differences in complication and emergency room (ER) visit rate between outpatient TSA and RTSA.

**METHODS:** A prospectively maintained institutional registry was retrospectively queried for all patients undergoing primary TSA or RTSA between September 2016 and April 2019 and confirmed as having undergone outpatient surgery, defined as surgery performed at an ambulatory surgery center (ACS). Ninety-day complications, readmissions, and ER visits were analyzed for outpatient TSA and RTSA. The 90-day complications included infection, thromboembolic disease (pulmonary embolism, deep venous thrombosis), neurovascular injury, revision surgery, and inflammatory processes.

**RESULTS:** A total of 140 patients were identified that underwent outpatient TSA or RTSA from 2016 to 2019. Four complications (3.7%) were reported in the TSA cohort, compared to four complications (12.9%) reported in the RTSA cohort ( $P = 0.060$ ). Three ER visits occurred in the RTSA group compared to zero in the TSA group ( $P = 0.001$ ). Higher rates of complications based on procedure in the RTSA trended toward significance ( $P = 0.060$ ). In addition, the RTSA had a significantly higher rate of ED visits ( $P = 0.001$ ). Patients who experienced a complication in the TSA group had significantly higher BMIs (TSA:  $P = 0.049$ , RTSA:  $P = 0.035$ ) and trended toward being more likely to have a history of hypertension ( $P = 0.072$ ) and CAD ( $P = 0.084$ ). In the RTSA group, patients who experienced a complication had significantly higher BMIs ( $P = 0.035$ ). In addition, those who had a postoperative ER visit trended toward having a higher age ( $P = 0.087$ ).

**CONCLUSION:** Overall, the rate of complications, ER visits, and readmission rates in outpatient TSA and RTSA was found to be low and below that historically reported for inpatient shoulder arthroplasty. Elevated BMI may significantly increase the risk of complications after both a TSA and RTSA. This study suggests that outpatient TSA and RTSA is safe in select patients.

Poster 069

Preventing Deltoid Dysfunction After Axillary Nerve Injury: Results of Partial Radial to Axillary Nerve Transfer as the Index Procedure

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Axillary nerve injuries can produce profound functional deficits and disability. Even after optimal microsurgical intervention performed in a timely manner, the results are often suboptimal. Furthermore, surgeons routinely recommend conservative care with hope that the injury may resolve. Instead, motor endplate degeneration occurs as time passes, leaving the patient with permanent sequelae. Here we present a novel concept of performing a partial radial to axillary nerve transfer as the index procedure for treatment of isolated axillary nerve injury. We present here an IRB approved retrospective single surgeon cohort of patients with isolated axillary nerve injury treated with partial radial to axillary nerve transfer between 2014-2022. Shoulder range of motion (forward flexion (FF), abduction (ABD), external rotation (ER)) and MRC scores (deltoid, triceps, wrist and digit extension) were recorded preoperatively and at final follow-up. 14 patients met inclusion criteria; an additional 17 patients received this transfer as part of the treatment for their BPI. Mean patient age was 50 years old with the mean time from injury to surgery 13.6 months and mean follow-up of 27.2 months. In one patient, a suitable donor radial nerve branch which exclusively innervated triceps extension could not be identified via an intraoperative nerve stimulator and the nerve transfer was not performed. Mean preoperative shoulder ROM was FF: 44°, ABD: 47°, and ER: 19°. Mean post-op ROM was FF: 148°, ABD: 132° and ER: 51°. Mean improvement in ROM was FF: 94° ( $p < 0.01\%$ ), ABD: 85° ( $p < 0.01\%$ ), and ER: 28° ( $p < 0.01\%$ ). Mean pre-op deltoid MRC score was 2. Mean post-op MRC score was 4+. In conclusion, we show here that partial radial to axillary nerve transfer as the index procedure offers the possibility of M5 or nearly normal ROM without donor site morbidity. Significant gain in average ROM and MRC scores was observed after nerve transfer, even for patients who underwent nerve transfer six months post-injury.

Poster 070

**Do Racial Differences Impact Complication Rates After Total Joint Arthroplasty?**

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**INTRODUCTION:** Racial disparities currently exist in the realm of healthcare that can have a significant impact on patient outcomes and access to quality care. Previous studies have indicated that Black patients are more likely to experience delays in treatment and increased surgical complications and Hispanic patients have more comorbidities, which are concerning for increased complications when undergoing orthopedic surgeries. In this study, we analyzed the disparities in patient outcomes following Total Joint Arthroplasty (TJA) based on race.

**METHODS:** A large healthcare network database was queried to identify 16,940 of total joint arthroplasty patients in regional healthcare system between 2017-2021. Demographics, comorbidities, race, and gender were collected. Logistic regression and odds ratio point estimate analysis were utilized to assess for associations. Race was defined as: Whites, Blacks, Hispanics, Asians, and Others. Postoperative complications and prosthetic complications were collected for all patients. Postsurgical complications included sepsis, bacterial infections, pneumonia, kidney failure, disruption of the surgical wound, or a repeat fracture. Prosthetic complications included infection, inflammatory reaction, fibrosis, hemorrhage, acute embolism and thrombosis, mechanical loosening, instability, dislocation, osteolysis, periprosthetic fracture, and wear of articular bearing surface of internal prosthetic.

**RESULTS:** The cohort consisted of 61.97% female (n=10,497) and 38.03% (n=6443) male with an average age of 71 years and an average BMI of 29.47. Based on race, the cohort included 12.33% Black (n=2089), 24.07% Hispanic (n=4077), 0.77% Asian (n=131), 1.20% Other (n=203), and 61.63% White (n=10,440) patients. Out of 16,940 patients analyzed, the average length of stay was 3.43 days with 5.28% (n = 894) of the cohort experiencing postoperative complications and 4.37% (n = 740) of the cohort experienced prosthetic complications. Our analysis indicated that race was not significantly associated with postoperative complications (p=0.5721) or prosthetic complications (p=0.6200).

**CONCLUSIONS:** Our results indicate that racial differences were not significantly associated with postoperative complications or prosthetic complications in patients who underwent a TJR.

Poster 071

Early Postoperative Improvement in Patient-Reported Outcomes Following Operative vs. Nonoperative Treatment for Proximal Humerus Fractures

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**INTRODUCTION:** The significance of early improvements in patient-reported outcomes following treatment for proximal humerus fracture (PHF) has not been well established. This study compares early improvement in patient-reported outcomes following PHF between patients who were treated conservatively vs. surgically. The primary outcome was Patient Reported Outcome Measurement Information System (PROMIS) Upper Extremity (UE) and Pain Interference (PI) scores at 6 weeks, 3 months, and 6 months from date of injury or date of operation for nonsurgical and surgical patients, respectively.

**METHODS:** This single surgeon, retrospective chart review was conducted on 76 patients treated for PHF between 2/2019 and 7/2021. Exclusion criteria were presentation >4 weeks and follow-up < 6 weeks from the date of injury, and pathologic fractures. The final cohort included 47 patients treated nonoperatively and 8 treated operatively (3 reverse total shoulder arthroplasty, 5 open reduction and internal fixation). Data points included age, sex, race, smoking status, diagnosis of insulin-dependent diabetes mellitus, Neer classification, glenohumeral dislocation, open fracture, and PROMIS UE and PROMIS PI scores.

**RESULTS:** There was no significant differences in age, gender, race, smoking status, dominant side injury, open fractures, or insulin dependent diabetes mellitus between the groups. Patients with 1- or 2-part fractures vs. 3- or 4-part fractures was not significantly different. Those with glenohumeral dislocation were statistically significantly more likely to be treated operatively, (operative 2/8 25%, nonoperative 2/47, 4.26%,  $p=0.037$ ).

PROMIS UE scores were not statistically different between the groups at any time point. At 6 weeks, the PROMIS PI scores were not statistically significantly different, but were found to be significantly lower in the operative group at both 3 and 6 months postoperatively (3 months, nonoperative  $57.46 \pm 7.38$ , operative  $49.25 \pm 6.85$ ,  $p=0.048$ ; 6 months, nonoperative  $61.80 \pm 9.31$ , operative  $46.33 \pm 6.35$ ,  $p=0.046$ ). Forward flexion and abduction were not found to be significantly different between the two groups at any time point

**DISCUSSION & CONCLUSION:** Patients treated with operative intervention had significantly reduced pain as evaluated on the PROMIS PI at both 3- and 6-month time points, but no significant differences in either function or range of motion as evaluated on PROMIS UE. However, short-term pain reduction may be a factor to consider when discussing treatment options with patients who sustain a PHF.

Poster 072

Validation of an App-Based Goniometer for Shoulder Range of Motion Assessment

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**INTRODUCTION:** Shoulder function has been found to be the primary predictor of success or failure after shoulder arthroplasty procedures. In addition, compensation and quality are bound to these reported shoulder outcomes. Therefore assessment of shoulder function and range of motion are critical measurements of surgical patients and for outcome-based research studies. Previous studies have validated the use of innovative smartphones and video-based technology for remote ROM assessment. The aim of this study was to investigate the accuracy and reliability of an app-based goniometer for shoulder ROM measurements.

**MATERIALS & METHODS:** The cohort consisted of 18 healthy volunteers with no shoulder ROM deficits. ROM was measured during forward flexion, abduction, internal rotation, and external rotation. Measurements were performed using a smartphone app-based goniometer and compared to a traditional manual goniometer as the gold standard. A trained independent investigator measured and recorded the ROM in degrees with both instruments during the four movements. A minimal clinically significant difference of 10° was used to determine accuracy. A Bland Altman analysis was performed to detect the systematic difference between instruments.

**RESULTS:** Instrument validity was examined by comparing the manual goniometer and app-based goniometer measurements. Repeated measurements for each volunteer were performed and demonstrated consistent accuracy of measurements ( $p < 0.01$ ). Bland Altman's analysis showed a minor mean systematic difference (MSD) during forward flexion (MSD: 1.12°), internal rotation (MSD: 3.75°), external rotation (MSD: - 0.16°), and abduction (MSD: -5.75°). Limits of agreement were below the minimal clinically significant difference value of 10°.

**CONCLUSION:** The App-based method is accurate and reliable compared to a manual goniometer as the gold standard for measuring shoulder ROM. This method can be used in the clinic as an additional instrument for the physician's toolbox for accurately evaluating patients. This novel technology demonstrated not only accuracy but also efficiency in assessing shoulder ROM. This could significantly impact surgeon's ability to accurately report outcomes and allow for both remote monitoring or at home assessments of patient shoulder function in real time to guide their recovery and optimize their success.



Poster 073

The Use of a Suture Cerclage Tension Technique to Improve Lesser Tuberosity Osteotomy Repair in Anatomic Total Shoulder Arthroplasty

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**INTRODUCTION:** Healing and function of the subscapularis continues to be a concern after anatomic total shoulder arthroplasty (ATSA). Most commonly, the lesser tuberosity osteotomy (LTO) is repaired with a tension-band technique using various sutures. This study aims to describe and establish the safety and reproducibility of a novel approach to repair the LTO site during ATSA using a suture cerclage tensioner technique.

**METHODS:** Sixteen consecutive patients underwent uncomplicated uncemented ATSA with the subscapularis taken down using an LTO. To repair the LTO, a standard transosseous suture bridge technique using four suture tapes was performed to reduce the fragment and compressed with a Fibertape cerclage technique using a mechanical tensioner with the operative arm in 20° of external rotation. The magnitude of tension on the cerclage suture was determined on a case-by-case basis and was influenced by the age and bone quality of the proximal humerus. Patient demographics, intraoperative suture cerclage tension, and complications were recorded. Patient reported outcomes measures, including SANE, ASES, and VAS, were collected preoperatively and at subsequent follow-up.

**RESULTS:** The average age, BMI, and follow-up was 62.6±9.8 year, 30.1±7.7, and 47±28 days. ATSA was performed for end-stage osteoarthritis (13) and avascular necrosis (3). Intraoperatively, suture cerclage tension averaged 38±11 lbs (range 20-50 lbs) with no intraoperative complications such as LTO fracture or greater tuberosity cut-out. At follow-up, all radiographs demonstrated maintenance of LTO reduction without notable complication. At 6 weeks, patients trended towards improved SANE scores (30.1±35, p=0.14), ASES scores (29.9±28, p=0.08), and VAS scores (4.0±3.7, p=0.07) from baseline. At 2 and 6 weeks, the average active forward elevation was 100 and 124 (p=0.7) and passive external rotation was 18 and 40 (p=0.07). One patient required reoperation for hematoma evacuation where the repair was found intact, one patient reported transient radial nerve sensory disturbance, and one patient suffered a traumatic dislocation after a fall.

**DISCUSSION:** Early postoperative outcomes using the suture cerclage tensioner technique for repair of LTO after ATSA show a reduction of nonunion compared to the literature. Further follow-up is necessary to ensure quality of the repair, complication profile, and the effect of this novel technique on functional outcomes for the patient.

Poster 074

**Physical Therapy Following Reverse Shoulder Arthroplasty: A Prospective Randomized Trial Comparing Formal Therapy and a Home Physical Therapy Regimen**

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**INTRODUCTION:** Outcomes following reverse total shoulder (RTSA) arthroplasty are influenced by surgical indications, surgical technique, implant design, and patient variables. The role of postoperative physical therapy (PT) is poorly understood following RTSA. The purpose of this study was to compare the functional and patient reported outcomes of a formal physical therapy program to a home therapy program after undergoing a reverse total shoulder arthroplasty.

**METHODS:** One hundred patients were prospectively randomized into two groups: formal PT (group 1) and home-based PT (group 2). Patient demographic variables along with range of motion, strength measurements, and SST, ASES, SANE, VAS, PHQ-2 outcomes were collected preoperatively and at 1.5, 3, 6, and 12 months postoperatively. Patient perceptions regarding their individual group, formal PT vs. home-based self-governed PT, were assessed via surveys with one year of follow-up. Patients completing more than half of follow-up visits were included in statistical analysis. In total, 37 patients in group 1, and 31 patients in group 2, met criteria for analysis.

**RESULTS:** One hundred patients were followed for 4.75 months on average (range: 0-12 months) with 68 completing over half of follow-up visits. Both study groups displayed similar increases in forward flexion, abduction, and external rotation ROM at the final timepoint compared to preoperative testing. At 12 months, external rotation strength was 0.8 kg/f greater in group 1 compared to group 2 ( $P = 0.04$ ), while other strength measures did not differ between groups. Improvements in patient-reported outcomes (SST, ASES-SS, SANE, VAS, PHQ-2) were identified in both groups. Those in group 2 stated they enjoyed the convenience and cost savings of a home-based PT program.

**DISCUSSION & CONCLUSION:** Formal physical therapy and home-based physical therapy programs after reverse shoulder arthroplasty result in similar improvements in range of motion, strength, and patient-reported outcomes scores.

Poster 075

**Humeral Component Malalignment in a Short-Stem, Inlay Shoulder Arthroplasty System: Rates and Risk Factors**

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**INTRODUCTION:** Short-stem and stemless humeral components in shoulder arthroplasty have theoretical advantages; however, malalignment of the humeral component is a theoretical drawback. The rate of malalignment for a similar short-stem humeral component has been previously reported as 47% and 27% (>5° malalignment). The purpose of this study was to investigate the rate of malalignment in a convertible, short-stem, inlay system implanted using an extramedullary guide (EM) for the humeral head resection.

**METHODS:** The first 50 Perform (Tornier) short-stem humerus components implanted by a single surgeon were retrospectively analyzed. Grashey x-rays with the arm in neutral rotation were obtained routinely at the initial postop visit, 6 weeks, 3 months, and 6 months postoperatively. The best Grashey view (defined as orthogonal to the humeral dish) from all available postoperative views was selected for measurements. A DICOM viewer (Efferent Platform) was used to perform the measurements of angle between stem and humerus axes and neck-shaft angle (humerus axis to the perpendicular of the humeral cup). The statistical analysis was done using Excel (Microsoft) and Wizard (v1.9.49) and values are reported as mean ± standard deviation (range). A chi-square test was used to determine if malunion was a risk factor for malalignment.

**RESULTS:** Fifty humeral components were implanted during the study period using an EM guide at 135°, 49 as rTSA, and 1 as an anatomic total shoulder (aTSA). The indications were osteoarthritis in 21 (42%), rotator cuff tear arthropathy in 13 (26%), massive rotator cuff tear in 11 (22%), proximal humerus malunion in 3 (6%), and inflammatory arthritis in 2 (4%). Six components (12%) were implanted malaligned, 4 (8%) in excess valgus and 2 (4%) in excess varus with respect to the alignment of the stem axis to the humerus axis. The stem-humerus axis angle was  $0^\circ \pm 3^\circ$  (-10° - 10°) and the neck-shaft angle was  $137^\circ \pm 4^\circ$  (125° - 145°). Malalignment was associated with malunion of the proximal humerus (p=0.003).

**DISCUSSION & CONCLUSION:** The rate of malalignment of the humerus in a series of a convertible, short-stem, inlay system was lower than previously reported for a similar short-stem component and might have been improved by routine use of an EM guide. Humerus malunion is a risk factor for stem malalignment.

Poster 077

**Defining and Predicting the "Optimal Observed Outcome" Following Surgical Treatment of Anterior Shoulder Instability: A Machine Learning Clustering Analysis of 200 Patients with 11-Year Mean Follow-Up**

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**BACKGROUND:** Desirable outcomes following surgery for anterior shoulder instability (ASI) include a multitude of functional and clinical functions, yet it remains uncertain if all of these outcomes are simultaneously achievable (i.e. can patients have full motion and no instability; does excellent stability coincide with stiffness?). The purpose of this study was to employ unsupervised machine learning techniques to define the actual "optimal observed outcome" for patients undergoing surgical treatment for ASI and to identify predictors of obtaining this outcome.

**METHODS:** Patients <40 years with an initial diagnosis of ASI from 1994 -2016 were included. Four unsupervised machine learning clustering algorithms were evaluated to partition subjects into "optimal observed outcome" or "suboptimal outcome" based on combinations of actually observed outcomes. Demographic, clinical, and treatment variables were compared between groups using descriptive statistics and Kaplan-Meier survival curves; multivariate stepwise logistic regression evaluated variable prognostic value.

**RESULTS:** 200 patients with a mean follow-up of 11 years were included. 146 (64%) obtained the "optimal observed outcome", characterized by significantly ( $P < 0.001$ ) lower rates of: recurrent postoperative pain (23% vs. 52%), recurrent instability (12% vs. 41%), revision surgery (10% vs. 24%), progression to osteoarthritis (OA) (5% vs. 19%), and mildly restricted motion ( $161^\circ$  vs.  $168^\circ$ ). Stepwise multivariate logistic regression identified time from initial instability to presentation (OR: 0.96, 95% CI: 0.92-0.98) and habitual instability (OR: 0.17, 95%CI: 0.04-0.77) as negative predictors of "observed optimal outcome". Increased rate of subluxation over frank dislocation preoperatively (OR: 1.30, 95% CI: 1.02-1.65) was a positive predictor. Type of surgery performed was not a significant predictor.

**CONCLUSION:** Following surgical treatment for ASI, an appropriate "optimal observed outcome" can be defined as: minimal postoperative pain, absence of recurrent instability, low rates of revision surgery, absence of OA, and increased ROM. This "optimal observed outcome" was achieved in over two-thirds of the cohort and this work demonstrated the synergistic relationship of these. The most significant predictors included shorter time to presentation and history of subluxations over frank dislocations preoperatively. This definition of the "optimal observed outcome" may be more appropriate for surgical decision making and setting appropriate expectations.

Poster 078

Unsatisfactory Outcomes After Rotator Cuff Repair: Factors Associated with High Levels of Pain and Shoulder Dysfunction

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**INTRODUCTION:** Rotator cuff repair is an increasingly common surgery, providing patients with improved comfort and function. While repair generally results in satisfactory outcomes, it is not infrequent for patients to have suboptimal results. Cuff re-tear is frequently evaluated to determine failure of a repair, yet many patients with an intact repair report unsatisfactory outcomes. The objectives of this study were to: 1) identify primary cause for revision surgery after a failed repair, 2) determine factors associated with high pain levels, and 3) shoulder dysfunction.

**METHODS:** This was a retrospective review of 200 patients between 2010-2021. Patient demographics and outcomes including the Simple Shoulder Test (SST), Single Assessment Numeric Evaluation (SANE), and Visual Analog Scale (VAS) were collected. Radiographs were analyzed for evaluation of glenohumeral arthritis and intraoperative documentation of cuff integrity was recorded. Modes of failure were documented, and for those with multiple modes, one was selected based on a hierarchy. Data was analyzed via one-way ANOVA and Chi-square to evaluate factors associated with high pain (VAS  $\geq 7$ ) or shoulder dysfunction (SST  $\leq 3$ ).

**RESULTS:** Among our cohort, pain/stiffness with an intact cuff was the most common mode of failure. Factors associated with VAS  $\geq 7$  included SST  $\leq 3$  (p= .003), BMI  $> 30$  (p= .013), infection (p= .039), scar tissue (p= .044), passive forward elevation  $< 120^\circ$ , (p= .030), and external rotation  $< 30^\circ$  (p= .016). Factors associated SST scores  $\leq 3$  included VAS  $\geq 7$  (p= .001), active and passive forward elevation  $< 90^\circ$  (p $<$  .001 and p=.015, respectively), and external rotation  $< 30^\circ$  (p= .001). Rotator cuff re-tear, glenohumeral arthritis, and humeral head migration were not significantly associated with high pain or dysfunction.

**CONCLUSION:** Although integrity of the rotator cuff after repair is emphasized as a gauge of a successful outcome, patients frequently present with unsatisfactory results for other reasons. Stiffness, decreased active motion, and infection were closely associated with high pain and dysfunction. Consideration should be given to prevention of scar tissue/adhesions and promoting early mobilization after surgery.

Poster 079

Upper Extremity Blood Flow Restriction Training Influences Proximal Shoulder Muscle Recruitment in an Occlusion Dependent Fashion

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**BACKGROUND:** Blood flow restriction (BFR) therapy provides partial occlusion at the proximal extremities and has been shown to stimulate muscle anabolism similarly to high intensity training, but at reduced workloads (20-30%1RM). While much of the literature has focused on tissues distal to the occlusion site, proximal benefits ( $\uparrow$ muscle mass, work capacity) have recently been observed in the shoulder region during upper extremity BFR that have been attributed to increased muscle activation (Electromyography, EMG). However, the specific relationship between the fraction of limb occlusion pressure (LOP) used and proximal muscle activation remains unknown.

**PURPOSE:** To compare muscle activation (EMG amplitude, EMG<sub>a</sub>) of the shoulder region during BFR training at variable occlusion pressures to optimize muscle-specific targeting for rehabilitation and preventative training.

**METHODS:** Fifteen healthy subjects (N=15; 7M, 8F; age=29.4 $\pm$ 4.26yr) consented to participate and underwent 4 sessions where they performed 3 common rotator cuff exercises [dumbbell scaption, cable external rotation (ER-0 $^\circ$ ), and cable internal rotation (IR-0 $^\circ$ )] at 20%1RM under different pre-assigned BFR pressures (0, 25, 50, 75% LOP, order randomized). Surface EMG<sub>a</sub> (Delsys<sup>®</sup>) was recorded for the anterior deltoid, middle deltoid, posterior deltoid, infraspinatus, teres minor, and upper trapezius muscles. Repetitions to failure (RTF) and discomfort ratings (VAS, 0-10) were also collected. A mixed-model ANOVA repeated on occlusion pressure was performed ( $\alpha$ =0.05).

**RESULTS:** An effect of %LOP on shoulder muscle activation was observed for all exercises ( $p$ <0.05). Of note, continued  $\uparrow$ EMG<sub>a</sub> was not observed above 50%LOP with the exception of the teres minor during IR or the posterior deltoid during scaption. Significant decreases in repetitions to failure relative to 0%LOP were observed at 75%LOP for all exercises as well as at 50%LOP for scaption ( $p$ <0.05). A linear increase in discomfort was observed for all exercises with increasing LOP ( $p$ <0.01).

**CONCLUSION:** The magnitude of shoulder region muscle activation during BFR appears to be occlusion dependent. However, based on these data, there may be an element of diminishing returns past 50%LOP for the exercises and musculature studied, ultimately limiting efficacy past this occlusion stimulus when considering discomfort or total achievable exercise volume. These findings paired with may be used to establish BFR guidelines which may be suitable for shoulder rehabilitation or injury prevention.

Poster 080

**Obesity is a Risk Factor for Atrophy in Rotator Cuff Tears**

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**BACKGROUND/SIGNIFICANCE:** In the United States, rotator cuff tears are among the most common causes of pain and disability among adults. Muscle atrophy of the rotator cuff is with failed surgical repair and worse clinical outcomes.

**PURPOSE:** Not all patients with rotator cuff tear develop muscle atrophy, and reasons for atrophy remain unclear. Investigating modifiable risk factors for muscle atrophy of the rotator cuff will inform prevention, care and improve patient outcomes.

**OBJECTIVE:** The primary goal of this study is to evaluate the relationship between body mass index (BMI) and muscle atrophy in men and women with rotator cuff tears.

**STUDY POPULATION:** The Multicenter Orthopedic Outcomes Network (MOON) Cohort consists of a well-defined cohort of patients with rotator cuff tears that was recruited from 10 sites across the United States. The cohort was recruited from January 2007 to January 2011, and patients 18 years and older with MRI images permitting assessment of muscle atrophy were included in this analysis. Additional details of this cohort have been previously published.

**METHODS:** Information regarding participant characteristics including body mass index (BMI) and symptoms were collected using structured questionnaires at the time of recruitment. Degree of atrophy of the four muscles surrounding the rotator cuff were recorded from MRIs in a standardized manner by trained orthopedic medical professionals who were blinded to other patient characteristics. We dichotomized data to report presence or absence of atrophy as the outcome. We used multivariable logistic regression to evaluate the relationship between BMI and presence of muscle atrophy while adjusting for age at MRI and participant's sex.

**RESULTS/ANTICIPATED RESULTS:** A total of 145 patients (33.5%) patients in the cohort (N = 433) had MRI data available on muscle atrophy. Among these patients 29 (20%) had atrophy of at least one of the muscles of the rotator cuff identified on MRI. There was no difference in atrophy status by age, however, those with atrophy were significantly more likely to be female (76 %,  $p < 0.01$ ). Using BMI  $< 25 \text{ kg/m}^2$  as the reference category, being overweight (define) was associated with a 1.47 fold (95% CI=1.00, 2.15) increased crude odds of muscle atrophy and being obese was associated with a 2.28 fold (95% CI = 1.38, 3.77) increased crude odds of muscle atrophy. When adjusting for age and sex those that are overweight or obese has 1.71 fold (95% CI = 1.09, 2.68) and 2.45 fold (95% CI = 1.46, 4.12) increased odds of muscle atrophy respectively. Each unit of increase in BMI was associated with a 1.10 fold (95% CI = 1.02, 1.18) increased odds of muscle atrophy.

**DISCUSSION/SIGNIFICANCE:** Obesity was associated with substantially higher odds of having muscle atrophy in this cross-sectional assessment. Efforts to modify BMI in patients with rotator cuff pathology may help improve clinical outcomes and candidacy for surgery, however, little is still known about the etiology of muscle atrophy of the rotator cuff and further investigation in this area is needed.

Poster 083

**Evidence Based Risk Factors for Injury to the Medial Ulnar Collateral Ligament of the Elbow in Baseball Players: A Systematic Review**

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**PURPOSE:** To analyze the current literature regarding risk factors associated with medial ulnar collateral ligament (MUCL) injury in baseball players.

**STUDY DESIGN:** Systematic Review

**METHODS:** Comprehensive search of the available literature was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Studies were included if they evaluated risk factors for MUCL injuries in the elbow of baseball players. Risk of bias assessment was performed via Methodological Index for Non-randomized Studies (MINORS) scoring system. The Oxford Centre for Evidence-Based Medicine was used to determine level of evidence. Variables of interest, including player age and position, were recorded.

**RESULTS:** Twenty-one studies were included in this systematic review. MINORS scores ranged from 75-87% and variables demonstrated significant heterogeneity. Performance-based risk factors for MUCL injury included: increased pitch count (both annual and per game), higher percentage of fastballs thrown, smaller pitch repertoire, and/or a loss of pitching velocity. Biomechanical studies demonstrated the relationship between decreased shoulder range of motion (total ROM, ER, IR, and Abduction), increased humeral retrotorsion, increased elbow valgus opening in the throwing arm, lower Y-Balance score, and increased lateral release position to increased MUCL injury.

**CONCLUSION:** Risk factors for MUCL injury can generally be categorized into 4 primary groups: 1) various player demographics and characteristics, 2) throwing too hard (high velocity), 3) throwing too much (pitch count/volume), and 4) throwing with poor mechanics. In this systematic review, the most significant non-modifiable risk factors for MUCL injuries included: increased glenohumeral retrotorsion and elbow valgus opening. Modifiable risk factors included: total shoulder ROM, pitch count, pitch selection, pitch velocity, Y-balance score, and lateral release position. While further studies are warranted, these risk factors may serve as appropriate targets for future evidence-based injury mitigation strategies.

**LEVEL OF EVIDENCE:** Level IV (Systematic review of level II-IV studies)



Poster 084

**Biomechanical Differences in a Catcher's Throw to Second Base Compared to a Pitcher's Throwing Motion**

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**INTRODUCTION:** The catcher position is extremely strenuous. Despite this, less consideration is typically given to the throwing motion of catchers and overuse injuries of this position compared to pitchers. Subtle, yet significant differences in the biomechanics and the kinetic chain of a catcher's throwing motion may help increase efficiency of the throwing motion. The goal of this study was to examine anatomical and biomechanical factors of the catcher's throwing motion to second base and discuss potential implications of their throwing motion compared to pitchers. We sought to characterize the catchers' throwing motion in six discrete phases similar to that of a pitcher.

**METHODS:** A literature search was performed to identify unique articles pertaining to the biomechanics of baseball and softball catchers. These articles were compared with the current body of literature regarding the phases of pitching to identify differences in throwing mechanics between the two positions. Photographs and video footage were also used to further characterize the unique phases of a catcher's throwing motion.

**RESULTS:** We determined that there are six unique phases of motion during a catcher's throw to second base. These are defined as: 1) secondary stance, 2) receiving, 3) stride, 4) cocking, 5) acceleration, and 6) follow-through. Some of these phases are similar in nature to those of a baseball pitcher, but catchers utilize distinctly different mechanics. Most notable differences are in stride length, elbow flexion angle at cocking, and the requirement of the catcher to quickly transition from a crouched to standing position.

**CONCLUSION:** We determined that, while there are similarities between the throwing motions of catchers and pitchers, catchers employ distinct, unique biomechanical adjustments. These changes may help to increase the efficiency of the throwing motion, but could also increase the potential for overuse injury. Additional studies are needed to further characterize the unique throwing motion of a catcher to second base and its implications on potential injury risk.

Poster 085

Finding Your Job in Orthopedic Trauma: The Cold Hard Facts

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**INTRODUCTION:** Finding your first job after fellowship can be stressful for a multitude of reasons. Every year, there are over 90 orthopedic trauma fellows seeking jobs. We surveyed orthopedic trauma fellows from the past five years to determine the job search process.

**METHODS:** An anonymous 37 question survey was created online. The questions included demographic information, the job search process, current job, and work details. Respondents' anonymity was kept secured through the exclusion of personal information. Data collection and descriptive analysis was performed using STATA 17.

**RESULTS:** There were 159 responses (40% response). The majority were male (82%), Caucasian (77%). Most respondents completed a fellowship at an academic program (84%). 10% completed a second fellowship. Many (36%) took an academic job and 23% were hospital employed. 16% had a job secured before fellowship; 49% went on 2-3 interviews, and 6% went on 5 or more interviews. Word of mouth was by far the top source for finding a job. Fellowship directors and other faculty were the most influential in this process, although 13% utilized a search firm. While 82% reported ending up in their first choice job, 34% of respondents felt they "settled". The top five reasons for choosing a job included location, prospective partners, practice setting, number of trauma cases, and compensation. The number of trauma cases was important. Most (54%) did not need to supplement their practice with other types of cases; however, surgeons who did supplement their practice most often did so with primary and revision total joints (37%). Importantly, 75% were satisfied or very satisfied with their first job and 77% indicated it met their expectations. An alarmingly high rate (41%) were experiencing some feelings of burnout and had experienced workplace conflict (16%).

**CONCLUSION:** Finding a job can be challenging as traditional sources like websites and job postings are not as useful. Jobs were most often found by word of mouth, indicating the influence of networking. The respondents' description of case load suggests it's important to have realistic expectations about case mix which may not include high volume pelvis and acetabulum. The majority were satisfied with their job. It is important to note that a high proportion described experiencing burnout and workplace conflict. We feel this highlights a need for education on physician well-being and tools to manage workplace conflict as part of training.

Poster 086

Cannabidiol Perceptions and Use in the Orthopedic Patient Population

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**BACKGROUND:** Opioid prescriptions for patients undergoing orthopedic procedures has recently been identified as a major contributor to the current opioid epidemic. Therefore, identifying opioid-free pain management strategies is of considerable interest in orthopedic populations. The use and efficacy of cannabidiol (CBD) has recently gained interest as a potential non-opioid intervention for pain, anxiety, sleep, depression, and other conditions. However, as an understudied treatment, patient perceptions regarding CBD use are not well understood and may be influenced by a number of factors.

**PURPOSE:** To determine patient perceptions and history of CBD use in a sample of orthopedic patients among several subspecialties in order to gain knowledge of factors related to patient acceptance or concern regarding use. We hypothesized the prevalence of use and general ratings of favorability would be higher amongst older age groups, that the primary purpose for consideration/use would be pain management, and that primary concerns regarding CBD would be related to lack of information and stigmatized association with THC.

**METHODS:** A sample of 381 adult orthopedic patients (m=158, f=223; 56±15yr) from a single hospital system completed an email-based survey which assessed age, gender, orthopedic procedure, previous use and awareness of CBD, and the reasons or concerns for its use. Independent sample t-tests and ANOVA were used to compare continuous data and chi-square analysis was used for frequency-based data comparisons between subcategories of respondents (alpha=0.05).

**RESULTS:** Answer comparisons across age groups showed a higher prevalence of CBD use with increasing age ( $p<0.05$ ) with no difference between sexes. In patients who had used CBD prior to survey, 79.3% had used it to alleviate pain and had been introduced to cannabidiol when looking for alternative treatments. Among primary concerns related to not taking CBD, availability (43%), lack of familiarity (36%), and general avoidance of medications (19%) were the top responses. To be considered for use among those who reported having not tried CBD, patients indicated they would require the availability of prescription grade CBD (62%), more evidence regarding safety/efficacy (47%), and improved regulations regarding CBD use (28%).

**CONCLUSION:** The results from this study serve to characterize perceptions and uncertainties of CBD use in the adult orthopedic population. Of note, older populations appear to be more inclined to seek CBD treatment to augment acute and chronic pain management. Further study remains ongoing to determine if patient injury type (chronic vs. acute) or orthopedic subspecialty may impact these findings.

Poster 087

Orthopedic Sub-Specialties Vary in Representation of Female Fellowship Program Directors

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**PURPOSE:** Female representation varies among orthopedic subspecialties as far as female surgeons and fellowship applicants. Mentorship has been identified as a factor affecting women's decision to choose a subspecialty. Orthopedic fellowship program director gender is an important factor for female applicants in choosing a subspecialty and has not been analyzed. The purpose of our study is to report on fellowship program director (PD) genders within orthopedic subspecialties and quantify the number of training positions represented by female PDs. Also, we wish to compare the academic ranks and h-indices, of male and female PDs within each specialty.

**METHODS:** Data was collected by utilizing the San Francisco Match program data, subspecialty program lists, and specific fellowship pages. San Francisco Match runs the orthopedic fellowship match for all subspecialties except hand. The hand match represents a combined match of orthopedic, general, and plastic surgery applicants and is run through the National Resident Matching Program. For each subspecialty, we calculated the percentage of fellowship program and fellowship positions led by female program directors. We compared academic ranks and h-indices between male and female program directors. Statistical significance was defined as a P-value of <0.05.

**RESULTS:** Female program directors led only 4.7% of programs and 3.4% of fellowship positions. Female leadership varied by subspecialties, with the highest representation of females in orthopedic oncology (20% programs, 18.5% positions) and pediatric orthopedics (13.3% program, 9.6% positions). The lowest female representation was in sports (2.2% programs, 1.2% positions) and joints (0.9% programs, 0.5% positions). Female fellowship PDs were more likely to be assistant professors than their male counterparts (39% vs. 22%), and less likely to be full professors (17% vs. 33%), but these differences were not statistically significant (P=0.13). For the six subspecialties for which an H-indices was calculated, the only significant difference was for pediatric orthopedics, with the h-index being significantly higher for male PDs compared to female PDs (17.5±11.8 vs. 6.3±4.9, P=0.028). P-values could not be calculated for shoulder and elbow and arthroplasty as each only had one female PD.

**CONCLUSION:** Women remain underrepresented in the roles as orthopedic fellowship program directors and there is significant variation amongst the subspecialties. Female program directors did not have a significantly different academic rank and H-indices did not differ significantly by program director gender in 5/6 orthopedic subspecialties.

Poster 088

Do Education Grants Pay Off for the MAOA?

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**INTRODUCTION:** The Mid-America Orthopaedic Association (MAOA) began awarding education grants for residents and those new in practice to attend the annual meeting in 1999. Medical student education grants began in 2019. The purpose of this study is to report on grant winners, their demographics and current position, and if they are MAOA members.

**METHODS:** The MAOA has provided funding for Senior Resident and New in Practice grants since 1999. Grants were provided to medical students beginning in 2019. The list of grant winners was obtained from the MAOA and their current membership status was provided. A review of social media, institution and hospital websites was completed to determine the current training or practice location for all award winners.

**RESULTS:** From 1999 to 2021, there has been 477 senior orthopedic residents and 50 New in Practice (NIP) physicians who received a grant from MAOA. 84% of NIP physicians stayed in the Mid-America territory representing 21 different institutions and practices. Of the senior residents, 63% remained in the MAOA region representing 63 institutions and practices. 39 medical students from 2019-2021 received a grant from MAOA. 59% of medical students receiving grants matched into orthopedic residency. The majority of medical students matched in MAOA territory (83%) while four students matched outside of the region (17%). Of the students that have not graduated yet, 36% are still interested in pursuing a career in orthopedics. 40% of NIP physicians, 22% of senior residents, and 10% of medical student grant winners are current members of MAOA. Additionally of all MAOA grant recipients, females represented 10.4% of winners whereas males accounted for 89.6%. Females accounted for 6% of NIP, 10.1% of senior residents, and 20.5% of medical student grant winners.

**CONCLUSION:** Our data would indicate the continued value of MAOA education grants to students, residents, and new faculty. Most awardees (64%) continue to practice in MAOA states. The MAOA has funded education grants for the annual MAOA meeting for over twenty years through member donations, totaling \$90,000 annually at this time. These grants serve to introduce trainees to the MAOA, forge relationships with physicians in local states, and allow for practice in scientific presentation. Membership in the MAOA of grantees could be improved and a concerted drive to encourage membership and loyalty in the organization should be considered.