MID-AMERICA ORTHOPAEDIC ASSOCIATION
38th Annual Meeting
April 22-26, 2020
Hyatt Regency Coconut Point Resort
Bonita Springs, FL

Meeting canceled due to COVID-19

Podium and Poster Abstracts

NOTE: Disclosure information is listed at the end of this document.

***Denotes presenter**

MAOA FIRST PLENARY SESSION
April 23, 2020

Differentiating Conversion Total Knee Arthroplasty from Primary Total Knee Arthroplasty

Abstract ID: Paper 001

Nicholas B. Frisch, M.D., M.B.A. / Rochester, MI
*Timothy C. Keating, M.D. / Chicago, IL
Tyler E. Calkins, M.D. / Memphis, TN
Chris Culvern, M.S. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

INTRODUCTION: With the continued push toward increased efficiency and improved clinical outcome pathways, there is a growing need to differentiate routine primary total knee arthroplasty (TKA) from more complex primary TKA procedures. Patients with a previous fracture or corrective osteotomy about the knee often require complex primary, or “conversion,” total knee arthroplasty due to retained hardware, scarred tissue, malalignment, bone loss, and other patient factors. The objective of this study is to compare short-term outcomes and resource utilization of primary and conversion TKA, and to differentiate what previous surgeries or injuries are likely to require conversion TKA.

METHODS: Retrospective chart review of 1319 primary TKA performed by a single surgeon at a single institution between 2011 and 2017 identified 130 patients with a history of previous knee surgery to form a ‘conversion’ cohort. One-to-one nearest-neighbor matching was used to identify 130 patients of similar age, ASA BMI, and sex without a history of previous knee surgery for a ‘primary’ cohort. Patient demographics, hospital stay, operative resource utilization, and outcomes for each group were compared. Patients in the conversion group were further stratified into those who had a previous fracture about the knee, osteotomy, ligament repair, open arthrotomy, or extensor mechanism realignment or repair.

RESULTS: The conversion group as a whole had longer operative times (96.1 vs. 90.8 minutes, $p = 0.022$) and revision component utilization (15.4% vs. 3.1%, $p = 0.003$) compared to the

primary cohort. Comparing patients with prior fracture and osteotomy to the remaining patients in the conversion group who had previous soft-tissue procedures showed a larger difference in operative time (107.1 minutes vs. 91.3 minutes, $p < 0.001$), higher 90-day readmission rate (21.1% vs. 4.4%, $p = 0.006$) and utilized more revision components (36.8% vs. 6.6%, $p < 0.001$).

CONCLUSION: Compared to routine primary TKA, conversion TKA requires increased resource utilization, specifically operative time and revision components. Conversion patients with prior fracture or osteotomy about the knee showed significantly longer operative times, revision component utilization and higher readmission rates compared to patients with previous soft tissue procedures. Policymakers should consider these variables, as they did in conversion THA, to consider adding an additional code to account for the increased complexity and resource utilization of select patients undergoing TKA.

Intravenous and Oral Tranexamic Acid are Equivalent at Reducing Blood Loss in Thoracolumbar Spinal Fusion: A Prospective Randomized Trial Phase 3

Abstract ID: Paper 002

---

*Charles C. Yu, M.D. / Detroit, MI
Omar M. Kadri, M.D. / Detroit, MI
Allen A. Kadado, M.D. / Detroit, MI
Mohsin S. Fidai, M.D. / Detroit, MI
Justin Jabara, M.D. / Detroit, MI
Jacob A. Pawloski, M.D. / Detroit, MI
Morenikeji A. Buraimoh, M.D. / Baltimore, MD
Stephen Bartol, M.D. / Detroit, MI
Gregory P. Graziano, M.D. / Detroit, MI

INTRODUCTION: The use of antifibrinolytic agents such as tranexamic acid (TXA) to decrease operative blood loss and allogenic blood transfusions is well documented in the literature. While evidence supports the use of intravenous (IV) and topical formulations of TXA in spine surgery, the use of oral (PO) TXA has not been studied. The objective of the study is to compare perioperative blood loss in patients undergoing elective posterior thoracolumbar fusion who were treated with IV versus PO TXA.

METHODS: A prospective randomized trial of patients enrolled at a university affiliated tertiary medical center between February 2017 and October 2018. 171 patients undergoing thoracolumbar fusion were randomized to receive 1.95g of PO TXA 2 hours preoperatively or 2g IV TXA (1g before incision and 1g before wound closure) intraoperatively. The sample was further stratified into 3 categories based on number of levels fused (1-2 level fusions, 3-5, and >5). The primary outcome was the reduction of hemoglobin. Secondary outcomes included calculated blood loss, drain output, postoperative transfusion, complications, and length of hospital stay. Equivalence analysis was performed with a two one-sided test (TOST). A P-value of <0.05 suggested equivalence between treatments.

RESULTS: 91 patients received IV TXA and 80 patients received PO TXA. Patient demographic factors were similar between groups except for age, weight, and BMI. The mean reduction of hemoglobin was similar between IV and PO groups (3.48 g/dL vs. 3.19 g/dL, respectively; P = 0.004, equivalence). Similarly, the calculated blood loss was equivalent (1274 mL vs. 1206 mL, respectively; P = 0.001, equivalence). 21 patients (23%) in IV TXA group received a transfusion compared with 10 patients in PO TXA group (13%) (P = 0.07). 2 patients (2% and 3% in IV and PO, respectively) in each group experienced a DVT/PE (P = 0.90). This is the last phase of an ongoing trial, so we predict that we will achieve over 300 patients by the MAOA meeting time.

DISCUSSION AND CONCLUSION: Patients treated with IV and PO TXA experienced the same perioperative blood loss after spinal fusions. Given its lower cost, PO TXA represents an excellent alternative to IV TXA in patients undergoing elective posterior thoracolumbar fusion and may improve healthcare cost-efficiency in the studied population.

The Diabetic Pilon Fracture: Are They As Bad As We Think?

Abstract ID: Paper 003

---

*Lasun O. Oladeji, M.D., M.S. / Columbia, MO
Brooks Platt / Indianapolis, IN
Brett D. Crist, M.D., F.A.C.S. / Columbia, MO

INTRODUCTION: Pilon fracture open reduction and internal fixation (ORIF) is associated with a relatively high risk of complications. Diabetes is a known risk factor for complications associated with any type of surgery. However, to date, little has been published on the outcomes for operative management of pilon fractures in diabetic patients. We sought to specifically identify how diabetes impacts the risk of complications (deep surgical site infection, nonunion, amputation, and arthrodesis) following pilon fracture ORIF.

METHODS: A retrospective review was performed to identify patients who presented for ORIF of a tibial pilon fracture (AO/OTA 43). Patient demographics, medical comorbidities, AO/OTA fracture type, and surgical outcomes were reviewed. Patients were stratified into cohorts based on the presence or absence of diabetes at the time of surgery. The complications of interest that proved significant during univariate analyses were then entered into a multivariable logistic regression model using stepwise method to identify the independent predictors for diabetes.

RESULTS: A total of 279 pilon fractures (276 patients) were included in this study. There were 43 fractures (15.4%) in patients with diabetes mellitus; 17 (39.5%) occurred in insulin-dependent diabetics. Patients with diabetes were significantly more likely to have a higher BMI (34.81 vs. 29.57, p=0.002) and be older (55.30 ± 16.3 years vs. 41.70 ± 14.05, p<0.001) at the time of injury. Patients without diabetes were more likely to sustain an AO/OTA 43-C3 fracture (36.0% vs. 11.6%, p=0.001). Univariate logistic regression demonstrated that overall, patients with diabetes were 3.64 times more likely to experience a complication following surgery (95% CI= 1.854-7.159; <0.001). Diabetics were 5.5 times more likely to require an arthrodesis (95% CI=1.894-16.214; p=0.001) and 2.7 times more likely to develop a deep infection (95% CI=1.261-5.630; p=0.008). Following multivariable logistic regression analysis, diabetes remained an independent risk factor for both arthrodesis (OR=4.30, CI=1.350-13.566, p=0.013) and deep infection (OR= 2.31, CI 1.061-5.006, p=0.035).

CONCLUSION: Diabetic patients have a significantly higher risk of complications following pilon fracture ORIF. Diabetics in this study were 3.64 times more likely to experience any complication, despite having less complex fractures. Given the increased rate of complications in diabetic patients, it is essential that diabetic patients understand their risk of complication and receive closer perioperative diabetic evaluation and management including screening for peripheral neuropathy and peripheral vascular disease, a hemoglobin A1C, and strict glycemic control.

Primary Reverse Shoulder Arthroplasty with Glenoid and Humeral Lateralization Does Not Result in Increased Blood Metal Ion Levels Regardless of Glenosphere Size: A Randomized Controlled Trial

Abstract ID: Paper 004

---

*Ayoosh Pareek, M.D.
Ngoc Tram V. Nguyen, B.A.
Mark E. Morrey, M.D.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
Rochester, MN

INTRODUCTION: Metal ions have been identified as a source for adverse tissue reactions and implant failure in hip arthroplasty. Most reverse shoulder arthroplasty designs incorporate one or more trunnions. However, changes in blood metal ions levels have not been investigated to date in reverse shoulder arthroplasty (RTSA), and they may change depending on design features and sphere size. The purpose of this study was to (1) determine in vivo levels of cobalt, chromium, and nickel in a randomized controlled trial of patients undergoing reverse total shoulder arthroplasty (RTSA) with one of four glenosphere sizes, and (2) to identify possible factors affecting metal ion levels.

METHODS: Between 2016 and 2018, 67 RTSA were performed for cuff tear arthropathy, massive irreparable cuff tear, or osteoarthritis as part of a prospective randomized controlled trial. Patients had a mean age of 72 years (54% female). All procedures were performed with implantation of a cementless design with both glenoid and humeral lateralization, and a 135° polyethylene opening angle (ReUnion, Stryker). Shoulders were randomized to receive one of four glenosphere sizes (36mm or 40mm heads, with 2mm or 6mm of lateral offset for four combinations). All patients were assessed preoperatively, at three months and at one year for pain, motion, QuickDASH, ASES Score, Oxford Shoulder Score (OSS), and Subjective Shoulder Value (SSV). Ion levels for cobalt, chromium and nickel were measured at these same time points. Categorical variables were assessed using Chi-square tests and continuous variables were assessed using Wilcoxon Rank-Sum tests. Analyses were conducted in a matched-pairs fashion.

RESULTS: RTSA did not lead to statistically significant changes in blood cobalt, chrome, or nickel levels. At most recent follow-up, average levels were 0.45 ng/mL for cobalt, 0.33 ng/mL for chromium, and 0.54 mg/mL for nickel, well below levels considered toxic after hip replacement surgery. With the numbers available, there were no statistically significant differences in blood metal ion levels when stratified by age, gender, diagnosis, glenosphere diameter, or glenosphere offset.

CONCLUSION: Primary RTSA with implantation of a cementless implant with lateralization on both the glenoid and the humeral side does not lead to increased blood metal ion levels during the first postoperative year.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
April 23, 2020

What Kind of Procedures are Orthopedic Hand Surgery Fellows Doing? An Analysis of ACGME Case Log Data from 2010 to 2018

Abstract ID: Paper 005

Azeem T. Malik, MBBS
Safdar N. Khan, M.D.
*Kanu S. Goyal, M.D.
Columbus, OH

INTRODUCTION: The goal of a fellowship is to ensure that a newly-minted orthopedic surgeon, interested in a specific specialty, is exposed to all types of surgical cases/procedures that they may encounter in their career. The current study aims to investigate the operative experience of trainees graduating from ACGME-accredited orthopedic hand surgery fellowships between 2010 and 2018.

METHODS: The 2010-2018 ACGME public case logs for orthopedic hand surgery fellowships were retrieved from the official website. Trends in the mean case volume for each logged hand surgical procedure type was analyzed using descriptive statistics. Linear regression was used to identify significant changes in trends over time for each surgical case/procedure. Additional analyses was also performed to report trends in adult-only and pediatric-only case volumes over time.

RESULTS: Between 2010 and 2018, the number of ACGME-accredited hand fellowships increased from 55 to 66, with the total number of positions increasing from 117 to 152. The average number of cases performed by a fellow increased by 15.8% from 2010 (676 cases) to 2018 (782 cases). The most significant increases over time were noted for the following surgical procedures/cases: wrist fracture/dislocation (37.9%; <0.001), wound closure without graft (35.2%; p=0.042), forearm/elbow/shoulder reconstruction or release (31.7%; p=0.038), forearm & proximal forearm fracture/dislocation (30.3%; p<0.001), releases for Duputryen's contracture (28.8%; p<0.001), nerve decompressions (26.4%; p<0.001), tendon sheath decompressions/synovectomy/ganglion excisions (26.1%; p<0.001), wound incision and drainage/fasciotomy (20.2%; p<0.001), nerve repairs for injury (19.5%; p=0.027), hand fractures/dislocations (18.4%; p<0.001), amputations (13.7%; p<0.001), and wound reconstructions with flaps (13.6%; p=0.01). The average microsurgery case volume decreased by 9.8% from 2010 (64 cases) to 2018 (58 cases). The number of elbow and wrist arthroscopies also decreased from 2010 to 2018 by an average of 6.4% and 20.7%, respectively. The overall pediatric case volume decreased by 9% from 57 cases/year in 2010 to 52 cases/year in 2017.

CONCLUSION: There has been a significant increase in the average number of cases performed by graduating hand surgery fellows over time. However, it appears that majority of the increase is attributable to a relative surge in the number of trauma and wound cases.

Carpal Tunnel Pressure Changes During Volar Fixation of Distal Radius Fractures

Abstract ID: Paper 006

---

*Jessell M. Owens, M.D.
Timothy P. Fowler, M.D.
Natalie Glass, Ph.D.
Joseph A. Buckwalter V, M.D., Ph.D.
Lindsey S. Caldwell, M.D.
Ericka A. Lawler, M.D.
Iowa City, IA

INTRODUCTION: Fractures of the distal radius result in increased pressure within the carpal tunnel. A percentage of these patients present with worsening paresthesias and pain consistent with acute carpal tunnel syndrome and require an emergent carpal tunnel release. The indication for carpal tunnel release (CTR) is less clear with mild to moderate paresthesias in the median nerve distribution. The standard volar approach for fixation of distal radius fractures (DRF) involves release of the flexor carpi radialis (FCR) tendon sheath. Anatomically, the floor of the FCR tendon sheath is confluent with the transverse carpal ligament. Therefore, in standard volar approach, pressure within the carpal canal may decrease. This study investigates whether the pressure within the carpal canal decreases during standard volar approach fixation of the distal radius.

METHODS: Twenty-five adult patients with isolated acute DRFs indicated for open reduction and volar plate fixation were prospectively enrolled. Patients were excluded if they were pregnant, minors, inmates, indicated for additional procedures on the ipsilateral extremity, presented with acute CTS, had a history of chronic CTS, history of CTR, or were unable to consent at the time of surgery. Carpal tunnel pressure (CTP) was measured using a pressure monitor. Ultrasound was used to confirm placement within the carpal canal and avoidance of the median nerve. CTP measurements were obtained prior to incision and repeated after skin closure. Pre- and postoperative pressures were compared.

RESULTS: Volar approach to the distal radius had a variable effect on the CTP. The mean preoperative CTP among all patients was 42.0 mmHg (range 17.0-91.0, SD 18.5). The mean postoperative CTP among all patients was 47.0 mmHg (range 18.0-80.0, SD 16.4). The mean change in pressure was 0.3 mmHg (SD 21.7). Signed rank test was used to compare pre- and postoperative pressures, $p=0.36$ (median = 5.0, IQR = 15.0, range -60-39). There was no relationship between pressure change and tourniquet time (estimate= -0.25, standard error (SE) =0.37, $p = 0.512$). There was no relationship between pressure change and time to surgery (estimate= 1.1, SE 1.07, $p=0.32$). There was a significant decrease in pressure in patients with AO/OTA 23-C fractures ($p < 0.02$).

CONCLUSIONS: The volar approach to the distal radius during fixation of a DRF variably affects CTP. Patients with more severe fractures have a significant decrease in CTP with volar approach.

Limb Occlusion Pressure vs. Standard Pneumatic Tourniquet Pressure in Open Carpal Tunnel Surgery - A Randomized Trial

Abstract ID: Paper 007

---

*Hannah Morehouse, M.D.
Haley M. Goble, M.H.A.
Bradley S. Lambert, Ph.D.
Jaclyn Jones, B.S.
Todd E. Siff, M.D.
Patrick C. McCulloch, M.D.
Shari R. Liberman, M.D.
Houston, TX

BACKGROUND: Pneumatic tourniquets are used extensively in orthopedic surgery. These are typically set to a standard tourniquet pressure (STP), traditionally 250 mm Hg in upper extremity surgery. Limb occlusion pressure (LOP) is the pressure at which arterial blood flow is restricted. This is believed to cause less tourniquet site pain without compromise of surgical field visualization or blood loss.

PURPOSE: To determine if there is a difference in postoperative pain at the surgical and tourniquet site between LOP and standard tourniquet pressure (STP) and if there is a difference in postoperative opioid usage.

METHODS: This investigation was performed as a cross-sectional double-blinded randomized control trial. Thirty-two adult patients undergoing open carpal tunnel release were recruited and randomized into either STP or LOP. All procedures were performed by two Hand Surgery fellowship-trained orthopedic surgeons. The primary outcome measure was a visual analog scale (VAS) for pain at the tourniquet site and overall, which was recorded for the first two weeks following surgery. Daily pain medication usage was recorded and quantified using oral morphine milligram equivalents (MME). Surgeons recorded intraoperative blood loss and any visual field difficulties in their operative notes. A group by time generalized mixed model analysis of variance repeated on time was used to detect within-group (relative to initial measure) and between group (LOP vs STP at same measurement time point) differences in VAS recorded pain at the surgical site and at the tourniquet site as well as medication use over the 14 day period. Significant interactions were followed by a Bonferroni post hoc test.

RESULTS: There were 15 patients (11 female, 4 male) within the LOP group versus 17 (11 female, 6 male) in the STP group. Mean tourniquet time was 7.44 minutes (8.29min STP, 6.47 LOP). Average LOP tourniquet pressure was 188 mm Hg. Both study groups demonstrated significantly reduced average VAS at surgical site on days 4-14 compared to day 1 ($p<0.05$). At the tourniquet site, only the STP group was found to have significant increase in VAS recorded pain from pre-surgery. The STP group had significantly increased tourniquet site VAS at days 1, 2, and 4 ($p<0.05$). The STP group had a higher MME at days 1 ($p<0.01$) and 2 ($p<0.001$) postoperative.

CONCLUSION: The use of LOP compared to STP may elicit reduced postoperative pain at the tourniquet site and an overall reduction in postoperative pain medication in the early days following surgery.

Increasing Antibiotic Resistance in Community Acquired Hand Infections

Abstract ID: Paper 008

Amelia A. Sorensen, M.D. / Kansas City, MO
*Anthony A. Oyekan / Kansas City, MO
Sanju P. Eswaran, M.D. / Syracuse, NY

BACKGROUND: Acute hand infections are a frequent reason for emergency room visits leading to antibiotic treatment and surgical drainage. Antibiotic resistance patterns continue to change and having complete information on antibiotic effectiveness available to physicians allows for appropriate treatment to be selected. The purpose of our study was to perform an inquiry into the antimicrobial resistance pattern at our urban community hospital to determine resistance patterns. We further sought to investigate the prevalence, treatment, and characteristics of common skin and soft-tissue infections (SSTI) of the hand to improve evidence-based treatment.

METHODS: A retrospective electronic medical record review was performed from 2015-2017 at a Level 1 urban community hospital for all patients admitted with hand infections based on ICD 9 and 10 codes for infections localized to the fingers, wrist, or hand including cellulitis, abscesses, or tenosynovitis. Patients were identified and reviewed for demographic data including age, sex, comorbidities, and long-term follow-up. Positive cultures obtained in the emergency room, inpatient unit, or operating room were reviewed for organism and sensitivities. Descriptive statistics were used to evaluate the data.

RESULTS: 167 patients were identified and reviewed. 85 patients with 90 different antimicrobial sensitivities were identified. 72% of patients were male. 21% of patients had diabetes, 69% were smokers, and 28% were IV drug users. 69% of patients reported a history of trauma or suspected bite. Patients had an average stay of 8.4 days. 127 procedures were performed. The most common organisms were Methicillin-Resistant Staphylococcus aureus with 42 isolates (49%), Methicillin-Sensitive Staphylococcus aureus with 25 isolates (29%), and Pasteurella with 7 isolates (8%). All isolates were sensitive to vancomycin and rifampin. Clindamycin resistance was found in 19% of organisms, 16% of MRSA isolates, and 15% of MSSA isolates. Trimethoprim/sulfamethoxazole (Bactrim) resistance was found in 5% of total samples. 9% of MRSA, and 0% of MSSA isolates.

CONCLUSION:
• MRSA infections make up a large portion of community acquired hand infections.
• Clindamycin resistance is increasing, while Trimethoprim/sulfamethoxazole resistance remains low in MRSA and MSSA hand infections.
• Diabetes, smoking, and IV drug abuse are common risk factors for admission for hand infections.
• Careful attention to community patterns of antibiotic resistance is recommended

Demographic Variables Determine Patient Reported Outcome Surveys Collection Compliance Rates

Abstract ID: Paper 009

---

*Ignacio Garcia Fleury, M.D.
Jill Corlette, M.S., A.T.C.
Qiang An, M.B.B.S., M.P.H.
John Davison, M.P.H.
Ericka A. Lawler, M.D.
Lindsey S. Caldwell, M.D.
Iowa City, IA

INTRODUCTION: Patient Reported Outcomes (PROs) are an indispensable tool used to measure patient experience and functionality. The purpose of this study is to investigate the relationship between demographic variables and the rate of PRO participation.

METHODS: All patients presenting to a tertiary care Hand Surgery clinic were asked to complete PROs on computer tablets during a two-month window. Answers were recorded as “Surveyed”, “Declined”, and “Not Surveyed”. Demographic data was obtained from electronic medical records. Chi square test and Odds Ratios (OR) were used for statistical analysis.

RESULTS: 1,423 patients were included, completing 2,098 visits. Of those, 936 had a single appointment, with 487 having two or more. The distribution by sex was 52.35% females with a mean age of 47 (SD 20.92) years old. The mean age of males was 42 (SD 20.96). Overall, males were 1.87 times more likely to declined PRO participation compared to females ($p<0.01$). Females aged 60-69 were 2 times more likely to decline PRO participation compared to other age groups (OR=2.09 CI: 1.3286-3.3052). Race distribution included 86.61% White, followed by African-American/Black at 5.47%. African-American males were 6 times more likely to decline PRO participation (R=6.2245 CI:2.6017-14.8917). The majority of patients traveled <150 miles driving distance (95.78%); 56.63% of these patients completed PROs and were 4 times more likely to participate in surveys compared to those who traveled 150-1,500 miles(OR= 4.0594 CI:1.6223-10.1626). Of the patients who agreed to participate on their first appointment, 53.58% continued participation and 20% declined on their second visit. Of patients who declined on their first appointment, 19.39% accepted and 43.88% declined to participate again on their second visit.

CONCLUSIONS: Older female patients, male patients who drove more than 150 miles to their appointment, and those that declined to participate on their previous visit were less likely to participate in PRO collection. While our data suggested a trend towards African-American males having a lower participation rate, our low numbers limit our ability to draw conclusions. Our data suggest that non-modifiable patient factors affect PRO participation rates, introducing an element of participation bias into PRO collection.

The Effect of Smoking on Short-Term Postoperative Complications after Elective Surgery of the Hand

Abstract ID: Paper 010

Co-Authors:

*Junho Ahn, B.S.
Michael A. Del Core, M.D.
Robert L. Bass, M.D.
Ann S. Golden, M.D.
Daniel M. Koehler, M.D.
Dallas, TX

INTRODUCTION: The primary aim of this study was to determine the effect of smoking on postoperative complications after elective surgery of the hand.

MATERIALS AND METHODS: Patient data was collected from the American College of Surgeons National Surgical Quality Improvement Program® (ACS-NSQIP) database between the years 2012-2017. Patients were included if they underwent elective surgery of the hand using predetermined current procedural terminology codes. Patients were excluded if they were older than 90 years of age or underwent surgery categorized as urgent or emergent. Current smoking status was defined as smoking within one year prior to surgery. Surgical complications were defined as superficial infection, deep infection, or wound dehiscence. Postoperative complications beyond 30-days after surgery were not reported by ACS-NSQIP.

RESULTS: Out of 107,943 patients undergoing elective surgeries of the hand, 73,806 met inclusion criteria. Of these, 57,986 (78.6%) were non-smokers in the year prior to surgery, and 2,563 (21.4%) were current smokers. Between these groups, current smokers were younger ($p<0.001$), more often male ($p<0.001$), had lower BMI ($p<0.001$), and more often underwent procedures that involved bone manipulation ($p<0.001$). No differences were noted with regard to inpatient or outpatient surgical setting ($p=0.991$) or ASA classification ($p=0.957$). In the adjusted odds ratio analysis, current smoking was significantly associated with overall surgical site complications (adjusted odds ratio [aOR] 1.62, 95% confidence interval [CI] 1.39-1.89), superficial surgical site infections (SSI) (aOR 1.51, 95% CI 1.22-1.85), deep SSI (aOR 1.73, 95% CI 1.34-2.22), reoperation (aOR 1.50, 95% CI 1.24-1.80), and readmission (aOR 1.49, 95% CI 1.23-1.80). In addition, the presence of chronic obstructive pulmonary disease was also associated with 67% increased odds of readmission (aOR 1.67, 95% CI 1.19-2.29).

DISCUSSION AND CONCLUSION: Current smoking as defined as smoking within one year prior to surgery was significantly associated with all surgical site complications, superficial and deep SSI, reoperation and readmission after elective hand surgery. Smoking status should be considered as a modifiable risk factor for patients undergoing elective surgery of the hand.

Effect of Trapeziectomy on Carpal Stability

Abstract ID: Paper 011

Aaron W. Paul, M.D. / Tulsa, OK
*Christian M. Athens, D.O. / Rochester, MN
Marco Rizzo, M.D. / Rochester, MN
Peter C. Rhee, D.O., M.S. / Rochester, MN

INTRODUCTION: The scaphoid-trapezoid-trapezium (STT) articulation stabilizes the scaphoid and links the proximal and distal carpal rows. The purpose of the study was to determine if trapezium excision, in the treatment of trapeziometacarpal (TM) arthritis, affects carpal stability.

METHODS: A retrospective chart and radiographic review was performed on all wrists that underwent trapeziectomy with suspensionplasty or ligament reconstruction, tendon interposition for TM arthritis between 2004 and 2016. Radiographic outcome measures included the modified carpal height ratio (MCHR), radioscaphoid (RS), radiolunate (RL), and scapholunate (SL) angles. Degenerative change at the TM and STT joints were classified according to the Eaton-Littler and Knirk and Jupiter classification system. Radiographic parameters were compared between preoperative and final follow-up time points.

RESULTS: A total of 122 wrists were included in the study with a mean follow-up of 3.5 years (range: 1.0-13.0). The mean RL (range: -2.2 ± 11.8 to -10.7 ± 16.5) and RS angles (range: 52.6 ± 13.8 to 44.4 ± 17.8) decreased significantly (<0.001) without significant change in SL angle (p=0.735) indicating progressive lunate and scaphoid extension after trapeziectomy. The mean MCHR decreased significantly (range: 1.6 ± 0.1 to 1.5 ± 0.1, p=0.037) following trapeziectomy, indicating progressive carpal collapse. Progressive scaphoid-trapezoid arthrosis was observed following trapeziectomy (<0.001). No other investigated preoperative radiographic factors were associated with significant differences in pre- to postoperative values for the radiographic outcome measures.

CONCLUSIONS: Trapeziectomy can lead to a loss of carpal height, coordinated extension of both the lunate and scaphoid, and progressive scaphotrapezoid arthrosis.

Treatment of Proximal Interphalangeal Joint Arthroplasty Dislocation

Abstract ID: Paper 012

Eric R. Wagner, M.D., M.S. / Atlanta, GA
*Nathan R. Wanderman, M.D. / Rochester, MN
Steven L. Moran, M.D. / Rochester, MN
Marco Rizzo, M.D. / Rochester, MN

PURPOSE: Little has been published regarding the treatment outcomes of dislocation after proximal phalangeal (PIPJ) arthroplasty. The purpose of this study was to assess the outcomes of surgical and nonoperative treatment modalities for PIP arthroplasty dislocations.

METHODS: Out of 380 PIPJ arthroplasties collected in a single institution's total joints registry, there were 25 (7%) acute dislocations including 18 primary arthroplasties and 7 revision arthroplasties. Eight dislocations involved border digits, with diagnoses including osteoarthritis (n=8), inflammatory arthritis (n=9), and post-traumatic arthritis (n=11). Dislocation was defined as radiographic evidence of PIPJ prosthetic dislocation diagnosed by a fellowship-trained hand surgeon.

RESULTS: Out of the 25 dislocations, treatments included 7 closed reduction and splinting, 6 soft tissue stabilization procedures, 17 revision arthroplasties, 1 amputation, and 1 arthrodesis. All of the patients treated nonoperatively and with soft tissue stabilization procedures alone failed management in achieving a stable PIPJ. Of the 17 revision arthroplasties, 10 (59%) had repeat instability, with 8 (47%) requiring revision surgery. Components used in revision PIPJ arthroplasty included pyrocarbon (n=13), SRA (n=1), and silicone (n=3). Patients who underwent ST procedures had an increased risk of repeat instability compared to revision arthroplasty. After revision arthroplasty, the 2 and 5-years survival-free of repeat instability was 47% and 41%, respectively. Although there was no significant difference in repeat instability when comparing the 3 components, silicone implants trended towards improved outcomes. However, only 4 of the 7 patients treated successfully with a revision arthroplasty remained painless at last follow-up.

CONCLUSIONS: Treatment of PIPJ dislocation is a challenging problem, with high rates of repeat instability requiring repeat intervention. Closed reduction with splinting and soft tissue stabilization procedures have an increased risk of failure compared to revision arthroplasty.

Level of Evidence: Case Series Level IV, Therapeutic

Does Radiotherapy Impact Oncological and Functional Outcome in the Treatment of Soft Tissue Sarcomas of the Hand?

Abstract ID: Paper 013

---

*Nicholas F. Munaretto, M.D.
Anthony L. Logli, M.D.
Peter S. Rose, M.D.
Karim Bakri, M.B.B.S.
Steven L. Moran, M.D.
Matthew T. Houdek, M.D.
Rochester, MN

INTRODUCTION: Previous reports have shown the use of radiotherapy for soft tissue sarcomas (STS) of the hand to be associated with poor function. The aim of this study was to compare functional outcome in patients with and without radiotherapy.

METHODS: We retrospectively reviewed the records of 46 hand STS. Mean age at diagnosis was 38 ± 19 years with a mean follow-up of 10 ± 5 years. The MSTS93 and the Quick DASH were used to assess function. 18/46 (39%) patients received radiotherapy as a part of their treatment protocol. RESULTS: The 10-year local recurrence (LR) free survival was 84%, with no difference in LR between patients with and without radiotherapy ($p = 0.78$). Surgical complication occurred more commonly in patients with radiotherapy (33% vs. 18%, $p = 0.29$).

Following surgical resection, the mean Quick DASH was 7 ± 8 and MSTS93 score was 92 ± 8%, respectively. When comparing patients with and without radiotherapy, there was no difference between the mean Quick DASH (5 ± 5 vs. 8 ± 9, $p = 0.43$) or MSTS93 (93 ± 9% vs. 91 ± 8%).

CONCLUSION: In contrast to previous reports, the use of radiotherapy was not associated with a worse functional outcome in patients with STS of the hand. Therefore, these patients should expect excellent hand function with a similar rate of complications.

SUMMARY: Perioperative radiotherapy for soft tissue sarcomas of the hand is not associated with worse functional outcomes.

Risk Factors for Failure of ORIF of Isolated Olecranon Fractures

Abstract ID: Paper 014

Daniel J. Lynch, B.S.
*Erik Contreras, M.D.
John Mickley, B.S.
Kanu S. Goyal, M.D.
Amy L. Speeckaert, M.D.
Columbus, OH

PURPOSE: Although ORIF is currently one of the most common procedures used to treat olecranon fractures, there is still a prevalence of fracture reduction loss after this surgery. We looked to determine if any patient, fracture, surgical, or postoperative characteristics could be associated with failure of ORIF of isolated olecranon fractures.

METHODS: Patients undergoing ORIF for olecranon fractures at our institution over the past 10 years were initially included in our study (n = 263). 133 patients were later excluded. Patients' x-rays, operative reports, and postoperative visits were reviewed to gather relevant demographic, fracture, surgery, and postoperative data. Two-tailed t tests assuming unequal variance and Fisher's exact tests were used to test for statistically significant differences between those who experienced fracture reduction loss and those who did not.

RESULTS: 9.23% of patients (n = 12) experienced a loss of fracture reduction, with a mean distance of fracture distraction of 10.65 SD 7.28 mm. These patients were significantly older at 57.9 SD 16.4 years compared to 47.0 SD 18.7 years for the other group (p = 0.049). 42% of patients in the reduction loss group were smoking at the time of injury compared to 24% for the other group (p = 0.18). Those who lost reduction demonstrated a smaller mean arc of intact articular surface of 101.6 SD 19.0 degrees vs. 108.1 SD 27.57 degrees (p = 0.3). Those who lost reduction demonstrated a larger mean gap at the main fracture site of 14.42 SD 7.31 mm vs. 12.15 SD 8.68 mm (p = 0.33). If a plate/screw hardware set was used, those who lost reduction showed a smaller mean distance from the plate to the olecranon of 0.50 SD 0.47 mm vs. 0.90 SD 0.92 mm (p = 0.056). Lastly, the loss of reduction group started elbow motion at 9.58 SD 5.81 days postop compared to 11.24 SD 5.57 days for the other group (p = 0.36).

CONCLUSIONS: Our findings suggest that there could be an increased risk for loss of fracture reduction in patients undergoing ORIF for isolated olecranon fractures who are older, who smoke at the time of injury, have a smaller arc of intact articular surface post-fracture, show a larger gap at the main fracture site, who have a plate placed closer on top of the olecranon, and who start elbow motion sooner after surgery.

Neurovascular Complications in Elbow Arthroscopy: A Systematic Review of 5,767 Cases

Abstract ID: Paper 015

Alan G. Shamrock, M.D.
*Christopher N. Carender, M.D.
Brian R. Wolf, M.D., M.S.
Timothy P. Fowler, M.D.
Zain Khazi, B.S.
Joseph A. Buckwalter V, M.D., Ph.D.
Iowa City, IA

INTRODUCTION: Neurovascular injuries are rare, but potentially serious complications in elbow arthroscopy. Literature is limited to case reports and small, retrospective series. The exact incidence of neurovascular complications following elbow arthroscopy is currently unknown. The purpose of the current study was to systematically review the literature to determine the rate of neurovascular injuries following elbow arthroscopic procedures. We hypothesized that the total complication rate following elbow arthroscopy would be <10%, with a <5% rate of reported neurovascular injury. Additionally, we hypothesized that the majority of neurologic symptoms would be transient in nature.

METHODS: A comprehensive literature search was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using the PubMed, Embase, and Cochrane Central databases. All original English-language studies of at least five patients reporting complications following elbow arthroscopy were included. Case reports and studies examining open elbow procedures, arthroscopic-assisted open procedures, and elbow arthroscopies with concomitant open procedure were excluded. Demographic data, operative indications, and complications were recorded. Neurologic complications were further classified as minor if transient or major if they required microsurgical repair or resulted in permanent deficit.

RESULTS: There were 88 studies including 5,767 elbow arthroscopies in 5,649 patients that met inclusion criteria. Males comprised 50.3% of the cohort (n=2,844) and mean age was 31.3 years (range 6-90). Mean postoperative follow-up was 17.2 months (range 1-192). The most common surgical indication was elbow contracture (n=1,001; 16.0%) followed by primary arthritis (n=619; 10.7%). The total complication rate was found to be 5.0% (n=290) with 126 (2.2%) neurovascular adverse events recorded. There were five major nerve injuries (0.1%) consisting of three ulnar nerve and two median nerve lacerations. The most common minor nerve complication was ulnar nerve palsy (n=46) followed by delayed-onset ulnar neuropathy (n=33) and radial nerve palsy (n=19). The most frequently reported non-neurovascular complication was superficial infection or persistent portal drainage (n=38). There were no reported vascular complications, and no reports of compartment syndrome.

DISCUSSION: Major neurovascular injuries are rare events during elbow arthroscopy. Furthermore, the majority of neurologic complications following elbow arthroscopy are transient. The ulnar nerve is most commonly affected and all patients undergoing elbow arthroscopy should be examined for an unstable nerve or surgical scar suggesting previous transposition.

Natural History of Poland Syndrome: Functional and Psychosocial Outcomes in Adulthood

Abstract ID: Paper 016

---

*Sarah M. Schippers, M.D.
Qiang An, M.B.B.S., M.P.H.
Joseph A. Buckwalter V, M.D., Ph.D.
Iowa City, IA

INTRODUCTION: Poland Syndrome (PS) is a congenital condition characterized by pectoral muscle agenesis and ipsilateral limb hypoplasia or hand deformity. Theories on the etiology of this condition are well published, but there is little data on how these patients function in adulthood. Our study attempts to quantify clinical strength deficits and determine how this correlates with self-reported outcomes of physical and psychosocial health in adulthood.

MATERIALS AND METHODS: Participants were recruited via diagnosis code search of our institution's records and social media exposure to the study.

Patients returned to clinic for strength testing of their shoulder, elbow, and hand on both the affected and unaffected extremity using a hand-held dynamometer. Participants also completed the Disabilities of the Hand and Shoulder (DASH), the Short Form Health Survey (SF-36), and the Upper Extremity (UE), and Satisfaction with Social Roles sections of the Patient-Reported Outcome Measurement Information System (PROMIS) as well as other assessments of psychosocial outcomes. Aggregate scores were compared to the general population.

RESULTS: Twenty-eight patients were enrolled. Sixteen returned to clinic for strength testing and all 28 completed surveys. Average patient age was 42 years (range 18-65) with average length of follow up being 25 years (range 1-52).

Dynamometer testing demonstrated decreased shoulder strength with internal rotation and abduction/adduction and decreased hand grip and key/tip-pinch strength compared to the unaffected extremity. No compensatory strength increases were identified in the affected extremity.

The average DASH score of 11.6 was comparable to the normal population average of 10.1. The PROMIS UE score of 46.2 was significantly lower than the population average of 50, however, the Social Roles score of 57.3 indicated less disability than normal. Patients reported significantly less disability on the SF-36 Physical Functioning and Role Limitations sections.

Seventy-nine percent reported higher than average satisfaction with life, 82% had normal self-esteem, 21% met screening criteria for depression, and 4% for anxiety. The Derriford Appearance Scale revealed 68% identified PS as their most self-conscious feature, but only 36% made subsequent significant life adjustments.

CONCLUSIONS: Our cohort of adult patients with PS self-reported more favorable functional, psychological, and emotional outcomes than might be expected based on the significant shoulder and hand strength deficits found during clinical testing. Despite these deficits, patients appear to make adaptations that allow them to lead fulfilling lives with psychosocial functioning similar to their peers.

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
April 23, 2020

A Prospective, Surgeon Blinded, Randomized Control Trial in Knee Arthroscopy: Can We Eliminate Opioid Medications for Postoperative Pain Control?

Abstract ID: Paper 017

Matthew J. Hartwell, M.D.
*Ryan S. Selley, M.D.
Michael A. Terry, M.D.
Vehniah K. Tjong, M.D.
Chicago, IL

INTRODUCTION: Opiates are frequently used as part of a multi-modal pain strategy following orthopedic surgery. There are limited studies regarding the appropriate number of opioids to prescribe postoperatively. The aim of this pilot study was to determine if patients require opioids for adequate pain control following knee arthroscopy.

METHODS: Patients undergoing isolated arthroscopic partial meniscectomy were enrolled in the study and questionnaires were used to obtain preoperative demographics and risk factors for increased narcotic usage. All patients received 14 days of Naproxen 500mg BID, ASA 325mg BID, and Tylenol 1,000mg TID postoperatively. Patients were randomized into two groups: Group 1 was prescribed Oxycodone 10mg every 6 hours as needed (#20 tabs), and physically given to them following surgery; Group 2 was provided a paper prescription for the same number of tablets and patients were instructed only to fill the prescription if needed. Patients were then called at various timepoints after surgery. Pain scores, opioid side effects, and number of opioid tablets consumed were recorded. Postoperative opioid use was then compared between groups. Preoperative variables were also used to assess for risk factors for increased narcotic usage.

RESULTS: 52 patients were enrolled (27 in group 1, 25 in group 2). Baseline demographic information was similar between groups with the exception of family history of narcotic use (0.0% vs. 16%, p=0.031). There were no significant differences between groups in total number of tablets consumed (3.6 vs. 6.7, p=0.079), tablets remaining (16.4 vs. 13.2, p=0.079), number of days narcotics were required (2.6 vs. 4.4, p=0.15), or pain level at final follow-up (2.0 vs. 2.8, p=0.19). Patients overall required an average of 5.1 tablets (range 0-20 tablets), with 31% (n=16) requiring more than 5 tablets. 31% (n=16) did not require any narcotic use. Pain scores at 2 hours postop identified 36% of patients as having pain scores <5, with these patients having significantly increased odds of not needing any narcotic pain medications (OR 4.60, p=0.030).

CONCLUSION: A majority of patients required less than 5 opioid tablets following knee arthroscopy. Two-hour postoperative pain scores predict total narcotic consumption and could be used to tailor specific prescription amounts to patients. The burden imposed on patients to fill a separate prescription does not appear to have a significant effect on pain scores or total narcotics consumed.

Biomechanical Evaluation of a Suture-Reinforced Human Dermal Allograft: A Pilot Study

Abstract ID: Paper 019

Cody S. Lee, B.S.
*Manoj Reddy, M.D.
Bryan Scott, M.D.
Daniel Curtis, M.D.
Farid Amirouche, Ph.D.
Aravind Athiviraham, M.D.
Chicago, IL

INTRODUCTION: Previous biomechanical studies have yielded promising results for the use of human dermal (HD) allograft for superior capsular reconstruction (SCR) in its ability to restore superior glenohumeral translation and subacromial pressure. While clinical studies have demonstrated excellent outcomes in return to activity, it is unclear how shoulder overuse can contribute to allograft elongation and eventual superior glenohumeral translation. The purpose of this study was to investigate the potential for a novel suture reinforcement technique for the HD allograft to prevent elongation with repetitive use.

METHODS: Using 8 scapulae and humeri Sawbones® models, the standard SCR was performed using three knotless suture anchors placed superomedially on the glenoid at roughly the 10 o'clock, 12 o'clock, and 2 o'clock positions, and a Speedbridge configuration for fixation laterally. Eight HD allografts were tested: 4 in the native state and 4 using the experimental suture reinforcement. HD allografts were reinforced using Fibertape suture in a running 360° fashion around the borders of the HD allograft, maintaining 5 mm of space from the edges. Two Fibertape sutures were used per HD allograft and tied together at the medial and lateral edges. Prior to testing, HD allografts were measured for length, width, and thickness. All specimens were affixed to a materials testing machine that allowed for allograft orientation in a longitudinal plane throughout testing. Specimens were preloaded to 10N, after which, they were cyclically loaded to 100N at a rate of 15 mm/s for 30 cycles. HD allografts were again measured for length, width, and thickness after testing concluded. Student's t-test was used to statistically compare differences in percent change in all dimensions measured for native and reinforced allografts. A p-value of ≤ 0.05 was set as significant.

RESULTS: After dynamic, cyclic loading, reinforced allografts experienced a statistically significant smaller percent change in anterior length (6.36% vs. 14.50%, p=0.013), posterior length (6.00% vs. 13.68%, p=0.002), medial width (5.80% vs. 21.05%, p=0.001), lateral width (5.45% vs. 19.29%, p<0.001), medial thickness (4.38% vs. 17.93%, p=0.005), central thickness (7.03% vs. 16.11%, p=0.026), and lateral thickness (4.55% vs. 20.80%, p<0.001) (Figure 4). Linear stiffness values obtained for reinforced allografts were significantly greater than those for native grafts when measured at cycles 1 (21.18 ± 1.03 N/mm vs. 17.69 ± 1.91 N/mm, p=0.02), 15 (29.90 ± 1.45 vs. 24.93 ± 2.79, p=0.03), and 30 (32.13 ± 1.98 N/mm vs. 25.72 ± 3.01 N/mm, p=0.01).

CONCLUSION: Our novel suture-reinforced HD allograft was successful at preventing allograft elongation in a biomechanical setting. Future biomechanical studies should evaluate the differences in glenohumeral translation, subacromial pressure, and range of motion in a cadaveric model between both types of allograft.

Injury Incidence on Artificial Turf and Natural Grass Among High School Athletes

Abstract ID: Paper 020

---

*Andrew S. Paliobeis, B.S.
Lakshmanan Sivasundaram, M.D.
Derrick M. Knapik, M.D.
Michael R. Karns, M.D.
Michael J. Salata, M.D.
James E. Voos, M.D.
Cleveland, OH

BACKGROUND: Artificial turf is commonly used as an alternative to natural grass for athletic playing surfaces primarily for logistical reasons. Multiple studies have described an increased risk of injury on artificial turf. However, the existing literature is limited primarily to professional and collegiate athletes. The few studies representing high school athletes only compare injury rates in football. The purpose of this study is to compare injury rates on artificial and natural playing surfaces among high school athletes for all sports played on artificial turf or grass.

METHODS: Injury data collected throughout the 2017-2018 athletic seasons by athletic trainers from 26 high schools was sorted to include all sports that are played on artificial turf or grass. Injury incidence rates were calculated as injuries per athlete using roster totals for the included sports. Injury incidence was compared between artificial turf and grass for all injuries by constructing relative risk ratios. Injury incidence was also compared for injuries stratified by body location and sport. The distribution of injuries among athlete level, and practice vs. competition were compared between artificial turf and grass.

RESULTS: Of the injuries identified, 585 occurred on synthetic turf and 368 on grass. These injuries corresponded to incidence rates of 0.1495 (0.1384, 0.1607) and 0.0941 (0.0849, 0.1032) respectively, with an overall relative risk of 1.5897 (1.4062, 1.7971) $p<0.0001$. When stratified by body location, lower extremity, torso, and upper extremity injury incidences were significantly increased on artificial turf with relative risk ratios of 1.9597 (1.6169, 2.3752), $p<0.0001$, 1.8636 (1.1123, 3.1225) $p=0.0181$, and 1.4494 (1.1104, 1.8919) $p=0.0063$, respectively. When stratified by sport, football, mens lacrosse, rugby, and soccer injury incidences were significantly increased on artificial turf, with relative risk ratios of 1.4572 (1.2726, 1.6687) $p<0.0001$, 27.0000 (1.6230, 449.1613) $p=0.0216$, 23.0000 (3.1998, 165.3244) $p=0.0018$, 1.7073 (1.1857, 2.4583) $p=0.0040$, 1.8286 (1.2296, 2.7194) $p=0.0029$, respectively. A significantly larger proportion of injuries occurred on artificial turf during competition compared to practice ($p<0.00001$).

CONCLUSIONS: Injury incidence was significantly increased on artificial turf for football, men's lacrosse, rugby, and soccer. Lower extremity, torso, and upper extremity injuries occurred with greater incidences on artificial turf. This may warrant further studies into the mechanisms of torso and upper extremity injuries on artificial turf. These findings also suggest that, in addition to football, men's lacrosse, rugby, and soccer injuries occurred with greater incidences on artificial turf.

Lateral Femoral Condyle Osteochondritis Dissecans: Does Weightbearing Zone Location Predict Healing?

Abstract ID: Paper 021

---

*Sharon G. Huang, B.S.
Liang Zhou, M.D.
K. John Wagner, III, B.S.
Shawn Gee, M.D.
Philip L. Wilson, M.D.
Henry B. Ellis, Jr., M.D.
Dallas, TX

BACKGROUND: Osteochondritis dissecans (OCD) is a focal, idiopathic alteration of subchondral bone with potential for instability and disruption of adjacent articular cartilage that may result in premature (early secondary) osteoarthritis.

PURPOSE: The purpose of this study was to evaluate differences in clinical, radiographic, and treatment outcomes in weightbearing (WB) versus non-weightbearing (NWB) lateral femoral condyle (LFC) OCDs.

METHODS: An IRB-approved retrospective review of 62 patients with LFC OCD lesions, 26 of which were weightbearing and 36 non-weightbearing (defined as Cahill and Berg sagittal zones B and C, respectively), treated at a single institution between 2004 and 2019 was performed. All participants were 18 years of age or younger at the time of diagnosis. Demographic and clinical characteristics, radiographic features, treatment modalities, and outcomes were evaluated. Continuous variables were analyzed using a Mann-Whitney test and a Kruskal-Wallis test when comparing across various groups. A Chi-square test was used to compare categorical variables.

RESULTS: The study cohort consisted of 40 (64.5%) male and 22 (35.5%) female participants, with an average age at diagnosis of 12.86 ± 2.74 years, and an average follow-up of 24 months. WB and NWB LFC OCDs had no differences in symptom chronicity or the presence of mechanical symptoms. NWB lesions were more likely to present with distinct ossification of the progeny bone segment (70.0% vs. 25.0%; $p = 0.044$) and were deeper lesions (MRI sagittal depth 7.11 vs. 5.96; $p = 0.046$).

Across a variety of treatment modalities, NWB lesions were significantly more likely than WB lesions to demonstrate full radiographic healing at final follow-up (52.8% vs. 24.0%; $p= 0.033$). There was no difference in the likelihood of initial non-operative versus operative treatment selection or in the outcomes of non-operative treatment between the two lesion types. Additionally, OCDs in either zone were equally likely to be pain-free at final follow-up.

CONCLUSION: Lateral femoral condylar OCD lesions in weightbearing and non-weightbearing zones have similar clinical presentation. However, lesions in non-weightbearing zones demonstrate improved radiographic healing at final follow-up. These data may aid in clinical decision-making and counseling during treatment of children and adolescents presenting with lateral femoral condylar OCD.

Outcomes Following Primary Anterior Cruciate Ligament Reconstruction Using a Partial Transphyseal (Over-the-Top) Technique in Skeletally Immature Patients

Abstract ID: Paper 022

---

*William T. Cates, B.S. / Fort Worth, TX
Robert A. Cates, D.O. / Iowa City, IA
Zain M. Khazi, B.S. / Iowa City, IA
Alan G. Shamrock, M.D. / Iowa City, IA
Kyle R. Duchman, M.D. / Iowa City, IA
Robert W. Westermann, M.D. / Iowa City, IA
Matthew J. Bollier, M.D. / Iowa City, IA
Brian R. Wolf, M.D., M.S. / Iowa City, IA

INTRODUCTION: The incidence of anterior cruciate ligament (ACL) injuries in skeletally immature patients is increasing, with ACL reconstruction preferred as it has been shown to have chondroprotective benefits in this population. Due to concerns with growth disturbances following ACL reconstruction in skeletally immature patients, results of various physeal-sparing, partial-transphyseal, or complete-transphyseal techniques have been explored. Currently, there is no consensus on the most effective ACL reconstruction technique in skeletally immature patients. Therefore, the purpose of this study was to report the outcomes of a partialtransphyseal, over-the-top (OTT) ACL reconstruction in a cohort of skeletally immature patients.

METHODS: All patients with radiographic evidence of open tibial and femoral physes that underwent primary ACL reconstruction using the partial-transphyseal OTT technique between 2009-2018 at a single tertiary-care institution were retrospectively reviewed. Patient demographics, physical examination findings, graft ruptures, return to sport, and Tegner activity levels were analyzed. Statistical significance was defined as $p < 0.05$.

RESULTS: Overall, 22 males and 2 females (25 knees) with a mean age of 13.0 years (Standard Deviation [SD], 1.7 years) were included in the study. The mean postoperative follow-up was 2.1 years (SD, 1.7 years). There were four cases of ACL graft rupture (16%). All patients successfully returned to unrestricted sport at an average time of 7.3 months. Preinjury and postoperative Tegner activity levels were documented in 22 knees, of which 21/22 (95%) returned to the same or higher level. There were no documented cases of clinically significant longitudinal or angular growth disturbance.

CONCLUSION: Partial transphyseal ACL reconstruction using a transphyseal tibial tunnel and an extra-articular, OTT position on the femur in skeletally immature affords minimal risk of growth disturbance with a graft rupture rate of 16% and a 95% return to sport at the same or higher level.

Quadriceps Strength in Adolescent Patients Undergoing Anterior Cruciate Ligament Reconstruction after Femoral Nerve Block vs. Adductor Canal Block

Abstract ID: Paper 023

James E. Ohliger, III, M.D.
*Craig Siesel, M.D.
Paul R. Fleissner, M.D.
Kodi A. Veale, P.A.
Akron, OH

PURPOSE: Anterior cruciate ligament reconstruction (ACLR) is one of the most common orthopedic sports medicine procedures performed on an outpatient basis. In patients undergoing ACLR, attention has been focused on providing adequate pain relief while limiting postoperative quadriceps weakness. Femoral nerve block (FNB) has been the mainstay of treatment in the past. Recent articles debate the efficacy of femoral nerve block versus adductor canal block (ACB) regarding pain control and residual quadriceps weakness after ACLR. This study was undertaken to identify if a difference exists in quadriceps strength at multiple time points after an ACB or FNB in ACLR utilizing only hamstring autograft.

METHODS: An IRB approved prospective double-blinded study of patients less than 18 years of age undergoing primary ACLR utilizing only hamstring autograft were enrolled. All patients were randomized to receive an ACB or FNB at the time of surgery and the surgeon was blinded to the block type. A dynamometer was used to measure the knee extension strength of both the operative and non-operative leg preoperatively and at multiple times postoperatively until completion of the MOON rehabilitation protocol. Tourniquet time, pain scores, and time to complete physical therapy were collected.

RESULTS: Sixty-one patients underwent ACLR and were evaluated. There was no significant difference in patient age, tourniquet time, pain scores or time to complete physical therapy between the FNB (n=26) and ACB (n=35) groups. Patients who received a femoral nerve block had a statistically significant quadriceps motor strength deficit at 4 hours (P=.01) and 6 weeks (P=.02) postoperatively compared to those who received an adductor canal block. At 3 (P=.17) and 6 (P=.31) months, there was no statistically significant difference in quadriceps motor strength between the two groups. There was also no significant difference in retear rate between the two groups.

CONCLUSION: Although there were early statistically significant quadriceps motor strength deficits, in the femoral nerve block group compared to the adductor canal block group, it did not persist after the six week postoperative time period. Adductor canal nerve block does not provide a persistent statistically significant quadriceps strength benefit over femoral nerve block in adolescent patients undergoing anterior cruciate ligament reconstruction utilizing autologous hamstrings.

Return to Sport Following Plate Fixation of Midshaft Clavicle Fractures in Adolescent Athletes

Abstract ID: Paper 024

Saygin Kamaci, M.D.
Georgina Glogovac, M.D.
*Laura Bess
Robert N. Matar, M.D.
Angelo J. Colosimo, M.D.
Cincinnati, OH

BACKGROUND: The clavicle is the most commonly fractured bone in adolescents and approximately 85% of the injuries occur in sports or recreational activities. Faster return to sports time and improved functional outcomes may be possible with surgical treatment of midshaft fractures in highly functional adolescent athletes.

PURPOSE: To investigate the clinical results of open reduction and internal fixation (ORIF) of adolescent midshaft fractures and evaluate the union and return to sports times.

METHODS: After Institutional Review Board (IRB) approval, adolescents who were treated with ORIF for midshaft clavicle fractures between May 1, 2011, and October 30, 2017, were identified in our institutional orthopedic sports medicine registry. Inclusion criteria included patients with closed fractures, treated within 3 weeks of injury, with a minimum 1 year of follow-up, and between 11 and 17 years of age. Patients were excluded if there was nonunion after conservative treatment or if there was a concomitant injury that delayed surgery. Demographic data, mechanism of injury, time to surgery, fracture type, complications, radiographic and functional healing time, return to sports time, and return to competition time were recorded.

RESULTS: 14 patients met inclusion criteria (12 male, 2 female). Mean age was 14.4 years. Radiographic union was achieved in all patients. All patients gained full shoulder range of motion and returned back to sports at the same level. Nine fractures were classified to group 2B1, two fractures as 2B2, and three fractures as 2A2 according to Edinburg classification. All were high school or secondary school competitive athletes that sustained a sports-related injury. Mean time to surgery was 4.1 days (range, 1-8 days). Mean follow-up time was 44 months (range, 12-89 months). Mean time to return back to training was 46 days (range, 24-70 days) and mean time to return back to competition was 64 days (range, 24-90 days). No intraoperative complications were noted. The mean Nottingham clavicle score was 91 (range, 84-98). The most common complication was implant prominence and irritation in five (36%) patients, which required implant removal in two patients. No re-fracture was reported after plate removal. All patients were satisfied with the outcome and would choose surgical treatment again.

CONCLUSION: This study demonstrates that plate fixation of clavicle midshaft fractures provides excellent outcomes and safe return to sports in adolescent athletes.

Femoral Tunnel Fixation for Medial Patellofemoral Ligament Reconstruction in the Growing Patient is Safe for Future Growth

Abstract ID: Paper 025

---

*Breann Tisano, M.D. / Frisco, TX
Bruno Gross, M.D. / Dallas, TX
Meagan J. Sabatino, B.A. / Frisco, TX
Madison Brenner / Frisco, TX
Charles W. Wyatt, CPNP, RNFA / Frisco, TX
Philip L. Wilson, M.D. / Frisco, TX
Henry B. Ellis, Jr., M.D. / Frisco, TX

BACKGROUND: Medial patellofemoral ligament (MPFL) reconstruction has been shown to be a successful treatment for patients with recurrent patellar instability and is increasingly used to treat skeletally immature patients.

PURPOSE: The purpose of this study is to compare radiographic parameters prior to and following an MPFL reconstruction with femoral tunnel fixation in the skeletally immature patient to investigate potential effects on the physis and future growth.

METHODS: Skeletally immature patients undergoing isolated MPFL reconstruction were retrospectively reviewed. Fixation of proximal MPFL was performed as a femoral socket using Schottle's point with the entry approximately 5 mm distal to the physis. Patients with open growth plates and one-year postoperative standing alignments were included. Radiographic measures of patellar tilt, patellar height, patellar subluxation, and trochlear dysplasia were compared preoperatively and postoperatively on the operative limb. Pre- and postoperative coronal alignment and limb length measurements were compared between the operative and non-operative limbs.

RESULTS: Nineteen skeletally immature patients with an average age of 11.6 years (range 5-15) underwent isolated MPFL reconstruction. The average follow-up time was 24 months. No significant differences were found between the change in femur (0.49 mm, p=0.526) or total limb length (1.08 mm, p=0.241) when comparing the operative to the non-operative limb, with an average of 47 mm of growth in the operative limb seen during the time period. There was no significant difference in the change in LDFA between operative and non-operative limb as well as symmetric changes noted in the mechanical axis. The change in patellar tilt on the operative limb was found to be significant (12.78°, p=0.030), and the change in patellar height by Caton-Deschamps approached significance (0.08mm, p= 0.077). No significant difference was found with trochlear dysplasia measures.

CONCLUSION: The present study suggests MPFL reconstruction with femoral tunnel fixation is safe and does not result in growth disturbance in skeletally immature patients.

All ACLs Are Not the Same: Sport-Specific Differences in Presentation and Response Surrounding Pediatric and Adolescent ACL Reconstruction

Abstract ID: Paper 026

James D. Munoz, B.S.
*K. John Wagner, III, B.S.
Meagan J. Sabatino, B.A.
Chan-Hee Jo, Ph.D.
Caroline P. Gekas, B.A.
Philip L. Wilson, M.D.
Henry B. Ellis, Jr., M.D.
Dallas, TX

INTRODUCTION: Soccer, football, and basketball are the sports with the highest ACL rupture rates. Sport-specific differences in injury and recovery surrounding ACL rupture are understudied. The purpose of this study was to compare presentation and recovery in athletes from different sports who underwent ACL reconstruction (ACLR).

METHODS: An IRB-approved, retrospective review of patients presenting to a pediatric sports medicine clinic for treatment of an ACL injury was performed. Inclusion criteria were primary ACLR and preoperative sport participation. Injury and surgical data, patient-reported outcome measures (PROMs), and time to return to play clearance were collected. A comparison between athletes whose primary sport was soccer, football, or basketball was performed.

RESULTS: Of 238 ACLRs, the mean age was 14.7 (7-19) and 49.6% were female. 132 athletes played soccer (31.9%), football (27.7%), or basketball (18.9%). Approximately two-thirds of the injuries in basketball and soccer were sustained by females. No difference in age was noted. Football had the highest percentage of middle school injuries (19.3%), and were more likely to undergo a physeal-sparing or respecting procedure compared to soccer or basketball athletes (p=0.02). Level of play was highest in soccer, with 44.6% participating at a select/travel level (p=0.001). There was no difference in preoperative physical exam or baseline PROM scores across the groups.

Soccer players (44.1%) were more likely to pass their functional clearance 6 months postoperatively, compared to 20.5% of basketball, and 18.2% of football players (p=0.001). Football players took significantly longer (2 months) to pass functional clearance than the other sports (p=0.004).

Functional PROMs at 12 and 24 months were no different between the sports evaluated. However, at 12 months, football players had a decrease in their psychological subscales of the ACSI-28 Coachability and Impact of Event Scale Avoidance scale compared to both soccer and basketball (p=0.0417 and p=0.0465, respectively). Also at 24 months, basketball players had lower Freedom from Worry subscales of ACSI-28 (Basketball 4.5, Football 9.0, Soccer 8.54; p=0.025).

CONCLUSIONS: Variability exists in athletes from differing sports following ACL surgery. Soccer players may pass functional testing prior to established safe return to play times, while football players may take longer to physically recover. Additionally, sport type may predict

trends in psychological response to ACL treatment, and investigation of sport-specific psychological considerations to augment treatment may be warranted.

Limitations of MPFL Reconstruction for Treatment of Patellar Instability with Patella Alta: Dynamic Simulation

Abstract ID: Paper 027

---

*Travis J. Jones, M.D.
Kerwyn C. Jones, M.D.
John J. Elias, Ph.D.
Akron, OH

INTRODUCTION: Medial patellofemoral ligament reconstruction is a popular treatment for patellar instability. For knees with patella alta, however, tibial tuberosity distalization is the most common approach due to concerns about adequate graft tensioning. The current study addresses MPFL reconstruction for knees with patella alta using dynamic simulation of knee function.

METHODS: Knee function was simulated with seven multibody dynamic simulation models constructed from MRI scans of subjects being treated for patellar instability. Models were individually validated against assessment of knee function for the subjects, producing patellar tracking patterns [1, 2], variations with surgery [2], and contact pressure distributions [3] similar to those measured from in vivo function. Patellar tracking was expressed by the bisect offset index and patellofemoral contact pressures determined from discrete element analysis were quantified.

Motion was simulated in a preoperative condition, and for two graft tensioning techniques. Analysis focused on the maximum bisect offset index during flexion as a measure of the risk of patellar instability and the maximum pressure applied to patellar cartilage as measures of the risk of overloading cartilage. Postoperative maximum bisect offset index was also correlated with the preoperative bisect offset index.

RESULTS: MPFL reconstruction decreased bisect offset index, with significant differences noted between preoperative and postoperative conditions. MPFL reconstruction did not significantly influence the maximum pressure applied to medial or lateral cartilage. The maximum postoperative bisect offset index was significantly correlated with the preoperative bisect offset index for both graft tensioning approaches ($r^2 = 0.90$ and 0.73 for grafts allowing 1 and 0.5 quadrants of translation, respectively).

CONCLUSION: The MPFL grafts did not significantly reduce pressure applied to lateral patellofemoral cartilage or increase pressure applied to medial cartilage. MPFL reconstruction for knees with patella alta decreased lateral maltracking. For knees with the largest preoperative bisect offset index, the postoperative bisect offset index was indicative of likely instability. Therefore, current approaches for MPFL reconstruction are not a viable option for patellar stabilization for all knees with patella alta. For knees with alta and high levels of lateral maltracking, current graft tension techniques may not prevent recurrent instability.

REFERENCES:
1. Elias JJ, et al. Orthop J Sports Med. 20;4:2325967116665080.
2. Elias et al. Knee Surg Sports Traumatol Arthrosc. doi: 10.1007/s00167-017-4799-9. [Epub ahead of print]
3. Elias et al. J Orthop Res. doi: 10.1002/jor.24108. [Epub ahead of print].

Arthroscopic vs. Open Irrigation and Debridement in Native Septic Knees: A Retrospective Review.

Abstract ID: Paper 028

---

*Theodore L. Schoenfeldt, M.D.
Madeline M. Lyons, M.D.
Michael W. Perry, M.D.
Nicholas M. Brown, M.D.
Maywood, IL

INTRODUCTION: Historically, open irrigation and debridement of a septic native knee joint was thought to be superior to arthroscopic irrigation and debridement, but the minimal data regarding these treatment options were limited to small case studies. Recent literature has suggested lower reoperation rates and improved postoperative range of motion with arthroscopic treatment compared to open treatment of a native septic knee. Given the limited literature on this topic, the purpose of this study was to further investigate the difference between these two treatment options in patients with native septic knees.

METHODS: Utilizing electronic medical records to perform a retrospective chart review at a single academic center in the United States, we identified all patients that were treated for septic arthritis of the knee with either open or arthroscopic irrigation and debridement from January 2007 to August 2018. Demographic information, laboratory results, mortality, reoperation, number of total operations, length of stay, and comorbidities were collected and compared.

RESULTS: 81 patients and 83 knees were treated surgically for native knee septic arthritis, of which 50 were culture positive. 49 knees underwent arthroscopy and 34 knees underwent open arthrotomy as their initial treatment. Treatment method was significantly impacted by the subspecialty of the attending surgeon on the case (P=0.00001). 16 of 49 (32.7%) knees initially treated with arthroscopic I&D required reoperation whereas 5 of 34 (14.7%) knees treated with open I&D required reoperation (P=0.064). There was no significant difference in length of stay (9.6 days vs. 10.0 days, P=0.322) or total number of operations (1.44 vs. 1.42, P=0.596). There was one death within 90 days of surgery and this patient was in the open irrigation and debridement group.

CONCLUSION: There is no significant difference in outcomes between native septic knees treated with arthroscopic versus open irrigation and debridement. We have observed a trend for higher reoperation rates with arthroscopically treated septic knee, but this difference is not statistically significant. Surgical treatment is significantly influenced by the subspecialty of the attending surgeon.

REFERENCES:
1. Jeon YD, Moon JY, Son JH, Kim JM, Choi Y. The Efficacy of Arthroscopic Debridement with Continuous Irrigation in Failed Arthroscopic Debridement for Septic Arthritis of the Knee. Journal of the Korean Orthopaedic Association. 2016;51(4):308-314. doi:10.4055/jkoa.2016.51.4.308.
2. Dave OH, Patel KA, Andersen CR, Carmichael KD. Surgical Procedures Needed to Eradicate Infection in Knee Septic Arthritis. Orthopedics. 2016;39(1):50-54. doi:10.3928/01477447-20151222-05.
3. Flood JN, Kolarik DB. Arthroscopic irrigation and debridement of infected total knee arthroplasty: report of two cases. Arthroscopy. 1988;4(3):182-186.

4. Johns BP, Loewenthal MR, Dewar DC. Open Compared with Arthroscopic Treatment of Acute Septic Arthritis of the Native Knee. The Journal of Bone and Joint Surgery. 2017;99(6):499-505. doi:10.2106/JBJS.16.00110.

MAOA BREAKOUT SESSION #3
TRAUMA
April 23, 2020

Novel Tricep Tenotomy Approach to Distal Humerus: Clinical Outcomes and Anatomic Characterization

Abstract ID: Paper 029

---

*Aaron R. Owen, M.D.
David V. Ivanov
Jonathan D. Barlow, M.D., M.S.
Michael E. Torchia, M.D.
Brandon J. Yuan, M.D.
Rochester, MN

PURPOSE: Operative fixation of complex distal humerus fractures remains a technical challenge. The olecranon osteotomy (OO) is considered the gold standard of distal humerus fracture fixation; however, complications with osteotomy site nonunion and painful hardware have led to the development of alternative exposure techniques. Herein, we describe the clinical outcomes and anatomic features of a novel triceps tenotomy (TT) approach to the distal humerus.

METHODS: A retrospective review of AO/OTA Type C fractures treated at our institution between 2004-2017 yielded 13 cases utilizing a TT approach. The TT cohort was matched 2:1 by age and fracture classification with a cohort of patients managed by OO. Outcomes including initial reduction quality, nonunion, hardware failure, tourniquet time, and development of post-traumatic arthrosis were documented.

Cadaveric exposures utilizing these approaches were performed using a pair of fresh frozen upper extremities from a single donor. After TT and OO approaches were performed, exposed distal humerus articular cartilage was marked with ink. After disarticulation of the elbow, measurements of the articular surfaces were obtained.

RESULTS: Average follow-up time was approximately 14 months for TT and 18 months for OO. Fractures repaired with OO were associated with a lower incidence of articular step-off greater than 1 mm after initial radiographic assessment, 4.0% vs. 31.0%, (p=0.035). No difference was observed in progression to post-traumatic arthrosis, nonunion or fixation failure (p=1.000). TT patients required fewer reoperations compared to OO patients, 15% vs. 46% (p=0.083). Additionally, TT patients had a mean tourniquet time of 91 minutes vs. 114 minutes for OO patients, (p=0.069).

Anatomically, the OO approach exposed 105.7cm^3 of articular surface – 82.10% of the total articular surface of the left arm. The TT approach exposed 52.6 cm^3 of articular surface – 35.95% of the total articular surface of the right arm. OO exposed 2.01 times more articular surface, and 2.3 times more relative articular surface compared to TT.

CONCLUSION: In our cohort, the greater exposure afforded by the OO approach resulted in

radiographically superior outcomes. Despite this, patients did not differ significantly in progression to fracture union, post-traumatic arthrosis or hardware failure. Although not statistically significant, our OO cohort experienced an increased incidence of postoperative complications and need for reoperation compared to the TT group. Notably, the majority of re-operations were performed for symptomatic or infected olecranon hardware. In conclusion, TT offers a novel, viable alternative to distal humerus exposure for fracture fixation with comparable clinical outcomes to OO.

Weightbearing CT Scan after Pilon Fracture Fixation Demonstrates Significant Early Joint Space Narrowing

Abstract ID: Paper 030

Michael C. Willey, M.D. / Iowa City, IA
*Jocelyn T. Compton, M.D. / Iowa City, IA
J. Lawrence Marsh, M.D. / Iowa City, IA
Conor Kleweno, M.D. / Seattle, WA
Julie Agel, M.A. / Seattle, WA
Elizabeth J. Scott, M.D. / Iowa City, IA
Gabrielle Anne Bui, B.A. / Iowa City, IA
John Davison, M.P.H. / Iowa City, IA
Donald Anderson, Ph.D. / Iowa City, IA

INTRODUCTION: Post-traumatic osteoarthritis (PTOA) is a common sequela of tibial pilon fractures. New approaches are needed to objectively quantify early disease progression in order to critically assess the impact of interventions aimed at reducing PTOA. Weight-bearing CT (WBCT) provides a means for measuring joint space while the ankle is in a loaded/functional position. The purpose of this study was to assess the reliability of a measurement technique and to determine patterns of joint space narrowing on WBCT at 6 and 12 months after pilon fracture compared to the uninjured contralateral ankle.

METHODS: 14 individuals that sustained pilon fractures were prospectively enrolled and underwent bilateral ankle WBCT scans at 6 and 12 months. We developed a standarized technique to measure joint space in 9 clinically relevant locations of the ankle joint on sagittal images. Four reviewers used this technique to independently measure joint space on the injured and uninjured ankles at 6 months follow-up with repeated measurements 2 weeks later. The same measurements were performed on the 12 month WBCT scans by a single reviewer. Inter-rater correlation coefficient (ICC) estimates were calculated based on a mean rating (k=4), absolute agreement, 2-way mixed effects model. Test-retest reproducibility was calculated based on a single rating, absolute agreement 2-way mixed effect model. An independent samples student's t-test was used to compare means between measurements of interest, and $p<0.05$ was deemed statistically significant.

RESULTS: Joint space measurements for each region of the ankle showed a significant difference in the injured and uninjured ankles seen primarily anteriorly, centrally, and lateral. The mean joint space in the uninjured ankles at all points was 2.58 mm, compared to 1.88 mm at 6 months and 1.92 mm at 12 months in the injured ankles ($p=0.001$). The difference in joint space was not significant comparing 6 month to 12 month scans. The ICC of the measurement technique was 0.88. The test-retest reproducibility at two weeks was 0.8.

DISCUSSION AND CONCLUSION: We found that joint space can be reliably measured on WBCT scans in multiple clinically relevant locations for the ankle joint. Significant joint space narrowing compared to the uninjured ankle was seen after pilon fracture at 6 months and persisted at 12 months after injury.

Immediate vs. Delayed Weightbearing after Ankle ORIF: A Retrospective Study

Abstract ID: Paper 031

Brandi R. Hartley, M.D.
Jon B. Carlson, M.D.
Lauren M. Nelson, M.D.
*Grant O. Schmidt, B.A.
Jordan L. Pamplin, B.S.
Louisville, KY

PURPOSE: Traditional postoperative management of ankle fractures following open reduction and internal fixation (ORIF) includes 6 weeks of non-weightbearing on the operative extremity in order to protect the fracture reduction and internal fixation as well as the surgical wound. However, advances in hardware necessitate a re-evaluation of this approach. The purpose of this study is to evaluate the effects of immediate weightbearing on postoperative complications following ankle ORIF.

METHODS: A retrospective review was performed on 286 patients with ankle fractures from April 2016 to May 2019. Data was collected from a database of ankle procedures performed by seven orthopedic traumatologists. Fracture types included bimalleolar, trimalleolar, medial malleolus, and distal fibular fractures, and were subclassified by Weber criteria. “Immediate” weightbearing status was defined as unrestricted weightbearing of the affected ankle immediately following ORIF. Primary outcome measures included rates of infection, fixation failure, nonunion, and DVT/PE. Groups were controlled for pre-existing diabetes mellitus (DM), smoking status, and peripheral vascular disease (PVD).

RESULTS: A total of 286 patients who underwent ORIF following ankle fractures were identified (N = 48 “immediate”, 238 “delayed”). No significant difference was identified between “immediate” and “delayed” groups for rate of infection (X^2 (1) = 0.286, p = 0.593), fixation failure (X^2 (1) = 0.398, p = 0.528), nonunion (X^2 (1) = 1.107, p = 0.293), or DVT/PE (X^2 (1) = 0.614, p = 0.433). Analysis showed no difference between groups in smoking status, DM, or PVD.

CONCLUSION: Immediate weightbearing following open reduction and internal fixation of ankle fractures resulted in no difference in rate of complications in the immediate postoperative period. Of note, immediate weightbearing in our study did not appear to have any increased risk of wound infection or fixation failure. While the ability to postoperatively bear weight earlier may improve patient quality of life, further studies are needed to fully assess the impact of immediate weightbearing on functional outcomes.

Primary ORIF vs. Staged Fixation of Gustilo II Open Ankle Fractures: A Retrospective Study

Abstract ID: Paper 032

Brandi R. Hartley, M.D.
Jon B. Carlson, M.D.
Lauren M. Nelson, M.D.
*Jordan L. Pamplin, B.S.
Grant O. Schmidt, B.A.
Louisville, KY

PURPOSE: Management of Gustilo II open ankle fractures typically consists of either primary open reduction and internal fixation (ORIF) or external fixation followed by ORIF at a later date (staged). However, controversy exists regarding the appropriate treatment of these fractures, and there is a lack of recent literature discerning the differences in outcomes between these two approaches. The purpose of this study is to evaluate the complication rates associated with primary ORIF vs. staged treatment of Gustilo II open ankle fractures.

METHODS: A retrospective review was performed on 54 patients with Gustilo II open ankle fractures treated from April 2016 to May 2019. Data was collected from a database of ankle procedures performed by seven orthopedic traumatologists. Fracture types included bimalleolar, trimalleolar, medial malleolar, and distal fibular fractures, and were subclassified by Weber criteria. Primary ORIF was defined as ORIF upon first surgical encounter, while “staged” fixation was defined as external fixation upon first surgical encounter, with subsequent ORIF at a later date. Primary outcome measures included rates of infection, fixation failure, nonunion, and DVT/PE. Groups were controlled for pre-existing diabetes mellitus (DM), smoking status, and peripheral vascular disease (PVD). Statistical analyses were conducted using IBM SPSS Statistics 25.

RESULTS: A total of 54 patients who underwent ORIF following Gustilo II open ankle fractures were identified (N = 33 “primary ORIF”, 21 “staged”). No significant differences were identified between the two groups for rates of infection (X^2 (1) = 2.048, p = 0.152), fixation failure (X^2 (1) = 0.351, p = 0.554), or nonunion (X^2 (1) = 0.037, p = 0.847). There were no instances of DVT or PE. Analysis showed no difference between groups in smoking status, DM, or PVD.

CONCLUSION: Primary ORIF of Gustilo II open ankle fractures does not appear to be associated with increased complication rates, including rates of postoperative infection, compared to staged fixation. However, additional studies are warranted to further elucidate this relationship as well as to determine the additional benefits of primary ORIF.

Outcomes of Open Ankle Fracture-Dislocations with Medial Transverse Wounds

Abstract ID: Paper 033

---

*Case W. Martin, M.D.
John H. Cabot, B.A.
Ahmed A. Makhani, B.A.
Farhan Ahmad, B.S.
Samuel S. Ornell, B.S.
J. Conner Ryan, M.D.
Boris A. Zelle, M.D.
San Antonio, TX

INTRODUCTION: The open ankle fracture-dislocation with a transverse medial-based skin laceration represents a common variant of an open ankle fracture. However, data pertaining specifically to this fracture pattern remains scarce. This study aims to examine the outcomes of this injury with a focus on surgical site complications arising from the medial-based transverse laceration. Additionally, it seeks to identify if patients with this fracture pattern requiring syndesmotic fixation sustained higher rates of complications than those who did not.

MATERIALS & METHODS: This study was performed at an urban university-based level-1 trauma center. Patients 18 years of age and older with open ankle fracture-dislocations associated with transverse medial skin laceration were included in this study. Patients with injuries sustained from 2014 until 2016 and a minimum of 10-week clinical and radiologic follow-up were included in this retrospective study. Primary outcome measures were surgical site complications (infection, wound dehiscence, delayed wound healing). Secondary outcome measures included radiographic outcomes (union and hardware failure).

RESULTS: A total of 48 patients (49 medially open ankle fractures) were included in this study. There were 17 (35.4%) surgical site complications. Eleven patients had infections (22.9%) – six superficial (12.5%) and five deep (10.4%). Additionally, six patients (12.5%) experienced wound healing issues without antibiotics or additional surgery required – one wound dehisced (2%) and five had delayed healing (10.4%). Adverse radiographic outcomes occurred in 5 (10.4%) cases, as malunion (n=2), nonunion (n=1), hardware failure (n=1) and peri-implant fracture (n=1). Nine (37.5%) of the 24 fractures requiring syndesmotic fixation had complications compared to 13 (52%) of the 25 fractures without syndesmotic fixation.

CONCLUSIONS: Open ankle fractures occur with a high rate of complications. Syndesmotic disruption in an ankle fracture is generally associated with higher energy mechanisms and thus may be expected to have higher rates of complications. Interestingly, patients who did not require syndesmotic fixation had a higher rate of complications than those who did. This may be due to the higher median age of patients in the group without syndesmosis fixation as lower energy open ankle fractures generally occur in the elderly. As the population continues to age, this fracture pattern may become more common for orthopedic surgeons. Understanding the morbidity associated with medially open ankle fractures is important for perioperative management of such cases. Care should be taken specifically regarding surgical site infections and wound healing.

Utility of Post-Mobilization Radiographs in Non-Operative Management of Pelvis and Acetabulum Fractures

Abstract ID: Paper 034

---

*Scott H. Conant, M.D.
Nathan Odor, M.D.
David C. Teague, M.D.
Oklahoma City, OK

BACKGROUND: During non-operative management of pelvis and acetabulum fractures, despite initial assessment with computed tomography (CT), radiographs are frequently taken following mobilization to ensure the fracture is stable within the prescribed weightbearing restriction. These radiographs increase cost of care and expose patients to additional radiation. Anecdotally, these rarely change fracture management.

PURPOSE: The goal of this study was to evaluate the efficacy of these radiographs by determining how often they changed management via alteration of weightbearing restriction or conversion of treatment plan to surgical stabilization. Secondarily, we sought to determine what patient or fracture characteristics if any, increase utility of such radiographs.

METHODS: Retrospective review of all pelvic ring and acetabulum injuries from 2010 to 2018 at our level 1 trauma center were reviewed. All such fractures in adults, initially intended for non-operative management, that had post-mobilization films taken during the inpatient period, and had CT scans available for review were included. The following patient and fracture characteristics were also recorded: fracture type or classification, mechanism of injury, initial weightbearing restriction, pain tolerance of mobilization (yes/no), number of other weightbearing restricted limbs, patient gender, age, and BMI. Chart review was used to determine if post-mobilization images resulted in a change in weightbearing restrictions or led to surgical stabilization.

RESULTS: 260 patients met inclusion criteria for review. Post-mobilization images resulted in management changes in only 4 of these patients (1.5%). 4/4 reported significant pain with mobilization. Final data analysis is not completed yet to report on significance of other patient and fracture variables, but will be finished prior to the conference.

CONCLUSION: We recommend against routine use of post-mobilization radiographs during non-operative treatment of pelvis and acetabulum fractures, as this increases cost of care and patient radiation exposure, while changing management in only 1.5% of cases. We recommend use of such radiographs be restricted to patients reporting significant pain with mobilization, which may suggest instability requiring a change in management. Other factors that impact utility of such films will be revealed by our pending final analysis.

Transiliac-Transsacral Screw Fixation of Vertically Unstable Pelvic Fractures: Do Fully Threaded Screws Impart Improved Stability?

Abstract ID: Paper 035

---

*Steven F. Shannon, M.D. / Lincoln, NE
Giovanni Oppizzi, B.S. / Baltimore, MD
Michael A. Schloss, B.S. / Baltimore, MD
Jared Atchison, B.S. / Baltimore, MD
Jason W. Nascone, M.D. / Baltimore, MD
Marcus F. Sciadini, M.D. / Baltimore, MD
Li-Qun Zhang, Ph.D. / Baltimore, MD
Robert V. O'Toole, M.D. / Baltimore, MD
Todd Jaeblon, D.O. / Baltimore, MD

OBJECTIVE: Vertically unstable transforaminal sacral fractures with significant fracture gap are challenging fractures due to their inherent mechanical instability with no current consensus on the best fixation techniques. The objective of this study was to determine whether fully threaded transiliac-transsacral (TI-TS) fixation is biomechanically superior to partially threaded TI-TS fixation of vertically unstable transforaminal sacral fractures.

METHODS: A vertically unstable Zone 2 sacral fracture injury was created in 20 human cadaveric pelves with a unilateral osteotomy and resection of 1cm of bone through the foramen of the sacrum. The model also included resection of the symphyseal ligament, release of the ipsilateral sacrospinous and sacrotuberous ligaments, and fixation of the symphysis to represent a clinically realistic surgical treatment strategy. Ten specimens received either two 7.3mm fully threaded or two 7.3mm partially threaded TI-TS screw fixation at the S1 and S2 body and every specimen received standard 3.5mm 8-hole parasympheal plating anteriorly. Based upon a previously described single limb stance model, each pelvis was loaded to 250N at 3Hz for 100,000 cycles and then loaded to failure. The primary outcome was fracture displacement at the S1 foramen, which was measured at 25,000, 50,000, 75,000, and 100,000 cycles with >1cm displacement representing simulated clinical failure. Secondary outcome was force to failure as defined by actuator displacement of 2.5cm. Specimens in the fully threaded and partially threaded cohorts were otherwise respectively comparable in regards to age (78 vs. 82 years old, p=0.54), gender (60% female vs. 70% female, p=1.0) and bone density (T score -2.9 vs. -3.0, p=0.64).

RESULTS: Five of the 10 TI-TS partially threaded specimens experienced simulated clinical failure with >1cm displacement at the S1 foramen compared to zero of the 10 TI-TS fully threaded cohort (p=0.03). The mean maximal displacement at the S1 foramen was greater in the partially threaded cohort (9.3mm) compared to the fully threaded cohort (3.6mm; p=0.004). Fully threaded specimens also demonstrated greater mean force to failure than the partially threaded specimens (461N vs. 288N, p=0.0001).

CONCLUSIONS: Fully threaded transiliac-transsacral screw fixation appears to be mechanically superior to partially threaded fixation in a cadaveric vertically unstable transforaminal sacral fracture model with significantly less displacement of the posterior pelvic ring. Traumatologists treating these complex fractures should consider fully threaded TI-TS fixation over partially threaded fixation for these injuries. Clinical validation of this finding is needed.

Does Subcutaneous Internal Fixation (INFIX) Perform Similar Radiographically to Other Methods of Anterior Pelvic Fixation for Pelvic Ring Injury?

Abstract ID: Paper 036

Malynda S. Wynn, M.D.
Brandon G. Wilkinson, M.D.
Nathan R. Hendrickson, M.D.
Matthew H. Hogue, M.D.
*Matthew D. Karam, M.D.
Iowa City, IA

INTRODUCTION: Optimal treatment for high energy pelvic ring injuries remains a challenge for orthopedic surgeons. Particularly, anterior pelvic ring fixation remains controversial. Many techniques have been described, including open reduction internal fixation (ORIF), percutaneous cannulated screw fixation, subcutaneous internal fixation (INFIX), and external fixation. Despite a variety of fixation techniques, there is scarce literature investigating direct comparisons between common methods of anterior pelvic fixation. We hypothesize that INFIX will not show a significant difference in pelvic deformity or pubic symphysis reduction when compared to ORIF and external fixation methods in the setting of pelvic ring injury.

METHODS: We retrospectively reviewed orthopedic trauma patients from 2011-2015 who sustained high energy pelvic ring injuries treated with ORIF, external fixation, or INFIX. Reduction assessment included pelvic deformity index and pubic symphysis widening measured from pre and postoperative AP pelvis radiographs. Inter-rater reliability of radiographic measurements was calculated between two independent reviewers. Comparison between fixation techniques was analyzed using t-test with significance as $p<0.005$.

RESULTS: Thirty-seven patients were included, average age 45.4 years. APC3 injuries were seen in 29.7%, and LC3 injuries in 21.6% patients. In more severely displaced injuries, INFIX was used in 42.1% of patients, ORIF in 36.8%, and external fixation in 21.1%. Fifteen patients underwent INFIX, 11 underwent ORIF of pubic symphysis or innominate bone, 6 underwent external fixation, and 5 underwent isolated sacroiliac screw placement. Average pelvic deformity index reduction with INFIX was 35.9% vs. 38.1% with external fixation ($p=0.71$), and 51.4% with ORIF ($p=0.78$). Average reduction of pubic diastasis with INFIX was 52.1% vs. 41.4% with external fixation ($p=0.34$), and 72.5% with ORIF ($p=0.002$). Inter-rater reliability of pre and postoperative measurements was 0.93 and 0.91, respectively. Full weightbearing with INFIX averaged 10.9 weeks, 12 weeks with external fixation, and 15.9 weeks with ORIF. Complications included 23 cases of lateral femoral cutaneous nerve (LCFN) neuritis (9 in INFIX patients), 2 cases of heterotopic ossification, 1 case of deep infection, and 1 case of hardware failure. Average follow-up was 1.2 years.

DISCUSSION: INFIX radiological reduction outcomes were comparable to traditional methods of anterior pelvic fixation. Consistent with prior anatomic and case series, a higher incidence of LCFN neuritis was reported in those patients with INFIX. In the cases of more severe injury, INFIX and ORIF were preferentially used over external fixation.

Is Follow-Up Imaging Necessary in Non-Operatively Treated Extra-Articular Scapula Body Fractures?

Abstract ID: Paper 037

---

*R. Garrett Steinmetz, M.D.
Jeremiah J. Maupin, M.D.
Eric B. Johnson, M.D.
Austin J. Cantrell
Jake Fox
Jeremy A. Bernhardt
Charles B. Pasque, M.D.
David C. Teague, M.D.
Oklahoma City, OK

INTRODUCTION: Non-surgical management of extra-articular scapula body fractures has been associated with good outcomes. There is minimal literature evaluating the need of post-injury radiographs for extra-articular scapula body fractures that are managed conservatively. The purpose of this study was to evaluate if post-injury radiographs resulted in any difference in management for extra-articular scapula body fractures treated non-surgically and to determine the cost of post-injury radiographs obtained at our institution.

METHODS: A retrospective review of consecutive scapula body fractures managed non-surgically from January 2013 to December 2016 was performed. Exclusion criteria included patients less than 18 years of age, death within six weeks of injury, less than six weeks of follow-up, inadequate radiographs, scapulothoracic dissociation, ipsilateral neurovascular injury, and fractures involving the glenoid fossa, coracoid, or acromion. Included in this study were 123 patients with 132 extra-articular scapula fractures. The number and cost of post-injury radiographs obtained in clinic was evaluated and the need for further intervention was documented. The glenopolar angle, lateral border offset, translatio, and angulation on scapular Y views were evaluated on injury computerized tomography scapula reconstructions and final follow-up radiographs to determine the displacement of the fractures in the follow-up period.

RESULTS: In our series, 108/123 (88%) of patients had post-injury radiographs obtained in clinic for extra-articular scapula body fractures that were managed non-surgically. No patients had change in management based on the radiographs. The total cost of the imaging obtained over the three-year time period was $144,411.50. There were no statistical differences of radiographic parameters that were measured between scapula reconstructions at time of injury and final radiographs. We did have 13 fractures in our series that displaced by either 10 millimeters or 10 degrees in one or more of the radiographic parameters with 11 of these fractures having a transverse extra-articular fracture pattern across the scapula body.

CONCLUSIONS: Based on our review, we believe that most extra-articular scapula body fractures that are managed non-surgically, do not need post-injury radiographs as they do not seem to be cost effective.

Locked Plating of Geriatric Olecranon Fractures and Early Mobilization Leads to Low Fixation Failure in Patients Over the Age of 75

Abstract ID: Paper 038

---

*Kelsey Wise, M.D.
Sarah C. Peck, B.S.
Lauren Casnovsky, M.D.
Chad Myeroff, M.D.
St. Paul, MN

PURPOSE: The purpose of this study was to report the rate of major complications, including fixation failure or deep infection requiring return to the operating room (OR), in patients with geriatric olecranon fractures managed operatively with a locking plate and early mobilization.

METHODS: A retrospective review of isolated geriatric olecranon fractures presenting from 2006-2019 was performed at a single level I trauma center. Inclusion criteria was ≥75 years of age, operative management with a locking plate, and clinic follow-up until evidence of radiographic union or a major complication (return to the OR for loss of fixation or deep infection). Exclusion criteria included non-operative management, insufficient follow-up, and absence of locking plate. Variables examined included demographic information, Charleston Comorbidity Index (CCI), living independence, gait assistance, mechanism of injury, time to surgery, length of postoperative immobilization, time until radiographic union, range of motion (ROM) at final follow-up, Visual Analogue Scale (VAS) score at final follow-up, major and minor complications, and return to OR. The primary outcome measure was presence of a major complication.

RESULTS: A total of 36 patients (26 females, 10 males) ≥75 years of age (mean 83.8 years) with olecranon fractures met inclusion criteria. Average follow-up was 23 weeks (range 5-207 weeks). Mean age-adjusted CCI was 5.6. Most patients lived independently (77.8%; 28/36) and walked with no assistive devices (72.2%; 26/36). The most common mechanism of injury was ground level fall (88.9%; 32/36). Mean time from injury to surgery was 4.81 days (range 1-21 days). Mean length of immobilization was 13 days (range 0-29 days). Thirty-two patients achieved radiographic evidence of union (88.8%, 32/36), of those without major complications 100% united. There were 4 (11.1%; 4/36) major complications, including one deep infection (2.8%) and three failures of fixation (8.3%). Mean time to union was 8.9 weeks (range 5.3-24.1 weeks). There were 8 minor complications in 6/36 (16.7%) patients, including symptomatic hardware leading to elective removal (8.3%; 3/36), malreduction (<5mm), (5.6%; 2/36), loss of fixation (<5mm) with no return to operating room (5.6%; 2/36), and heterotopic ossification (2.8%; 1/36). At final follow-up, the average VAS score was 2.6 and the average elbow ROM was: 13-128° flexion/extension, 87/82° pronation/supination.

CONCLUSION/DISCUSSION: Management of geriatric olecranon fractures is controversial. We present the largest series of geriatric olecranon fractures treated with locked plates. This study supports use of operative anatomic fixation with pre-contoured locked plates and early mobilization with an acceptable failure rate.

Inclusion of Olecranon Osteotomy with the Posterior Approach for Fixation of Distal Humerus Fractures (OTA/AO 13) Does Not Increase Surgical Complications

Abstract ID: Paper 039

Erin Wilson
Joseph A. Buckwalter V, M.D., Ph.D.
John Davison, M.P.H.
Ignacio Garcia Fleury, M.D.
Grant D. Henning, B.A.
*Michael C. Willey, M.D.
Iowa City, IA

INTRODUCTION: The posterior paratricipital approach, with or without an olecranon osteotomy, is the preferred approach for fixation of displaced distal humerus fractures. Operative fixation using this approach carries a significant risk of postoperative complications, including ulnar neuropathy (UN), nonunion, and surgical site infection (SSI). The purpose of our investigation was to determine if inclusion of an olecranon osteotomy significantly affects complication rates following operative fixation of distal humerus fractures using a posterior approach (OTA/AO 13).

METHODS: Subjects at a single Level 1 trauma center who underwent operative fixation of a distal humerus fracture between 2007 and 2017 were identified by CPT code. Injury radiographs were reviewed to confirm fracture classification. Operative notes were reviewed to determine type of approach. Rates of complications including: nonunion, postoperative ulnar nerve palsy, and SSI were determined. Postoperative ulnar nerve palsy was defined as either sensory and/or motor deficits following operative repair with no preoperative ulnar nerve symptoms documented on physical exam. The Charlson comorbidity index (CCI) was also obtained.

RESULTS: 134 subjects underwent operative fixation of distal humerus fractures during the study period. 119 subjects without documented preoperative ulnar nerve palsy underwent distal humerus fixation with an olecranon osteotomy (n= 56) or without an olecranon osteotomy (n=63). Of subjects with no preoperative ulnar nerve symptoms, 21 patients (33.3%) who underwent paratricipital approach without olecranon osteotomy and 15 patients (26.8%) who underwent olecranon osteotomy approach developed postop ulnar nerve neuropathy. There was no significant difference in postop ulnar neuropathy rate between the two approaches (p=0.438). Additionally, there was no significant difference in rates of SSI (p= 0.323) or nonunion (p=0.575) between approaches at minimum 6-month follow-up. Subjects with CCI ≥2 were more likely to not undergo an olecranon ostotomy (p= 0.0079) whereas subjects with more complex fractures by OTA/AO classification were more likely to have an olecranon osteotomy approach (p= 0.0064).

DISCUSSION AND CONCLUSION: Paratricipital and olecranon osteotomy approaches for ORIF of distal humerus fractures have similar rates of postoperative ulnar nerve neuropathy, nonunion, and SSI. Despite more complex fracture patterns in subjects with olecranon osteotomy there was a trend demonstrating decreased ulnar nerve neuropathy postoperatively. Based on this investigation, we cannot recommend favoring one approach over the other as a way to minimize these postoperative complications.

Cut Cortical Screw Purchase in Diaphyseal Bone: A Biomechanical Study

Abstract ID: Paper 040

---

*Alexander C. Wendling, M.D.
Benjamin J. Cooper, M.D.
Joel D. White, M.S.
Chad M. Corrigan, M.D.
Bradley R. Dart, M.D.
Wichita, KS

INTRODUCTION: Cortical screws used during osteosynthesis can be too long and protrude from the far cortex of bone. Some surgeons remove the screw, cut it to the appropriate length, and reinsert it instead of getting a new screw of appropriate length. The rationale behind this is based on cost-savings as any screw inserted into a patient cannot be reused. By using a new screw, surgeons “burn” the long screw increasing the operations cost to the health care system. The goal of our study is to determine if cutting a screw and reinserting decreases the screw purchase in bone. Our hypothesis is that cutting a screw alters the distal thread in such a way that reinserting a screw removes additional bone and will decrease screw purchase.

METHODS: Synthetic bone models 30 mm in diameter were used to approximate femoral diaphyseal bone and had a 7mm outer “cortical” density of 1650kg/m3 and an inner “medullary” density of 270 kg/m3. Screw purchase was determined by measuring the maximal insertional torque (MIT) before stripping. MIT was measured on the following 3.5mm cortical screws: long screw inserted into predilled bone analog (control), a cut screw inserted after long screw was removed, and a screw of appropriate length after long screw was removed. Five stainless steel screws were inserted for each group. Insertional torque was measured continuously on a torque measuring load frame up to 550 Newton-centimeters (N*cm). If the screw MIT was >300 N*cm, the screw was considered as not stripping under clinical conditions.

RESULTS: The MIT of long screws was 546±6 N*cm with a 95% confidence interval of 539-553 N*cm. Reinserted screws of appropriate length had an MIT of 465±61 N*cm and a 95% confidence interval of 458-472 N*cm. Resinserted cut screws had an MIT of 457±108 N*cm with a 95% confidence interval of 451-464 N*cm. None of the screws stripped at the screw-bone interface in this study. All screws that failed below the machine limit stripped or broke at the screw head-screw driver interface. All groups had 95% confidence intervals above the MIT of clinical relevance of 300 N*cm ($p<0.05$).

CONCLUSIONS: Cutting and resinserting a stainless steel cut screw in normal cortical bone will not affect its purchase to a level of clinical significance. Further studies aimed at examining cut screw MIT in osteoporotic bone models may be clinically useful.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
April 23, 2020

The Relationship Between Prosthetic Joint Infections and Mental Health Conditions: Are Total Knee Arthroplasty Patients with Prosthetic Joint Infections at a Greater Risk for Mental Health Issues?

Abstract ID: Paper 041

Hiba Anis, M.D. / Cleveland, OH
Jared A. Warren, D.O. / Cleveland, OH
*Alison K. Klika, M.S. / Cleveland, OH
Siran Koroukian, Ph.D. / Cleveland, OH
Guangjin Zhou, B.S. / Cleveland, OH
Wael K. Barsoum, M.D. / Cleveland, OH
Carlos A. Higuera, M.D. / Weston, FL
Nicolas S. Piuzzi, M.D. / Cleveland, OH

INTRODUCTION: Prosthetic joint infections (PJIs) after total knee arthroplasty (TKA) confer substantial burdens on patients' quality of life. Although there is an abundance of literature on outcomes, there is a paucity of literature on the effect of PJIs on mental health. The purpose of this study was to compare prevalence of mental health conditions among (1) primary TKA,(2) septic revision TKA, and (3) aseptic revision TKA patients.

METHODS: The Healthcare Cost and Utilization Project State Inpatient Databases were queried for TKAs from 2007-2012 yielding 351,635 patients. Patients were separated into the following cohorts based on procedure: primary, septic revision, and aseptic revision. Diagnoses of any mental health condition and the following specific conditions were compared with univariate analysis: schizophrenia/delusion, bipolar disorder, depression/mood disorder, personality disorder, anxiety/somatic/dissociative disorder, eating disorders, ADHD/conduct/impulse control, alcohol abuse, and drug abuse.

RESULTS: There was a significantly higher prevalence of mental health conditions among patients in the septic revision cohort (n=1,229, 22.6%) compared to primary (n=58,419, 17.9%, p< 0.001) and aseptic revision (n=4,121, 20.3%, p< 0.001) cohorts. Specifically, septic revision TKA patients had higher prevalence of schizophrenia (0.7 vs. 0.5%, p=0.034), bipolar disorder (1.5 vs. 1.0%, p< 0.001), depression (14.9 vs. 11.3%, p< 0.001), alcohol abuse (1.5 vs. 0.8, p< 0.001), and drug abuse (1.7 vs. 0.8%, p< 0.001) compared to primary TKA patients. There was a significantly higher prevalence of depression (14.9 vs. 13.4%, p=0.004), alcohol abuse (1.5 vs. 0.7%, p< 0.001), and drug abuse (1.7 vs. 0.9%, p<0.001) among septic revision patients compared to aseptic revision patients.

DISCUSSION: Mental health conditions were significantly more prevalent among septic revision patients. Rates of alcohol and drug abuse in septic revision patients were approximately twice as high compared to primary and aseptic revision patients. Future studies should investigate prevalence of self-harm and suicide after TKA and evaluate strategies for perioperative mental health support.

Prosthetic Joint Infection after Isolated Tibial Polyethylene Exchange for Aseptic Instability

Abstract ID: Paper 042

---

*John V. Horberg, M.D.
Dane J. Church, M.D.
R. David Graham, M.D.
Monica Stumpf, M.D.
D. Gordon Allan, M.D.
Springfield, IL

INTRODUCTION: One of the theoretical benefits of modularity in total knee arthroplasty is the ability to perform an isolated tibial polyethylene insert exchange (ITPE) in selected cases. The most common indication for ITPE is acute postoperative prosthetic joint infection (PJI), though its role in management of non-infectious stiffness, laxity, imbalance, or polyethylene wear/failure is well documented. Though typically viewed as a low morbidity procedure, to date there have been no studies specifically addressing infection rate following ITPE in non-infected knees or comparing it to that of primary or revision TKA. We present as retrospective cohort with minimum 2 year follow-up assessing infection rate after ITPE.

METHODS: We retrospectively identified all patients who underwent ITPE during a 3-year period between 01/01/2013 and 12/31/2015 (n=118). All patients with identified preoperative PJI were excluded (n=27). The rate of infection following ITPE was 18.6%. This was compared to previously reported PJI rates following primary and revision TKA. Patient demographic factors and medical comorbidities were then evaluated to identify any factors predisposing patients to PJI following ITPE.

RESULTS: After exclusion, 91 patients who underwent ITPE for non-infectious indications were included in the study. An infection rate of 18.6% was observed. Mean age was 61 at time of infection, mean BMI 35.9. Diabetes, BMI over 30, and preoperative use of blood thinners were risk factors for infection.

CONCLUSION: ITPE is typically thought of as a low morbidity procedure. We retrospectively assessed 91 patients for postoperative complication risk following preoperative aspirate negative ITPE and found an infection rate of 18.6%. This is a significantly higher rate of infection than anticipated and indicates that ITPE is not a completely benign procedure. It is possible that PJI with a low virulence organisms may be mistakenly attributed to bearing wear or instability in aspirate negative patients with painful TKAs. Further study is needed to determine the cause of this abnormally high infection rate.

Outcomes of Primary Total Knee Arthroplasty Following Septic Arthritis of the Native Knee: A Case-Controlled Study

Abstract ID: Paper 043

---

*Jacob W. Bettencourt, B.S.
Cody C. Wyles, M.D.
Douglas R. Osmon, M.D.
Arlen D. Hanssen, M.D.
Daniel J. Berry, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

INTRODUCTION: Septic arthritis (SA) of the native knee often results in irreversible joint damage leading to the need for a total knee arthroplasty (TKA). This study examines the mid-term risk of deep infection, revision, and reoperation in primary TKA patients after subsequent SA of the native knee, compared to a control cohort of primary TKA for osteoarthritis (OA).

METHODS: We retrospectively identified 221 primary TKAs following SA of the native knee performed between 1971 and 2016 at a single institution. Each case was matched 1:1 based on age, sex, BMI, and surgical year to a primary TKA for OA. Mean age and BMI were 64 years and 30 kg/m^2, respectively. Mean follow-up was 8 years.

RESULTS: Survivorship free of deep infection at 10 years was 90% and 99% for the SA and OA groups, respectively (HR=5.7;p<0.01). Mean time from primary TKA to deep infection was 3.3 years, for the SA group. 10-year survivorship free of any revision was 77% and 88% (HR=2.2;p<0.01), and survivorship free of any reoperation was 63% and 82% (HR=2.3;p<0.01) for the SA and OA groups, respectively. Ten-year survivorship free of other complications, not associated with infection, was 71% and 91% (HR=3.3;p<0.01) for the SA and OA groups, respectively.

CONCLUSION: There was a 6-fold increased risk of deep infection in the SA vs. OA group. Overall, there was a 10% chance of subsequent infection in the SA group following primary total knee arthroplasty at 10 years. The 10-year survivorship free of any revision, any reoperation, and any other complications, not associated with infection, were significantly decreased in the SA cohort. Although patients with native SA had an increased risk of infection after primary THA, implant survivorship was relatively good at 10 years.

Two-Stage Exchange Arthroplasty for Prosthetic Joint Infection: Ultimate Fate of Spacers and Risk Factors for Failure

Abstract ID: Paper 044

---

*Cameron B. Barton, M.D.
David L. Wang, M.S.
Qiang An, M.B.B.S., M.P.H.
Timothy S. Brown, M.D.
Jesse E. Otero, M.D.
Iowa City, IA

INTRODUCTION: Two-stage exchange arthroplasty is the gold standard for treatment of prosthetic joint infection (PJI). Limited data exists pertaining to risk factors leading to failure after initial resection. We sought to determine the ultimate fate of patients who undergo resection arthroplasty as a first stage in the process of two-stage exchange and evaluate risk factors for all modes of failure.

METHODS: After institutional review board approval, we performed a retrospective case series and queried our hospital electronic medical record for all consecutive patients with minimum 2-year follow-up who underwent first stage resection of a hip or knee prosthetic joint infection (PJI) from 2008-2015. Patient demographic, laboratory, and health status variables were collected. Three primary outcomes were analyzed: (1) failure defined as any outcome other than a successful two-stage revision, (2) failure of second-stage reimplantation, (3) death. Multivariate regression analysis determined risk factors for modes of failure with p-values <0.05 considered statistically significant.

RESULTS: 89 patients underwent resection arthroplasty as a first step in two-stage exchange with a minimum two-year follow-up (27 hips, 62 knees). Mean age was 64 years (range 43-84), 56.2% males, and mean follow-up was 56.3 months. 31.5% failed to undergo second-stage reimplantation, and 41.6% did not achieve a successful two-stage exchange. Of patients who underwent second-stage re-implantation, 14.75% had failure due to persistent or recurrent infection. Mortality rate was 23.6%. Independent risk factors for failure, defined as all outcomes except a successful 2 stage revision were: presence of polymicrobial infection (p-value=.004; Adjusted odds ratio (AOR) 7.8; 95% confidence interval (CI) 2.1-29.0), Mcpherson extremity grade 3 (p-value=.024; AOR 4.1; 95% CI 1.2-14.3), and history of prior resection (p-value=.013; AOR 4.7; 95% CI 1.4-16.4).

CONCLUSION: Patients who undergo a two-stage exchange protocol for PJI are at high risk of death and failure including failure to proceed with second stage after initial resection and failure of second stage reimplantation. Polymicrobial infections, extremity grade, and history of prior resection are risk factors for failure.

Two-Stage Treatment for TKA Infection Utilizing a Second Generation Articulating Pre-Fabricated Antibiotic Spacer: Allow Function, Maintain Safety, Eradicate Infection

Abstract ID: Paper 045

---

*Lucian C. Warth, M.D.
Michael Stefl, M.D.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: A two-stage approach for treatment of peri-prosthetic joint infection (PJI) in total knee arthroplasty (TKA) remains the gold standard. Impaired function and independence during the convalescent period between interventions is onerous for the patient. The study purpose was to evaluate safety and efficacy of a modular articulating pre-fabricated TKA spacer and a rehabilitation protocol which allowed for progression to weight bearing as tolerated (WBAT) during the convalescent period.

METHODS: We reviewed PJI TKA treated with a first-stage debridement utilizing a prefabricated articulating spacer performed by two arthroplasty surgeons from 4/2016-3/2018. Patients were allowed to progress to WBAT with a walker during the convalescent period. Patient demographics, mean time to re-implantation, and clinical failure due to recurrent infection were assessed. Clinic notes, one-month radiographs, and re-implantation Operative Reports were evaluated to assess for wound dehiscence, excessive bone loss, and mechanical prosthetic complications.

RESULTS: We identified 24 articulating spacers in 23 patients during the study period with a 1:1 Male to Female ratio. Average age and BMI were 68.0 and 39.2 respectively. Initial debridement and spacer was successful in 23/24 (96%) of cases. Average convalescence between first and second-stage surgery was 2.8 (2.0-6.0) months. At an average of 21 (13-36) months follow-up, two patients (8%) developed late recurrent infection requiring further intervention. With a rehabilitation protocol allowing for progression to WBAT, there were no mechanical complications associated with the pre-fabricated articulating TKA spacer.

CONCLUSION: While the primary goal of first-stage surgery is to eradicate infection, an extended convalescence is more palatable to the patient when the surgeon is able to salvage a stable, functional articulating knee joint. Our results suggest that the current iteration of pre-fabricated articulating knee spacers can successfully eradicate infection, and safely allow progression to WBAT without significant soft tissue compromise, progressive bone loss, or mechanical implant complication.

Patient Outcomes after Contemporary Two-Stage Reimplantation for Infected Hip and Knee Arthroplasty

Abstract ID: Paper 046

---

*Christian Sikoski, B.S.
Mary Ziemba-Davis, B.A.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: With claims of less morbidity and promotion of single-stage treatment for all periprosthetic joint infections (PJI) ramping up, it is critical to investigate and report patient outcomes (PROMS) following treatment with contemporary two-stage exchange. This study examined PROMS following contemporary two-stage treatment for PJI.

METHODS: 39 hips and 40 knees consecutively treated with two-stage exchange arthroplasty by a single surgeon using standardized contemporary protocols were reviewed. UCLA activity level, WOMAC and Knee Society pain scores, HOOS/KOOS joint health, and satisfaction were prospectively collected. Covariates included sex, age, BMI, fibromyalgia, autoimmune disease, lumbar spine disease, depression, preoperative narcotic use, and McPherson infection stage.

RESULTS: 50% of hips and knees were female. Mean BMI was higher in knees than hips (34.0 vs 29.4; p=0.006). Mean age at reimplantation was equivalent (66.2 years). Mean follow-up was 37 months. Preoperative activity level improved from 2.9 (sometimes mild activities) to 4.7 (sometimes moderate activities) at follow-up, with no differences based on joint ($p \geq 0.399$). In hips, mean pain scores improved from 58.2 preoperatively to 80.0. In knees, walking pain improved from 5.5 preoperatively to 2.6 at follow-up. Patients with lumbar spine disease (p=0.030) or autoimmune disease (p=0.017) had more walking pain. 83% of patients were satisfied or very satisfied at follow-up with no difference between joints (p=1.00). Significantly more knees (70%) than hips (46.2%) were chronically infected poor hosts (p=0.041); however, PROMS did not vary based on infection stage ($p \geq 0.133$) with numbers available.

CONCLUSION: Conclusion: Activity level was modest in reimplantation patients at latest follow-up, and pain improved from baseline but remained moderate for both hip and knee patients. Nonetheless, 83% of patients were satisfied or very satisfied following two-stage reimplantation despite remaining clinical and functional limitations. This contemporary benchmark should be considered when analyzing single-stage treatment results and claims of patient preference.

Only Host Grade and Neutrophil Percentage Predicts Failure of Two-Stage Reimplantation for Periprosthetic Joint Infection

Abstract ID: Paper 047

---

*Ashleigh N. Bush, B.S.
Michael Stefl, M.D.
Evan R. Deckard, BSE
Mary Ziemba-Davis, B.A.
Lucian C. Warth, M.D.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Two-stage exchange remains the gold standard for treatment of chronic periprosthetic joint infection (PJI) after total joint arthroplasty (TJA). However, little data exists to accurately determine timing of reimplantation via optimal serum and synovial fluid markers. The study purpose was to identify optimal pre-reimplantation laboratory markers predictive of clinical success after reimplantation TJA.

METHODS: A retrospective review of 232 consecutive two-stage reimplantation TJA procedures for PJI defined by MSIS criteria from 2011 to 2018 was performed. McPherson staging system was utilized and clinical failure after reimplantation defined according to Delphi Criteria. ESR, CRP, synovial WBC count, and neutrophil percentage were obtained preoperatively, mid-treatment, and prior to reimplantation. Multivariate analysis was performed to determine correlation of lab markers with clinical success.

RESULTS: After exclusions, 135 patients with complete data were analyzed. 16 failures (11.9%) occurred with subsequent PJI after reimplantation. 14 of 16 failures (87.5%) were McPherson host grade B or C ($p=0.06$). ESR and CRP pre-reimplantation were not different between success and failure groups ($p>0.25$). In the success group, mean synovial cell count and neutrophil percentage were 627.0 and 55.6%, respectively, compared to 844.0 and 74.0% in the failure group ($p=0.63$ and $p=0.13$, respectively). Pre-reimplantation neutrophil percentage had the highest AUC (0.66; $p=0.20$) of all metrics, indicating the greatest ability to predict successful infection eradication.

CONCLUSION: It remains challenging to confirm elimination of infection prior to reimplantation after 2-stage resection for PJI. Neutrophil percentage from synovial aspirate prior to reimplantation was the only value predictive of success, and the predictability was modest. Patients with worsening host grade also had higher rates of subsequent PJI after reimplantation. This data suggests that patients with severe medical comorbidities should be medically optimized and scrutinized for signs of persistent PJI prior to reimplantation after resection for PJI.

Diagnostic Utility of a Novel Point-of-Care Test of Calprotectin for Periprosthetic Joint Infection in Total Knee Arthroplasty Patients

Abstract ID: Paper 048

---

*Jared A. Warren, D.O. / Cleveland, OH
Hiba K. Anis, M.D. / Cleveland, OH
Kathleen Bowers M(ASCP) / Cleveland, OH
Alison K. Klika, M.S. / Cleveland, OH
Xiaochun Zhang, M.D., Ph.D. / Cleveland, OH
Nicolas S. Piuzzi, M.D. / Cleveland, OH
Carlos A. Higuera, M.D. / Weston, FL

INTRODUCTION: Recently several synovial fluid biomarkers for diagnosis of periprosthetic joint infection (PJI) are being investigated. Point-of-care (POC) tests using these biomarkers are not widely available. Synovial calprotectin has been reported to effectively exclude diagnosis of PJI and a novel lateral flow POC test for synovial calprotectin has shown potential to be an effective PJI diagnostic tool. Thus, the objective of this study was to test the sensitivity, specificity, and positive and negative predicted values (PPV and NPV) of a calprotectin POC test for PJI in total knee arthroplasty (TKA) patients, using the Musculoskeletal Infection Society (MSIS) 2013 PJI diagnosis criteria as the gold standard.

METHODS: Synovial fluid samples were prospectively collected from 73 patients who underwent revision TKA (rTKA) at two academic institutions from October 2018 to May 2019. The study was conducted under IRB approval. Patients followed the hospital standard for their diagnostic work-up. Data collection included demographic, clinical, and laboratory data in compliance with the MSIS 2013 PJI diagnosis criteria. Synovial fluid samples were analyzed by calprotectin POC tests for synovial fluid in accordance with manufacturer's instructions. Quantitative calprotectin read-outs were categorized into high risk (>50 mg/L), medium risk (14-50 mg/L), and low risk (<14 mg/L) for infection by the test reader system. Patients were categorized as septic or aseptic using MSIS 2013 PJI diagnosis criteria by two independent reviewers blinded to the calprotectin results. Test performance characteristics including sensitivities, specificities, PPV, NPV, and areas under the curve (AUC) were calculated for 2 scenarios: (1) a threshold of >50 mg/L for infection, (2) a threshold of >14 mg/L for infection.

RESULTS: Following MSIS criteria, 26 rTKAs were MSIS positive, while 47 rTKA were MSIS negative. The corresponding calprotectin classifications were 28 high, 8 medium, and 37 low risk. Of the MSIS criteria positive cases, 25 were high risk and only 1 was medium risk, while all 37 low risk read-outs were infection negative. In the 1) >50 mg/mL threshold scenario, the POC performance showed a sensitivity, specificity, PPV, NPV and AUC, respectively, of 96.2%, 93.6%, 89.3%, 97.8%, and 0.95. In the 2) >14 mg/mL threshold scenario, there was a sensitivity, specificity, PPV, NPV and AUC, respectively, of 100.0%, 78.7%, 72.2%, 100.0%, and 0.89.

DISCUSSION: The calprotectin POC test has excellent diagnostic properties including high sensitivity and specificity for diagnosing PJI in rTKA. However, further investigations with larger cohorts are necessary to further validate these results.

Utility of Serum D-Dimer Test for the Diagnosis of Periprosthetic Joint Infection in Revision Total Hip and Knee Arthroplasty

Abstract ID: Paper 049

Tejbir S. Pannu, M.D., M.S. / Weston, FL
*Jesus M. Villa, M.D. / Weston, FL
Aldo M. Riesgo / Weston, FL
Alison K. Klika, M.S. / Cleveland, OH
Preetesh D. Patel, M.D. / Weston, FL
Wael K. Barsoum, M.D. / Weston, FL
Carlos A. Higuera, M.D. / Weston, FL

INTRODUCTION: Serum D-Dimer seems promising to aid in the diagnosis of periprosthetic joint infection (PJI). However, there is a paucity of data supporting the use of this inflammatory marker for this indication in revision THA and TKA. Therefore, the purpose of this study was to test the accuracy of serum D-Dimer when compared to 2013 Musculoskeletal Infection Society (MSIS) criteria for diagnosis of PJI.

METHODS: A retrospective review of the electronic medical records was performed on a consecutive series of 172 revision THA and TKA patients (same number of operations) who had serum D-Dimer tested before the procedure as part of the diagnostic workup for PJI. Surgeries were performed by 3 fellowship-trained surgeons at a single institution between August 2017 and May 2019. Out of 172 patients, 61 did not have complete MSIS criteria and were excluded. As a result, a total of 111 cases (42 THA and 69 TKA) were included for statistical analyses. Septic and aseptic revisions were categorized using MSIS criteria. The optimal threshold value for serum DDimer in the diagnosis of PJI has been previously determined to be 850 ng/ml. We used this cutoff value to define D-Dimer test results as positive (septic) or negative (aseptic). Sensitivity, specificity, likelihood ratios, positive and negative predictive values were determined. Independent t-tests, Fisher's exact tests, Chi-square, and a receiver operating characteristic (ROC) curve analysis (a plot to further test serum D-Dimer against MSIS criteria) were performed.

RESULTS: There was no statistically significant differences in baseline demographics between septic and aseptic cases as determined by MSIS criteria. Serum D-dimer demonstrated high sensitivity (95.9%) and negative predictive value (90.9%) but low specificity (32.3%), positive predictive value (52.8%), and overall accuracy (61%) to diagnose PJI. Positive likelihood ratio (LR) was 1.42 while negative LR was 0.13 (Table 2). ROC curve analysis showed that the area under the curve (AUC) was 0.64.

CONCLUSION: Serum D-Dimer has poor accuracy to discriminate between septic and aseptic cases in the setting of revision total knee and hip arthroplasty. However, it seems to be useful as a ruleout test for the diagnosis of periprosthetic joint infection.

Do Septic Revision Total Hip Arthroplasty Patients have Improved Pain and Function at 1 Year and What Factors Drive Their Outcomes?

Abstract ID: Paper 050

---

*Hiba K. Anis, M.D. / Cleveland, OH
Olivia Krebs, B. Eng. / Cleveland, OH
Jared A. Warren, D.O. / Cleveland, OH
Alison K. Klika, M.S. / Cleveland, OH
Isaac Briskin, M.S. / Cleveland, OH
Viktor E. Krebs, M.D. / Cleveland, OH
Trevor G. Murray, M.D. / Cleveland, OH
Carlos A. Higuera, M.D. / Weston, FL
Nicolas S. Piuzzi, M.D. / Cleveland, OH

INTRODUCTION: Current literature on septic revision total hip arthroplasty (rTHA) outcomes largely focus on re-infection, implant survivorship, and technical surgical features to improve postoperative success rates. In contrast, there is a relative paucity of literature on patient reported outcome measures (PROMs) which are widely used in arthroplasty to quantify patient outcomes. By identifying contributors to improved PROMs, clinicians can incorporate a holistic evaluation of postoperative outcomes which can better guide the clinical decision-making process and optimize the quality of care patients receive. Therefore, the purpose of this study was to determine (1) PROMS improvements at one year, and (2) factors that influence pain- and function-related PROMs after septic rTHA.

METHODS: A validated, proprietary database which prospectively collects baseline characteristics, baseline PROMs, and 1-year PROMs at a large integrated health system was used to analyze 214 revision THAs performed between January 2016 and December 2017. Baseline (preoperative) and 1-year PROMs were available for 99 (65% of eligible cohort) patients meeting the inclusion criteria. The primary outcomes of interest were: Hip injury and Osteoarthritis Outcome Score (HOOS) pain score and HOOS Physical Function Shortform (KOOS-PS) at 1-year follow up. Mean 1-year change in PROMS and the percent of patients that improved by 10 points were calculated. The baseline predictors of 1-year PROMs were evaluated with multiple linear regression models which were constructed for each of the continuous PROMs.

RESULTS: Mean 1-year postoperative PROMS improved for all septic rTHAs patients overall. Mean HOOS-pain score improvements were 26.4 (SD±28.7). Of all patients, 73.2% had improved, 14.4% unchanged, and 12% had worse HOOS-pain scores. One-year HOOS-PS scores improved by -18.56 (SD±22.5). HOOS-PS scores improved for 61.6%, remained unchanged for 16.3%, and were worse for 22.1% of all patients. Multivariate analyses revealed that the only significant predictor for increased (better) 1-year postoperative HOOS-Pain were higher baseline HOOS-Pain scores. No significant baseline risk factors were found to be predictors of 1-year HOOS-PS scores.

DISCUSSION: Overall, patients undergoing septic rTHA had improved 1-year pain- and function-related PROMs. Seventy percent of the patients had improvements in pain scores whereas 60% had improvements in function. The only predictors of 1-year pain was identified as baseline pain. Clinicians may use these results in the shared decision-making process and in

setting expectations before surgery. Further research is required in the field of rTHA to continue to explore PROMs in conjunction with traditional survivorship analysis.

Reduced Infection Rate after Aseptic Revision Total Hip Arthroplasty with Extended Antibiotic Protocol

Abstract ID: Paper 051

Amer Mohiuddin, B.S.
Justin Rice, B.S.
Mary Ziemba-Davis, B.A.
*R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Periprosthetic joint infection (PJI) after aseptic revision total hip arthroplasty (RTHA) can be catastrophic due to larger revision acetabular and femoral components, bone loss, and soft-tissue compromise. While well documented in the primary setting, perioperative antibiotic duration is not well described in RTHA where risk of PJI is reported to be up to 8%. The purpose of this study was to evaluate whether extended oral antibiotic prophylaxis minimizes PJI in aseptic RTHA patients compared to the published literature.

METHODS: 142 consecutive aseptic RTHAs performed from 01/2013 to 05/2018 at a single academic institution with modern perioperative and infection prevention protocols were retrospectively reviewed. Intraoperative cultures were obtained in all but two surgeries and patients received IV antibiotics during the inpatient stay. Patients were discharged on 7-day oral antibiotic prophylaxis until intraoperative cultures were final. Subsequent complications, reoperations, and infections were documented.

RESULTS: Average age and BMI were 64 years and 31 kg/m^2, respectively. 65% of patients were ASA-III/IV, signifying the comorbidity burden in this revision cohort. Instability (23%), ALTR (25%), and loosening (32%) were the most common diagnoses. 82.4% of intraoperative cultures were negative and 17.6% (25 cases) had isolated positive cultures considered contaminants. No cases underwent reoperation for infection within 90 days. Four cases were treated for deep infection 110, 161, 579, and 1038 days following RTHA, with 97.2% of cases infection free at mean follow-up of 51 months (range, 13 to 78 months). No patients were diagnosed with an antibiotic-related complication within 90 days.

CONCLUSION: Compared to published infection rates following RTHA, our protocol of extended oral antibiotics while intraoperative cultures were incubating resulted in a clinically meaningful decrease in PJI in these challenging patients with substantial medical comorbidities. We encourage further study regarding extended oral antibiotic prophylaxis in RTHA weighed appropriately against potential consequences.

Contemporary Three-Month Extended Oral Antibiotic Prophylaxis after Two-Stage Arthroplasty Reimplantation Reduces Reinfection Rates

Abstract ID: Paper 052

---

*Michael Stefl, M.D. / Ames, IA
Ashleigh N. Bush, B.S. / Indianapolis, IN
Mary Ziemba-Davis, B.A. / Indianapolis, IN
Lucian C. Warth, M.D. / Indianapolis, IN
R. Michael Meneghini, M.D. / Indianapolis, IN

BACKGROUND: Two-stage exchange continues as the gold standard in the U.S. for treatment of chronic periprosthetic joint infection (PJI) after total joint arthroplasty (TJA). Recently, interim analysis of a multi-center randomized trial from the Knee Society Research Group published increased infection-free survival after reimplantation with 3 months of oral antibiotic prophylaxis. The purpose of this study was to evaluate if decreased reinfection rates are realized in practice with adoption of the 3-month oral prophylaxis protocol after two-stage reimplantation.

METHODS: A retrospective cohort review of 232 consecutive two-stage reimplantation TJA procedures for chronic PJI defined by MSIS criteria from 2011 to 2018 was performed. 167 met inclusion criteria and 32 were excluded (ultimately not reimplanted or reimplantation performed elsewhere), leaving 135 patients for evaluation. The 3-month extended oral antibiotic prophylaxis protocol was instituted April 2016 on all patients. McPherson staging system was utilized for host and extremity grade and clinical failure defined according to the Delphi Criteria.

RESULTS: There were 16 failures due to subsequent infection of TJA. These could not be predicted by age (p=0.276), sex (p=0.792), BMI (p=0.873), or hips versus knees (p=0.429) as these were similar between cohorts. 14 of the 16 failures (87.5%) were in McPherson host grade B or C patients. Total failure rates due to reinfection were 15.1% (13/86 patients) prior to extended oral antibiotic prophylaxis and 6.1% (3/49 patients) after implementation of the extended oral antibiotic prophylaxis (p= 0.167).

CONCLUSIONS: Extended oral antibiotic prophylaxis led to a nearly 3X decrease in the failure rate for reinfection after two-stage reimplantation TJA for chronic PJI. These data appear promising and support the continued use of this protocol in clinical practice to prevent devastating reinfection. However, continued study and monitoring of this extended antibiotic prophylaxis is recommended to ensure no deleterious side effects or consequences are identified.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
April 23, 2020

Mid-Term Results of Tantalum Acetabular Cup for Total Hip Arthroplasty after Pelvic Radiation

Abstract ID: Paper 053

Matthew P. Abdel, M.D.
Peter S. Rose, M.D.
Matthew T. Houdek, M.D.
Arlen D. Hanssen, M.D.
David G. Lewallen, M.D.
*Cory G. Couch, M.D.
Rochester, MN

INTRODUCTION: High failure rates have been reported with conventional total hip arthroplasty (THAs) in patients who have had prior pelvic radiation. Although small studies have shown promising results at mid-term with the use of tantalum acetabular components, it is unclear what longer-term implant survivorship and clinical outcomes are in a much larger series.

METHODS: We retrospectively reviewed 119 patients with prior pelvic radiation who had 134 primary THAs using a tantalum acetabular component from 2001 to 2016. The mean number of acetabular screws was 4, and 30 patients had a supplemental cage. The mean pelvic radiation dose was 5200 cGy, and mean time from radiation to THA was 7 years. Implant survivorship via Kaplan-Meier curves, radiographic results, and clinical outcomes via Harris hip scores (HHS) were assessed. Of note, 31 patients died prior to 2 years of follow-up. Mean follow-up was 6 years.

RESULTS: The 10-year survivorships free of revision for aseptic loosening, free of any revision or implant removal, and free of any reoperation were 92%, 90%, and 89%, respectively. At most recent follow-up, 2 tantalum acetabular components were revised for aseptic loosening. These patients had pathologic pelvic discontinuities as their indication for the index THA. There were only 3 infections. On radiographic analysis, five acetabular components had progressive radiolucent lines (two in zone 1, two in zone 2, and one in zone 3). The mean HHS improved from 39 preoperatively to 79 at 2 years, and 83 at 10 years postoperatively ($p < 0.001$ for all analyses).

CONCLUSION: Tantalum acetabular components with supplemental screws, and cages when needed, provided excellent mid-term implant fixation in patients with prior pelvic radiation. At 10 years, only 2 acetabular components were revised for aseptic loosening, resulting in a survivorship of 92%. Moreover, there was a significant and maintained improvement in clinical function.

Can We Identify Meaningful Thresholds for the Facility Volume-Outcome Relationship in Treatment of Primary Malignant Bone Tumors?

Abstract ID: Paper 054

---

*Azeem T. Malik, M.B.B.S.
John Alexander, M.D.
Safdar N. Khan, M.D.
Thomas J. Scharschmidt, M.D.
Columbus, OH

BACKGROUND: Current evidence regarding the impact of increasing hospital/facility volume on treatment patterns and survival rates for primary malignant bone tumors remains limited.

METHODS: The 2004-2015 National Cancer Database (NCDB) was queried using International Classification of Disease for Oncology (ICD-O-3) topographical codes to identify patients undergoing treatment (surgery, chemotherapy and/or radiotherapy) for primary malignant bone tumors of extremities (C40.0-C40.3, C40.8, C40.9) or pelvis (C41.4). Histological codes were used to group the tumors into the following categories: osteosarcomas, Ewing sarcomas, chondrosarcomas, chordomas and other/unspecified. Facility volume was calculated based on the average number of cases/year for the entire study period. A preliminary stratified cox-regression model was used to identify evidence-based thresholds/cut-offs for high-volume and low-volume facilities, while adjusting for differences in patient, tumor and treatment characteristics. Based on our cut-off, we identified high-volume facilities as those treating at least 20 cases/year. Kaplan-Meier survival analysis was used to compare overall 5-year survival rates between high and low volume facilities. Multi-variate cox regression analyses were used to report the independent impact of undergoing treatment at a high-volume facility on overall risk of mortality.

RESULTS: A total of 14,039 patients were included – out of which 2,115 (15.1%) underwent treatment in a high-volume facility. Patients undergoing treatment at a high-volume facility were more likely to be white, have tumors involving the pelvis, have larger tumor sizes, and have higher tumor grade at presentation. Five-year overall survival rates were significantly greater for high-volume facilities as compared to low-volume facilities (65.0 vs. 61.3%; p=0.003). After controlling for differences in patient demographics, tumor characteristics (including histologic type, grade, stage, size and location) and treatment factors in a multi-variate cox regression model, patients treated at high-volume facilities had lower overall risk of mortality (HR 0.85 [95% CI 0.77-0.93]; p<0.001) as compared to low-volume facilities. Patients treated at high-volume facilities were also were more likely to undergo resections with limb-salvage surgery (OR 1.14 [95% CI 1.14-1.59]; p=0.001) as compared to amputations. Patients undergoing surgical treatment at high-volume facilities also had lower odds of having positive resection margins (OR 0.56 [95% CI 0.44-0.72]; p<0.001) as compared to low-volume facilities.

CONCLUSION: Patients undergoing treatment for primary malignant bone tumors at high-volume facilities experience better 5-year survival as compared to those receiving treatment at low-volume facilities. Health-policy makers can utilize the evidence-based volume thresholds identified in our study to facilitate discussions regarding the need to centralize orthopedic cancer care.

Surgical Treatment of Primary Mobile Spine Chordomas

Abstract ID: Paper 055

Joshua M. Kolz, M.D., M.S.
*Bayard C. Carlson, M.D.
Matthew T. Houdek, M.D.
Peter S. Rose, M.D.
Rochester, MN

INTRODUCTION: Chordomas of the mobile spine (C1-L5) are a rare, locally aggressive tumor with the ability to metastasize. There is currently a paucity of data examining outcomes of primary surgical resection of mobile spine chordomas. The purpose of this study was to review the overall survival, local recurrence, and distant metastasis of all patients receiving surgical treatment of primary mobile spine chordomas.

METHODS: Over a 29-year period (1990-2019), there were 34 primary mobile spine chordomas treated with surgical resection at our institution. There were 21 (60%) males, a mean age of 57±18 years, and mean BMI of 29±7.1 kg/m^2. Tumor location included cervical (n=16, 47%), thoracic (n=3, 9%), and lumbar (n=15, 44%) spine. Eighteen (53%) patients presented with a pathological fracture. The mean maximal tumor dimension was 5±3 cm, with a mean tumor volume of 140±424 cm^3. The final resection margin was considered positive in 15 (44%) patients. Radiotherapy was used in 23 (68%) patients to assist with margin control. Mean follow-up was 7 years (up to 22 years).

RESULTS: Following surgical resection, the mean 2-, 5- and 10-year survival was 86%, 60%, and 46%. There was no difference (p=0.96) in the 5-year overall survival between patients with a cervical (61%), thoracic (66%), and lumbar (58%) spine tumors. Local tumor recurrence was associated with death due to disease (HR 3.39, 95% CI 1.16-9.87, p=0.02).

Tumor recurrence occurred in 17 (50%) patients and defined as local only (n=8, 24%), distant only (n=4, 12%) and local and distant (n=5, 15%). The 2-, 5- and 10-year local recurrence free survival was 78%, 59%, and 46%. A positive surgical margin (HR 16.17, 95% CI 2.05-127.53, p<0.008) was associated with local tumor recurrence. The 2-, 5- and 10-year distant disease recurrence free survival was 85%, 73%, and 66%. Larger tumor size (>140 cm^3.) was associated with metastatic disease (HR 9.20, 95% CI 1.53-55.21, p=0.01).

Following resection, complications occurred in 30 (88%) patients, leading to a reoperation in 13 (38%) patients. The most common indication for reoperation was for failure of surgical hardware (n=5, 15%).

DISCUSSION: Surgical resection of mobile spine chordomas is associated with a high rate of complications; however, can provide a curative resection in a majority of patients. A positive surgical margin was associated with local tumor recurrence, with a local tumor recurrence being associated with death due to disease.

Comparison of Reconstruction Techniques Following Oncologic Intra-Articular Proximal Humerus Resection

Abstract ID: Paper 056

Matthew T. Houdek, M.D. / Rochester, MN
*Brandon R. Bukowski, M.D. / Rochester, MN
Alexander G. Athey, M.D. / Rochester, MN
Peter S. Rose, M.D. / Rochester, MN
Jonathan D. Barlow, M.D., M.S. / Rochester, MN
Eric R. Wagner, M.D., M.S. / Atlanta, GA
Joaquin Sanchez-Sotelo, M.D., Ph.D. / Rochester, MN

INTRODUCTION: The proximal humerus is the most common site of primary and metastatic disease in the upper extremity. Historically, the goal of an endoprosthesis (EPR) reconstruction was to provide a stable platform for hand and elbow function with little shoulder function. Allograft prosthetic composites (APC) utilizing a hemiarthroplasty or reverse prosthesis have emerged as common reconstruction techniques with improved shoulder function. The purpose of this study is to compare functional outcomes, implant survival, and complications following proximal humeral reconstructions.

MATERIALS AND METHODS: 78 consecutive patients undergoing an oncologic intra-articular resection from 2000-2016 were reviewed. Reconstructions included hemiarthroplasty EPR (n=35), hemiarthroplasty APC (n=16), reverse EPR (n=18) and reverse APC (n=9). All surviving patients had minimum 2-year clinical follow-up. Mean follow-up was 7±4 years. Mean time to death was 3±3 years.

RESULTS: Patients undergoing hemiarthroplasty APC were younger at the time of surgery while patients undergoing EPR procedure were more likely to have a non-primary malignancy, presence of a pathological fracture, and shorter surgical procedures. When comparing a reverse prosthesis (APC or EPR) to a hemiarthroplasty (APC or EPR), there was no difference in mean operative time (221±77 minutes vs. 239±86 minutes, P=0.39). Two- and five-year survival following the procedure were 60% and 43%. Patients with metastatic disease had worse 5-year survival compared to those with primary disease (25% vs. 74%, P<0.001). A reverse prosthesis had improved forward elevation (83±37° vs. 44±29°, P<0.001) and external rotation (28±18° vs. 19±13°, P=0.03) compared to a hemiarthroplasty. When comparing reconstruction types, patients with a reverse APC (P<0.001) had the greatest arc of motion (FE 101±36°, ER 36±11°). A reverse prosthesis had improved Simple Shoulder Tests (7±2 vs. 4±2, P=0.08), ASES scores (67±10 vs. 57±15, P=0.01), and MSTS93 scores (73±11 vs. 63±14, P<0.001) compared to a hemiarthroplasty. Subluxation was the most common complication (n=23, 29%), and only occurred in patients undergoing a hemiarthroplasty reconstruction [EPR (n=13, 36%) and APC (n=10, 63%)].

CONCLUSION: Oncologic reconstructions of the proximal humerus involving a reverse prosthesis resulted in improved function and complication rates compared to hemiarthroplasty. Reverse APC demonstrate reliable pain relief and functional improvement and is our preferred reconstruction technique in patients with primary sarcomas.

Resident Involvment is Not Associated with Increased Risk of Postoperative Complications after Arthroscopic Knee Surgery: A Propensitiy Matched Study

Abstract ID: Paper 057

---

*Zain M. Khazi, B.S.
Trevor R. Gulbrandsen, M.D.
Alan G. Shamrock, M.D.
Qiang An, M.B.B.S., M.P.H.
Kyle R. Duchman, M.D.
Brian R. Wolf, M.D., M.S.
Robert W. Westermann, M.D.
Iowa City, IA

INTRODUCTION: The impact of resident involvement on postoperative complications and operative time following knee arthroscopy cases is unknown. Therefore, the purpose of the current study was to investigate whether resident involvement in knee arthroscopic procedures impacts postoperative complication rates and operative time.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) registry was queried to identify patients who underwent common knee arthroscopy procedures between 2005 through 2012. Patients with a history of knee arthroplasty, treatment for septic arthritis or osteomyelitis of the knee, or concomitant open or mini-open procedures were excluded from the study. Cases without information on resident involvement were also excluded. A 1:1 propensity score match was utilized based on age, sex, body mass index (BMI), obesity, smoking history, and American Society of Anesthesiologist (ASA) classification to match cases with resident involvement to attending only cases. Fisher's exact test, Pearson's Chi-square tests, and student t-tests were utilized to compare patient demographics, comorbidities, and 30-day postoperative complications. Poisson regression analysis were used to compare operative time between the two groups, with statistically significance defined as $P<0.05$.

RESULTS: Overall, 15,536 patients that underwent knee arthroscopy were identified, of which 32.8% (n=5092) were excluded due to missing information on resident involvement, concomitant open or mini-open procedures, or treatment of septic arthritis or osteomyelitis of the knee. After propensity score matching, 2,954 cases (50% with resident involvement) were included in the study. Both groups were similar in all demographic factors confirming an appropriate match. The overall rate of 30-day complications was similar in the attending only (1.31%) group compared to the resident (1.11%) group ($P=0.610$). There was no significant difference in postoperative surgical complications including superficial wound infection ($P=1.00$), deep wound infection ($P=0.625$), wound dehiscence ($P=0.250$), neurological deficit ($P=1.00$), or blood transfusion ($P=0.375$). Furthermore, there was no significant difference in postoperative medical complications including pulmonary embolism ($P=0.500$), deep vein thrombosis ($P=0.616$), urinary tract infection ($P=1.00$), or sepsis ($P=1.00$). Knee arthroscopy cases with resident involvement had significantly longer operative time (69.6 minutes vs 60.9 minutes, $P<0.0001$) when compared to cases performed without a resident.

CONCLUSIONS: Resident involvement in knee arthroscopy procedures is not a significant risk

for medical or surgical 30-day postoperative complications. Resident participation in knee arthroscopy cases did increase operative time; however, this finding is likely clinically insignificant. This information is valuable for resident education and patient reassurance.

Factors Considered in Ranking Orthopedic Trauma Fellowship Applicants: A Survey of Program Directors

Abstract ID: Paper 058

---

*Kevin P. Sandhu, M.D. / Madison, WI
Natasha M. Simske, B.S. / Madison, WI
Porter Young, M.D. / Jacksonville, FL
Nathaniel M. Wilson, M.D. / Madison, WI
Lisa K. Cannada, M.D. / Jacksonville, FL
Paul S. Whiting, M.D. / Madison, WI

INTRODUCTION: Orthopedic surgery is a competitive specialty, and the vast majority of orthopedic residency graduates pursue fellowship training. Between 2010 and 2017, the number of training positions offered increased for all subspecialties except for spine and trauma. Furthermore, orthopedic trauma had the lowest applicant-matching success at 80.0%. The purpose of this study is to identify the factors considered most important by orthopedic trauma fellowship program directors (PDs) in ranking fellowship candidates.

METHODS: A web-based questionnaire was sent to all 59 Orthopaedic Trauma Association accredited fellowship PDs via email. A list of 12 factors was presented in the survey. PDs were asked to rank all 12 factors in order of importance. A weighted score for each factor was calculated using the following scale: 5 points each time a factor was ranked 1st, 4 points each time a factor was ranked 2nd, 3 points for each 3rd place rank, 2 points for each 4th place rank, and 1 point for each 5th place rank. PDs were also allowed to write in other factors they considered important when ranking fellowship candidates. Reminders were sent 2 and 4 weeks after initial survey distribution. Surveys could only be completed once.

RESULTS: Response rate was 83% (49/59 programs). 45% of responding PDs (22/49) listed interview as the most important factor in ranking fellowship applicants. Other factors considered important by PDs included letters of recommendation (ranked first by 22% of PDs), personal connections to applicant (ranked first by 18% of PDs), and strength of applicant's background in trauma (ranked first by 8% of PDs). The interview was found to be the most important factor in ranking fellowship candidates (weighted score of 192 points), followed by letters of recommendation (141 points), personal connections to applicant (95 points), residency program of applicant (73 points), strength of applicant's background in trauma (35 points), and research experience (34 points).

CONCLUSION: Orthopedic trauma fellowship program directors clearly consider certain factors more highly than others when ranking fellowship candidates. Other factors include the interview, letters of recommendation, and personal connections to applicant and/or letter writers are considered most important by fellowship directors. Our results provide useful information to orthopedic residents who intend to pursue fellowship training in orthopedic trauma.

Unmatched Orthopedic Applicants: Similar Outcome Between Surgical Internship and Research Year

Abstract ID: Paper 059

---

*Michael M. Kheir, M.D. / Indianapolis, IN
Timothy L. Tan, M.D. / Philadelphia, PA
Alexander J. Rondon, M.D., M.B.A. / Philadelphia, PA
Antonia F. Chen, M.D., M.B.A. / Boston, MA

BACKGROUND: Obtaining an orthopedic residency is extremely competitive and is the most applied to surgical subspecialty, with approximately one-third of applicants not matching yearly. For unmatched applicants, the new application cycle is a perplexing and disconcerting period, where unique decisions must be addressed by the applicant. The aims of this study were to investigate the risk factors and outcomes of unmatched orthopedic applicants.

METHODS: A retrospective survey-based questionnaire was administered to medical students annually from 2015-2018 after Match Day, which included 934 orthopedic applicant responses, of which 81 were unmatched. Variables collected included demographics, United States Medical Licensing Examination (USMLE) scores, Electronic Residency Application Service (ERAS) application characteristics, and interim pursuits (research year, surgical internship, etc.). Fisher's exact test and Student's t-test were performed.

RESULTS: Overall, 58.0% (47/81) of unmatched applicants subsequently matched into an orthopedic residency. Applicants who pursued an interim research year or surgical internship after not matching had a subsequent match rate of 52.1% (25/48) and 64.0% (16/25), respectively (p=0.46). 34.1% (14/41) of subsequently matched applicants matched at the institution where they pursued their research year or surgical internship. Applicants who matched had more interviews compared to those who did not match (9.3 vs. 6.0, p=0.03). Applicants were more likely to interview at different programs during their subsequent attempt, as they were only offered on average 1.7 interviews from same programs as their first attempt. Of those that matched, 9/47 were Alpha Omega Alpha (AOA) compared to 1/34 in the unmatched group (p=0.04). 83.3% of females (15/18) matched compared to 50.8% of males (32/63, p=0.02,). There were no differences in Step 1 USMLE scores (p=0.60), Step 2 clinical knowledge (CK) scores (p=0.60), or number of publications (p=0.28) between applicants who matched or did not match.

CONCLUSION: Our findings demonstrate that the majority of orthopedic applicants matched during their subsequent attempt. Females and those with AOA status had significantly higher match rates than their counterparts. There was no difference in outcomes with regards to pursuing a research year or surgical internship, Step 1 or 2CK scores, or number of publications. Applicants are unlikely to be interviewed by the same programs as the first cycle. Further study is needed to analyze other risk factors for not matching into orthopedic surgery on a subsequent attempt.

Residency Program Reputation Influences Fellowship Match

Abstract ID: Paper 060

---

*Lisa K. Cannada, M.D. / Jacksonville, FL
Chad A. Krueger, M.D. / Philadelphia, PA
Jonathan R. Helms, M.D. / Greenville, NC
Anthony Bell, M.D. / Jacksonville, FL
Heidi Israel, Ph.D. / St. Louis, MO

PURPOSE: The primary goal of this study was to determine if applicants from top tier orthopedic surgery residency programs fared better in the match.

METHODS: San Francisco Match (SF Match) provided results regarding applicant data and match results from 2014-2018 for all orthopedic subspecialties except hand and shoulder & elbow. Data included match specialty, applicants' residency program, number of programs to which each applicant applied, number of interviews granted to each applicant, matched fellowship program, the matching fellowship programs' rank of each applicant, and the applicant's rank list. Residency programs were divided into 5 tiers (with tier 1 being the most reputable residency programs and tier 5 being the least reputable programs) based on 2017 Doximity rankings of Orthopedic Residency Programs. Statistical analysis consisted of descriptive Chi-Square and ANOVA analyses.

RESULTS: 2811 applicants met our inclusion criteria. Applicants from residency programs in tiers 1 and 2 applied to significantly few programs than those from tiers 3, 4 or 5 ($p<0.0001$). Applicants from tier 1 or 2 residencies were invited to interview at a higher percentage of fellowship programs to which they applied. Applicants from tier 1 residency programs had a 'successful match' (defined as matching to one of their top two choices) 78% of the time compared to 55% of applicants from tier 5 residencies. Applicants from higher tier residency programs were ranked more desirably by fellowship programs. Applicants from tier 1 residency programs matched at a significantly higher position ($p<0.001$) on their rank list (more desirable by the resident) compared to all other tiers. Similarly, applicants from tier 1 ($p=0.003$) were ranked significantly higher by programs (more desirably ranked by the fellowship program) compared to tiers 2, 3, 4, and 5.

DISCUSSION: The fellowship match process is a competitive, expensive and time-consuming process. Our study found that residency prestige plays a large role in the match process. Applicants who attended a residency program with a higher ranking on Doximity apply to fewer programs, interview at a greater percentage of these programs and are more likely to match to a higher ranked program. Furthermore, applicants from more reputable residency programs are also ranked as more desirable by fellowship programs. These findings may help future applicants in formulating their rank lists and should lead to future investigations as to why a residency program reputation appears to influence the fellowship match process.

Unplanned Emergency and Urgent Care Visits Following Outpatient Orthopedic Surgery

Abstract ID: Paper 061

---

*Benjamin R. Williams, M.D.
Lauren C. Zurek, M.D.
Harsh R. Parikh, M.P.H.
Marc F. Swiontkowski, M.D.
Brian P. Cunningham, M.D.
Minneapolis, MN

BACKGROUND: As payment models increasingly focus on value, reducing unplanned healthcare mediums will be critical to improve cost efficiency. Utilization of emergency (ED) and urgent care (UC) facilities following outpatient orthopedic procedures are a high-cost and low-value intervention. The purpose of this study is to determine: (1) incidence, (2) chief complaint, (3) risk factors, and (4) total cost of unplanned healthcare visits to an ED/UC facility within 30-days of an outpatient orthopedic procedure.

METHOD: A total of 5,590 outpatient procedural encounters from a large upper Midwest healthcare system, between 2012-2016, were reviewed. Procedures were stratified into four groups: hand, foot and ankle, sports, and trauma. Accompanying insurer data was utilized to quantify cost in both charges and reimbursement. Statistical analysis consisted of relative risk (RR) regression, comparing ED/UC rates across procedural groupings, adjusting for demographics and injury characteristics.

RESULTS: Subgroups of sports (1,879; 33.6%) and foot and ankle (1,807; 32.3%) were the most common procedures associated with unplanned encounters. Of the 5,590 patients, 5.0% (281) presented to an ED/UC and 0.4% (23) were admitted from an ED/UC within 30 days of the index procedure. The chief complaints on presentation were: pain, 61 (14.1%), wound concerns, 55 (12.7%), and medication-related issues 45 (10.4%). Multivariable regression analysis identified increased visit risk with hand procedures (RR:1.47, $p<0.01$) and reduced risk with sports procedures (RR:0.70, $p=0.05$). Increased risk with smoking (RR:1.26) and non-English speakers (RR:2.53) and reduced risk when married (RR:0.56). Unplanned ED/UC charges totaled $328,225.36, averaging $1,176.43 per visit [95% CI, $1,024.06 to $1,328.81] with reimbursements totaling $151,116.80, averaging $541.64 per visit [95% CI, $478.80 to $604.47].

CONCLUSION: As orthopedics continues to transition into the outpatient setting, this study identifies patient populations that are at an increased risk for unplanned healthcare utilization. This study helps identify a source of hidden costs of outpatient surgery.

Preoperative Warming Reduces Intraoperative Hypothermia in Total Joint Arthroplasty Patients

Abstract ID: Paper 062

---

*Andrew B. Kay, M.D.
Derek M. Klavas, M.D.
Takashi Hirase, M.D.
Michael O. Cotton, M.D.
Bradley S. Lambert, Ph.D.
Stephen J. Incavo, M.D.
Houston, TX

BACKGROUND: Perioperative hypothermia (PH) is common in total joint arthroplasty (TJA). The largest drop in body temperature occurs prior to the start of surgery. PH is associated with increased blood loss and risk of transfusion, delayed wound healing, and up to triple the incidence of surgical site infection.

PURPOSE: To evaluate the effect of preoperative warming measures on perioperative hypothermia in TJA.

METHODS: A retrospective case series was conducted of patients undergoing primary total knee or hip arthroplasty (TKA or THA) by 16 surgeons at a single institution between April 1 and October 31, 2017. Consistent with prior studies, perioperative hypothermia was defined as core body temperature ≤ 35.5°C for any portion of the procedure. Under the new normothermia protocol, patients received warmed crystalloid IV fluids and forced-air warming gowns in preoperative holding in addition to previously-instituted intraoperative measures. Body temperature was measured with a temporal artery thermometer outside the operating room (OR), and an esophageal probe thermometer in the OR. Time and temperature data were collected from the health record. Chi-square and paired t-tests were used to compare between TKA and THA patients, as well as between new and old protocols.

RESULTS: 672 patients met inclusion criteria under the new protocol and were compared to 383 patients under the prior protocol. In the new protocol, 173 of 672 (26%) of all patients were hypothermic at incision, compared to 140 of 383 (37%) of patients in the prior protocol ($p<0.05$). Rates of PH were significantly lower in the new protocol for TKA (26% vs. 34%, $p<0.05$) and THA patients (26% vs. 40%, $p<0.05$). The largest drop in body temperature occurred between preoperative holding and induction of anesthesia, and was less than in the previous protocol (-0.71°C± 0.68°C vs. -0.82± 6.67°C, $p<0.05$). The duration of time from OR entry to incision was less for normothermic TKA (36 ± 12.3 vs. 39 ± 12.5 minutes, $p<0.05$) and THA patients (40.3 ± 12.2 vs. 48.7 ± 32.0 minutes, $p<0.05$). Duration of hypothermia was similar between new and old protocols, but significantly fewer THA patients remained hypothermic for the entire surgery under the new protocol (10% vs. 34%, $p<0.05$).

CONCLUSIONS: Forced-air warming and warmed IV fluids in preoperative holding reduced perioperative hypothermia by approximately 30% in TJA patients. Additionally, the time from entry into the operating room to surgery start should be minimized as patients are most vulnerable to perioperative hypothermia during this interval.

Effects of C-UVC Filtration on Operating Room Airborne Bacterial Concentration During Pediatric Orthopedic Procedures

Abstract ID: Paper 063

---

*David J. Ulery, D.O. / Toledo, OH
Benjamin Boothby, D.O. / Toledo, OH
James T. Lehner, M.D. / Dayton, OH
Michael C. Albert, M.D. / Dayton, OH

BACKGROUND: Airborne bacteria are known to be a source of wound contamination in major orthopedic procedures. Crystalline ultraviolet C (C-UVC) filter units have been designed to disinfect and then recirculate air in the operating room (OR). To our knowledge, the effect of viable particle count reduction with C-UVC filters on infection rates in pediatric and/or spinal surgeries has never been studied. This preliminary study was designed to assess the effectiveness at reducing particles of C-UVC filtration units in pediatric orthopedic operating rooms.

METHODS: A particle counter was used in a single positive-pressure OR during a series of 8 consecutive pediatric scoliosis deformity correction surgeries. The particle counter measured total and viable particle counts (TPC/VPC). The particle counter was used alone as a control in the first 4 cases. For the second 4 cases, a C-UVC filtration unit was also deployed. The surgical events collected included patient time in OR and time out of OR. Outcomes included overall TPC and VPC and change in TPC and VPC between the 2 study groups.

RESULTS: When compared to controls, the surgeries in which the C-UVC filter was used had significantly lower TPC and VPC levels. For TPC at 5 microns, the control group demonstrated an average of 9,084 total particles over the collection period vs. 5,370 particles in the C-UVC group (p-value < .05). Similarly, a reduction was seen for 10 microns with the control group showing 3,528 average total particles vs. 2,110 for the C-UVC group (p-value < .05). When examining VPC at 5 microns, the control group had an average of 246 particles vs. 123 for the C-UVC group (p-value < .05). Finally, VPC at 10 microns in the control group showed an average of 192 vs. 91 for the C-UVC group ((p-value < .05). The C-UVC unit was able to reduce TPC by 40% and VPC by 50%.

CONCLUSIONS: C-UVC filters have proven effective at significantly reducing TPC and VPC in a standard pediatric scoliosis OR. With this reduction in airborne particles, C-UVC units may be capable of reducing overall infection rates and the risk of infection in pediatric scoliosis surgery. Further studies examining specific variables as well as infection rates with and without C-UVC units need to be performed.

Can the Addition of Robotic Terminal Cleaning Via Pulsed-Xenon Ultraviolet Light Reduce Bioburden in the Operating Room

Abstract ID: Paper 064

---

*Ashley E. Xiong
Nayef Bin Dajim, M.D.
Benjamin Nelson
Arjun S. Sebastian, M.D.
Brett A. Freedman, M.D.
Rochester, MN

INTRODUCTION: Methods for operating room (OR) cleaning have seen little innovation. Pulsed-Xenon Ultraviolet (PX-UV) disinfection is an opportunity for standardized, touch-free disinfection that may augment current manual cleaning protocols. The combination of manual and PX-UV disinfection may provide the greatest reduction in OR bioburden, as measured by Colony Forming Units (CFUs), and frequency of site contamination. This study tests the hypothesis that the addition of PX-UV robotic disinfection can significantly reduce bioburden in the operating room following terminal cleaning.

METHODS: Fifteen ORs were sampled at three time points – before terminal manual cleaning, after terminal manual cleaning, and after PX-UV. For each OR, at each time point, five high-touch surfaces were cultured using a Tryptone Soy Agar touch plate. A total of 225 touch plate samples were acquired. Samples were incubated and the number of CFUs reported. Distinct colonies were identified and counted. Descriptive statistics and Rank Sum Testing with a Bonferroni correction were used to analyze results.

RESULTS: There was a 26.8% reduction of CFUs after manual cleaning ($p>0.8014$) and a further 81.0% reduction of CFUs after PXUV ($p = 0.0086$). Overall, the combination of manual and PX-UV disinfection resulted in an 86.1% reduction in CFUs ($p = 0.004$). The frequency of sites with CFUs prior to cleaning was 26.7%. There was no change in frequency of sites with CFUs after manual cleaning. Following PX-UV cleaning, the frequency of sites with CFUs reduced to 8.0%, which is a 70.0% reduction in sites with CFUs. Interestingly, the frequency of sites with an increase in CFUs after manual cleaning was 20.0%. There was no occurrence of an increase in CFUs after PX-UV disinfection.

DISCUSSION AND CONCLUSION: The combination of PX-UV with manual cleaning yields the greatest reduction in OR bioburden as measured by CFUs. Manual cleaning alone resulted in a low reduction of CFUs and almost no change in the frequency of site contamination. The increase in CFUs following manual cleaning may represent cross contamination due to inconsistent manual terminal cleaning.

The use of PX-UV disinfection resulted in a significant reduction in CFUs when compared to both the preand post-manual cleaning time points. There was no cross-contamination with PX-UV disinfection. This reduction in bioburden may contribute to a decreased risk of surgical site infection. Further research into the benefits of combining between case and terminal PX-UV disinfection, as well as the relationship between reduced bioburden and surgical site infection, are needed.

MAOA SECOND PLENARY SESSION
April 24, 2020

Pain Control after Total Hip Arthroplasty: A Randomized Trial Determining Efficacy of Fascia Iliaca Compartment Blocks in the Immediate Postoperative Period

Abstract ID: Paper 065

---

*Kamil Bober, M.D.
Allen A. Kadado, M.D.
Wayne T. North, M.D.
Michael Charters, M.D.
Detroit, MI

Dr. Bober is the recipient of the Edward D. Henderson, M.D. Physician in Training Award.

INTRODUCTION: The purpose of this randomized trial was to identify if fascia iliaca blockade reduces postoperative pain and narcotic consumption and improves early functional outcomes in primary THA performed through the mini-posterior approach.

METHODS: Patients were recruited from September 2017 to May 2019. Eligible patients had to receive a primary THA with epidural anesthesia. All arthroplasties were performed using a mini-posterior approach to the hip. Postoperatively, patients were randomized to receive a fascia iliaca compartment block or a placebo block. VAS pain scores and narcotic consumption were recorded at regular time intervals after surgery. Functional outcomes including distance walked during therapy, timed-up-and-go testing, and quadriceps strength were recorded. The patients completed PROMIS pain and physical function surveys at 4 weeks postoperatively.

RESULTS: During the study period 120 patients were recruited and included in the analysis. There was no difference in the average pain scores at any time interval between the placebo and block groups during the first 24 hours ($p = 0.21$-0.99). There was no difference between the pre-block and post-block pain scores in the block group (4.42 vs. 3.83, $p = 0.97$). There was no difference in the cumulative morphine equivalents consumed between the placebo and block group during any 4 hour time interval postoperatively ($p=0.06$ - 0.25). Functional testing showed no difference between the two groups in regards to distance walked during the first therapy session (65.6 vs. 76.8 ft., $p=0.33$) and timed-up-and-go testing (63.7 vs. 64.7 sec, $p=0.95$). There was an increased incidence of nausea and vomiting in the placebo group, although this did not reach statistical significance (22% vs 40%, $p = 0.052$). There was an increased incidence of quadriceps weakness in the block group (22% vs 0%, $p = 0.004$). All patients with quadriceps weakness required a knee immobilizer and alterations in the postoperative therapy protocols.

CONCLUSION: This randomized trial shows that the fascia iliaca compartment blockade does not improve functional performance and does not decrease pain levels or narcotic usage after mini-posterior THA. It does, however, increase the risk of quadriceps weakness postoperatively leading to an increased fall risk and need to alter therapy protocols. Based on these results we do not recommend routine fascia iliaca compartment blocks after THA performed with the posterior approach.

Quicker and More Predictable Return of Motor Function and Ambulation after Mepivacaine vs. Bupivacaine Spinal: A Double Blind RCT in Primary TKA and THA

Abstract ID: Paper 066

---

*Cody C. Wyles, M.D.
Mark W. Pagnano, M.D.
Robert T. Trousdale, M.D.
Rafael J. Sierra, M.D.
Michael J. Taunton, M.D.
Kevin I. Perry, M.D.
Dirk R. Larson, M.S.
Hugh M. Smith, M.D., Ph.D.
Christopher M. Duncan, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

Dr. Wyles is the recipient of the E. W. Johnson, Jr., M.D. Physician in Training Award.

INTRODUCTION: Spinal anesthesia provides several benefits for patients undergoing total knee arthroplasty (TKA) and total hip arthroplasty (THA), but historically comes at the cost of slower return of lower extremity motor function. In this prospective, double-blind, randomized clinical trial we sought to determine if a mepivacaine spinal would allow substantially quicker and more predictable return of motor function as compared to our traditional low-dose bupivacaine spinal anesthesia during primary TKA and THA.

METHODS: This trial was conducted at a single academic institution. Prior to trial initiation, strong internal pilot data determined that 154 patients were required to achieve 80% power. Patients were randomized in a 1:1 fashion with advanced computerized stratification based on procedure, sex, age group, and BMI. Following surgery, motor function was assessed in the nonoperative lower extremity according to the Bromage scale and discontinued once Bromage 0 was achieved (spontaneous movement at hip/knee/ankle).

RESULTS: Mean time to return of lower extremity motor function was 29 minutes quicker and less variable in patients receiving mepivacaine: 184 minutes (95% CI=168-199 minutes) compared to low-dose bupivacaine 213 minutes (95% CI=184-241 minutes). Mean time to successful participation in physical therapy including ambulation was 20 minutes quicker and less variable in patients receiving mepivacaine 399 minutes (95% CI=375-423 minutes) compared to low-dose bupivacaine 419 minutes (95% CI=388-451 minutes). The proportion of patients experiencing postoperative orthostatic hypotension or transient neurologic symptoms in patients receiving mepivacaine compared to low-dose bupivacaine was 18% vs. 11% and 0% vs. 0%, respectively (non-significant).

CONCLUSION: For patients undergoing primary TKA and THA, spinal anesthesia with mepivacaine allowed quicker and less variable return of lower extremity motor function compared to low-dose bupivacaine, without a concomitant increase in complications potentially associated with spinal anesthetics. This is particularly of value in an era of short-stay and outpatient surgery.

An Injury Prevention Program for Professional Ballet: A Randomized Controlled Investigation

Abstract ID: Paper 067

---

*Angelina M. Vera, M.D.
Bene D. Barrera, ATC
Leif E. Peterson, Ph.D.
Thomas R. Yetter, B.S.
David Dong, B.S.
Domenica A. Delgado, B.S.
Patrick C. McCulloch, M.D.
Kevin E. Varner, M.D.
Joshua D. Harris, M.D.
Houston, TX

Dr. Vera is the recipient of the Carl L. Nelson, M.D. Physician in Training Award.

BACKGROUND: There are few investigations regarding dance-specific injury prevention programs, and there are no published randomized controlled trials evaluating an injury prevention program for dance.

HYPOTHESIS: The implementation of an injury prevention program (IPP) will significantly reduce the risk of injury in professional ballet dancers.

METHODS: A randomized controlled trial was designed using a superiority model for the intervention group. All professional dancers from a single ballet company were eligible to participate. Randomization and allocation were performed prior to the start of the season. The control group practiced and performed without change to pre-existing years' standard operating practice. The IPP group was instructed to perform a 30-minute exercise program three times per week over the 52-week study period. Injuries were recorded by the athletic trainer and physicians using electronic injury tracking software (ATS, Grove City, PA, USA). Standard continuous and categorical data comparisons and correlations were utilized. Cox proportional hazards (PH) regression models for recurrent failures were employed wherein hazard ratio indicates the relative likelihood of injury in the control versus intervention groups.

RESULTS: Seventy-five percent of the eligible dancers (n = 39/52) participated. Nineteen (nine males; 10 females; mean age 26.6 ± 4.0 years) were randomized to the control group and 20 (11 males; nine females; mean age 25.1 ± 5.1 years) to the IPP. There was no significant ($p>0.05$) difference in age, body mass index (BMI), or company rank between the groups. After the 52-week study period, a total of 116 injuries had been recorded for the entire study population (49 IPP, 67 control). Traumatic and chronic injuries accounted for 54% and 46% of injures, respectively. The injury rate was 82% (IPP HR 0.18, $z=-2.29$, $p=0.022$) less in the IPP group when controlling for confounding variables, and time between injuries was 45% (IPP HR 0.55, $z=-2.20$, $p=0.028$) longer than for controls.

CONCLUSION: The present study is the first prospective randomized controlled investigation of an injury prevention program for professional ballet. The results showed an 82% decrease in injury rate for the intervention group and an extended period from previous injury to recurrent or new injury.

Positive Reframing: An Important but Underutilized Coping Strategy in Youth Athletes Undergoing Sports-Related Knee Surgery

Abstract ID: Paper 068

---

*Sean Fitzpatrick, M.D.
Scott A. Kuzma, M.D.
Joshua S. Everhart, M.D., M.P.H.
Alex C. DiBartola, M.D.
Steven Schiele, M.A.
Kristie Harris, M.S.
Chalres F. Emery, Ph.D.
Robert A. Magnussen, M.D., M.P.H.
Christopher C. Kaeding, M.D.
David C. Flanigan, M.D.
Columbus, OH

Dr. Fitzpatrick is the recipient of the Dallas B. Phemister, M.D. Physician in Training Award.

INTRODUCTION: Effective coping strategies can improve recovery and rehabilitation after sports-related knee surgery, but it is unknown whether this relationship is age or sex specific. The purpose of this study is to determine the following among athletes undergoing sports-related knee surgery: (1) self-reported coping strategies by sex and age group, and (2) the sex and age-specific relationship between coping strategies and surgery outcomes

METHODS: 184 athletes undergoing sports-related knee surgery (57% male; n=38 age <20 years, n=35 age 20-25, n=36 age 26-31, n=36 age 32-40, n=39 age >40) preoperatively completed the brief COPE inventory (frequency of use of specific coping strategies on a 2-8 point scale) subscales for self-distraction, use of emotional or instrumental support, venting, positive reframing, and acceptance. The association between specific coping strategies and outcomes including postoperative satisfaction, return to prior level of sport, Tegner activity score, International Knee Documentation Committee-subjective scores (IKDC-S), and Tampa Sale for Kinesiophobia (TSK-11) scores were assessed at mean 12.4 months follow-up.

RESULTS: Return to prior level of sport was 72% and satisfaction was 86% overall. Coping strategies other than venting and acceptance had age-specific utilization rates ($p<0.05$) with under-utilization of positive reframing in athletes age <20 years (mean 3.9/8 SD 1.1, max 6/8) compared to ≥20 years (mean 4.6/8 SD 0.9, max 8/8) ($p=0.001$). Positive reframing increased odds of return to sport in ages ≤31 years (per point: OR 2.36 CI 0.12, 5.10; $p=0.009$) and satisfaction in all athletes (per point: OR 1.60 CI 0.99, 2.63; $p=0.06$), particularly athletes <20 years (satisfaction: OR 6.21 CI 1.29, 115 $p=0.02$); the beneficial effect of positive reframing did not vary by surgical procedure ($p>0.30$ all comparisons). Positive reframing correlated with postoperative Tegner scores in ages <20 ($r=0.52$; $p=0.02$) and >40 years ($r=0.45$, $p=0.03$) as well as lower postoperative kinesiophobia in ages <20 years ($r=-0.53$, $p=0.02$). Instrumental support was correlated with greater improvement in kinesiophobia ($r=0.59$, $p=0.002$) and higher postoperative Tegner activity scores ($r=0.70$, $p<0.001$) in ages >40 years only.

DISCUSSION AND CONCLUSION: Coping strategies among athletes undergoing sports-related knee surgery have age-specific associations with outcomes. Positive reframing is an

underutilized but effective coping strategy in youth athletes regardless of surgical procedure. Greater use of instrumental support appears to improve activity levels and reduce kinesiophobia for older athletes.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 24, 2020

Review of Variability in Rehabilitation Protocols after Lateral Ankle Ligament Repair

Abstract ID: Paper 069

Christina A. Hermanns / Kansas City, KS
Reed G. Coda / Kansas City, KS
Sana G. Cheema / Kansas City, KS
*Matthew L. Vopat, M.D. / Wichita, KS
Armin Tarakemeh / Kansas City, KS
J. Paul Schroeppel, M.D. / Kansas City, KS
Scott M. Mullen, M.D. / Kansas City, KS
Bryan G. Vopat, M.D. / Kansas City, KS

INTRODUCTION: Ankle sprains are one of the most common athletic injuries. Lateral ankle ligament repair may be performed in patients who fail nonoperative management. The purpose of this study is to analyze the variability across different rehabilitation protocols after lateral ankle ligament repair.

METHODS: A web-based search for rehabilitation protocols specifically for postoperative care after a lateral ankle ligament repair was performed to find both academic and private practice published protocols. Protocols for reconstructions using allografts or autografts, internal brace procedures, multi-ligament surgeries and nonoperative care were excluded. A scoring rubric was created to analyze inclusion, exclusion, and timing of protocols in areas such as weightbearing, range of motion (ROM), bracing, strengthening exercise, return to running, and return to sport. Protocols were compared based on different recommendations pertaining to the categories listed above.

RESULTS: 13 protocols were analyzed, of which 8 were academic and 5 were private practice. 92% of protocols recommended no ROM postoperatively, with return to full ROM anywhere from week 6 to week 12 depending on the protocol. Inversion of the ankle was restricted to week 8 to 10 in 50% of protocols but ranged from week 6 to 12 total. Return to partial weight bearing ranged from day 0 to week 6 with 38% recommending partial weight bearing at 2 to 4 weeks. Full weight bearing ranged from week 4 to 10 with 41.6% recommending full weight at 6 to 8 weeks. 50% of protocols recommended postoperative bracing with a short leg cast. 76% of protocols recommended returning to sport at week 12 and 50% recommended returning to running at week 12 to 14. The types and timing of strengthening exercises recommended for physical therapy showed considerable variation across protocols.

CONCLUSIONS: 84% of protocols recommended some sort of postoperative bracing and return to sport was generally consistent at 12 to 14 weeks in 76.9% of protocols, making these the most consistent aspects of rehabilitation across protocols. There was significant variability between different protocols, especially in weight bearing status, range of motion, and specific rehab exercises. The rehabilitation protocols following a lateral ankle repair lack standardization of care and would benefit from a consensus on how to best rehab and protect the post-surgical

ankle while strengthening and returning the patient to previous activity level after a lateral ankle repair.

Predictive Variables for Patient Compliance with Physician-Prescribed Orthotics

Abstract ID: Paper 070

---

*Trenton T. Stevens, M.D. / Memphis, TN
Clayton C. Bettin, M.D. / Memphis, TN
David R. Richardson, M.D. / Memphis, TN
Garnett A. Murphy, M.D. / Memphis, TN
Benjamin J. Grear, M.D. / Memphis, TN
Oluwatosin Ojo, M.D. / Macon, GA
Jacob T. Hartline, B.S. / Memphis, TN

INTRODUCTION: Custom and off-the-shelf orthotics frequently are prescribed by foot and ankle orthpedic surgeons. This study aimed to quantify the rate at which patients receive their prescribed orthotic and explore the variables that could be predictive of patients' receiving and using orthotics.

METHODS: We analyzed the demographics of 382 patients who received an orthotic prescription from a group of foot and ankle surgeons to assess variables predictive of patients receiving their prescribed orthotic. Of these 382 patients,186 (49%) completed a survey regarding insurance status, cost of the orthotic, education, income, and satisfaction with the orthotic. This information was used to identify variables that may help identify patients who are at an increased risk of failing to receive their prescribed orthotic.

RESULTS: Patients received their orthotic at an overall rate of 61.2% (235/382). Patients with commercial insurance were more likely to receive their orthotic (67%) than patients with Medicaid (40%). Of the 186 patients who completed the survey, those whose insurance covered all or part of their orthotic were more likely to receive their orthotic (100% and 96%, respectively) compared to those whose insurance did not cover the orthotic (81.5%). Overall 86.5% reported being "better" or "completely relieved" with orthotic use, and 13.4% reported "no difference" or "worse." There were no differences in receive rates according to age or gender, but there was a disparity in race, with 71% (155/219) of white and only 48% (72/151) of black patients receiving their orthotics.

CONCLUSION: A substantial number of patients (38.8%) do not receive their physician-prescribed orthotic. Patients who do receive and use their orthotic report positive results. Insurance status, race, and coverage of costs by the insurance company play important roles in predicting which patients are at risk for failing to receive their orthotic.

Do Geographic Region, Pathologic Chronicity, and Hospital Affiliation Affect Access to Care Among Medicaid- and Privately-Insured Foot and Ankle Surgery Patients?

Abstract ID: Paper 071

Aaradhana J. Jha, M.D.
Charles C. Pitts
*Bridgette M. Love
Haley M. McKissack, B.S.
Mohit Jain, M.D.
Jun Kit He, M.A.
Alexander Dombrowsky, B.S.
Ashish Brahmbhatt, M.D.
Ashish B. Shah, M.D.
Birmingham, AL

BACKGROUND: Studies show that patients enrolled in Medicaid have difficulty obtaining access to care compared to patients with private insurance. Whether variables such as geographic location, state expansion vs. non-expansion, and private vs. academic affiliation affect access to care among foot-ankle surgery patients enrolled in Medicaid is not established. We assessed differences in access to care between foot-ankle patients with privately-insurance and those with Medicaid.

METHOD: Twenty providers from each of five Medicaid-expanded and five non-expanded states in different geographic regions were randomly chosen via American Orthopaedic Foot & Ankle Society(AOFAS) directory. Each office was contacted, requesting the earliest available appointment for a fictitious patient's acute Achilles rupture or hallux valgus. Insurance was stated to be Medicaid for half the calls and, Blue-Cross Blue-Shield (BCBS) for the other half. Appointment success rate and average time to appointment were compared between private-insurance and Medicaid. Results were further compared across geographic regions, between private and academic practices, acute injury(Achilles rupture) and chronic injury(hallux valgus).

RESULTS: Appointments were successful for all 100 (100%) calls made with BCBS and for 73 of 100 calls (73%) with Medicaid ($p<0.001$). Both acute and chronic injuries had significantly higher success rates with BCBS than Medicaid ($p<0.001$). Medicaid patients had similar appointment success rates for complaints of hallux valgus (72.0%) and Achilles rupture (74.0%). Appointment success rate was significantly lower with Medicaid than with BCBS ($p\leq0.01$) in all geographic regions, with highest and lowest success occurring in the West (80.0%) and Northeast (65.0%). There was no significant difference in success rate between Medicaid-expanded (88.0%) and non-expanded (85.0%) states ($p=0.53$). Success rate with Medicaid (66.7%) was significantly lower than with BCBS (100.0%, $p<0.001$) for private-practice offices, but there was no significant difference in success rate for academic practices. Additionally, there was no significant difference in appointment wait-time between insurance types.

CONCLUSION: Patients with Medicaid have difficulty obtaining outpatient appointments for common non-emergent foot-ankle problems and may experience difficulty scheduling appointments at private rather than academic institutions. Patients with Medicaid have decreased success of receiving an appointment regardless of geographic region. The chronicity and time-sensitivity of the injury does not appear to impact the ability to gain an appointment.

The medical community should continue to seek and identify potential interventions which can improve access to orthopaedic care for all patients, regardless of insurance status.

Comparison of Krackow vs. Bunnell Techniques for Midsubstance Achilles Tendon Ruptures: A Radiographic Marker Study of Postoperative Tendon Elongation

Abstract ID: Paper 072

---

*Najib R. Ussef, M.D.
Kelechi R. Okoroha, M.D.
Toufic R. Jildeh, M.D.
Vasilios Moutzouros, M.D.
Zeni Ferras, M.D.
Detroit, MI

INTRODUCTION: Acute midsubstance Achilles tendon ruptures are a common orthopedic problem for which the optimal repair technique remains controversial. Head-to-head comparisons of current fixation constructs have been done to establish which repair technique is most biomechanically favorable. However, most of these studies are cadaveric. Our study looks at Bunnel versus Krackow suture techniques in vivo using radiographic bead measurements over a 6-week time period.

Of the tested fixation constructs, we hypothesized that there would be no significant difference in tendon lengthening between the Krackow and Bunnel repair techniques.

METHODS: This was a prospective cohort study of patients undergoing midsubstance achilles tendon repair using a Krackow or Bunnell type repair. There was a total of two surgeons involved in the study. One surgeon performed a Krackow repair and a second surgeon performed a Bunnell repair technique. All patients underwent an accelerated rehabilitation protocol after surgery that consisted of early weight bearing after two weeks. During repair, two 2-mm tantalum beads with laser-etched holes were sutured to the Achilles tendon at the repair site. X-rays were obtained at time 0 and at 2, 6 weeks postoperatively. Measurements were made using the bead-to-bead distances to assess repair site elongation over time. The primary outcome was postoperative tendon elongation as measured by radiographic beads.

RESULTS: There was a total of 10 patients in the study, 5 in each group. There was no significant difference in tendon elongation at 6 weeks between the Bunnell and Krackow repair techniques respectively (11.72 mm versus 14.5 mm, p= 0.56). There was no significant difference in patient reported outcomes as measured by the Achilles Tendon Rupture Score (ATRS) (80.2 versus 85, p=0.56).

CONCLUSION: There was no significant difference in gap formation at the repair site in an early weight bearing rehabilitation regimen when comparing Achilles tendon repair using a Krackow technique versus Bunnell technique. There was no significant difference in patient reported outcome measures between the two groups. This study is limited by a small sample size.

First Tarsometatarsal Fusion Using Saw Preparation vs. Standard Preparation of the Joint: A Cadaver Study

Abstract ID: Paper 073

Karthikeyan Chinnakkannu, M.D.
Haley M. McKissack, B.S.
Aaradhana J. Jha, M.D.
Ashish Brahmbhatt, M.D.
Alexander Dombrowsky, B.S.
*Jessyca L. Ray, B.S.
Sameer M. Naranje, M.D.
Ashish B. Shah, M.D.
Birmingham, AL

INTRODUCTION: First tarsometatarsal (TMT) joint fusion is indicated for several causes of first ray dysfunction and pain. Preparation of the joint surface by denuding the articular cartilage is key for arthrodesis. However, excessive removal of cartilage and bone may result in excessive shortening of the ray. Despite the importance of joint preparation on the outcomes of fusion, the effects of using a bone saw versus osteotome on ray length is poorly documented in the literature. The purpose of this study was to investigate whether utilization of an osteotome or saw would minimize shortening of the first ray in TMT arthrodesis.

METHODS: Ten fresh-frozen cadaver specimens without evidence of musculoskeletal abnormalities were used for this study. A medial incision was made along the first ray from the medial aspect of the medial cuneiform to the base of the first metatarsal. The first TMT joint was exposed through transverse capsulotomy. The soft tissues surrounding the joint were not removed from the bone. The specimens were randomly assigned to undergo cartilage removal and joint preparation using either an osteotome (n=5) or saw (n=5). Care was taken to reach the plantar-most aspect of the joint. Fusion was then performed using a cross-screw construct through the dorsal aspect of the proximal phalanx and the medial cuneiform. Pre- and postoperative x-rays were taken with a radiopaque ruler in the field, and length changes were compared between osteotome and sawblade groups.

RESULTS: The average change in metatarsal length was significantly smaller in the osteotome group (1.6 mm) as compared to the saw group (4.4 mm) ($p=0.031$). The average percent change in metatarsal length was also significantly smaller in the osteotome group (3.0%) compared to the saw group (8.4%) ($p=0.025$). There was no significant difference between the two groups with respect to change in cuneiform length. The osteotome group demonstrated a significantly smaller average measured change (3.0 mm vs. 6.9 mm, $p=0.001$) and percent change (4.1% vs. 9.3%, $p<0.001$) in total length (cuneiform plus metatarsal) in comparison to the saw group.

CONCLUSION: The results of this study demonstrate that first TMT joint preparation with an osteotome may prevent over-shortening of the first ray. Judicious use of the bone saw for joint preparation may still be beneficial in some cases.

Biomechanical Comparison of a Novel Method of Tricortical Kirschner Wire Fixation of First Metatarsal Distal Chevron Osteotomy vs. Traditional Fixation

Abstract ID: Paper 074

Jie Chen, M.D., M.P.H.
*Natalie Renee Black
Randal Morris
Vinod Kumar Panchbhavi, M.D.
Galveston, TX

INTRODUCTION: The distal chevron osteotomy of the first metatarsal is a frequently used and accepted method to treat hallux valgus deformity. Traditional Kirschner wire (K-wire) stabilization of the osteotomy involves one cortex of fixation. Fixation utilizing three cortices may be biomechanically superior to traditional unicortical K-wire fixation and potentially equivalent to single screw fixation. We biomechanically compared the fixation of a distal chevron osteotomy using a novel method of tricortical K-wire fixation to traditional unicortical K-wire and screw fixation.

METHODS: Seventeen matched pairs (8 for tricortical vs. unicortical testing, 9 for tricortical vs. screw testing) of fresh-frozen human cadaver first metatarsals were tested under physiologic axial loading and cantilever bending in the intact condition, and following osteotomy, fixed with either tricortical K-wire fixation, unicortical K-wire fixation, or single screw fixation. Differences in physiologic and cantilever fixed/intact stiffness ratio and cantilever failure load were determined.

RESULTS: The tricortical fixation specimens had a significantly higher stiffness ratio in cantilever loading than the unicortical fixation specimens (60.50% tricortical, 34.17% unicortical, $P = 0.02$). Stiffness ratio was not significantly different in physiologic load (15.34% tricortical, 25.75% unicortical, $P = 0.23$). In cantilever failure loading, the tricortical fixation specimens had a significantly higher load to failure than the unicortical fixation specimens (132.81N tricortical, 58.58N unicortical $P < 0.01$). Stiffness ratio under physiologic load, cantilever load, and ultimate load to failure were not significantly different between tricortical K-wire and screw fixation groups (Physiologic 33.23% tricortical, 42.67% screw, $P = 0.59$. Cantilever 72.61% tricortical, 52.71% screw, $P = 0.34$. Failure load 155.77N tricortical, 136.15N screw, $P = 0.65$).

CONCLUSION: Tricortical K-wire fixation for distal chevron osteotomies may be biomechanically superior to traditional unicortical K-wire fixation, and equivalent to traditional single screw fixation, with the added benefit of being less costly and having no permanent hardware.

A Comparison of Ultrasound and the Klaue Device for Diagnosis and Evaluation of First Ray Hypermobility in Symptomatic and Asymptomatic Hallux Valgus Patients

Abstract ID: Paper 075

---

*Rohan Bhimani, M.D. / Boston, MA
Jirawat Saengsin, M.D. / Boston, MA
Tanawat Vaseenon, M.D. / Chiang Mai, Thailand
Nuttaya Pattamapaspong, M.D. / Chiang Mai, Thailand

INTRODUCTION: Hypermobility of the first ray is associated with problems such as transfer metatarsalgia and painful callosity. Existing methods to assess this condition have diverse advantages and disadvantages. This study assessed the accuracy of a new alternative technique of first ray hypermobile evaluation using ultrasound and compared with the Klaue device.

METHODS: 64 feet were included in this study. First ray hypermobility assessed in all patients using Klaue device and ultrasound. Ultrasound evaluation included dorsal translation, plantar gapping, and medial gapping of first metatarsal-cuneiform joint and compared to measurements made with a Klaue device. Hypermobility was defined as the translation of more than 9.3 mm in subjects evaluated with a Klaue device. The two-sample t-test was used to find a significant difference ($p<0.05$) between hypermobile versus non-hypermobile groups and between symptomatic versus asymptomatic groups. Logistic regression analysis was used to analyze ultrasound parameters and find a cut point at which it defines hypermobility. The cut-off points were chosen based on the highest area under the Receiver Operating Characteristic (ROC) curve. Moreover, inter- and intra-rater reliability were assessed for ultrasound values.

RESULTS: Width of the feet and hallux valgus angle was found to be significantly different between the normal and hypermobile groups ($P = 0.037$, $P = 0.046$). Comparison between the symptomatic group and asymptomatic group found the hallux valgus angle and the first-second intermetatarsal angle, measured from weight-bearing x-ray, significantly higher in the symptomatic group ($P = 0.004$, $P =0.028$). The interclass correlation coefficient showed excellent agreement for both inter-rater and intra-rater agreement. The cut-off point for the ultrasound parameters used to diagnose hypermobility of the first ray was set at an increase in dorsal translation of ≥1mm, an increase in gapping of ≥1.1 mm in plantar gapping, and an increase in medial gapping of the first metatarsocuneiform joint of ≥0.8 mm. When we combined these three parameters to diagnose hypermobility of the first ray, we found improvement in accuracy (sensitivity= 78.79%, specificity= 95.65%, PPV= 96.29%, NPV= 75.86%).

CONCLUSION: These three sonographic parameters have acceptable power to identify hypermobility and offers the physician an alternative way of evaluating hypermobility using a feasible and measurable method.

Anatomic Structures at Risk in Proximal Fifth Metatarsal Fracture Fixation: A Cadaver Study

Abstract ID: Paper 076

Leonardo Moraes, M.D.
*Bradley K. Alexander, B.S.
James T. McMurtrie, M.D.
Haley M. McKissack, B.S.
Ashish Brahmbhatt, M.D.
Joshua L. Washington, B.S.
Ashish B. Shah, M.D.
Birmingham, AL

INTRODUCTION/PURPOSE: Jones fractures have an increased risk for refracture, delayed union, and nonunion secondary to poor vascularization. When chosen for surgical treatment, percutaneous fixation with screws is most often used. It has been shown that the peroneal brevis and longus, the cuboid, and the sural nerve lie in close proximity to the pins' starting point and, therefore, have theoretical risk of injury. The study aims to evaluate the presence of injury of the structures at risk and to measure the distance of these structures to the entry point.

METHODS: Eleven fresh-frozen below-the-knee specimens underwent standard operative fixation for a Jones fracture via the "High and inside" percutaneous technique. A guide wire was placed through the medullary canal and confirmed on fluoroscopy. The cannulated drill with drill sleeve was then placed over the wire and advanced to the diaphysis. The guide wire was left and the skin and subcutaneous tissues were carefully removed from the lateral midfoot to fully expose the structures at risk. The guidewire was then removed, and then the solid screw was placed. The distance of the wire in the base of fifth metatarsal and these structures was measured and documented, including the branches of the sural nerve, cuboid, fourth metatarsal, peroneus longus, and peroneus brevis tendons.

RESULTS: The structure with the shortest average distance from the pin was the peroneus brevis, measuring 0.91 mm (±1.22 mm S.D.), followed by the cuboid articular surface, sural nerve, peroneus longus, and base of the fourth metatarsal, respectively. The pin had damaged the peroneus brevis in 5 of 11 cadavers. The average distance from the tendon insertion point was 7.2 mm. The furthest measured distance was 10 mm, while the closest was 3 mm. The screw head contacted the articular surface of the cuboid in 3 of 11 cadavers.

CONCLUSION: This is the only study that evaluated the risk of injury to nearby structures after a procedure that simulated an actual surgical act. It is also the only one that was aware of the risk of tendon injury not only in its insertion but also in its path during the placement of the wire and drill. We conclude that percutaneous fixation of fractures of the base of the fifth metatarsus presents a risk of partial lesion of the peroneus brevis tendon and lateral aspect of the cuboid.

Patient-Reported Opioid Consumption Following Outpatient Foot and Ankle Surgery

Abstract ID: Paper 077

---

*Samuel F. Thompson, M.D. / Oklahoma City, OK
Zac P. Burrow, M.D. / Oklahoma City, OK
Scott H. Conant, M.D. / Oklahoma City, OK
Jonathan L. Tobey, M.D. / Oklahoma City, OK
Ryan W. Morrisett, M.D. / Oklahoma City, OK
Evan S. Fene, M.D. / Dallas, TX
Samantha P. Kelly, B.S. / Oklahoma City, OK
Jake Fox, B.S. / Oklahoma City, OK
Amgad M. Haleem, M.D. / Oklahoma City, OK

BACKGROUND: The expanding opioid crisis has forced orthopedic surgeons to evaluate their prescribing practices, yet there remains limited evidence to guide providers in achieving safe and effective postoperative analgesia. Our goal was to prospectively evaluate opioid consumption following outpatient foot and ankle surgery and determine predictors of increased narcotic usage.

METHODS: A prospective observational study of 78 adult patients undergoing outpatient foot and ankle surgery was conducted. Narcotic consumption was documented with phone and in-office follow up surveys on postoperative days (PODs) 5, 10, 14, and 42. Additional data collected included age, gender, BMI, payer status, education level, preoperative pain level, procedure performed, opioid exposure in the 12 months preceding surgery, and the amount of narcotic prescribed postoperatively. Prescription information was collected utilizing the state Prescription Monitoring Program (PMP) database.

RESULTS: The median number of opioids prescribed postoperatively was 42 pills (range, 0-166). Overall, the median postoperative reported opioid consumption was 31.5 pills, (75.8% utilization rate). At final follow-up, 91% of patients had discontinued opioid use and 72.2% reported having leftover pills. The median number of pills consumed was greatest in the hindfoot/ankle region (40 pills), followed by the midfoot region (17.5 pills), and the forefoot region (11 pills) ($p = 0.08$). Preoperative VAS pain score ($p = .005$) and the quantity of pills prescribed at the first prescription ($p < 0.0001$) were significantly associated with increased narcotic consumption.

CONCLUSIONS: We found the median number of opioids consumed following outpatient foot and ankle surgery was 31.5 pills. The majority of patients had leftover pills, while maintaining adequate pain control. Region of surgery, preoperative pain level, and the number of pills provided at the first prescription were predictive of increased narcotic usage.

Treatment of Ankle Arthritis: A Long-Term Follow-Up

Abstract ID: Paper 078

---

*Luke Winkel, B.S. / Grand Rapids, MI
Matthew J. Pate, B.S. / Grand Rapids, MI
Alexander B. Sawatzke, M.D. / Seattle, WA
Jacob T. Hall, B.S. / Grand Rapids, MI
Leland E. Gossett, M.D. / Grand Rapids, MI
Bruce J. Sangeorzan, M.D. / Seattle, WA
Michelle A. Padley, M.S. / Grand Rapids, MI
Lindsey A. Behrend, B.S. / Grand Rapids, MI
John G. Anderson, M.D. / Grand Rapids, MI

BACKGROUND: Ankle arthritis is a debilitating disease that can be compared to hip arthritis. Ankle arthritis is usually caused by post-traumatic or secondary arthritis, making primary OA of the ankle much less common than the knee or hip. Despite differences in etiology, ankle arthritis is frequently treated similarly. While arthrodesis has been the gold standard for treatment in the past, there has been an increase in utilization of total ankle arthroplasty (TAA) due to improvements in implant design and improved gait and motion preservation when compared to arthrodesis. However, this comes at the cost of increased re-operation and less certainty with long-term durability. Our study addresses the surgical management of ankle arthritis with long-term comparison of TAA and arthrodesis.

METHODS: A multi-center prospective short-term follow-up comparing arthrodesis and two generations of TAA has already been completed. The original study included 273 patients, 103 with arthrodesis and 170 with arthroplasty, from 2005-2011. Patients were evaluated at baseline, 6, 12, 24, and 36 months, where they completed a pain score, Musculoskeletal Function Assessment and a Short Form-36 survey. Patients are currently 7-13 years postop, and we have begun contacting them. We will complete an initial analysis of our current responses to score the SF-36, pain scores, and re-operation rates.

RESULTS: In the short-term follow-up study, mean improvements in MFA and SF-36 Physical Function scores over the 3-year-period were significantly better in the TAA group compared to the ankle arthrodesis group (3.6 ± 1.6 [p=0.023] for MFA and 7.5 ± 2.9 [p=0.0098] for the SF-36 PF scale). When comparing only newer TAA devices to arthrodesis, MFA and SF-36 PF score improvements were even greater, with improved pain scores as well (0.8 ± 0.4 [p+0.038]). Longterm SF-36 and pain scores will be reported on patients that continue to respond, and reoperation rates will also be reported.

CONCLUSION: While both arthrodesis and TAA exhibited significant mean improvement in most outcomes after surgery, mean improvements in the MFA and SF-36 PF scores over the 3-year-follow-up were significantly better for TAA over arthrodesis. We expect that the long-term data will reveal maintained or improved patient reported outcomes in the ankle arthroplasty group, at the cost of increased re-operation rates.

Accuracy of Talonavicular Injection Using Ultrasound vs. Anatomical Landmark: A Cadaver Study

Abstract ID: Paper 079

Aaradhana J. Jha, M.D.
Leonardo Moraes, M.D.
*Jared R. Halstrom, B.S.
John C. Prather, II, M.D.
Gean C. Viner, M.D.
Bradley K. Alexander, B.S.
Haley McKissack, B.S.
James R. Jones, B.S.
Ashish B. Shah, M.D.
Francisco J. Caycedo, M.D.
Birmingham, AL

INTRODUCTION: Intra-articular injections play diagnostic as well as therapeutic roles in foot and ankle pathologies owing to the complex anatomy, small size, diverse bones and joints with close proximity in this region. Conventionally, these injections have been carried out using the anatomical landmark technique and/or under fluoroscopic guidance. The small joint space and needle size make the injection challenging. Fluoroscopy is not readily available in the clinical setting, and ultrasound guidance for injections is, therefore, increasingly being used in these settings. The purpose of this cadaveric study was to compare the accuracy of intra-articular talonavicular injections using the anatomical landmark technique versus ultrasound guided method.

METHODS: The study was carried out in 10 foot and ankle cadaveric specimens that were harvested transversely at mid-calf level. The foot was held in neutral position by an assistant while a fellowship-trained foot and ankle orthopedic surgeon injected 2 cc of radiopaque dye using the anatomical landmarks and palpation method in 5 specimens. Same amount of radiopaque dye was injected in the remaining 5 specimens under ultrasound guidance. The needles were left in situ in all specimens and intraarticular placement was confirmed fluoroscopically.

RESULTS: In 4 out of the 5 specimens injected under ultrasound guidance, the needle was found to be in the joint under fluoroscopic examination. Fluoroscopic data for one specimen injected under ultrasound guidance could not be obtained due to missing film. All 5 needles injected by palpation method were found to be out of the joint, with one injected into the naviculo-cuneiform joint.

Ultrasound-guided intra-articular injections were found to be significantly superior in terms of accuracy to the ones injected by palpatory method alone.

CONCLUSION: Intra-articular injections of the foot and ankle have considerable diagnostic as well as therapeutic values. Although injections using anatomical landmarks and palpation are easily performed at the office set-up, correct placement of the needle cannot be confirmed. Ultrasound guided injections cannot only confirm correct needle placement, but can also delineate any tendon and/or joint pathology simultaneously.

Effectiveness of the Saline Load Test in Diagnosis of Traumatic Ankle Arthrotomies

Abstract ID: Paper 080

---

*Erin E. Ohliger, M.D. / Cleveland, OH
James E. Ohliger, M.D. / Akron, OH
Assem Sultan, M.D. / Cleveland, OH
Sara Lyn Miniaci-Coxhead, M.D. / Cleveland, OH

BACKGROUND: Limited studies have been conducted to determine the minimum amount and sensitivity of the saline load test of the ankle. Prior studies, only performed in arthroscopic models, have suggested a wide range of volumes necessary to confirm arthrotomy. The purpose of this study was to investigate the amount of fluid required and the sensitivity of the saline load test to identify an intra-articular arthrotomy of the ankle. Using cadavers without prior ankle trauma or surgeries, we aim to assess volume needed to detect ankle arthrotomies at varying arthrotomy locations. We hypothesized that the volume needed would vary based on site of arthrotomy.

METHODS: Twenty thawed, fresh-frozen below knee cadavers were divided into four groups based on arthrotomy location. An ankle arthrotomy was made using a 4 mm trochar at the four standard ankle portal sites; anteromedial, anterolateral, posteromedial, and posterolateral. To confirm intra-articular location, an arthroscope was inserted for direct visualization of the ankle joint. An 18-gauge needle was then inserted into the ankle joint, and saline mixed with methylene blue was injected. During the injection, the known arthrotomy site was viewed for extravasation. Amount of saline required to diagnose arthrotomy was recorded. All injections were confirmed as intra-articular by demonstrating methylene blue staining of the anterior joint.

RESULTS: The saline volume required to achieve extravasation ranged from 3 mL to 11 mL. The median saline volume required to achieve extravasation was 5.3 mL. A total of 8 mL was required to achieve 90% sensitivity, 10 mL for 95% sensitivity, and 11 mL for 99% sensitivity. For the anterolateral, anteromedial, posteromedial, and posterolateral arthrotomy sites the median saline volume needed to detect a traumatic arthrotomy was 5.2 ml, 6.2 ml, 5ml, and 4.8 ml respectively. There was no statistically significant difference in volume needed to detect arthrotomies across all four locations ($p=0.69$).

CONCLUSION: In this cadaveric model, an injection of 10 mL identified 95% of arthrotomies approximately 4 mm in size. No difference in volume needed to detect extravasation was found across all four arthrotomy locations. Prior studies performed in arthroscopic models with patients undergoing ankle arthroscopy may overestimate volume needed to detect arthrotomies.

AP Screw Fixation for Posterior Malleolus Fractures: A Cadaver Study

Abstract ID: Paper 081

Haley M. McKissack, B.S.
Jonathan Yu, M.D.
Jun Kit He, M.A.
Tyler Montgomery, B.S.
Leonardo Moraes, M.D.
Gean C. Viner, M.D.
Ashish B. Shah, M.D.
*Charles R. Sutherland, B.S.
Birmingham, AL

BACKGROUND: Percutaneous anterior-posterior (AP) screw is an option for posterior malleolus fracture fixation when the fracture fragment can be reduced indirectly by the mean of ligamentotaxis. However, anterior anatomic structures could be injured during screw placement. We assessed this risk in cadavers.

METHODS: Eleven below-knee cadavers were employed for the placement of AP screws in an attempt of fixing assumed Haraguchi Type-I posterior malleolar fractures. Three entry point, medial, middle, and lateral, were selected as medial to the tendon of tibialis anterior (TAT), lateral to the TAT, and lateral to the extensor digitorum longus (EDL). On each cadaver, three AP screws were placed under the guidance of fluoroscopy. After dissection, measurements were made (mm) from each screw to nearby structures. Mean, minimum, maximum distances, and 95% confidence intervals were calculated. Instances of damage to the structures were recorded.

RESULTS: Mean, minimum, and maximum distances from the medial screw to the saphenous vein, TA, EHL, anterior tibial artery (ATA), and deep peroneal nerve (DPN), were 18.1 (12-25) mm, 2.0 (0-5) mm, 13.6 (9-20) mm, 16.6 (9-25) mm, and 20.1 (12-27) mm. From the middle screw to the ATA, DPN, TA, EHL, and EDL, were 1.2 (0-3) mm, 4.9 (3-9) mm, 3.8 (1-7) mm, 0.4 (0-2) mm, and 13.6 (10-18) mm. From the lateral screw to the superficial peroneal nerve (SPN), EDL, DPN, and ATA, were 10.8 (0-16) mm, 1.2 (0-4) mm, 15.9 (11-25) mm, 19 (15-27) mm. The SPN was found partially cut by the lateral screw on 1 specimen. The middle screws were adjacent to the ATA and DPN without damaging to them.

CONCLUSION: Lateral and middle percutaneous AP screw placement put certain anatomic structures at-risk of injury. Medial screw placement did not result in appreciable damage to adjacent structures. Entry point of AP screws should be selected with respect to posterior malleolar fracture and anatomic structures. Meticulous dissection should be performed when placing anteroposterior screws.

Key Words: Posterior malleolus fracture, anterior-posterior screw, cadaver, iatrogenic injury

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 24, 2020

Is There an Optimal Dilution of Liposomal Bupivacaine In Multimodal Pain Management after Rotator Cuff Repair?

Abstract ID: Paper 082

Ravi T. Rudraraju, M.D. / Weston, FL
Kiran Chatha, M.D. / Miami, FL
Mauricio Drummond, Jr., M.D. / Weston, FL
*Wilfredo J. Borroto / San Juan, Puerto Rico
Vani J. Sabesan, M.D. / Boca Raton, FL

BACKGROUND: Arthroscopic rotator cuff repairs are one of the most painful orthopedic procedures and it has been established that postoperative pain management can be difficult. Liposomal bupivacaine has been an addition to this multimodal pain management that has been shown to be effective in reducing pain, narcotic consumption, and hospital length of stay in shoulder arthroplasty, but limited literature exists on its application to RCR. The purpose of this study was to identify the optimal of LB to assess the optimal dilution for pain control and decreased opioid consumption.

METHODS: A prospective RCT was conducted with 39 patients undergoing RCR randomized into 40mL or 60mL dilution of LB with saline. Patient-reported pain scores, opioid consumption, and opioid related side-effects were recorded at 24, 48, and 72 hours, and 7 days. Opioids consumed were converted to total morphine equivalents (TMEs) and Student's t-tests were performed to compare between groups.

RESULTS: There were 27 males with an average age of 59.2 years, BMI of 28.68, and ASA class of 2.07 in the cohort. There were no significant differences between groups in demographic variables. Twenty-one patients were included in the 40mL group and 18 were included in the 60mL group. Our results showed there were no significant differences in pain scores between the groups at 24, 48, and 72 hours ($p>0.05$). There was a significant difference in opioid consumption between the two groups postoperatively, with the 40mL group being less (at 15 TMEs) compared to the 60mL group (37.5 TMEs)($p<0.05$).

CONCLUSION: Our results demonstrated that adequate pain control can be achieved with LB as part of multimodal pain control in RCR, the optimal dilution appears to be 40mL (20mL LB and 20mL of saline) to reduce the need for postoperative opioids.

Forearm Position Matters During Eccentric Shoulder Exercises: An EMG Recruitment Study with Implications for Rehabilitation

Abstract ID: Paper 083

Corbin A. Hedt, PT
*Bradley S. Lambert, Ph.D.
Jentry M. Pearson, PT
Joshua Daum, B.S.
Patrick C. McCulloch, M.D.
Houston, TX

STUDY DESIGN: Prospective randomized descriptive study

BACKGROUND: Eccentric exercise has demonstrated great utility in the rehabilitation of various shoulder pathologies. Research on the electromyographic (EMG) activity of the shoulder musculature during these activities is limited, however. Furthermore, no studies have observed how forearm positioning during exercise affects EMG output.

OBJECTIVES: Investigators wanted to examine the degree of specific muscle recruitment between commonly used eccentric exercises in rehabilitation of the upper extremity and shoulder. Secondly, hand/forearm positions were varied throughout the exercises to determine if differences exist in amplitude of EMG activity within the targeted musculature.

METHODS: This observational study analyzed EMG data obtained from 10 healthy individuals during 5 randomized eccentric exercises of the dominant extremity. Each exercise was performed with 2-3 forearm position variants, including neutral, pronation, or supination. EMG collection was from the upper trapezius, infraspinatus, teres minor, latissimus dorsi, and anterior/middle/posterior deltoid. Data were analyzed using a mixed-model ANOVA repeated across forearm positions for each exercise followed by a Tukey's post hoc test for pairwise comparisons.

RESULTS: Significant differences in EMG activity for the selected musculature exist between forearm positions for 4 of the 5 exercises with $p < 0.05$ and Cohen's d effect sizes 0.178 – 1.159.

CONCLUSION: Specific eccentric shoulder exercises activate muscles of the shoulder complex differently based on forearm positioning. This data provides rehabilitation professionals with information to more selectively and efficaciously prescribe exercises for the shoulder.

Level of Evidence: Level 2

Key Words: upper extremity, strength, muscle activity, EMG, rotator cuff

Short-Term Outcomes of Surgical Intervention for Massive Rotator Cuff Tear: An Institutional Comparison of Superior Capsular Reconstruction, Partial Arthroscopic Repair, and Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 084

---

*Travis Frantz, M.D.
Andrew Mundy, M.D.
Saul Fredrickson, M.D.
Joshua S. Everhart, M.D., M.P.H.
Gregory L. Cventanovich, M.D.
Andrew S. Neviaser, M.D.
Grant L. Jones, M.D.
Julie Y. Bishop, M.D.
Columbus, OH

INTRODUCTION: The management of massive and irreparable rotator cuff tears remains a challenge for orthopedic surgeons. Multiple surgical options exist to address this pathology. The purpose of this study was to (1) determine complications and if there is any significant loss of range of motion (ROM) or strength following surgical intervention for massive rotator cuff tear; and (2) to determine any outcome differences between superior capsular reconstruction (SCR), partial arthroscopic repair (PR), and reverse total shoulder arthroplasty (rTSA).

METHODS: A retrospective chart review of all patients at a single institution having undergone surgical intervention with a primary diagnosis of massive rotator cuff tear from January 1, 2006, to January 1, 2018, was conducted. Surgical groups included SCR, PR (margin convergence), and rTSA. Patients with evidence of cuff arthropathy or humeral head migration were excluded; thus, those undergoing rTSA had no evidence of cuff arthropathy or arthritis. Demographic data and pre- and postoperative measures of ROM and strength were recorded for forward flexion (FF), internal rotation (IR), and external rotation (ER).

RESULTS: 123 patients met inclusion criteria (SCR n=41; PR n=30; rTSA n=52). Patients undergoing rTSA were older (median SCR – 57.0; median PR – 59.0; median rTSA – 66.0 ; $p<0.001$), but otherwise there was no difference between groups in duration of preoperative symptoms, prior surgery, smoking status, or presence of diabetes ($p>0.05$). There was also no difference in length of follow-up (median SCR – 240 days; median PR – 282 days; median rTSA – 295 days; $p=0.327$). All patients receiving surgical intervention for massive cuff tear demonstrated significant improvement in postoperative strength in all planes compared to preoperative measurements ($p<0.002$ for all). The SCR group experienced a 7.3% complication rate, partial repair 3.3%, and rTSA 13.5%. In the SCR group, two patients experienced persistent pain, with one improving after a 7-month postop subacromial injection, and the other requiring conversion to rTSA approximately 3 years postop. One additional patient suffered a fall and subsequent HAGL lesion. In the partial repair group, one patient was converted to rTSA at 15 months postop. In the rTSA group, there were 3 patients with persistent pain, 2 with acromial stress fractures (1 ORIF, 1 non-op), 1 with dislocation, and 1 with severe stiffness.

When comparing between groups, there were no significant differences in postoperative strength (FF $p=0.35$; IR $p=0.47$; ER $p=0.06$). In regards to ROM, patients undergoing SCR or rTSA demonstrated improved FF compared to preoperative measures (SCR – 121.6° vs. 148.2°; $p=0.004$; rTSA – 107.8° vs 137.7°; $p<0.001$). Those undergoing PR did not have

significantly improved postoperative ROM in any plane (FF p =0.162; IR p =0.337; ER p=0.076). When comparing ROM between groups, patients undergoing PR had significantly better baseline FF (140.8°) and IR (35.5°) than those selected for rTSA (FF – 107.8° p=0.007; IR – 26.7° p=0.002), and this was redemonstrated postoperatively as well (FF – PR 153.5° vs rTSA 137.7° p =0.036; IR – PR 33.3° vs rTSA 26.8° p=0.002). Furthermore, rTSA had significantly worse ER postoperatively when compared to SCR or PR (SCR – 48.6°; PR – 50.4°; rTSA – 38.6°; p<0.001), despite no significant preoperative difference (p=0.183).

DISCUSSION AND CONCLUSION: SCR, PR, and rTSA for massive rotator cuff tear all significantly improved postoperative strength. SCR and rTSA also improved postoperative FF and IR. Between groups, PR had better baseline ROM than rTSA, and this was redemonstrated postoperatively. rTSA had decreased postoperative ER compared to SCR or PR, as well as the highest complication rate overall.

The Effect of Shoulder Range of Motion on Arm Stress in College Pitchers: A MOTUS Baseball Study

Abstract ID: Paper 085

---

*Lafi S. Khalil, M.D.
Caleb M. Gulledge, B.S.
Toufic R. Jildeh, M.D.
Joseph S. Tramer, M.D.
Fabien Meta, M.D.
Kevin Taylor, M.D.
Grace Smith, B.S.
Eric C. Makhni, M.D., M.B.A.
Kelechi R. Okoroha, M.D.
Vasilios Moutzouros, M.D.
Detroit, MI

BACKGROUND: Overuse injuries in overhead athletes are becoming more prevalent, with an unclear relationship between shoulder biomechanics and medial elbow symptoms and injury. The purpose of this study was to investigate the relationship of shoulder range of motion to torque across the medial elbow in college pitchers using a validated MOTUS sensor baseball sleeve.

METHODS: Pitchers were recruited from three local university baseball teams. Exclusion criteria included injury or restricted activity due to pain. They were evaluated in the preseason, within two weeks before their first game of the season. Pitchers completed workload questionnaires and patient reported outcome measurement information system (PROMIS) pain interference (PI), physical function (PF), and upper extremity (UE) surveys. Shoulder range of motion and upper extremity lengths were measured bilaterally. After adequate warm-up, pitchers were fitted with a MOTUS sensor baseball sleeve and instructed to throw 5 fastballs in a standardized manner off the mound at game-speed effort. The sensor placed at the medial elbow reported elbow torque, arm speed, arm slot, and shoulder rotation for each pitch, while a radar gun measured peak ball velocity. The primary outcome was to evaluate the relationship between shoulder range of motion and increased stress across the medial elbow. Additional outcomes evaluated pitcher characteristics, demographics, and outcome scores. Outcomes were assessed via a multivariable model, which controlled for possible covariates.

RESULTS: Twenty-eight pitchers were included in the preseason analysis with an average (SD) age of 20.1 (1.3) years and playing experience of 15.3 (1.8) years, 2.5 (1.2) of those years at collegiate level. The dominant shoulder demonstrated decreased internal rotation (54.5+/-10.6 vs. 65.8+/-9.1) and increased external rotation (94.1+/-10.4 vs. 88.4+/-9.2) relative to the non-dominant side ($p < 0.001$), while total rotational range of motion (TRROM) was significantly decreased in the dominant arm (148.6+/-12.4 vs. 154.1+/-10.6, $p < 0.001$). The average glenohumeral internal rotation deficiency (GIRD) was 11.25 (9.87) and average external rotation gain (ERG) was 5.71 (8.8). Average arm stress (46.09+/-0.48) and arm rotation was (151.40+/-1.16) as measured by the MOTUS sleeve correlated with years played, $r = 0.43$ and $r = 0.40$ ($p < 0.001$), respectively. External rotation was found to be a predictor of arm stress (beta = 0.35+/-0.11, $p = 0.003$). ERG greater than 10° as compared to less than 5° was significantly associated with decreasing pitching velocity (75.5+/-0.8 vs. 77.4+/-0.5 mph, $p = 0.047$), decreasing arm speed (846.6+/-12.5 vs. 898.4+/-8.9), and decreased arm slot (38.6+/-2.9 vs.

46.4+/-2.1, p = 0.032). Decreased arm speed was associated with loss of TRROM greater than 5°, ERG greater than 10°, and GIRD less than 15° ($p<0.05$). GIRD greater than 20° as compared to less than 15° was associated with decreased shoulder rotation (140.3+/-3.7 vs. 151.7+/-1.2, $p < 0.001$). Multivariate analysis demonstrated significant predictors of PROMIS PF and UE scores were arm stress, ERG, and GIRD ($p<0.05$), while increased PROMIS PI scores were predicted by increased ERG and GIRD ($p<0.05$).

CONCLUSIONS: We found medial elbow stress, arm speed, arm slot, and shoulder rotation as measured by the MOTUS baseball sensor sleeve were influenced by rotational adaptations of the pitching shoulder in collegiate throwing athletes prior to their season. Likewise, arm stress and shoulder rotational adaptations were reflected as predictors of PROMIS PF, UE, and PI scores.

Level of Evidence: Descriptive Cross-Sectional Study

Lateral Elbow Overuse Injuries in Pediatric Female Gymnasts: A Comparison of Radial Head Stress Fractures and Capitellar OCD

Abstract ID: Paper 086

---

*William C. Searls, B.S.
Chuck W. Wyatt, CPNP
Aaron J. Zynda, B.S., CCRP
Henry B. Ellis, M.D.
Philip L. Wilson
Dallas, TX

BACKGROUND: Radial head stress fractures (RHSF) and capitellar osteochondritis dissecans (OCD) are rare and may be seen in pediatric gymnasts. Clinical and radiographic factors correlating with these differential lesions are unclear.

PURPOSE: To describe the clinical presentation of RHSF and compare the demographic, radiographic, and clinical characteristics of elbows in pediatric gymnasts presenting with either RHSF or OCD of the capitellum.

METHODS: An IRB-approved retrospective review of female gymnasts presenting with RHSF or capitellar OCD over a 5-year period (1/2014-2/2019) was performed. Gymnasts <18 years old at the time of presentation with signs of a radial head stress fracture (Salter-Harris III or IV) or with diagnostic features of capitellar OCD were included. Those with congenital anatomic elbow abnormalities or prior ipsilateral elbow surgery were excluded. Patients were dichotomized into either the RHSF or OCD group. Demographic, radiographic, and clinical characteristics were compared. Statistical analysis was performed using a Mann-Whitney test for continuous variables and a chi-square test for categorical variables.

RESULTS: Forty-five patients (9 with bilateral OCD, 1 with bilateral RHSF, and 3 with each lesion in alternate elbows), contributing 58 elbows, met inclusion criteria. Thirty-nine elbows in the OCD group and 19 elbows in the RHSF group were studied. Average age was 11.58 years (9-16 years), with no difference between groups (OCD: 11.47 vs. RHSF: 11.78; $p=0.34$). No differences in height, weight, BMI, or laterality were noted. Gymnasts presenting with RHSF were competing at a higher level than those with OCD, with 94.74% of RHSF group competing at level 7 or greater compared to 66.67% of OCD patients ($p=0.02$).

Compared to those with OCD, the RHSF group presented more acutely following onset of symptoms ($p=0.014$), reported significantly more pain with valgus stress ($p<0.001$), and concurrent medial elbow pain than those with OCD ($p<0.01$).

The RHSF group demonstrated significantly smaller distal humeral width and decreased height of the proximal radial epiphysis, as well as increased valgus angulation of the radial neck shaft angle ($p<0.01$). No differences in olecranon or medial epicondyle hypertrophy, or avulsive changes were identified.

CONCLUSION: Gymnasts competing at a high competitive level and presenting more acutely may be at risk for RHSF. Additionally, differing anatomy in the lateral elbow may be a predisposing risk factor for RHSF as opposed to OCD and merits further investigation.

The Impact of Resident Involvement on Postoperative Complications Following Shoulder Arthroscopy

Abstract ID: Paper 087

---

*Trevor R. Gulbrandsen, M.D.
Zain M. Khazi, B.S.
Alan G. Shamrock, M.D.
Qiang An, M.B.B.S., M.P.H.
Kyle R. Duchman, M.D.
J. Lawrence Marsh, M.D.
Robert W. Westermann, M.D.
Brian R. Wolf, M.D., M.S.
Iowa City, IA

INTRODUCTION: Arthroscopy is an essential component to orthopedic resident training. While other surgical specialties (general surgery, ophthalmology, neurosurgery) have demonstrated varied results with associated complications and resident involvement, previous studies have demonstrated that resident involvement is not associated with increased short-term complications after common orthopedic surgeries. However, the impact of resident involvement on complications following shoulder arthroscopy is poorly understood. Our purpose is to evaluate shoulder arthroscopic procedures and how resident involvement impacts intraoperative variables and postoperative complications.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program registry was queried to identify patients who underwent common shoulder arthroscopy procedures 2005 through 2012. Patients with a history of shoulder arthroplasty, treatment for septic arthritis or osteomyelitis of the shoulder, or concomitant open or mini-open procedures were excluded from the study. A 1:1 propensity score match was utilized based on age, sex, body mass index (BMI), smoking history, and American Society of Anesthesiologist (ASA) classification to match resident involvement cases to attending only cases. Patient demographics, comorbidities, and 30-day postoperative complications were analyzed. Poisson regression analysis were used to compare operative time between the two groups, with statistically significance defined as $p<0.05$.

RESULTS: Overall, 15,857 patients that underwent shoulder arthroscopy were identified, of which 36.9% (n=5,858) were excluded. After propensity score matching, 3,474 cases (50% with resident involvement) were included in the study. Both groups were similar in age (p=0.58), sex (p=0.92), BMI (p=0.91), diabetes mellitus (p=0.52), chronic obstructive pulmonary disease (p=0.33), smoking history (p=0.59), and ASA classification (p=0.37). The overall rate of 30-day complications was similar in the attending only (0.92%) group compared to the resident (0.75%) group (P=0.58). There was no significant difference in postoperative surgical complications including superficial wound infection (p=1.00), deep wound infection (p=1.00), neurological deficit (p=1.00), or blood transfusion (p=1.00). Furthermore, there was no significant difference in postoperative medical complications including pulmonary embolism (p=0.22), deep vein thrombosis (p=0.25), urinary tract infection (p=1.00), pneumonia (p=1.00), or sepsis (p=1.00). Shoulder arthroscopy cases with resident involvement had significantly longer operative time (75.9 minutes vs. 75.1 minutes, p=0.03) when compared to cases performed without a resident.

CONCLUSIONS: Resident involvement in shoulder arthroscopy procedures is not a significant risk for medical or surgical 30-day postoperative complications. Resident participation in shoulder arthroscopy cases did increase operative time, however, this finding is likely clinically insignificant. This information is valuable for resident education and patient reassurance.

The Relationship Between Laxity and Injury Severity in Patients Undergoing Anterior Shoulder Stabilization Surgery

Abstract ID: Paper 088

Jacqueline E. Baron, B.A. / Marlboro, NJ
Kyle R. Duchman, M.D. / Iowa City, IA
Carolyn Hettrich, M.D., M.P.H. / Boston, MA
Natalie Glass, Ph.D. / Iowa City, IA
Shannon Ortiz, M.P.H. / Iowa City, IA
MOON Shoulder Group
*Brian R. Wolf, M.D., M.S. / Iowa City, IA

BACKGROUND: Recognition and appropriate treatment of glenoid and humeral head bone loss has been increasingly indicated as an important factor to reduce recurrent instability. The purpose of this study was to investigate the relationship between glenohumeral translation as assessed during examination under anesthesia (EUA) and the degree of bony and soft tissue injury identified at the time of surgery for patients undergoing anterior shoulder stabilization surgery.

METHODS: This study utilized the Multicenter Orthopaedic Outcomes Network (MOON) Shoulder Group dataset to investigate patients undergoing anterior shoulder stabilization surgery between November 2012-September 2018. Surgeons measured glenohumeral translation during examination under anesthesia (EUA) using a standardized protocol and grading system (0, 1+, 2+, or 3+). Demographic and injury characteristics including labral tear length, duration of injury, and the number of times dislocated in the previous year were analyzed (chi-square for categorical variables; t-tests or Wilcoxon rank sum tests for continuous variables). Logistic regression was used to assess whether the odds of injury severity (glenoid bone loss >10% or Hill-Sachs Lesions [HSL] >20%) increased based on EUA translation.

RESULTS: A total of 711 participants, including 137 females (19.3%), with a median age of 22 (min-max:12-66) years and a mean BMI of 25.3 ± 4.3 kg/m^2 were included in analyses. There were 68 (9.6%) participants with >10% glenoid bone loss, 19 (2.7%) participants with HSL >20% of the humeral head, 80 (11.8%) participants with a Beighton score ≥4 and the median labral tear length was 126° (min-max: 0-360°). EUA scores were positively associated with greater odds of glenoid bone loss > 10% (Odds Ratio [OR] 2.18, 95% CI 1.44-3.29, p<0.01); HSL > 20% (OR 2.48, 95% CI 1.16-5.31, p<0.02), Beighton score ≥4 (OR 1.75, 1.20-2.55, p<0.01) and ≥2 dislocations in past year (OR 1.62, 95% CI 1.27-2.06, p<0.01), but not an injury of >3 month duration (OR 0.92, 95% CI 0.71-1.19, p< 0.51).

CONCLUSIONS: Participants undergoing anterior shoulder stabilization surgery with greater glenohumeral translation more frequently presented with >10% glenoid bone loss and an HSL measuring >20% of the humeral head. Self-reported dislocations ≥2 and Beighton score ≥4 were positively associated with increasing EUA grade. These findings provide important information for surgical planning to reduce the risk of recurrent instability, particularly for at-risk individuals.

Level of Evidence: III

Anterior Shoulder Instability: Outcome of Initial Nonoperative Treatment in 739 Patients with a Mean Follow-Up of 15 Years

Abstract ID: Paper 089

---

*Nicholas C. Duethman, M.D.
Christopher D. Bernard, B.S.
Devin P. Leland, B.S.
Lucas K. Keyt, B.S.
Aaron J. Krych, M.D.
Diane L. Dahm, M.D.
Christopher L. Camp, M.D.
Rochester, MN

BACKGROUND: Rate of recurrence of anterior shoulder instability varies widely throughout the literature. There remains a paucity of data describing the natural history of shoulders treated nonoperatively following an index anterior instability event.

HYPOTHESIS/PURPOSE: The purpose of our study was to: (1) Define the success rate of initial nonoperative treatment for anterior shoulder instability (2) Describe the long-term outcomes of nonoperative treatment, and (3) Describe factors that predict conversion to surgery after initial nonoperative management.

STUDY DESIGN: Cohort study; Level of evidence, 3

METHODS: The Rochester Epidemiology Project database was utilized to retrospectively identify patients under the age of 40 treated for anterior shoulder instability between January 1, 1994, and July 31, 2016. Patient demographics, comorbidities, injury characteristics, instability history, activity level, x-rays, advanced imaging, treatment course, and outcomes were evaluated. Patients treated nonoperatively for the first six months following index instability event were analyzed to determine success rate of continued nonoperative treatment, long-term outcomes, and factors predicting conversion to surgery.

RESULTS: 739 patients met criteria with average follow-up of 190 months (range 0.13 to 490 months). Average age was 23.8, mean BMI was 25.6, 9.1% had a history of hyperlaxity, and 83.9% of instability events were due to trauma. 29.7% of patients had a Hill-Sachs lesion on index x-ray, and 6.3% had a bony Bankart. 198 shoulders went on to operative treatment (26.8%) with a mean time to surgery of 62.7 months following initial instability event. At final follow-up, 24.0% reported mild pain, 6.2% as moderate, 0.2% as severe. 16.0% of patients had evidence of glenohumeral arthritis on final follow-up x-rays compared to 1.6% on initial radiographs. Factors associated with conversion to surgery included 2 or more dislocations prior to first clinical evaluation (RR=1.75, $p<0.01$), labor intense occupation (RR=1.49, $p=0.03$), Hill Sachs lesion on index x-ray (RR=1.31, $p=0.03$), and MRI findings including: anteroinferior labral tear (RR=2.15, $p<0.01$), posteroinferior labral tear (RR=1.38, $p=0.05$), SLAP tear (RR=1.29, $p=0.05$), Hill-Sachs lesion (RR=1.85, $p<0.01$), glenohumeral ligament tear (RR=1.1, $p=0.01$), and glenohumeral cartilage injury (RR=1.26, $p=0.04$).

CONCLUSIONS: The majority of patients are treated with continued nonoperative treatment after initial 6-month episode of nonoperative treatment. A small proportion will report pain over the long-term and/or develop glenohumeral arthritis. Multiple factors upon initial evaluation are

associated with conversion to surgical treatment including number of prior instability events, occupation, and soft tissue injury pattern on MRI.

Key Terms: Anterior shoulder instability, Hill-Sachs, Bankart, dislocation

Should We Operate after a First Time Anterior Shoulder Dislocation? A Comparison of Pathology, Surgical Techniques, and Outcomes of Patients Undergoing Surgery after One vs. Multiple Dislocations

Abstract ID: Paper 090

Christopher D. Bernard, B.S.
*Bradley M. Kruckeberg, M.D.
Devin P. Leland, B.S.
Lucas K. Keyt, B.S.
Matthew D. LaPrade, B.S.
Aaron J. Krych, M.D.
Diane L. Dahm, M.D.
Jonathan D. Barlow, M.D., M.S.
Christopher L. Camp, M.D.
Rochester, MN

BACKGROUND: There has recently been a shift in approach to the optimal treatment for a first time anterior shoulder dislocation in high-risk patients, as some individuals may benefit from early surgical intervention. However, studies have provided conflicting results on whether or not to perform surgery after a single dislocation event.

PURPOSE: To compare the difference in pathology, surgical technique, and outcomes between patients treated surgically after a single dislocation event compared to those with multiple dislocations.

STUDY DESIGN: Cohort study; Level of evidence, 3

METHODS: The Rochester Epidemiology Project was utilized to identify all patients <40 years old undergoing surgery for anterior shoulder instability between January 1, 1994, to July 31, 2016, in a defined geographic area. Patient medical records were reviewed to obtain demographic information, patient history, physical exam findings, imaging findings, clinical progression, surgical details, and outcomes. Comparative analysis was performed between patients who had surgery following a single dislocation and those with multiple preoperative dislocations.

RESULTS: The study population consisted of 187 patients who had a single (n=55) or multiple (n=132) anterior shoulder dislocations prior to surgery. Mean follow-up was 103.3 months (range 0.3 – 328.4 months). Demographics were not significantly different between groups. While the presence of Hill-Sachs lesions on x-ray was more common for the multiple dislocation group (42.1%) compared to the single dislocation group (18.8%; p=0.005), there were no other significant differences in concomitant pathology between groups. Latarjet procedures were more commonly performed for the multiple dislocation group (12.5% vs. 2.1% for the single dislocation group, p=0.04). There were no other significant differences among surgical techniques and characteristics between groups. Survival free from recurrent instability (p=0.790), revision surgery (p=0.726), and from progression to symptomatic osteoarthritis (p=0.588) was not significantly different between groups.

CONCLUSION: Although patients with multiple dislocations prior to surgery were more likely to demonstrate radiographic evidence of Hill Sachs lesions, and undergo a Latarjet procedure

compared to those who received surgery after a single dislocation, no significant differences in outcomes with respect to recurrent instability, revision surgery or progression to symptomatic osteoarthritis were found between these two groups.

Keywords: anterior shoulder instability; Bankart; dislocation; shoulder; labrum

Risk Factors For Postoperative Opioid Use In Arthroscopic Shoulder Labrum Surgery

Abstract ID: Paper 091

Kevin A. Taylor, M.D. / Detroit, MI
Toufic R. Jildeh, M.D. / Detroit, MI
Lafi S. Khalil, M.D. / Detroit, MI
*Joseph S. Tramer, M.D. / Detroit, MI
Laith Hasan, B.S. / New Orleans, LA
Kelechi R. Okoroha, M.D. / Detroit, MI
Vasilios Moutzouros, M.D. / Detroit, MI

PURPOSE: Opioid medications are frequently used to manage postoperative pain in arthroscopic shoulder labral surgery. The purpose of this study was to determine the correlation between pre- and postoperative opioid use in patients undergoing arthroscopic labral surgery, as well as patient risk factors associated with increased postoperative opioid use following the procedure.

METHODS: A retrospective review of all patients undergoing arthroscopic shoulder labral surgery at a single institution between August 2013 and November 2017 was performed. Patients were stratified as opioid non-users, acute users, and chronic users based on preoperative consumption. Patient demographics, injury characteristics, surgical interventions, and postoperative opioid use for the first 12 months after surgery were then analyzed. Prescriptions were corroborated using a state-based prescription monitoring program.

RESULTS: A total of 340 patients were included. The average age was 26.3 years old (range 13-68) and the average body mass index was 27.5 kg/m^2 (range 18.4-45.0). Preoperative opioid users (acute and chronic) were found to require opioid medications for extended time points beyond 2 months postoperatively compared to non-users ($P < .001$). Accordingly, total postoperative refill counts were significantly higher as chronicity of preoperative opioid use increased. Patients with intraoperatively identified SLAP tears experienced significantly more preoperative pain, leading to greater postoperative opioid prescription totals in this group ($P < .018$). Upon stratifying for other subtypes of sequalae, there were no differences between the number of postoperative opioid prescriptions filled and incidence of Bankart, Hill Sachs, Reverse Hill Sachs, anterior labroligamentous periosteal sleeve avulsion, glenolabral articular disruption, or humeral avulsion of the glenohumeral ligament lesions, ($P > .05$).

CONCLUSION: In patients undergoing arthroscopic labral surgery, the chronicity of preoperative opioid use and presence of a SLAP tear were found to significantly increase postoperative opioid demand. Orthopedic surgeons should recognize these risk factors for increased opioid use postoperatively and counsel their patients accordingly.

Perioperative Opioid Use Predicts Postoperative Opioid Use and Inferior Outcomes after Shoulder Arthroscopy

Abstract ID: Paper 092

---

*Matthew R. Cohn, M.D.
Yining Lu, B.S.
Alexander Beletsky, B.S.
Bhavik H. Patel, B.S.
Jourdan Cancienne, M.D.
Michael Nemsick, B.S.
Adam B. Yanke, M.D.
Nikhil N. Verma, M.D.
Brian J. Cole, M.D.
Brian Forsythe, M.D.
Chicago, IL

HYPOTHESIS/PURPOSE: The purpose of this study is to define the impact of preoperative opioid use on postoperative opioid use, patient-reported outcomes, and revision rates in a cohort of patients receiving arthroscopic shoulder surgery.

STUDY DESIGN: Retrospective cohort study, Level III

METHODS: Patients who underwent shoulder arthroscopy were identified from an institutional database. Inclusion criteria were completion of preoperative and postoperative PROMs at one-year follow-up, in addition to a questionnaire on use of opioids and number of pills per day. One-year and two-year outcomes assessed included postoperative PROM scores, postoperative opioid use, persistent pain, and achievement of the patient acceptable symptomatic state. A stepwise multivariate logistic regression was performed to evaluate the impact of preoperative opioid use on achievement of postoperative outcomes while controlling for modifiable and non-modifiable risk factors. Receiver operating characteristic curves were used to establish threshold values in oral morphine equivalents (OME) that predicted each outcome.

RESULTS: A total of 247 (16.3%) were included in the opioid use (OU) group and 1,265 in the N-OU group. The OU and non-opioid use (N-OU) group demonstrated statistically significant differences in both preoperative and postoperative scores across all PROMs ($P<0.001$). Multivariate logistic regression identified preoperative opioid use as a significant predictor of reduced achievement of PASS (OR: 0.49, 95% CI: 0.29-0.83, $P = 0.008$), increased likelihood to endorse persistent pain (OR: 1.78, 95% CI: 1.09-2.91, $P=0.008$), increased opioid use at 1-year (OR: 23.53, 95% CI: 9.67-57.25, $P<0.001$), and increased risk of revision surgery (OR: 5.22, 95% CI: 1.83-14.92, $P<0.001$). ROC analysis found that total OME > 1,430 mg/day in the perioperative period (AUC: 0.71) or preoperative daily OME >32.5 predicted postoperative opioid consumption (AUC: 0.73), while total OME >396 in the perioperative period (AUC: 0.74) or daily OME >9 predicted revision surgery (AUC: 0.76).

CONCLUSIONS: Preoperative opioid use negatively impacts patients' level of satisfaction and is a significant predictor of pain, continued opioid usage, and revision surgery after shoulder arthroscopy. Patients with risk factors can be targeted for narcotic-sparing, multimodal pain management approaches with the potential to reduce the risk for long-term abuse and related adverse events.

Does an Early Mobilization Rehabilitation Protocol Influence Pain Scores and Opioid Consumption in Patients Undergoing Arthroscopic Rotator Cuff Repair?

Abstract ID: Paper 093

Mauricio Drummond, Jr., M.D. / Weston, FL
John Merriam, B.S. / Boca Raton, FL
*Conner Dalton, B.S. / Boca Raton, FL
Gregory Gilot, M.D. / Weston, FL
Vani J. Sabesan, M.D. / Boca Raton, FL

INTRODUCTION: The United States is facing a crisis with opioid medication misuse and abuse and efforts are being made to explore alternatives. Rotator cuff repairs (RCR) have increased in volume over the past decade, but the procedure has a reported slow and painful recovery. Recent literature suggests that early mobilization after a number of orthopedic surgeries may provide more rapid return of function and prevent stiffness, however, no studies have looked at effect on pain and opioid consumption specifically. The purpose of this study was to evaluate the impact of early mobilization rehabilitation program on pain scores, opioid consumption, and time to return to work following RCR.

METHODS: A prospective case-controlled study was performed on 65 patients who underwent RCR at a single institution by two fellowship-trained shoulder surgeons. Two groups included: immediate mobilization (IM) group (n=29) and delayed mobilization (DM) group which started PT progression after 4-6 weeks (n=36). Pain scores (NRS and ASES), time to return to work, opioid dependency, and consumption were recorded using total morphine equivalents (TME) per day from state prescription drug monitoring database preoperatively and postoperatively for all patients. Opioid dependence was defined as more than three consecutive months of opioid prescriptions. Demographic data were collected. Statistical analyses included Chi-square, Independent, and paired t tests.

RESULTS: Preoperatively there were no significant differences seen between groups for age ($p=0.26$), gender ($p=0.33$), BMI ($p=0.06$), opioid dependence (IM=7% vs DM=0%) ($p=0.11$), or opioid consumption (IM=20.18 TME vs. DM=10.22 TME) ($p=0.34$). The IM group had higher ASES scores for pain (29.35 vs. 17.05) ($p<0.01$) and lower NRS (4.1 vs. 6.6) ($p<0.01$) preoperatively. Postoperatively, there was no significant difference in NRS ($p=0.31$), ASES for pain ($p=0.15$), or time to return to work (1.88 vs. 2.21 weeks) ($p=0.08$). The opioid dependence rates (IM=13% and DM=19%) ($p=0.37$) and narcotic consumption (IM=64.7 TME vs. DM=85.3 TME) ($p=0.14$) were similar between the groups.

CONCLUSION: In the setting of the opioid crisis, especially with painful procedures like RCR, it appears that early mobilization is not effective in decreasing pain, opioid consumption, dependence, or time to return to work. When surgeons are deciding on proper rehab progression for a patient, they can focus on function and intraoperative assessments of the repair as early and delayed mobilization do not significantly affect patient pain levels or opioid consumption.

Outcomes Following Single vs. Double Hamstring Tendon Harvest for ACL Reconstruction

Abstract ID: Paper 094

---

*Patrick A. Nelson, B.S. / Chicago, IL
Alex Hu, B.S. / Chicago, IL
Cort D. Lawton, M.D. / Chicago, IL
Ryan S. Selley, M.D. / Chicago, IL
Patrick Sweeney, M.D. / Chicago, IL
John R. Tuttle, M.D. / Lexington, VA
Daniel J. Johnson, M.D. / Chicago, IL
Earvin S. Balderama, Ph.D. / Chicago, IL
Stephen M. Gryzlo, M.D. / Chicago, IL
Michael A. Terry, M.D. / Chicago, IL

PURPOSE: To compare isometric hamstring strength, knee laxity, functional outcomes, and patient reported outcomes between patients following ACL reconstruction with doubled semitendinosus and gracilis tendon autograft (ST/G) vs. quadrupled semitendinosus autograft (ST).

METHODS: Patients who underwent ACL reconstruction with ST/G or ST hamstring autografts with minimum one-year follow-up were retrospectively identified. Isometric hamstring strength was tested with a hand held dynamometer at 30, 60, and 90 degrees of knee flexion. Anterior knee laxity was assessed using a KT-1000 arthrometer. Functional outcomes were collected using the single leg hop test and single leg squat test. Side-to-side differences were determined and compared between the ST/G and ST groups. Patient-reported outcomes were collected on all patients.

RESULTS: Eighty-four patients who underwent ST/G (n = 34) or ST (n = 50) autograft ACL reconstruction were recruited to participate in this study. There was no difference in knee laxity between the groups. Side-to-side hamstring strength deficits increased with increased flexion angles. At 90° of flexion, the ST/G group had a significantly greater flexion strength deficit compared to the ST group (37.8 ± 15.1% vs. 24.7 ± 12.5%, P-value < 0.01). There was no significant difference in functional or patient-reported outcomes between the groups.

CONCLUSION: Patients who underwent ACL reconstruction with ST/G compared to ST autograft have a significantly greater isometric flexion strength deficit at 90° of flexion. This deficit does not appear to be clinically relevant.

Level of Evidence: IV

MAOA BREAKOUT SESSION #8
TRAUMA
April 24, 2020

Plate Assisted Bone Segment Transport Utilizing a Magnetic Intramedullary Limb Lengthening System: Five Patients

Abstract ID: Paper 095

Kory D. Blank, M.D.
Austin Beason, M.D.
*Erlena Josifi, M.D.
Matthew Riley
Matthew P. Gardner, M.D.
Springfield, IL

WHAT WAS THE QUESTION? Is plate-assisted bone segment transport using a magnetic intramedullary limb lengthening device effective as treatment of segmental bone defects of the tibia, and can it be performed in the antegrade and retrograde direction?

HOW DID YOU ANSWER THE QUESTION? Plate assisted bone segment transport (PABST) was performed on 5 patients (4 men, 1 woman) with a Gustilo-Anderson type IIIB tibia fracture by a single orthopedic surgeon at our institution. The average patient age at time of surgery was 45 (range = 23-76), average defect size was 5.63 cm (range = 2.25-9 cm), and average follow-up is 509.2 days (range = 177-1,201 days). Bone segment transport was done in both the antegrade (N = 3) and retrograde (N = 2) direction for distal and proximal tibial defects, respectively.

WHAT ARE THE RESULTS? All patients have successfully salvaged their post-traumatic lower limb. A plastic surgeon was required in all cases to perform complex closure as these injuries are highly associated with significant soft tissue damage. Three patients have achieved complete union and two patients continue to progress toward union. Technical pearls include: placement of a blocking screw can prevent nail drift, screw placement in the transport segment should be placed nearest to the docking site to reduce segment drift, and careful preoperative planning is essential to select nail length with adequate stroke. Complications resolved included: infection in one case requiring antibiotic bead placement, delayed union requiring exchange nailing and/or bone grafting, and intraoperative fractures during corticotomy.

WHAT ARE YOUR CONCLUSIONS? PABST is an effective means of limb salvage and treating post-traumatic segmental bone defects in the tibia. The ability to perform retrograde and antegrade transport offers increased usability of the intramedullary limb lengthening system in addressing tibial bone defects. Technical pearls learned can be valuable to surgeons considering PABST for bone defects.

Outcomes of Vancouver B Periprosthetic Femur Fractures Treated with Open Reduction and Internal Fixation Regardless of Prosthesis Loosening

Abstract ID: Paper 096

---

*Michael W. Perry, M.D. / Chicago, IL
John-Luke Rivera, M.D. / Maywood, IL
Daniel Schmitt, M.D. / Chicago, IL
Cameron J. Killen, M.D. / Chicago, IL
Joseph B. Cohen, M.D. / Chicago, IL
William Lack, M.D. / Seattle, WA
Nicholas M. Brown, M.D. / Chicago, IL

BACKGROUND: Treatment of periprosthetic proximal femur fractures is a complex problem. The Vancouver classification has traditionally guided treatment of these fractures. The distinction between B1 and B2 fractures is of particular clinical interest. B1 fractures have a well-fixed stem despite the fracture and are treated with ORIF. B2 fractures have a loose stem and are traditionally treated with a more distally fixed revision arthroplasty. Recent literature has begun to suggest that ORIF of B2 fractures may provide adequate stability.

METHODS: Patients treated with Vancouver B periprosthetic proximal femur fractures from 2007 to 2017 at a single institution were queried. Demographic data including age, gender, BMI, and CCI was collected. Radiographic classification was performed by both an arthroplasty and a trauma-trained surgeon. Interobserver reliability was assessed. Classification, mode of treatment, and treating surgeon specialty was analyzed. Outcomes included reoperation for any reason and satisfaction at final follow-up.

RESULTS: 45 Vancouver B fractures were available for review. Thirty cases were classified as Vancouver B2 by either a trauma-trained or arthroplasty-trained surgeon. The trauma-trained surgeon was more likely to classify the fracture as B2 (28 of 30 vs. 18 of 30, $p < 0.01$), but trauma-trained surgeons were more likely to perform ORIF without revision arthroplasty (14 of 19 cases) than arthroplasty-trained surgeons (1 of 11 cases), $p < 0.01$. There were similar rates of revision surgery after these disparate treatments. At average final follow-up of 45 weeks, 1 patient treated with ORIF required revision arthroplasty for aseptic loosening. At average final follow-up of 75 weeks, 2 patients treated with revision arthroplasty required revision for infection. One patient in each group required an I&D for surgical site infection.

CONCLUSION: Periprosthetic proximal femur fractures present complex surgical problems. Surgical training appears to significantly bias treatment of these injuries with trauma fellowship-trained surgeons being more likely to perform isolated ORIF, despite high concern for compromise of the implant/bone interface. Arthroplasty-trained surgeons are more comfortable treating Vancouver B2 fractures with revision arthroplasty whereas trauma-trained surgeons are more comfortable with ORIF. Both of these treatment modalities appear to be an effective treatment in the short- and mid-term management of Vancouver B2 fractures with similar rates of revision procedures within one year.

Operative Treatment Delays of Vancouver B2 Fractures are Not Associated with Increased Mortality, Revision, or Reoperation

Abstract ID: Paper 097

Juan S. Vargas-Hernandez, M.D.
*Marc Greenberg, B.S.
William W. Cross, III, M.D.
Jonathan D. Barlow, M.D., M.S.
Matthew P. Abdel, M.D.
Brandon J. Yuan, M.D.
Rochester, MN

INTRODUCTION: Vancouver B2 periprosthetic fractures are complex injuries associated with a high risk of complications, morbidity, and potentially mortality. Their treatment requires specialized expertise that often cannot be provided by general orthopedic surgeons, and thus is frequently delayed. Similar delays in the hip fracture population have proven to increase mortality rates. The purpose of our study was to investigate if treatment delays negatively affect mortality, revision, and reoperation rates for patients with periprosthetic Vancouver B2 fractures.

METHODS: We retrospectively reviewed 173 patients with 174 Vancouver B2 periprosthetic femur fractures treated with revision total hip arthroplasty (THA) between 2000 and 2018. We compared 67 “early” cases (treated within 48 hours of injury), and 107 “delayed” cases (treated after 48 hours). The mean age at revision THA was 74 years, with 49% being female. Mean follow-up was 3 years.

RESULTS: One-year survival free of mortality was 79% for the early group and 81% for the delayed group (p=0.41). No significant differences in mortality, revision, and reoperation rates at any time point were identified (all p >0.2). Multivariate analysis demonstrated a risk ratio for mortality in the delayed group of 0.97 (95% CI 0.57-1.66) when compared to the early group.

CONCLUSION: Delays in treatment for patients with Vancouver B2 periprosthetic femur fractures were not associated with increased risk of mortality, revision, or reoperation at any time point. This is in contrast to multiple prior studies demonstrating an increase in mortality when surgery for hip fracture is delayed. It is possible that a deferral of surgery due to availability of surgical expertise does not affect patient mortality in the same way that delay due to medical complexity does. Although early surgery is still preferable, we did not discover an increase in patient mortality in patients who waited more than 48 hours for surgery.

SUMMARY: Delay prior to surgery for Vancouver B2 periprosthetic fractures by more than 48 hours was not associated with higher rates of mortality and reoperation.

Early Readmissions and Prior Admissions in Patients Surgically Treated for Femur Fractures

Abstract ID: Paper 098

---

*Robert B. Erlichman, M.D.
Nicholas N. Kolodychuk, M.D.
Nicholas J. DiNicola, M.D.
Brook Maxheimer
Joseph N. Gabra, Ph.D.
Akron, OH

INTRODUCTION: Hip fractures are a significant economic burden to our healthcare system. Bundled payment models such as the Surgical Hip and Femur Fracture Treatment (SHFFT) bundle have been proposed as a way of reducing healthcare costs. This may be problematic given the significant differences in medical comorbidities in the hip fracture and elective surgical populations. Our study investigates the 90-day readmissions for surgically-treated hip and femur fractures. We hypothesized that many of these 90-day readmissions will have been admitted to the hospital in the recent past prior to their fracture, and often for the same diagnosis as their 90-day readmission.

METHODS: This study is a retrospective chart review of 598 patients who underwent surgical fixation of a hip or femur fracture at our hospital during a five-year period. Of the 90-day readmissions, we recorded if they had been admitted to the hospital within one or two years prior to sustaining their hip or femur fracture. We also analyzed subgroup populations of geriatric hip fractures and of hemiarthroplasty for femoral neck fracture.

RESULTS: There was a 90-day readmission rate of 27% in our total study population. Of the total 90-day readmission patients, 67% had been admitted to our hospital in the two years prior to their injury. Of these prior admissions, 47% were for the same diagnosis as their 90-day readmission.

DISCUSSION: We found that this patient population has a relatively high prior admission rate. This supports the idea that 90-day readmissions in this population are related more to the patient's overall health and comorbidities, than factors controlled by the hospital or surgeon. The economic burden of hip fractures in our country continues to be significant. However, our study provides data as to why applying the bundled payment model to the surgical treatment of hip and femur fractures may unjustly penalize hospital systems for 90-day readmissions.

Length of Stay Following Geriatric Hip Fracture Surgery; Do Physical Therapy Availability and Day of Surgery Matter?

Abstract ID: Paper 099

Paul S. Whiting, M.D.
James T. Bernatz, M.D.
*Andrew E. Brooks, M.D.
Ryan M. Graf, M.D.
Alexander B. Siy, B.S.
Christopher J. Doro, M.D.
David C. Goodspeed, M.D.
Gerald J. Lang, M.D.
Madison, WI

PURPOSE: Management of geriatric hip fractures requires a multidisciplinary approach, and multiple factors impact hospital length-of-stay (LOS) after hip fracture surgery. Day of surgery and availability of rehabilitation personnel have been shown to be independent predictors of LOS following total joint arthroplasty. The purpose of this study was to investigate the impact of day of surgery and postoperative physical therapy sessions on LOS following hip fracture surgery.

METHODS: We performed a retrospective analysis of all surgically-treated geriatric hip fractures (age 60 and above) at a level 1 trauma center over a 2-year period. The primary outcome variable was hospital LOS. Patient demographics, ASA scores, and medical comorbidities were recorded, as were surgical characteristics including procedure performed and day of the week of surgery. Hospital unit, admitting and discharging service, and number of PT sessions received in the first three postoperative days (PODs) were also recorded. All variables associated, univariably, with LOS were identified by Kruskal-Wallis tests. A multivariable negative binomial regression analysis was then performed adjusting for patient age and medical comorbidities.

RESULTS: Three hundred fifteen patients met inclusion criteria with an average age of 79.8 (Std dev 9.87) years; 71% of patients were female. On multivariable analysis, LOS was significantly associated with day of surgery, ASA score, day of surgery, discharging service, discharge disposition, and number of PT sessions within three days. After adjusting for other variables in the model, patients who had surgery Thurs/Fri/Sat (weekend surgery) stayed in the hospital 15% longer than those who had surgery on another day ($p=0.02$). Patients not seen by PT on the first three PODs stayed 2.37 times longer than patients seen all three days ($p<0.001$).

CONCLUSION: Day of surgery and availability of PT during the first three postoperative days significantly impact length of stay following geriatric hip fracture surgery.

Postoperative Outcomes of Hip Fracture Surgery in Geriatric Patients on Clopidogrel or Warfarin at the Time of Surgery

Abstract ID: Paper 100

---

*Joshua C. Locker, M.D.
Elizabeth R. Lyden, M.S.
Justin C. Siebler, M.D.
Omaha, NE

INTRODUCTION: The purpose of this study was to evaluate if surgical intervention in the setting of an elevated INR or continued use of Clopidogrel lead to elevated postoperative mortality, increased blood loss, or an increase in wound infections when compared to INR reversal or surgical delay.

METHODS: We retrospectively reviewed all 1,007 patients age > 55 undergoing hip fracture fixation at our institution over a 10-year span. We placed patients into four groups based upon their status at the time of surgery: (1) patients not on Coumadin or Clopidogrel; (2) patients only on Clopidogrel; (3) patients on Coumadin upon presentation with INR <1.5 at the time of surgery; (4) patients on Coumadin upon presentation with INR >1.5 at the time of surgery. Descriptive statistics were utilized to evaluate for differences in estimated blood loss, changes in hemoglobin, transfusion rates, mortality rates, time to surgery, and wound complications.

RESULTS: Comorbid conditions such as congestive heart failure, coronary artery disease, chronic kidney disease, and diabetes occurred at a higher rate in patients on either anticoagulant when compared to patients not on anticoagulants ($p<.0001$; $p<.0001$; $p=.0035$; $p=.008$ respectively). There was found to be no difference ($p>.05$) between all four groups in regards to units of blood transfused, net preoperative to postoperative hemoglobin change, 30 day mortality, wound infections, and postoperative thromboembolic events. There was a statistically significant difference in estimated intraoperative blood loss between groups 1 and 3 ($p=.0079$). Average time to surgery was 1.6 days for group 1, 1.9 days for group 2, 1.95 days for group 3, and 1.42 days in group three ($p=0.14$).

CONCLUSION: In this retrospective cohort study, patients who underwent surgery with an INR > 1.5 did not have statistically significant elevations in postoperative mortality, increased objective blood loss, greater occurrence of wound infections, or an increase in thromboembolic events. While there was a statistical difference in estimated blood loss in patients on Coumadin, this had no effect on outcomes and may not be clinically relevant. While not statistically different, there was a trend towards decreased time to surgery in patients who underwent surgery in the setting of an INR >1.5. This study suggests that an INR > 1.5 may not be a reason to delay surgery in the setting of a geriatric hip fracture.

Are Orthopedic Trauma Surgeons Being Adequately Compensated for Treating Nonunions of the Femoral Shaft? An Analysis of Relative Value Units

Abstract ID: Paper 101

Azeem T. Malik, M.B.B.S.
*Krystin Hidden, M.D.
Carmen E. Quatman, M.D.
Laura S. Phieffer, M.D.
Safdar N. Khan, M.D.
Thuan V. Ly, M.D.
Columbus, OH

INTRODUCTION: Critics of Relative Value Unit (RVU) based physician reimbursements in orthopedic trauma have often voiced concerns with regards to the relatively low reimbursement associated with surgical management of nonunions, as compared to native fractures despite the higher complexity and effort required in managing the former. We have performed a comprehensive RVU cost-analysis to report differences in reimbursement rates between native femoral shaft fractures treated with an intramedullary nail vs. those undergoing repair of nonunion of femoral shaft fractures.

MATERIALS AND METHODS: The 2016-2017 American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) was queried using CPT and International Classification of Diseases 10th Edition (ICD-10) diagnosis codes to identify patients undergoing surgery for native femoral shaft fractures (27506) and/or repair of nonunion of femoral shaft fracture (27470, 27472). Mean total RVU, operative time, and RVU/min for each procedure type (Native/27506 vs. Repair w/o graft/27470 vs. Repair w/graft/27472) were calculated. Reimbursement rate ($/min) was derived by multiplying the RVU/min by a CMS conversion factor. Average reimbursement/case was calculated by multiplying the reimbursement rate ($/min) by the total operative time.

RESULTS: A total of 425 patients were included in the final cohort – out of which 358 (84.2%) underwent IM nailing for a native femoral shaft fracture, 33 (7.8%) underwent repair of nonunion of femoral shaft fracture without use of graft, and 34 (8.0%) underwent repair of nonunion of femoral shaft fracture with use of a bone graft. The mean total RVU and operative time for each group were as follows: (1) Native (RVU=19.70, Operative time=97.4 mins), (2) Nonunion w/o graft (RVU=17.23, Operative time = 135.8 mins), (3) Nonunion w/graft (RVU=18.88, Operative time = 164.5 mins). Reimbursement rates decreased significantly as complexity of case grew (Native = $8.74/min vs. Nonunion w/graft = $6.07/min vs. Nonunion w/graft = $5.27/min; $p<0.001$). The average reimbursement/case was $707 for native femoral shaft fracture, $618 for repair of femoral shaft nonunion w/o graft, and $678 for repair of nonunion of femoral shaft with bone graft.

CONCLUSIONS: Orthopedic surgeons are reimbursed at a lower rate ($/min) for femoral shaft nonunions as compared to IM nailing for native femoral shaft fractures, despite the higher complexity, greater effort, and longer operative times required in the former. The study highlights the need for a change in the RVUs assigned to nonunions of the femur to ensure surgeons are being adequately compensated for treating a more complex and technical case.

Polymeric Brushite Cement (P-DCPD): A New Injectable Drug-Eluting Bone Void Filler for the Repair of Load-Bearing Bone Defects

Abstract ID: Paper 102

Weiping Ren, M.D., Ph.D. / Detroit, MI
Tong Shi, M.S. / Detroit, MI
*David C. Markel, M.D. / Southfield, MI

INTRODUCTION: Developing injectable ceramic drug-eluting bone void filler for the repair of load-bearing bone defects is challenging. We developed a polymeric dicalcium phosphate cement (P-DCPD). We have demonstrated that P-DCPD is superior to existing calciumphosphate cements (CPCs) including, but not limited to, mechanical strong, excellent antiwashout, controllable setting, injectability, and sustained drug release. The aim of this study was to provide a summary of the in vitro release of different drugs from P-DCPD cement and the molecular interaction between embedded drugs and P-DCPD matrix.

METHOD: P-DCPD was prepared by reacting of calcium polyphosphate (CPP) gel with tetracalcium phosphate. Drugs (erythromycin, tobramycin, peptide, protein, and strontium, Sr^{2+}) were added to P-DCPD cement by simply mixing with CPP gel before setting. The drug release was measured by UV-VIS, ELISA, or by inductively coupled plasma optical emission spectrometry (ICP-OES, for Sr^{2+}). Bactericidal activity of released antibiotics was evaluated by a modified bacterial inhibition assay. Raman was used to define the molecular interaction between embedded drugs and P-DCPD matrix.

RESULTS: A sustained release of drugs from P-DCPD was observed. Antibiotics released remained their bactericidal activity. Sr^{2+} was continuously released over 140 days (~ 5 months) from P-DCPD cements. A zero-order release of Sr^{2+} is mainly due to the ionic interaction between Sr^{2+} and the ionic polyphosphate backbone of CPP gel, which was validated by Raman analysis. Sr^{2+}-doped P-DCPD cements significantly enhanced new bone formation in a rat femur defect model.

DISCUSSION: Load-bearing bone defects cause significant disability in patients and remain a major clinical and socioeconomic problem. The synergy between P-DCPD and pharmacology has opened a wide field of possibilities, especially for the load-bearing bone defect healing and the treatment of bone infections. There is an urgent clinical need to develop new injectable and self-setting bone cements that can be used to rebuild contaminated bone defects and avoid drawbacks of CPC/PMMA cements. Data generated from this study is very promising. We believe that P-DCPD cement represents unique injectable and functional bone void filler cement with a plethora of applications by including growth factors, antibiotics, and other biomolecules.

Evaluation of Intraoperative Fluoroscopic Techniques to Estimate Femoral Rotation: A Cadaveric Study

Abstract ID: Paper 103

---

*David V. Ivanov
John P. Welby
Jonathan D. Barlow, M.D., M.S.
S. Andrew Sems, M.D.
Michael E. Torchia, M.D.
Brandon J. Yuan, M.D.
Rochester, MN

PURPOSE: Several methods of intraoperative evaluation of femoral rotation (FR) to prevent malrotation of femur fractures treated with intramedullary nailing have been described. Minimal data exists comparing these methods. We sought to compare different fluoroscopic techniques for estimating rotation of uninjured femurs, as well as establishing rotation of the injured side utilizing cadavers.

METHOD: Measurement of native FR via computed tomography (CT) was performed in 10 cadavers that yielded 20 intact femurs. A transverse diaphyseal osteotomy was created in each right femur. Four surgeons utilized the following fluoroscopic techniques to match the rotation of the fractured side to uninjured side: the lesser trochanter profile (LTP), the true lateral (TL), and neck-horizontal (NH) angle techniques, as previously described[1-3]. Accuracy was assessed via measurement of the angle subtended by two pins above and below the osteotomy. By comparing this angle to the angle subtended by the same pins prior to the osteotomy, the accuracy of each observation was assessed. For the TL and NH techniques, each surgeon also estimated the FR of the intact femur.

RESULTS: The absolute mean error in estimating FR of the intact femur using the TL and NH methods compared to CT was 8.2° (95% confidence interval [CI] 6.5, 10.0), and 4.4° (CI 3.3, 5.4), respectively, but was not statistically significant (p=0.52). The absolute mean rotational error in the fractured femur was 6.0° (CI 4.6, 7.6) for the TL method, 6.6° (CI 5.03, 8.15) for the NH method, and 8.5°(CI 6.5, 10.6) for the LTP method, but the difference was not statistically significant (p=0.10). Significantly more femurs were malrotated by > 15° using the LTP method than the TL or NH method (20% vs. 2.5%, p-value =0.03).

CONCLUSION: The TL and NH methods had similar accuracy in estimating the rotation of the intact femur. In the fractured femur, the differences in rotational error were not statistically significant. However, significantly more femurs were malrotated utilizing the LTP method. We therefore advocate for use of the NH or TL method to determine femoral version intraoperatively.

References:
1. Deshmukh et al., A technique to obtain correct rotational alignment during closed locked intramedullary nailing of the femur, Injury 1998;29(3):207-10.
2. Tornetta P III et al., Femoral torsion after interlocked nailing of unstable femoral fractures. J Trauma 1995;38(2):213-19.
3. Bråten M et al., The role of fluoroscopy in avoiding rotational deformity of treated femoral shaft fractures: An anatomical and clinical study. Injury 2000;31(5):311-15.

Early Weight Bearing after Distal Femur Fractures in the Elderly: A Prospective, Cohort Pilot Study

Abstract ID: Paper 104

Lisa K. Cannada, M.D. / Jacksonville, FL
*Jennifer L. Bruggers, M.D. / Atlanta, GA
Kyle J. Jeray, M.D. / Greenville, SC
Robert D. Zura, M.D. / New Orleans, LA
Heidi Israel, Ph.D. / St. Louis, MO
Sarah Dawson, R.N. / St. Louis, MO
Stephanie Tanner, R.N. / Greenville, SC

PURPOSE: To determine if early weightbearing in distal femur fractures in the geriatric population maintains fracture reduction and allows early return to function.

METHODS: We performed a prospective cohort pilot study (NCT# #02475941) involving 5 Level 1 Trauma Centers. Patients 64-90 with an OTA 33 distal femur fracture were eligible for inclusion. All patients were household ambulators or higher at time of the injury. The patients were treated with surgical stabilization. Following surgery, the surgeon decided if patients would be weightbearing as tolerated (EWB) or protective/non-weightbearing (NWB). Patients were followed at regular intervals clinically and with radiographs until healed. ANOVA was performed within each group to detect differences between time points. T tests and Chi square was performed to detect differences between the groups at each time point.

RESULTS: There were 46 patients with an average age 75. 11 patients (24%) were in the EWB group. There were 37 33A, 2 33 B, and 7 33C fractures. 44/46 patients were injured in ground level falls. In the NWB group, there were 2 hardware failures and the remaining patients were healed by 12 weeks. In the EWB group, all patients were healed at 12 weeks with no hardware failures. The VAS scores were reported as < 5 in 44/46 patients at 6 and 12 weeks. Narcotic use is of concern in orthopedics, especially in the elderly. 22/46 (48%) never used narcotic pain medication and 19/46 (41%) used narcotics for less than one week. Oxford scores at baseline ranged from 16-48; at week 6 was 5-44 and at week 12 was 5-43.The average Oxford score was 37 (17-47). There were no significant differences between the groups in any outcome variables. The mortality rate was 6.5%. All patients who died had multiple medical co-morbidities and were in the NWB group.

CONCLUSION: We investigated a prospect cohort of geriatric patients with distal femur fractures to determine efficacy of EWB. We chose a prospective cohort design, so the surgeon felt comfortable with WB choice after surgery in this patient population. The majority of surgeons chose NWB. Our results demonstrate EWB can be safely done in a small cohort study for geriatric distal femur fractures with minimal complications. Early mobilization has the advantage of a more rapid return to function for the geriatric patient with minimal complications. A randomized clinic trial could be useful in geriatric distal femur population.

Far Cortical Locking Constructs Generate Increased Callus Area in Distal Femur Fractures Compared to Standard Locking Plates

Abstract ID: Paper 105

---

*Brandon G. Wilkinson, M.D. / Iowa City, IA
Yanin Plumarom, M.D. / Bangkok, Thailand
Nathan R. Hendrickson, M.D. / Iowa City, IA
Natalie A. Glass, Ph.D. / Iowa City, IA
Michael C. Willey, M.D. / Iowa City, IA
J. Lawrence Marsh, M.D. / Iowa City, IA
Matthew D. Karam, M.D. / Iowa City, IA

PURPOSE: Distal femur fractures are commonly treated with locking plate fixation. These fractures are often comminuted and depend on some degree of interfragmentary motion to stimulate osseous union. Far cortical locking (FCL) screw constructs are designed to permit increased, controlled interfragmentary motion—which has been shown in animal models to increase callus formation to a greater extent than standard locking plate (LP) constructs. However, data on FCL constructs in humans is limited. The purpose of this study is to quantify callus area (mm^2) from radiographs of distal femur fractures treated with FCL as compared to traditional locking plate constructs.

METHODS: A retrospective medical records review was conducted to identify patients ≥age 16 with distal femur fractures (no AO/OTA Type B or nonunion). Average range of follow-up was 12 months (3-55 months). Medial callus area from AP radiographs was quantified from 6-, 12- and 24-week postop radiographs. Callus areas were compared between groups using the Wilcoxon Rank Sum test due to non-normal distributions. Following callus area results presented as median (min-max).

RESULTS: A total of 96 (65.3% women, mean age 66.2±18.0 years) out of 143 patients met eligibility criteria and were included in analyses. There were no significant differences between FCL (n=52) and LP (n=44) in terms of demographic data or rates of complications (18%), fixation failures (10%), union (90%), or revision (10%) (all p>0.05). Callus areas did not significantly differ between FCL vs. LP at 6 (195.2 mm^2 (0.0-2007.1) vs. 200.7 mm^2 (0.0-1137.0), p=0.737) or 12 (372.1 mm^2 (0.0-2241.9) vs. 298.1 mm^2 (0.0-1959.9), p=0.351) weeks postop. However, between group differences were statistically significant at 24 weeks postop (FCL:455.7 mm^2 (30.4-2388.2) vs. LP:287.8 mm^2 (0.0-1514.7), p=0.023). Similar results were found when analyses were limited to titanium materials.

CONCLUSIONS: In this study, larger medial callus was formed as duration from surgery increased in the FCL as compared to the LP group (p=0.02) at 24 weeks. This is in accordance with previous animal models and indicates a potential advantage of FCL over standard LP constructs. Future prospective studies are needed to further compare FCL and LP constructs in distal femur fractures.

Medial Buttress Plate Augmentation of Fixation Constructs for Pauwel's III Femoral Neck Fractures

Abstract ID: Paper 106

---

*Daniel A. Bechtold, M.D. / St. Louis, MO
Robert Owen, M.D. / St. Louis, MO
Thomas Hong, M.D. / Iowa City, IA
Matthew Silva, Ph.D. / St. Louis, MO
Christopher M. McAndrew, M.D. / St. Louis, MO

INTRODUCTION: Significant research has focused on the treatment of femoral neck fractures in the geriatric population. These injuries result primarily from low energy falls, whereas the pathology in young adults often differs in energy imparted, bone quality, and fracture pattern. Precise reduction and optimal osteosynthesis are required in this population for long-term preservation of hip function. Despite multiple fixation options available, there remains equipoise regarding the optimal construct design.

METHODS: A novel fracture model was developed to replicate the described morphology of young adult femoral neck fractures. The cortex of composite femur models was perforated circumferentially using a rotary tool and simulated comminution introduced by additional scoring of the posterior superior cortex. Femoral necks were predrilled under fluoroscopic guidance in a standardized fashion to ensure consistent screw placement. Predrilled models were fractured through a controlled axial load. Fractures were fixed using 7.3 mm partially threaded cannulated screw. On half of the models, a 5-hole pelvic reconstruction plate was applied freehand in buttress mode to the medial femoral neck utilizing reproducible landmarks for placement. Models were potted in polyester resin at a 15 degree valgus angle as previously described. Specimens were subjected to axial stiffness and load to failure testing on an Instron load frame. Pre-test power analysis indicated n=5 for statistical significance.

RESULTS: Load to failure was 4649 +/- 962N for cannulated screw (SCR) constructs and 5084 +/- 1215N for cannulated screws + buttress plate (PLT) constructs (p=0.55). Stiffness for the SCR group was 1063 +/-396 N/mm vs 1632 +/- 275 N/mm in the PLT group (p=0.03). Within the SCR group, 80% of constructs failed in a varus/vertical shear mechanism through the fracture whereas 100% of the PLT group failed in head fracture through the proximal construct.

DISCUSSION: This work demonstrates that augmentation with a medial femoral buttress plate significantly increases construct stiffness and prevents failure through a vertical shear mechanism. Additionally, augmentation increases average load to failure, however, this was not statistically significant. In clinical practice, the application of a medial buttress plate may allow for better direct reduction and increased cortical apposition compared to that achieved with cannulated screws alone.

Re-Operation and Complication Rates Following Patellar Fracture Repair with Plates. A Retrospective Review of 60 Patients

Abstract ID: Paper 107

---

*Jake X. Checketts, B.S.
Jared Scott, D.O.
Jake Whitener, D.O.
Jesse Putman, D.O.
Azad Dadgar, D.O.
Mark M. Calder, M.D.
Brent L. Norris, M.D.
Tulsa, OK

BACKGROUND: Fractures of the patella significantly affect knee function through loss of the extensor mechanism. Operative treatment is generally reserved for displaced fractures and the fixation is often dependent on the fracture type. Non-comminuted displaced fractures can be treated with modified tension band wiring. Most comminuted displaced fractures will not be amenable to tension band wiring and often need a formal ORIF. Recent work has suggested good functional results with dorsal surface plating. The primary outcome measurement of this project was reoperation rates for patella fractures treated with dorsal plating.

METHODS: This work consists of a retrospective review of clinical data following repair of a patella fracture with low profile dorsal plates (all off label). We obtained IRB approval for this study and then conducted an eight-year consecutive review of our groups trauma practice. The patients were selected by searching our medical records using the patella repair Current Procedural Terminology (CPT) code: 27524. The primary outcome of this study was the need for secondary surgery in patients with patella fracture plating.

RESULTS: 59 patients with 60 patellar fractures were treated with ORIF plating over the 8 years. The average age of the included patients was 50.77 years. The average BMI of our patient population was 28.29. Seven (11.66%) of our patients required reoperation. Of these reoperations, 3 (5.00%) were needed due to wound dehiscence (2 of which were due to non-compliance resulting in falls, and 1 patient had significant peripheral vascular disease), 2 (3.33%) were needed due to painful hardware, and 1 (1.66%) each was needed for loss of reduction and post-traumatic contractures about the knee joint. Of the patients needing reoperation, 4/7 (57.14%) had comorbid medical conditions or risk factors. 58 of the 60 patients (96.66%) achieved successful union and healing of their fracture at 16 weeks post-operation. 57 of the 60 patients (95.00%) maintained the reduction of their fracture at 16 weeks post-operation. On average, patients were able to flex their knee to 110 degrees at the 16-week postoperative period.

CONCLUSION: Our results indicate that plating of comminuted patellar fractures is a safe, viable treatment strategy. Favorable outcomes were seen especially in patients without comorbid conditions and/or risk factors. Additionally, it may allow for early return of function and less postoperative bracing. Low profile dorsal tension band plating of the patella should be considered for comminuted patella fractures. Patient reported outcomes are currently being collected.

MAOA BREAKOUT SESSION #9
OPIOID MANAGEMENT
April 24, 2020

Education Increases Disposal of Unused Opioids after Total Joint Arthroplasty: A Randomized Controlled Trial

Abstract ID: Paper 108

---

*Cindy R. Nahhas, B.S.
Charles P. Hannon, M.D.
Chris Culvern, M.S.
Tad L. Gerlinger, M.D.
Denis Nam, M.D., MSc.
Craig J. Della Valle, M.D.
Chicago, IL

BACKGROUND: The purpose of this study was to determine the rate of proper disposal of unused opioids and the impact of education on disposal rates.

METHODS: Following IRB approval, 563 patients undergoing primary total hip (183 patients) and knee arthroplasty (380 patients) were randomized to receive no education (Group 1), an educational pamphlet (Group 2), or an educational pamphlet plus text messages reminding the patient to dispose of their opioids (Group 3). Patients were surveyed at their six-week postoperative visit to determine if they had disposed of their unused opioid pills using an FDA recommended method. To avoid behavioral modifications, patients were blinded to participation in the study. Assuming a 10% difference in opioid disposal rates as a clinically relevant difference, a priori power analysis determined that 140 patients per group (420 total) were required. Treated statistical analysis was conducted with Fisher's Exact and ANOVA tests with alpha= 0.05.

RESULTS: 539 (95.7%) patients completed the survey. 342 patients (60.1%) indicated that they had unused opioid pills at 6 weeks postoperatively. Of these 342 patients, 9.0%, 32.8%, and 38.4% properly disposed of their unused opioids in Groups 1, 2, and 3, respectively ($p<0.001$ for no education vs. either strategy with no difference between the two educational strategies). Unused opioid pills were kept by 82.0%, 64.1%, and 54.4% of patients in Groups 1, 2, and 3, respectively ($p<0.001$ for no education vs. either educational strategy). There were no differences between groups including daily inpatient opioid use, refill requirements, and preoperative opioid use other than gender (41.5%, 55.0% and 37.4% male; $p=0.001$), suggesting appropriate randomization.

CONCLUSIONS: Education on proper opioid disposal more than triples the rate of proper opioid disposal compared to no education. Further innovation is warranted given the inadequate rates of disposal even with appropriate education.

Is Preoperative Tramadol a Safe Alternative to Opioids in Total Knee Arthroplasty?

Abstract ID: Paper 109

---

*David E. DeMik, M.D., Pharm.D.
Nicholas A. Bedard, M.D.
Christopher N. Carender, M.D.
Alan G. Shamrock, M.D.
John J. Callaghan, M.D.
Iowa City, IA

INTRODUCTION: Preoperative opioid use has been shown to lead to postoperative opioid use following total knee arthroplasty (TKA). Tramadol is recommended for symptomatic treatment of osteoarthritis, however, it acts on opioid receptors and may confer similar adverse effects. The purpose of this study was to assess postoperative opioid use in the setting of preoperative opioid and tramadol use.

METHODS: Patients undergoing primary TKA between 2007 and 2016 were identified in the Humana administrative claims database using CPT code 27447. Patients were stratified by whether they filled a prescription for an opioid, tramadol, either, or neither within three months prior to TKA. Prescription claims for opioids and tramadol were tracked for 12 months postoperatively. Relative risk for each group was calculated.

RESULTS: 107,973 patients undergoing TKA were identified. Preoperatively, 29,890 (27.7%) patients filled a prescription for only opioids, 8,049 (7.5%) for only tramadol, 44,403 (41.1%) for either tramadol or opioids, and 63,570 (58.9%) did not fill a prescription for either. At 12 months after TKA, an opioid prescription was filled by 6.0% of preoperative opioid-free patients, 35.2% preoperative opioid users (RR: 5.83 [5.63-6.03], $p<0.0001$), 9.2% preoperative tramadol users (RR: 1.52 [1.40-1.63], $p<0.0001$), and 29.5% preoperative opioid or tramadol users (RR: 4.88 [4.72-5.05], $p<0.0001$). Opioid or tramadol prescriptions were filled by 7.7% of preoperative opioid-free patients, 37.3% preoperative opioid users (RR: 4.84 [4.70-4.99],$p<0.0001$), 26.2% preoperative tramadol users (RR: 4.34 [4.14-4.56], $p<0.0001$), and 35.7% preoperative opioid or tramadol users (RR: 5.91 [5.72-6.11], $p<0.0001$) at 12 months after TKA.

CONCLUSIONS: Patients taking tramadol preoperatively were found to be at lower risk for prolonged postoperative opioid use following TKA compared to those taking opioids preoperatively. However, patients taking either tramadol or opioids preoperatively continued to fill prescriptions for these medications at a significantly higher rate than those who were not. Additional studies are needed to assess if preoperative tramadol use is associated with inferior clinical outcomes after TKA.

Who is Prescribing Opioids Preoperatively? A Survey of New Patients Presenting to Tertiary Care Adult Reconstruction Clinics

Abstract ID: Paper 110

---

*Tyler E. Calkins, M.D. / Memphis, TN
Charles P. Hannon, M.D. / Chicago, IL
Denis Nam, M.D. / Chicago, IL
Tad L. Gerlinger, M.D. / Chicago, IL
Scott M. Sporer, M.D. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: Preoperative opioid use is detrimental to outcomes following hip and knee arthroplasty. This study aims to identify the prevalence of preoperative opioid prescriptions and the specialty and practice setting of the prescriber.

METHODS: 461 consecutive new patients evaluated for an arthritic hip or knee were retrospectively studied using institutional data and the state Prescription Monitoring Program (PMP) to identify opioid prescriptions within six months prior to their first appointment. Patients were separated into opioid and non-opioid cohorts for statistical analysis using t-tests and Mann-Whitney U tests for continuous variables, Fisher's exact test for categorical variables and multiple linear regression.

RESULTS: 105 patients (22.8%) received an opioid prior to the appointment. Fifty-two (11.3%) received schedule II or III opioids, 43 (9.3%) received tramadol, and 10 (2.2%) received both. Primary care physicians were the most common prescriber (59.5%, $p < 0.001$), followed by pain medicine specialists (11.3%), and orthopedic surgeons (11.3%). More prescribers practiced in the community than academic setting (63.8% vs. 36.2%, $p < 0.001$). 78 patients (74.3%) self-reported their opioid prescriptions with the remaining 27 patients (25.7%; 14 schedule II or III opioids and 13 tramadol) identified only after query of the PMP. In regression analysis, higher BMI, a diagnosis other than osteoarthritis, and benzodiazepine use were associated with receiving opioids ($p < 0.05$), while anti-depressant use decreased the likelihood of self-reporting opioids prescriptions ($p = 0.044$).

CONCLUSION: A striking number of patients are being treated with opioids for hip and knee arthritis. Further, many patients who have received opioids within six months do not report their prescriptions. While primary care physicians prescribed the majority of opioids for nonoperative treatment of arthritis, a substantial percentage came from orthopedic surgeons. Further education of physicians and patients on the ill effects of opioids when used for the nonoperative treatment of hip and knee arthritis is warranted.

Patient and Surgical Factors Influence Postoperative Opioid Prescription in Single Admission, Single Surgery Orthopedic Trauma Patients

Abstract ID: Paper 111

---

*John P. Mickley
Austin J. Roebke, M.D.
Joshua S. Everhart, M.D., M.P.H.
Kanu S. Goyal, M.D.
Thuan V. Ly, M.D.
Columbus, OH

INTRODUCTION: The purpose of this retrospective cohort was to determine the patient and surgical factors associated with increased postoperative opioid prescription after single admission, single surgery orthopedic trauma patients.

METHODS: 131 total patients, categorized by anatomical location (hip/pelvis n=50, lower extremity n=74, upper extremity n=7), operated on by one senior orthopedic traumatologist were included in the study. Opioid usage converted to morphine milligram equivalent (MME) was recorded during the inpatient stay and 42 days postoperatively. A series of multivariate linear regression models and logistic regression models were created to determine independent predictors ($p<0.05$) and risk factors ($p<0.05$).

RESULTS: A history of opioid use (11.6 MMEs more) and longer length of surgery (0.31 MME per additional minute of surgery) were found to be significant factors for greater opioid use the day prior to discharge. While increasing patient age (0.58 MME less per 1.0 year increase in age), inpatient gabapentin or pregabalin use (9 MMEs less), and inpatient muscle relaxant (13.5 MMEs less) were all found to be significant factors for decreased opioid use the day prior to discharge. Inpatient opioid use the day prior to discharge was the best predictor of increased outpatient prescription. For each additional 1.0 MME required in the day prior to discharge, patients required 6.2 greater MMEs in the 42-day postoperative period. Unemployed patients required on average 56.2 additional oxycodone 5 mg pills (i.e., 281 greater MMEs) and patients with a history of opioid use required on average 55.9 additional oxycodone 5 mg pills (i.e., 279.6 greater MMEs) during the 42-day outpatient period. A history of opioid usage was an independent predictor of trips to the ED or another provider for pain control and use opioids beyond 42 days. Male sex was an independent predictor of opioid use beyond 42 days as well.

DISCUSSION AND CONCLUSION: Opioid prescription following single admission, single surgery orthopedic trauma cases is strongly predicted by surgical and patient factors. Length of surgery, not the actual procedure or anatomic site, was a better predictor of inpatient requirements. The best predictors of postoperative opioid prescription are the amount of opioids prescribed the day prior to discharge, a history of opioid use, and unemployment. Interestingly, regional or neuraxial anesthesia and anatomical site of surgery had no effect on postoperative opioid prescription amounts, opioid refill requests, or pain-related calls or office visits.

Patterns in Opioid and Non-Opioid Prescriptions for Patients Operatively Treated for Ankle Fractures Following Implementation of 2017 Ohio Opioid Prescriber Law: A One-Year Follow-up

Abstract ID: Paper 112

---

*Robert N. Matar, M.D.
Georgina Glogovac, M.D.
Colin Cotton
Michael Rubeiz
Jamal Fitts, M.D.
Jordan Henning, D.P.M.
Tonya L. Dixon, M.D., M.P.H.
Richard T. Laughlin, M.D.
Cincinnati, OH

INTRODUCTION: The state of Ohio implemented legislation in August of 2017, limiting the quantity of opioid medications a provider could prescribe for the treatment of acute pain. This may impact the management of pain by orthopedic surgeons.

PURPOSE: Report patterns of opioid and non-opioid prescriptions in patients surgically treated for ankle fractures before and after implementation of the law up to one year postoperatively.

METHODS: A retrospective review of 144 patients treated for isolated ankle fractures during two six-month periods (a pre-law group from January 2017 to July 2017 [n = 73] and a post-law group from January 2018 to July 2018 [n = 71]). Postoperative narcotic and non-narcotic use was reviewed using electronic medical records and a legal prescriber database. Total number of prescriptions and milligrams of morphine equivalents (MME) per patient prescribed during incremental 90-day postoperative periods up to 1 year were compared between those treated before implementation of opioid legislation and those treated after. Additionally, non-opioid prescriptions, clinical visits and last x-ray dates were documented.

RESULTS: Mean number of opioid prescriptions prescribed per patient in the immediate 90-day postoperative period was 1.36 in the pre-law group and 1.15 in the post law group ($p = 0.23$). Only one patient in the pre-law group and two in the post-law group continued to take opioids one year postoperatively (total = 2.1%). Mean MME prescribed per patient decreased from 817.2 MME pre-law to 380.9 post-law ($p = 0.0009$) in the immediate 90-day postoperative period. Mean number of non-opioid prescriptions prescribed in the immediate 90-day postoperative period decreased from 1.85 in the pre-law group to 1.58 in the post-law group ($p = 0.15$). However, the number of non-opioid prescriptions increased from 2.0 in the pre-law group to 2.33 in the post-law group at 1 year postoperation ($p = 0.33$). 11 out of the 144 patients (7.6%) were seen after 1 year surgery. 15 (10.4%) received x-ray imaging at greater than 1 year follow-up.

CONCLUSION: There was a significant decline in the number of prescriptions and MME in the immediate 90-day postoperative period after enforcement of the Ohio Opioid Law. There was no significant difference in non-opioid analgesic prescriptions between pre-law and post-law groups suggesting non-opioid analgesics may not be replacing opioids for pain management. Approximately 10% of patients continued to be seen for chronic pain at 1-year follow-up.

Effect of Postoperative Gabapentin Administration on Opioid Consumption

Abstract ID: Paper 113

Haley M. McKissack, B.S.
Jun Kit He, B.S.
*Alexandra M. Arguello
Joshua L. Washington, B.S.
Sameer Naranje, M.D.
Gerald McGwin, Jr., M.D., Ph.D.
Michael D. Johnson, M.D.
Ashish B. Shah, M.D.
Birmingham, AL

INTRODUCTION: Prescription opioids are commonly used to control postoperative pain in foot/ankle surgery, but include potential side effects – sedation, respiratory depression, and addiction. In foot/ankle surgery, pain commonly delays hospital discharge and decreases movement, thereby, slowing recovery. Gabapentin decreases lesion-induced hyperexcitability of posterior horn neurons and central sensitization, and has been explored as a potential addition to patients' pain regimen. Studies have previously assessed effects of gabapentin on pain relief, but not whether gabapentin is effective in opioid consumption reduction beyond the immediate postoperative period. The purpose of this study is to assess whether gabapentin acts synergistically to improve postoperative pain among patients undergoing foot/ankle surgery.

METHODS: Patients from a single institution who underwent elective foot/ankle surgery were identified using CPT codes 27700, 27702, 27870, 28705, 28715, 28725, 28730, and 28740. Those prescribed opioids postoperatively were included. A retrospective chart review was conducted for each patient to identify prescription dose, number of pills, date in which prescription was filled, and dates of refills for oxycodone, hydrocodone, oxycodone-acetaminophen, hydrocodone-acetaminophen, tramadol, and gabapentin. Medication information was collected for prescriptions by the operating surgeon, nurse practitioner, physician assistant, resident, or fellow which were pertinent to the foot/ankle surgery performed; prescriptions from other services or providers were not included in order to ensure medications prescribed were specific to postoperative pain. Opioid quantities were converted to morphine equivalents and compared at various time intervals between patients who were prescribed only opioids, and patients who were prescribed opioids and gabapentin.

RESULTS: Among patients prescribed gabapentin plus opioids, total opioids prescribed (in morphine equivalents, OME) was 68.33, 221.25, 87.50, and 400.83 at weeks 1-2, 3-6, 7-12, and greater than 12, respectively. Although not statistically significantly different, patients prescribed only opioids had greater average amounts of opioids prescribed at all time intervals, equaling 98.34 OME, 553.52 OME, 540.53 OME, and 766.25 OME at weeks 1-2, 3-6, 7-12, and greater than 12, respectively. When excluding patients taking opioids preoperatively, total morphine equivalents prescribed was significantly less among patients prescribed gabapentin (196.94 OME) in comparison to those prescribed only opiods (457.41 OME) ($p=0.0255$).

CONCLUSION: Findings of this study suggest gabapentin may be effective in reducing postoperative opioid consumption beyond the immediate postoperative period among elective foot and ankle surgery patients. Gabapentin may be particularly beneficial postoperatively within three to six weeks. Prospective clinical trials are warranted to further validate these results.

Innovative Methods to Achieve Opioid Free Arthroscopic Rotator Cuff Repair

Abstract ID: Paper 114

---

*Kiran Chatha, M.D. / Miami, FL
Sandra Koen, ATC / Aventura, FL
Gregory Gilot, M.D. / Weston, FL
Wilfredo Borroto, B.S. / San Juan, Puerto Rico
John Merriam, B.S. / Weston, FL
Vani J. Sabesan, M.D. / Weston, FL

BACKGROUND: Creation of pain as the 5th vital sign has led to skyrocketing opioid prescriptions and a crisis with addiction and abuse among Americans. In the realm of shoulder surgery, literature has established that arthroscopic rotator cuff repair (RCR) is one of the most painful procedures and is often associated with higher opioid consumption. The purpose of this study was to evaluate effectiveness of preoperative patient education and multimodal pain management to achieve an opioid-free postoperative recovery after RCR.

METHODS: Forty patients who underwent RCR were divided in two groups. The Opioid-Free group (OFG) patients received preoperative education on expectations of pain, non-opioid pain protocol, and alternate therapies to minimize pain. Control group received standard postoperative opioid pain management and instructions. All patients received an interscalene block and local infiltration of liposomal bupivacaine. Patients were compared on pain levels and opioid consumption at 48 hours, and 2 weeks as well as PROs preoperative and 3 months postoperatively. A retrospective of patients with VAS scores of 7 and greater was conducted to assess for protocol failures. Student's t-tests were used to compare opioid usage, pain levels, and outcome scores.

RESULTS: Of the 40 patients in the cohort, 20 patients were in the OFG and matched with 20 patients in the (CG) control. There were no significant differences in demographics. In the OFG, 15% of patients reported use of rescue opioids in the first 48 hours following surgery, and no patients reported opioid use at 2 weeks compared to 100% on opioids at 48 hours and 90% at 2 weeks in the CG. Patients in both groups showed significant improvements in outcome scores ($p \leq 0.05$). At last follow-up, there were no significant differences in PROs between groups (ASES pain, ASES function, PENN function, Constant, Satisfaction). On average, the patients in the protocol failure group were significantly older, with an average age of 65.4 compared to 57.8 ($p=0.025$) and had a significantly higher rate of chronic pain syndromes (100%) ($p<0.001$) and previous surgical procedures (46%) ($p<0.05$).

CONCLUSIONS: RCR has been reported as one of the most painful surgeries requiring significant amounts of opioids for extended periods of time. Application of patient education tools and innovative multimodal pain management protocols successfully eliminates the need for opioid use while maintaining excellent patient satisfaction and outcomes. The limitation of this protocol appears to be with patients with chronic pain syndromes and a history of surgical procedures, likely due to previous opioid use. Further research in application of these methods to a broader RCR patient population is needed.

Opioid Prescribing Patterns in Reverse Shoulder Arthroplasty: What Surgeons Need to Know

Abstract ID: Paper 115

Vani J. Sabesan, M.D. / Boca Raton, FL
Jordan Grauer, B.S. / Boca Raton, FL
Matthew Stankard, B.S. / Boca Raton, FL
*Nikolas Echeverry, B.S. / Boca Raton, FL
Arjun Meiyappan, M.D. / Weston, FL
Kiran Chatha, M.D. / Miami, FL

INTRODUCTION: Orthopedic surgeons are the third highest prescribers of opioid medications and the declaration of the recent opioid crisis has placed more scrutiny on physicians and their prescribing habits. Many patients undergoing reverse shoulder arthroplasty suffer from chronic pain requiring opioids even before and after surgery. Preoperative opioid use can result in increased postoperative opioid use and dependence. The purpose of this study was to understand opioid usage and prescribing patterns for patients undergoing shoulder arthroplasty.

METHODS: A retrospective review of opioid prescriptions in 523 patients who underwent a reverse shoulder arthroplasty from 2014-2016 was performed. Demographics including age, gender, race, ethnicity, BMI, ASA class, and smoking status were collected for all patients. Opioid prescriptions within 90 days before and after surgery were collected using the state-mandated opioid dispensation database. Prescriber specialty was recorded as orthopedic surgeon or other. Opioid dependence was defined as three months of continuous opioid prescriptions surrounding surgery. Descriptive statistics were performed and a Chi square test was performed for all categorical variables and frequency of opioid prescriptions between prescriber specialties.

RESULTS: Average age was 71-years-old, with 275 females and 192 males. Average BMI was 30.38 and average ASA class was 2.85. Preoperatively, dependence rate was 33%. 46% of patients had a preoperative opioid prescription, 24.7% written by orthopedists compared to 60% by internal medicine specialties. Preoperatively, 14.2% of patients received opioid prescriptions from both orthopedists and other specialists and 20% of patients received >2 overlapping prescriptions with an average of 33.88 TMEs. Postoperatively, 92% of patients filled at least one opioid prescription with an average of 2.37 opioid prescriptions filled by each patient. Postoperatively, 60.3% of prescriptions were written by orthopedists while 26.5% were made by all other specialties and 13.2% were prescribed by both orthopedists and other specialty physicians. 36.4% of patients received >3 opioid prescriptions. Three months postoperatively, 34% of patients were dependent. Postoperatively, 62% of preoperatively dependent patients remained dependent and 80% received multiple opioid prescriptions from their orthopedic surgeon.

CONCLUSIONS: Orthopedic surgeons must be aware of their prescribing patterns and contribution to dependence in the shoulder patient population. With one-third of patients being opioid dependent and receiving more than three prescriptions from their orthopedic surgeon, we need to lead the charge for better physician prescribing practices and patient education on the risks.

Can We Eliminate Opioids after Common Orthopedic Sports Procedures? A Novel Multimodal Pain Protocol

Abstract ID: Paper 116

---

*Toufic R. Jildeh, M.D. / Detroit, MI
Vasilios Moutzouros, M.D. / Detroit, MI
Lafi S. Khalil, M.D. / Detroit, MI
Kaylin Schwartz, P.A. / Detroit, MI
Laith Hasan, B.S. / New Orleans, LA
Kelechi R. Okoroha, M.D. / Detroit, MI

BACKGROUND: The opioid epidemic has increased concerns about the safety of opioids and the appropriate management of pain with opioid medications. We sought to determine if postsurgical pain following common orthopedic sports procedures could be managed effectively with a non-narcotic multimodal analgesic protocol.

STUDY DESIGN: Level IV

METHODS: We performed a prospective study evaluating a novel multimodal non-opioid pain protocol in all patients undergoing common orthopedic sports procedures by a single sports surgeon from May 2018 to December 2018. The non-opioid pain protocol consisted of preoperative analgesics, intraoperative local infiltration analgesia, and a postoperative pain regimen. Patient pain levels were reported at one week postoperatively using the visual analogue scale and rescue opioids (oxycodone 5 mg) used were recorded.

RESULTS: A total of 141 patients were included. The average age of patients included was 37.8 ± 18.9 years, the average BMI was 29.3 ± 7.1 kg/m^2, and 66.0% of the patients were male. One week following surgery patients reported a mean visual analogue scale level of 3.1 ± 2.3 and required on average 2.6 ± 3.6 breakthrough oxycodone pills, correlating to 8.6 ± 12.0 morphine equivalents. Forty-five percent of patients did not require any breakthrough narcotics and reported satisfaction with pain management. Patients who required opioids were more likely to have a history of anxiety/depression (44.2% vs. 23.8%, P = .012) and reported higher pain scores as compared to non-users (3.94 ± 2.5 vs. 2.41 ± 1.75, P = .016). All patients were satisfied with their pain management postoperatively.

CONCLUSION: Our study found that a novel multimodal non-opioid pain protocol was effective in managing postoperative pain following common orthopedic sports procedures. Patients were found to have low levels of pain, require minimal rescue opioids, and had no severe complications while using the protocol. Requirement of opioids postoperatively was found to be associated with pain level, procedure type, and psychiatric diagnosis. These results suggest a non-opioid alternative to pain management following common orthopedic sports procedures.

Impact of Preoperative Opioid Use in Patients Undergoing Surgical Management of Patellofemoral Instability

Abstract ID: Paper 117

Zain M. Khazi, B.S.
*Alan G. Shamrock, M.D.
Christina J. Hajewski, M.D.
Natalie A. Glass, Ph.D.
Brian R. Wolf, M.D., M.S.
Kyle R. Duchman, M.D.
Robert W. Westermann, M.D.
Matthew J. Bollier, M.D.
Iowa City, IA

PURPOSE: Previous studies have demonstrated that preoperative opioid use is an independent risk factor for postoperative opioid use and poor patient reported outcomes (PROs) after multiple orthopedic procedures. The purpose of the present study was to investigate the association between preoperative opioid use and persistent postoperative use and to determine the impact of preoperative opioid use on PROs in patients undergoing patellofemoral stabilization surgery.

METHODS: A retrospective analysis of 60 cases of patellofemoral stabilization surgery with a minimum of 2-year follow-up was performed using a prospectively-collected patellar instability registry. Patients were categorized as opioid naïve (n=48) if they did not use opioids within 3 months before surgery or preoperative opioid users (n=12). Postoperative opioid use was assessed for all patients at two and six weeks after surgery. Knee Injury and Osteoarthritis Outcome Score (KOOS) and Kujala questionnaires were administered at baseline, and six months, and two years after surgery. Fisher's exact test, Student's t-test, and Wilcoxon rank sum tests were utilized to compare demographics and PROs between the two cohorts with statistical significance defined as $p<0.05$.

RESULTS: There was no difference in gender ($p=0.934$) or body mass index ($p=0.061$) between the cohorts, however, the opioid naïve cohort was significantly younger than the preoperative opioid cohort (22.8 vs. 30.3 years; $p=0.0236$). Preoperative opioid use was identified as an independent risk factor for postoperative opioid use at 2 weeks ($p=0.0023$) and 6 weeks ($p<0.0001$) following surgery. Preoperative opioid use was associated with significantly lower KOOS and Kujala scores at baseline ($p=0.0105$), 6 months ($p=0.0339$), and 2 years ($p=0.0249$) postoperatively. Both groups significantly improved from baseline KOOS and Kujala scores at six months and two years postoperatively. Regardless of preoperative opioid use, opioid use at 6 weeks after surgery was associated with inferior KOOS (6 months: $p<0.001$; 2 years: $p<0.001$) and Kujala (6 months: $p<0.001$; 2 years: $p<0.001$) scores at 6 months and 2 years postoperatively.

CONCLUSION: In patients undergoing patellofemoral stabilization surgery, preoperative opioid use was predictive of postoperative use. Additionally, preoperative opioid use was associated with inferior PROs at six months and two years following surgery.

Opioid Requirement Following Arthroscopic Knee Surgery: Are There Predictive Factors Associated with Long-Term Use?

Abstract ID: Paper 118

Georgina Glogovac, M.D.
Mark Kennedy, B.S.
*Michael D. Parman, M.D.
Robert N. Matar, M.D.
Katherine A. Bowers, Ph.D., M.P.H.
Angelo J. Colosimo, M.D.
Brian M. Grawe, M.D.
Cincinnati, OH

PURPOSE: To identify patterns of postoperative narcotic use and determine the impact of psychosocial and perioperative factors on postoperative opioid consumption following arthroscopic knee surgery.

METHODS: Fifty consecutive patients undergoing arthroscopic knee surgery were prospectively enrolled. Patients were contacted via telephone at one week postoperatively to report their pain level and opioid consumption. The patient was contacted again at 2 weeks, 4 weeks, and 90 days as necessary until opioid cessation, at which time the patient's plan for unused pills was inquired. Opioid consumption was compared using t-tests and one-way analysis of variance for demographic and surgical factors. Linear regression was used to determine whether the Pain Catastrophizing Scale (PCS), Resilience Scale (RS-11), International Knee Documentation Committee (IKDC) questionnaire, or patient-reported pain at one week predicted higher opioid consumption.

RESULTS: The average morphine equivalent dose of opioid consumption was 142 mg. Sixty-four percent consumed less than 100 mg, and 68% discontinued opioid use by 1 week postoperatively. Seventy-four percent reported surplus pills, and 49% of those patients plan for pill disposal. Factors associated with higher consumption included undergoing a major procedure, having a regional anesthesia block, and higher Area Deprivation Index score ($p<0.05$). Higher Pain Catastrophizing Scale scores and reported average pain level at one week were predictive of higher opioid consumption ($p<0.05$).

CONCLUSION: A majority of patients undergoing outpatient knee surgery did not require the entirety of their narcotic prescription. The majority of patients consumed less than 100 mg of morphine equivalents and discontinued opioid use by one week postoperatively. Ligament reconstruction, living in an area with a higher index of deprivation, and higher score on the Pain Catastrophizing Scale were associated with greater opioid consumption. Overall, patient knowledge regarding opioid disposal was poor, and patients would likely benefit from additional education prior to surgery.

Risk Factors and Rate of Prolonged Opioid Consumption after Hip Arthroscopy in Opioid Naïve Patients: A Population-Based Study

Abstract ID: Paper 119

Zain M. Khazi, B.S.
Alan G. Shamrock, M.D.
Trevor R. Gulbrandsen
*Edward O. Rojas
Kyle R. Duchman, M.D.
Robert W. Westermann, M.D.
Iowa City, IA

PURPOSE: To determine (1) the rate of postoperative opioid use, and (2) risk factors for prolonged opioid consumption among opioid naïve patients undergoing hip arthroscopy.

METHODS: Patients that underwent primary HA between 2007 and 2017q1 were identified within the Humana Inc. administrative claims database using relevant Current Procedural Terminology (CPT) codes. Patients with prior total hip and hemiarthroplasty, and history of septic arthritis of the hip were excluded. Patients with subsequent ipsilateral or contralateral hip arthroscopy within one year of index surgery were also excluded. Subsequently, patients were categorized as opioid naïve if they did not fill opioid prescriptions during the six months prior to the index surgery. In this cohort, rates of postoperative opioid utilization were longitudinally tracked for 12 months, and prolonged opioid use was defined as opioid utilization at ≥3 months following HA. Preoperative tramadol use was not used to screen opioid naïve patients, but was included as an independent study variable. Multivariate logistic regression models were used to identify risk factors associated with prolonged opioid use at 3, 6, 9, and 12 months postoperatively.

RESULTS: In total, 1,274 opioid naïve patients that underwent hip arthroscopy met our inclusion criteria. Rates of postoperative opioid use declined precipitously after the first postoperative month, with only 5% and 3.3% of patients using opioids at 3 and 12 months, respectively. The most significant risk factor for prolonged opioid use was preoperative tramadol use (Odds Ratio [OR]: 1.97, 95% CI: 1.01-3.87, p=.0486) at 3 months, obesity (OR: 2.55, 95% CI: 1.1-5.95, p=.0298) at 6 months, tobacco use (OR: 2.95, 95% CI: 1.13-7.7, p=.0275) at 9 months, and high Charlson Comorbidity Index (OR: 1.38, 95% CI: 1.13-1.70, p=.0018) at 12 months following index surgery.

CONCLUSION: Among opioid naïve patients, prolonged opioid use after hip arthroscopy was low, however, preoperative tramadol use, obesity, tobacco use, and high Charlson Comorbidity Index were independently associated with prolonged opioid use following hip arthroscopy.

The Effect of Written Prescriptions for Over-the-Counter Non-Opioids on Postoperative Pain and Medication Consumption

Abstract ID: Paper 120

---

*Daniel J. Lynch, B.S.
James S. Lin, M.D.
Kanu S. Goyal, M.D.
Columbus, OH

PURPOSE: There has been a recent sharp increase in opioid-related deaths in the United States, partly due to over-prescribing of opioid pain medication after surgery. That is why over-the-counter, non-opioid pain medication is often recommended in addition to opioid medications after outpatient surgery to reduce opioid consumption. The current literature lacks adequate analysis of the effects of prescribing non-opioids for outpatient surgery. We hypothesized that writing prescriptions for non-opioids will increase patients' use of them after surgery.

METHODS: Patients undergoing hand and upper extremity surgery were recruited (n = 244) after implementation of a postoperative pain control program encouraging non-opioid use before opioid use. 47% (n =115) of these patients were given prescriptions for non-opioids, and 53% (n = 129) were not. At their first postoperative visit, patients reported their medication consumption and pain control satisfaction. We examined whether a prescription for non-opioid medication altered patients' non-opioid and opioid medication use and postoperative pain control. Two-tailed t tests assuming unequal variance and Fisher's exact tests were used to test for statistical significance, and Grubbs tests were used for the removal of outliers.

RESULTS: 87% of patients given a written non-opioid prescription, compared to 97% of patients who were not provided a written prescription for non-opioids, consumed non-opioids after surgery ($p = 0.007$). Analysis of patients' pain control (0 = poor, 10 = great) showed that those who received a prescription for non-opioids reported an average pain control of 8.4 +/- 2.1 while their counterpart reported an average pain control of 7.9 +/- 2.6 ($p = 0.17$). Patients given non-opioid prescriptions reported an average postoperative consumption of 22.6 +/- 21.9 non-opioid pills while patients not given a prescription reported an average postoperative consumption of 30.1 +/- 28.6 non-opioid pills ($p = 0.043$). Patients given a prescription for non-opioids reported an average consumption of 8.6 +/- 12.02 opioid pills compared to 6.3 +/- 8.1 opioid pills for those not prescribed non-opioids ($p = 0.092$).

CONCLUSIONS: At our institution, we provide all of our patients undergoing outpatient surgery discharge instructions encouraging non-opioid use before opioid use. In our study, patients' postoperative pain control and medication consumption did not differ based on their receipt of prescriptions for postoperative non-opioid medication. These findings suggest our current pain plan emphasizing non-opioids as first line postoperative pain control has been effective.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 24, 2020

Hip Arthroscopy for Patients with Persistent Pain Following Periacetabular Osteotomy: No Significant Changes in Pre- and Postoperative Patient Reported Outcomes

Abstract ID: Paper 121

---

*Mario Hevesi, M.D. / Rochester, MN
Cody C. Wyles, M.D. / Rochester, MN
Wahid Abu-Amer, M.D. / St. Louis, MO
John C. Clohisy, M.D. / St. Louis, MO
Robert T. Trousdale, M.D. / Rochester, MN
Aaron J. Krych, M.D. / Rochester, MN
Rafael J. Sierra, M.D. / Rochester, MN

INTRODUCTION: Periacetabular osteotomy (PAO) remains the gold standard procedure for joint preservation in symptomatic developmental dysplasia of the hip (DDH). To date, the role for hip arthroscopy to address and correct intra-articular and labral pathology for patients with unsatisfactory outcomes following PAO remains controversial, with few and small available series to guide clinicians. The purpose of this study was to harness the combined Academic Network of Conservational Hip Outcomes Research (ANCHOR) database in order to provide guidance regarding outcomes and arthroplasty rates in patients undergoing hip arthroscopy for persistent pain following PAO.

METHODS: The ANCHOR database was reviewed for all PAOs performed between 2008 and 2018 undergoing subsequent PAO. Patient demographics, patient-reported outcome scores (Hip disability and Osteoarthritis Outcome Score [HOOS], Western Ontario and McMaster Universities Osteoarthritis index [WOMAC], UCLA score, and Harris Hip Score [HHS]), and total hip arthroplasty rates were determined to evaluate the utility of arthroscopy following PAO.

RESULTS: A total of 29 patients (5 males, 24 females, age: 23.4±8.4 years) undergoing 32 PAOs (21 right, 11 left) with subsequent arthroscopy at 7 high-volume academic centers were evaluated. Mean preoperative lateral center edge angle (LCEA) was 17.5±9.3° which was corrected to a mean of 32.0±4.7° at the time of PAO. Patients were followed for a mean of 3.9±2.0 years (range: 0.8 – 9.1) from the time of PAO and underwent hip arthroscopy at a mean of 1.5±1.1 years, with 23 (72%) undergoing concurrent hardware removal.

Following arthroscopy, no patient reported outcome measure demonstrated a statistically significant postoperative difference. HOOS changed from 56.5±18.5 preoperatively to 58.1±20.5 postoperatively (p=0.74), WOMAC changed from 73.7±18.5 to 69.7±20.7 (p=0.63), UCLA score from 6.6±2.8 to 6.0±2.7 (p=0.64), and HHS from 63.6±17.0 to 65.0±19.8 (p=0.91). At the time of final follow-up, one hip (3%) had converted to THA at 4.1 years following PAO and 3.0 years following hip arthroscopy.

DISCUSSION AND CONCLUSION: In the largest available cohort of its kind, patients undergoing hip arthroscopy following PAO demonstrated no statistically significant postoperative change in HOOS, WOMAC, UCLA, or HHS scores. Given these findings, patients

and surgeons alike should expect a guarded prognosis for persistent pain following PAO undergoing evaluation for revision arthroscopic management.

Incidence and Risk Factors for Failure of Primary Hip Arthroscopy within One Year: A Population-Based Study

Abstract ID: Paper 122

Zain M. Khazi, B.S. / Iowa City, IA
*Steven Dayton / Chicago, IL
Daniel J. Johnson, M.D. / Chicago, IL
Richard W. Nicolay, M.D. / Chicago, IL
Vehniah K. Tjong, M.D. / Chicago, IL
Michael A. Terry, M.D. / Chicago, IL

PURPOSE: To determine the incidence and risk factors for revision hip arthroscopy (HA) or conversion to total hip arthroplasty (THA) within one year following index HA.

METHODS: Patients that underwent primary hip arthroscopy between 2007 to 2017q1 were longitudinally tracked for one year to identify patients that failed primary HA in the Humana Inc. database. Failed primary HA was defined as revision HA or conversion to total hip arthroplasty (THA) within one year following index HA. Patients that were not active in the database for at least one year or with incomplete laterality information were excluded from the study. A control group of patients that did not fail primary HA were identified to compare patient demographics and medical comorbidities between those who failed primary HA. Additionally, multivariate logistic regression analyses were performed to identify independent risk factors for failed primary HA within the first year following primary hip arthroscopy, with statistical significance defined as $P<0.05$.

RESULTS: There were 836 patients (37.3% male) that underwent primary hip arthroscopy and met our inclusion criteria in the database. Of these, 9.9% (n=83) failed primary HA within the first year with 46 patients converting to THA and 39 undergoing revision HA. There was a significantly higher incidence of diabetes mellitus (21.7% vs. 11.7%, P=0.0094), hypertension (48.2% vs. 33.5, P=0.0076), hip osteoarthritis (71.1% vs. 36.5%, P<0.0001), depression or anxiety (29.4% vs. 24.3%, P<0.0001), and tobacco use (27.7% vs. 10.8%, P<0.0001) in patients that failed primary HA compared to the control group. The multivariate model identified age >40 years (OR: 2.15, 95% CI: 1.05-4.76, P=0.0455), hip osteoarthritis (OR: 2.28, 95% CI: 1.24-4.45, P=0.0111), and diagnosis of depression or anxiety (OR: 2.77, 95% CI: 1.57-5.04, P=0.006) as independent risk factors for failing primary HA.

Subgroup analysis identified hypertension (OR: 2.95, 95% CI: 1.20-7.25, P=0.0181) and depression or anxiety (OR: 2.62, 95% CI: 1.21-5.65, P=0.0143) as independent risk factors for conversion to THA. Similarly, depression or anxiety (OR: 2.77, 95% CI: 1.24-6.51, P=0.0151) was independently associated with revision HA, whereas, hypertension (OR: 0.15, 95% CI: 0.05-0.45, P=0.0011) was protective for revision HA.

CONCLUSION: Nearly 10% of patients required THA or revision HA within 1 year following primary HA. Age >40 years, hip osteoarthritis, and preoperative diagnosis of depression or anxiety are risk factors for THA or revision HA within 1 year following primary HA.

Predictors of Clinical Outcomes after Hip Arthroscopy: Five-Year Follow-Up Analysis of 1,038 Patients

Abstract ID: Paper 123

Ajay C. Lall, M.D., M.S.
Sarah L. Chen, B.A.
Cammille C. Go, B.S.
Rafael Walker-Santiago, M.D.
David Maldonado, M.D.
*Jacob Shapira, M.D.
Benjamin G. Domb, M.D.
Des Plaines, IL

BACKGROUND: Although hip arthroscopy has been shown to have favorable results, there is a paucity of literature describing predictive factors of five-year clinical outcomes.

PURPOSE: Identify predictive factors of midterm outcomes after hip arthroscopy in a cohort of 1,038 patients, whose outcomes at minimum 2-year follow-up have previously been reported. In addition, to provide a comparison of short-term and mid-term predictive factors in outcome measures following hip arthroscopy.

STUDY DESIGN: Case-control study; Level of evidence, 3.

METHODS: Data were prospectively collected and retrospectively reviewed on all patients undergoing hip arthroscopy between February 2008 and June 2012. Patients were included if they had minimum five-year follow-up on three patient-reported outcomes: Nonarthritic Hip Score (NAHS), modified Harris Hip Score (mHHS), and Hip Outcome Score-Sport Specific Subscale (HOS-SSS). Patients were excluded if they had any prior ipsilateral hip conditions. Using bivariate and multivariate analyses, we analyzed the effect of 36 preoperative and intraoperative variables on NAHS.

RESULTS: A total of 1,038 patients met our listed inclusion and exclusion criteria, with a mean follow-up time of 62.0 months (range, 60.0 - 120.0 months). The bivariate analysis identified 11 variables (4 categorical and 7 continuous) that were predictive of 5-year postoperative NAHS. For the multivariate analysis, seven variables were identified as being significant: preoperative NAHS, body mass index (BMI), age, lateral joint space, alpha angle, revision hip arthroscopy, and acetabular microfracture. These seven variables were also predictive in the bivariate analysis.

CONCLUSION: This study reports favorable mid-term clinical outcomes in the largest cohort of hip arthroscopies with minimum five-year follow-up in the literature to date. Seven variables were identified as being significant predictors in both the bivariate and multivariate analysis: preoperative NAHS, body mass index (BMI), age, lateral joint space, alpha angle, revision hip arthroscopy, and acetabular microfracture. Of these, preoperative NAHS, BMI, age, and revision hip arthroscopy were predictive of both two-year and five-year postoperative NAHS. These predictive factors may prove useful to clinicians in determining indications for hip arthroscopy and counseling patients on its expected outcomes.

Isolated Acetabuloplasty for the Treatment of Femoroacetabular Impingement: Long-Term Patient-Reported Outcomes

Abstract ID: Paper 124

---

*Matthew J. Hartwell, M.D.
Ujash Sheth, M.D.
Patrick Nelson, B.A.
Allison M. Morgan, B.A.
Claire Fernandez, M.D.
Vehniah K. Tjong, M.D.
Michael A. Terry, M.D.
Chicago, IL

INTRODUCTION: Femoroacetabular impingement (FAI) frequently results from mixed osseous abnormalities of the acetabulum (pincer-type) and/or the femur (cam-type), resulting in premature contact between the two structures. The goal of surgery is to decompress the impinging osseous structures; thus, an isolated decompression of the pincer lesion (acetabuloplasty) should allow for adequate decompression without the need to resect portions of the femoral neck. The purpose of this study was to evaluate long-term patient-reported outcomes following this procedure.

METHODS: A retrospective review of patients undergoing isolated acetabular osteoplasty and labral repair for FAI was performed. Patient reported outcomes (PROs), using both traditional legacy measures and a computer adaptive testing (CAT) tool, the Patient Reported Outcomes Measurement Information System (PROMIS), were assessed at minimum of two-year follow-up. PROs included the PROMIS for Physical Function (PROMIS-PF) and Pain Intensity (PROMIS-Pain), and the traditional legacy measures included the modified Harris Hip Score (mHHS), Hip Outcome Score (HOS) for ADLs and Sport, International Hip Outcome Tool-12 (iHOT-12), Numeric Pain Rating Scale (NPRS), and Visual Analog Scale (VAS) for pain. Preoperative x-rays were reviewed to assign Tonnis grades, and mean PRO scores were compared between Tonnis grades.

RESULTS: We identified 88 patients with an average age of 38.6 (range, 17-64) and an average clinical follow-up of 5.2 years (range, 2-9.8). Patients were grouped according to preoperative Tonnis grade: Tonnis 0 (n=47, 53.4%) and Tonnis 1 (n=41, 46.4%). There was no significant difference in length of follow-up between Tonnis 1 and Tonnis 2 (5.0 years vs. 5.3 years, $p=0.46$). Patients with a Tonnis grade of 0 had significantly better PROs than those with a Tonnis grade of 1 for all PROs: PROMIS-PF (55.2 vs. 49.5, $p=0.0006$), PROMIS-Pain (36.0 vs. 42.4, $p<0.0001$), mHHS (84.0 vs. 75.0, $p<0.0001$), HOS-ADL (95.6 vs. 89.2, $p=0.0031$), HOS-Sport (90.1 vs. 77.7, $p=0.0024$), HOS-Total (93.9 vs 85.5, $p=0.0016$), iHOT-12 (86.6 vs 66.6, $p<0.0001$), NPRS (1.0 vs 2.8, $p<0.0001$), and VAS (1.3 vs. 2.9, $p<0.0001$).

CONCLUSION: Isolated acetabuloplasty for the treatment of FAI provides excellent long-term PROs at five-year average follow-up in patients with no preoperative evidence of hip arthritis, according to both traditional legacy measures and the more generalizable PROMIS-CATs with respect to pain and physical functioning. Patients without any evidence hip arthritis had significantly improved long-term outcomes compared to patients with early signs of hip arthritis.

Outcomes of Hip Arthroscopy for Patients with Femoroacetabular Impingement in the Context of Age and Arthritis

Abstract ID: Paper 125

---

*Fernando A. Huyke, B.S.
Sanjum P. Samagh, M.D.
Vehniah K. Tjong, M.D.
Michael A. Terry, M.D.
Chicago, IL

Though usually reserved for younger non-arthritic patients, hip arthroscopy has recently led to favorable outcomes for both older patients as well as arthritic patients with femoroacetabular impingement (FAI). In this prospective case series, we matched FAI patients by age and osteoarthritis (OA) severity and examined hip arthroscopy outcomes. FAI patients (N=100) receiving hip arthroscopy were divided by age: patients under 40 years old (N=54) and patients over 40 (N=46). They were also divided by OA severity: patients with Tönnis grade 0-1 OA (N=46) and patients with grade 2-4 OA (N=54). The groups were then divided into subgroups: younger patients with no-to-mild OA (N=34), older patients with no-to-mild OA (N=12), younger patients with moderate-to-severe OA (N=20), and older patients with moderate-to-severe OA (N=34). We administered five different previously validated self-reporting questionnaires to patients preoperatively and postoperatively at six months and one year, and outcomes were compared from baseline within each group. Additionally, subgroups were matched by age and OA severity, and their outcomes were compared. At six months and one year after hip arthroscopy, patients in all groups reported significantly better scores compared to their preoperative baseline for all surveys ($p<0.05$). Between age groups, there was no significant difference in outcomes for all surveys at 6 months ($p>0.1$) and most surveys at 1 year ($p>0.1$). Between OA groups, there was no difference in outcomes for all surveys at 6 months ($p>0.4$) and at 1 year (all $p>0.1$). There was no significant difference in outcomes between OA-matched subgroups for all surveys at 6 months ($p>0.1$) and most surveys at 1 year ($p>0.1$), and there were no differences between age-matched subgroups for all surveys at 6 months ($p>0.5$) and at 1 year ($p>0.3$). The findings support hip arthroscopy as a viable intervention for patients with FAI regardless of age or arthritis.

Comparative Efficacy of Preoperative Quadratus Lumborum Blocks in Hip Arthroscopy

Abstract ID: Paper 126

---

*Ryan E. Blackwell, M.D.
Michael Kushelev, M.D.
John Norton, M.D.
W. Kelton Vasileff, M.D.
Columbus, OH

INTRODUCTION: Significant postoperative pain remains one of the most frequently cited negative effects of hip arthroscopy. With the current opioid epidemic and the rapidly increasing number of hip arthroscopy procedures performed in the outpatient setting, the balance between providing adequate analgesia while minimizing postoperative opioid consumption has become more important. Multimodal pain control algorithms form an important part of the hip arthroscopy perioperative algorithm and helps to ensure the overall success of the procedure. The purpose of this study is to evaluate the effect of the single shot quadratus lumborum (QL) block versus the more traditional femoral and fascia iliacus (F/FI) blocks performed preoperatively on immediate postoperative outcomes.

METHODS: Forty patients were retrospectively reviewed. Twenty-one patients received preoperative QL blocks and 19 patients received preoperative femoral or fascia iliacus blocks. Intraoperative, post-anesthesia care unit (PACU), and total morphine equivalents were analyzed using unpaired t-test. Secondary outcome measures including total time in PACU and block-related complications were recorded and analyzed as well.

RESULTS: QL block patients required significantly lower total morphine equivalents (64.3 vs. 84.4, p=0.02). The QL block patients also had shorter PACU stays (117 vs. 147 minutes, p=0.01), and lower subjective pain scores at time of discharge (3.05 vs. 5.38, p=0.003) compared to the F/FI block group. There were no significant differences in intraoperative opioids (p=0.17) or PACU opioids (p=0.06) given when analyzed separately. One patient in the femoral nerve block group had noted a fall postoperatively. No patients in the QL block group had a block-related complication noted in the record.

CONCLUSION: Patients receiving a preoperative QL block for hip arthroscopy had lower total opioid requirements, shorter PACU stay, and lower pain scores at discharge than patients receiving preoperative F/FI blocks with no reported adverse events. This dataset suggests that further prospective data may be worthwhile to collect and analyze to further confirm the utility of QL blocks for hip arthroscopy surgery.

The Evolving Sourcil: Postoperative Radiographic Measurements Change in Response to a New Weight-Bearing Zone Following Periacetabular Osteotomy

Abstract ID: Paper 127

Cody C. Wyles, M.D.
Juan S. Vargas-Hernandez, M.D.
*Mark J. Heidenreich, M.D.
Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Periacetabular osteotomy (PAO) reorients the acetabulum in patients with developmental dysplasia of the hip (DDH) or retroversion. Common radiographic measurements for determining acetabular position include the lateral center-edge angle (LCEA), anterior center-edge angle (ACEA), and Tönnis angle. All three of these metrics rely upon the sourcil, a zone of sclerosis formed in response to weight bearing. The purpose of this study was to determine if the postoperative LCEA, ACEA, and Tönnis angles change over time in response to a new weight-bearing zone.

METHODS: We evaluated all patients undergoing PAO from 1996-2012 at one academic institution. Inclusion criteria were PAO for DDH or DDH and concomitant acetabular retroversion with minimum five-year radiographic follow-up. Exclusion criteria were PAO for isolated acetabular retroversion, neurogenic dysplasia, Legg-Calve-Perthes, and any prior surgery about the hip including arthroscopy and childhood osteotomies. There were 159 patients in the final cohort with 83% women; mean age was 29 years and mean BMI was 25 kg/m^2. Mean clinical and radiographic follow-up was 9 years (range, 5-21). All available postoperative radiographs were used to determine LCEA, ACEA, and Tönnis angle at each time point.

RESULTS: All 3 of the assessed radiographic parameters changed over time in the postoperative period, with a stable new position achieved after a mean of 2 years (range, 0.5 to 10). LCEA changed by at least 2° in 77% patients with a mean change of -2.3° (range,-37° to 13.9°). ACEA changed by at least 2° in 86% patients with a mean change of -2° (range, -34.5° to 13°). Tönnis angle changed by at least 2° in 66% patients with a mean change of -0.6° (range,-20.9° to 28.5°). The amount of change observed in the postoperative period was correlated with the size of correction at the time of PAO for each of the measurements as follows: LCEA (correlation =0.32; p=0.005), ACEA (correlation =0.26; p=0.074), Tönnis angle (correlation =0.57; p<0.001).

CONCLUSIONS: This study demonstrates that the acetabular sourcil undergoes evolution in the postoperative period following PAO. Furthermore, the degree of change is proportional to the amount of correction at the time of PAO with the new sourcil reaching final stability after approximately two years. Data from the presented work highlight inherent plasticity of the acetabulum, which raises questions about how hip preservation surgeons should optimally assess acetabular position and quality of correction following PAO.

Differences In Radiographic Measurements on Standing vs. Supine Pelvic Radiographs

Abstract ID: Paper 128

Andrea M. Spiker, M.D.
*Ryan M. Graf, M.D.
Sean P. Duminie, M.S.
Stephanie A. Kliethermes, Ph.D.
David C. Goodspeed, M.D.
Madison, WI

BACKGROUND: Accurate pelvic radiographic measurements is of clear clinical importance, as these measurements can drive the indications for surgery, the surgical approach utilized, and/or the degree of correction during hip preservation surgery. Currently, there are a large number of measurements available and reported on the literature when referencing anterior-posterior (AP) pelvic radiographs. However, there is no standardization of whether these pelvic radiographs are obtained in the standing or supine position.

HYPOTHESIS/PURPOSE: Standing vs. supine radiographs, obtained in the same patient, will result in different value for standard radiographic measurements used in making hip pathology diagnoses.

METHODS: All new patients who presented for evaluation of hip pain between September 2016 and July 2018 were retrospectively reviewed. Inclusion criteria included age 18-50, no prior hip surgery/injury, and both standing and supine AP pelvis radiographs dated within 2 years of each other. Measurements were obtained on 26 radiographs (52 hips), blinded to patient demographics and standing vs. supine radiograph. Measurements included minimum joint space, lateral center edge angle (LCEA), acetabular depth, acetabular inclination, Tönnis Grade, crossover sign, posterior wall sign, and ischial spine sign.

RESULTS: Standing films resulted in significantly lower LCEA and acetabular depth measurements, and higher acetabular inclination. Supine measurements for crossover sign were 5.69 times more likely to be positive than standing measurements. Similarly, supine measurements for ischial spine were 7.93 times more likely to be positive.

CONCLUSION: Based on our study, supine films are almost six times more likely to give a positive crossover sign and almost eight times more likely to give a positive ischial spine sign than a standing film in the same patient. Additionally, LCEA, acetabular depth will be lower and acetabular inclination will be higher on standing films. As such, our recommendation is to obtain standing AP pelvis radiographs to obtain the most accurate pelvic radiographic measurements in hip preservation patients.

Identifying Variables for Progression to Poor Outcomes after Periacetabular Osteotomy, a Multi-Center Study Utilizing Machine Learning

Abstract ID: Paper 129

Ayoosh Pareek, M.D. / Rochester, MN
Alexander G. Athey, M.D. / Rochester, MN
Cody C. Wyles, M.D. / Rochester, MN
Christopher L. Peters, M.D. / Salt Lake City, UT
John C. Clohisy, M.D. / St. Louis, MO
Robert T. Trousdale, M.D. / Rochester, MN
*Rafael J. Sierra, M.D. / Rochester, MN

BACKGROUND: Periacetabular osteotomy (PAO) is a common procedure for symptomatic hip dysplasia (DDH) and is thought to prevent progression of arthritis and to arthroplasty. Still, current studies evaluating risk factors for poor outcome are limited by power, long follow-up, or both.

PURPOSE: The goal of this study was to use machine learning utilizing preoperative demographic and radiographic characteristics to evaluate factors which increase the likelihood of poor outcome after PAO, defined as progression to arthroplasty or progression of at least one Tonnis grade.

METHODS: All patients who underwent PAO for DDH from 1996 to 2012 at 3 academic institutions in the U.S. for DDH with a minimum radiographic follow-up of 5 years were included. Patients with prior surgery on that hip were excluded. Every preoperative and postoperative radiograph was assessed for radiographic characteristics including, but not limited to osteoarthritis grade by Tonnis classification. This resulted in inclusion of 221 patients with 83% female, mean age of 29.5 years, and mean clinical and radiographic follow-up of 9.5 years (range, 5 to 21 years). Preoperative patient and radiographic factors were used as candidate variables in building predictive models for progression to arthroplasty with 50:25:25 splits in Train:Validation:Test data subsets. Models created included (1) Lasso Regression, (2) Ridge Regression, (3) Bootstrap/Random Forest, (4) Boosted Tree, (5) Neural network models.

RESULTS: At final follow-up, 53% of the patients had progressed at least one Tonnis grade or to THA. Boosted tree model (AUC 75%) was superior to other models, and was chosen due to the relative ease of interpretability. Variables, in order of importance, were preoperative retroversion, Tonnis grade, joint space, BMI, anterior center edge angle (ACEA), lateral center edge angle (LCEA), Tonnis angle, age, and gender. First 5 variables explained >75% of the model and when used in a logistic regression for creation of a model, resulted in a final AUC of 84% on test data.

CONCLUSION: DDH can be a source of functional limitation and progress to arthritis/arthroplasty. Periacetabular arthroplasty can allow patients to return to previous activity and in this validated machine learning model, we have discovered the most important preoperative variables to accurately predict poor prognosis after PAO. This model assists in patient treatment in addition to patient counseling in providing prognostic information.

Predictors of Hip Disease Progression in Patients with Femoroacetabular Impingement

Abstract ID: Paper 130

---

*Heath P. Melugin, M.D.
Jun Zhou, M.D., Ph.D.
Devin Leland, B.S.
Christopher D. Bernard, B.S.
Rena F. Hale, Ph.D.
Bruce A. Levy, M.D.
Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: Femoroacetabular impingement (FAI) is a known risk factor for hip osteoarthritis (OA) and total hip arthroplasty (THA) at a young age. Unfortunately, little is known about the specific factors associated with an increased risk of progression to OA and THA. Therefore, the purposes of this study were to report the overall rate of progression to hip OA and THA in patients with FAI, to identify risk factors associated with progression to hip OA, and to identify risk factors for conversion to THA.

METHODS: A geographic database was used to identify all patients with hip pain and hip radiographs between 2000 and 2016. Clinical and radiographic review was performed from their earliest radiograph (often prior to January 1, 2000) to identify patients with FAI for inclusion. Medical records were reviewed to obtain demographics, clinical history, physical exam findings, imaging details, treatment details, and clinical or radiographic progression. Contingency analysis and nominal logistic regression models were performed to determine risk factors and predictors of OA and THA progression.

RESULTS: In total, 1,188 patients (796 F: 392 M) diagnosed with FAI were included. Mean age at the time of presentation was 27 years (± 8.7). Mean follow-up time was 27.5 years (± 11.6). The overall rate of progression to hip OA or THA was 10% (7.4% OA: 2.7% THA). Most patients who developed OA or underwent THA presented with hip pain between the ages of 31-40 years (62% and 100%, respectively). Risk factors for development of hip OA included identification of a cam lesion ($p<0.045$), BMI greater than 24 kg/m^2 ($p<0.042$), and an alpha angle greater than 55° ($p<0.005$). Risk factors for conversion to THA included identification of a cam lesion ($p<0.045$), BMI > 24 kg/m^2 ($p<0.009$), diabetes mellitus ($p<0.005$), and a Tonnis angle less than 0° ($p<0.001$). Alpha angle greater than 55° and a BMI greater than 24 kg/m^2 were most predictive of progression to OA ($p<0.002$). Tonnis angle less than 0° was the most predictive of conversion to THA ($p<0.025$).

CONCLUSIONS: The overall rate of progression to hip OA or THA in patients with FAI was higher in those who presented with hip pain at an older age. Increased BMI was a risk factor for both hip OA and conversion to THA. Alpha angle greater than 55° was most predictive of hip OA, whereas Tonnis angle less than 0° was most predictive of conversion to THA.

Assessment of Disability Related to Hip Dysplasia Using Objective Measures of Physical Performance

Abstract ID: Paper 131

---

*Elizabeth J. Scott, M.D.
Michael C. Willey, M.D.
Arthur Mercado, B.S.
John Davison, B.S.
Jason Wilken, Ph.D., D.P.T.
Iowa City, IA

BACKGROUND: Physical performance measures (PPMs) which objectively quantify functional ability are an attractive adjuvant to patient-reported outcome instruments (PROs) which rely on subjective recollection and yield scores which can be difficult to interpret.

HYPOTHESIS/PURPOSE: We evaluated (a) the ability of four physical performance measures to differentiate between young adults with hip pain indicated for periacetabular osteotomy (PAO) and asymptomatic controls, (b) inter-test reliability of these PPMs, and (c) correlation with common PRO instruments for nonarthritic hip pain.

METHODS: Twenty-four patients age 15-39 years (100% female) with hip dysplasia (LCEA <25°) indicated for periacetabular osteotomy (PAO) completed HOOS PAIN and PS, iHOT-12, mHHS, PROMIS PF-CAT, and PI as well as four physical function tests: (1) Timed Stair Ascent (TSA), (2) Self-Selected Walking Speed (SSWS), (3) Four-Square Step Test (FFST), and (4) Sit-to-Stand Five Times Test (STS5). Twenty-one young asymptomatic adults ages 18-39 (91% female) also underwent physical function testing. Inter-rater reliability was assessed in 38 subjects by repeating the PPMs at a second visit within two weeks. Unpaired t-tests were used for between group comparisons, and intraclass correlation coefficients (ICCs) were used to assess reliability.

RESULTS: Statistically significant differences between patients with symptomatic hip dysplasia and asymptomatic controls were observed for all PRO measures (HOOS Pain 48.09 vs. 99.21, iHOT-12 34.39 vs. 99.27, mHHS 56.38 vs. 90.61, PROMIS PF-CAT T-score vs. 42.09 vs. 65.61; all $p<.001$). Patients showed significant impairment in all four physical performance tests ($p<0.001$) compared to controls. All PPMs demonstrated excellent test-retest reliability. ICCs (95% CI range) for SSWS, TSA, STS5, and 4SST were 0.91 (0.78-0.96), 0.88 (0.72-0.95), 0.71 (0.23-0.89), and 0.96 (0.88-0.98), respectively. PPMs correlated highly with physical function PROs including PROMIS PF, mHHS, and iHOT-12, with STS and TSA tests showing the strongest correlation ($r>0.5$), and SSWS demonstrating the weakest correlation ($r<0.25$).

CONCLUSION: Patients with symptomatic hip dysplasia demonstrate significant impairment on functional testing compared to normal controls, and performance measure testing demonstrated excellent test-retest reliability. Timed Stair Ascent and Sit-to-Stand testing in particular correlated strongly with self-reported physical function on PRO testing. PPMs may be a viable and well-received adjuvant to standard PRO testing for patients with nonarthritic hip conditions. Further investigation of the ability for PPMs to assess surgical or rehabilitative outcomes after hip preserving surgery is warranted.

Decisional Conflict Changes after Evaluation in a Hip Preservation Clinic

Abstract ID: Paper 132

---

*W. Kelton Vasileff, M.D.
Lindsey Brown, P.T., D.P.T.
John M. Ryan, M.D.
Stephanie DiStasi, Ph.D.
Columbus, OH

PURPOSE/HYPOTHESIS: Patients presenting for femoroacetabular impingement syndrome (FAIS) have often seen many providers, report years of symptoms, and experience physical and mental distress which may produce high decisional conflict during treatment planning. The purpose of this study was to identify factors associated with decisional conflict for patients with FAIS in a hip preservation clinic. We hypothesized that (1) longer duration of symptoms, worse pain and function, and no prior physical therapy (PT) would be associated with higher pre-evaluation conflict, that (2) receipt of an interdisciplinary evaluation and more time spent during the evaluation would be associated with greater reductions in conflict, and that (3) participants who agreed with provider(s) regarding the final treatment plan would report lower post-evaluation conflict.

SUBJECTS: 78 participants with FAIS (66% female, 38±11y.o.) were recruited for a randomized controlled trial to evaluate the impact of interdisciplinary evaluation between an orthopedic surgeon and physical therapist.

MATERIALS/METHODS: Participants completed the Decisional Conflict Scale (DCS) before evaluation regarding anticipated treatment, then were randomized to receive standard or interdisciplinary evaluation with an orthopedic surgeon or the surgeon and a physical therapist, respectively. Time spent with providers and provider recommendation were recorded. Participants indicated their post-evaluation treatment plan and completed the DCS regarding this plan. Duration of symptoms was recorded. Groin pain was collected using a visual analog scale. The 33-item International Hip Outcome Tool was used to collect hip function. Pearson correlations and independent sample t tests were used to evaluate relationships between decisional conflict and continuous vs. categorical variables, respectively ($P<0.05$). Nonparametric tests were used if assumptions were violated.

RESULTS: Participants presented with considerable baseline decisional conflict. Those who reported symptoms >1 year reported higher baseline conflict than those with symptoms <1 year ($P=0.05$). Better hip function ($\rho=0.28$, $P=0.01$), but not groin pain ($\rho=-0.16$, $P=0.15$), was weakly associated with more conflict. Baseline conflict was not associated with prior PT ($P=0.64$). Interdisciplinary evaluation patients reported similar reductions in conflict to standard evaluation ($P=0.66$). More time spent with providers was not associated with greater reductions in conflict ($r=-0.07$, $P=0.55$). Only 2 participants continued to report considerable levels of conflict (>37.5) after evaluation. Participants whose self-reported treatment plan agreed with the providers reported lower conflict ($P=0.10$).

CONCLUSIONS: Persons with FAIS in a hip preservation clinic reported considerable decisional conflict before their appointment. Those with better function reported higher conflict, suggesting that less severe symptoms may contribute to more patient confusion during treatment planning. The evaluation process, whether standard or interdisciplinary, contributed to

a major reduction in conflict. Current clinical processes in this hip preservation clinic reduced decisional conflict experienced by patients with FAIS.

Complications in Over 1,000 Joint Arthroplasty Procedures Performed in Ambulatory Surgery Centers

Abstract ID: Paper 133

---

*James S. Chambers, M.D.
Anthony M. Mascoli
Memphis, TN

INTRODUCTION: Advancements in technology, surgical techniques, and pharmacology have allowed total joint procedures to be effectively performed in ambulatory surgical centers. The purpose of this study was to determine the frequency of, and risk factors for, complications in outpatient joint arthroplasty procedures performed at ambulatory surgery centers and to identify predictors of complications.

METHODS: Retrospective chart review at three ambulatory surgical centers (ASC) identified patients who had primary joint replacement surgery from 2008 to 2017. Intraoperative and postoperative complications were determined from operative reports and subsequent clinic visits. Gender, age, medical comorbidities, tobacco use, and body mass index were recorded as potential predictors of complications. Only complications that occurred within 90 days of the procedure were included. Descriptive statistics were generated for all demographic and clinical variables and multivariable logistic regression was performed to identify risk factors for complications.

RESULTS: Of the 1,038 primary joint arthroplasties, there were 459 (44.2%) total hip, 302 (29.1%) total knee, 148 (14.3%) unicompartmental knee, 69 total shoulder (6.6%), 26 (2.5%) reverse shoulder arthroplasty, 24 (2.3%) total ankle arthroplasties, and 10 (1%) hemiarthoplasties. Overall, there were 4 (0.39%) intraoperative complications and 62 (5.9%) postoperative complications. History of thromboembolism was associated with both intraoperative (OR 11.95; 95%CI 1.31-107.7, P= 0.001) and postoperative complications (OR 4.57; 95%CI 1.5-14.3, P=0.009). While not statisically significant current tobacco use, depression, and restrictive airway disease were associated with increased risk of postoperative complications.

DISCUSSION AND CONCLUSION: Compared to previously published in-hospital arthroplasty data, procedures performed at ASCs have similar rates of complications. Patients with a history of thromboembolism appear to be more likely to have intraoperative and postoperative complications. Outpatient arthoplasty procedures done at ASCs are a safe and cost-effective alternative to inpatient procedures for low-risk patients, with similar complication rates.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 25, 2020

Is it Safe? Using Big Heads and Small Cups with Highly Crosslinked Polyethylene in Total Hip Arthroplasty

Abstract ID: Paper 134

---

*Courtney E. Baker, M.D.
Brandon R. Bukowski, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Using larger femoral heads during total hip arthroplasty (THA) may help minimize impingement and instability. However, the particular combination of large heads and small cups poses a potential risk for implant failure secondary to liner fracture or liner wear. The purpose of this study was to evaluate reoperation and revision rates and linear wear rates in THA using large heads and small cups.

METHODS: Eighteen patients undergoing primary THAs from 2000-2016 with heads ≥ 36mm and cups ≤ 52mm and highly crosslinked polyethylene liners with minimum 10-year follow-up were identified through a total joint registry. Mean age was 64 years and 77% of patients were female. Mean body mass index (BMI) was 28 kg/m^2. Radiographs from first postoperative appointment and most recent follow-up were analyzed for femoral head penetration and osteolysis using a validated radiographic analysis software package. Harris hip scores, revision, and reoperation events were all recorded up to last clinical follow-up.

RESULTS: At final clinical follow-up (average 10.7 years), median femoral head penetration was 0.25mm (IQR -0.1 to 0.8) and median steady state femoral head penetration was 0.023mm/yr (IQR -0.01 to -0.07). When excluding hips with negative wear (n=6), median femoral head penetration was 0.63mm (IQR 0.25 to 0.99) and steady state femoral head penetration was 0.05mm/yr (IQR 0.02 to 0.10). No hips demonstrated radiographic evidence of component loosening or liner fracture. There were no reoperations or revisions. Mean Harris hip score at final follow-up was 85 points (range 56.8 to 100).

CONCLUSION: In a small cohort with minimum 10-year follow-up, utilizing large heads and small cups with highly crosslinked polyethylene liners had excellent wear characteristics, durability, with no liner fractures or revision surgeries.

No Clinically Meaningful Difference in One-Year Patient-Recorded Outcomes Among Major Approaches for Primary Total Hip Arthroplasty

Abstract ID: Paper 135

James Bircher, D.O. / Cleveland, OH
*Atul F. Kamath, M.D. / Cleveland, OH
Nicolas S. Piuzzi, M.D. / Cleveland, OH
Alison K. Klika, M.S. / Cleveland, OH
Carlos A. Higuera, M.D. / Weston, FL
Kurt P. Spindler, M.D. / Cleveland, OH
Greg Strnad, M.S. / Cleveland, OH
Alexander Zajichek, M.S. / Cleveland, OH
Michael R. Bloomfield, M.D. / Cleveland, OH

INTRODUCTION: Debate continues as to the most effective surgical approach for primary total hip arthroplasty (THA). The purpose of this study was to compare one-year postoperative Patient Reported Outcome Measures (PROMs) of patients who underwent direct anterior (DA), anterolateral (AL)/direct lateral (DL), and posterolateral (PL) approaches.

METHODS: A prospective cohort of primary THA for osteoarthritis (n=2,390) were performed between 2015 and 2017 at 5 sites within a single institution with standardized care pathways (20 surgeons). Patients were categorized by approach: DA (n=913; 38%), AL/DL (n=505; 21%), or PL (n=972; 41%). The primary outcomes were PROMs and reoperation rates at one-year postoperative. PROMs included the Hip disability and Osteoarthritis Outcome Score (HOOS) Pain subscore, HOOS Physical Function Shortform (PS), and University of California Los Angeles Activity Scale. There were no significant differences in baseline PROMs ($p>0.05$). Multivariable regression modeling was used to control for differences among the groups. Wald tests were performed to test the overall significance of select patient factors and simultaneous 95% confidence intervals were constructed for pairwise comparisons of approaches.

RESULTS: At 1 year postoperative, PROMs were available for 1,842 (77.1%) patients. Approach was only a statistically significant factor for 1-year HOOS Pain ($p=0.002$). Approach was not a significant factor for 1-year HOOS-PS ($p=0.16$), 1-year UCLA activity ($p=0.382$). Reoperation rates at 1 year were not significantly different among the groups ($p=0.505$). Pairwise comparisons showed no significant difference in 1-year HOOS Pain scores between DA and PL approach ($p>0.05$). However, AL/DL approach had lower (worse) pain scores than DA or PL approaches with differences in median score of 3.47 and 2.43, respectively ($p< 0.05$).

CONCLUSION: Patients receiving the AL/DL approach had statistically worse pain scores at 1 year than those with the DA or PL approach, but no clinically meaningful difference exists in pain, activity, or function at 1 year postoperative among approaches.

Anterior Acetabular Retractors and the Femoral Neurovascular Bundle in Anterior Total Hip Arthroplasty: A Cadaveric Study

Abstract ID: Paper 136

Trevor Stubbs, M.D.
*Romil Kanu Patel, B.S.
Andrew Moon, B.S.
Nicholas Dahlgren, B.S.
Harshadkumar Patel, M.D.
Ashish Shah, M.D.
Sameer Naranje, M.D.
Birmingham, AL

PURPOSE: The direct anterior approach for primary total hip arthroplasty (THA) has become increasingly popular in recent years. Nerve compression or traction with a retractor is a common cause of nerve injury in this approach. The purpose of this cadaveric study was to evaluate the anatomic relationship of the femoral neurovascular bundle to the anterior acetabular retractor during direct anterior approach THA.

METHODS: Eleven fresh-frozen cadavers underwent a standard direct anterior THA, with placement of an anterior acetabular retractor in the usual fashion between the iliopsoas and acetabulum for visualization during acetabular preparation. Careful dissection of the femoral triangle was performed and the distances from the anterior retractor tip to the femoral nerve, artery, and vein were recorded and analyzed as mean distance ± standard deviation.

RESULTS: In all 11 cadavers, the retractor tip was medial to the femoral nerve. The mean distance from retractor tip to femoral artery and vein were 5.9 mm (S.D. = 5.5, range 0- 20) and 12.6 mm (S.D. = 10.7, range 0-35), respectively.

CONCLUSIONS: Surgeons should be aware of the proximity of the neurovascular structures in relation to the anterior acetabular retractor in the direct anterior approach, taking care to avoid perforating the iliopsoas muscle during retractor insertion and limit excessive traction to prevent nerve injury.

Primary Total Hip Arthroplasty in Patients 20 Years Old and Younger

Abstract ID: Paper 137

Graham D. Pallante, M.D.
Joseph M. Statz, M.D.
*Chad W. Parkes, M.D.
Todd A. Milbrandt, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

BACKGROUND: Total hip arthroplasty (THA) in patients 20 years old and younger historically has poor survivorship due to bearing-surface wear with conventional polyethylene, acetabular loosening with cemented sockets, and liner fracture in ceramic-on-ceramic (CoC) THA. There is a paucity of data on outcomes of THA in this population using modern implants and bearing surfaces. The purpose of this study was to examine the mid- to long-term outcomes of modern THA in this population.

PATIENTS AND METHODS: Utilizing a single-institution, prospectively collected total joint registry, we retrospectively identified 91 primary THAs in 84 patients 20 years old or younger from 1999 to 2016. Average age was 17 (range 11-20) years and BMI was 26 (range 16-49) kg/m^2. Forty-eight (53%) THAs were performed in male patients. Bearing surfaces included CoC (53 THAs, 58%), metal on highly-crosslinked polyethylene (MoP, 28 THAs, 31%), and ceramic on highly-crosslinked polyethylene (CoP, 10 THAs, 11%). Outcomes studied included reoperations, revisions, complications, clinical outcomes scores, and bearing surface wear utilizing Martell software.

RESULTS: At mean follow-up of 8 (range 2-18) years, modified Harris Hip score averaged 92 (range 54-100). At 5 and 10 years, survivorship from reoperation was 96.7% and 95.0%; from revision was 98.9% and 97.2%; and from complications was 91.2% and 89.5%, respectively. The most common complications were instability (3%), aseptic acetabular loosening (2%), and postoperative foot drop (2%). Linear wear averaged 0.019 mm/year and 62.5 mm^3/year. There were no correlations between age, gender, BMI, bearing surface, head size, or operative time and survivorship from complications (p=0.0584-0.8284), reoperations (p=0.1094-0.4881), or revisions (p=0.0600-0.8767). There was no difference in linear wear between CoC, CoP, and MoP bearings (p=0.1142-0.6992).

CONCLUSIONS: Total hip arthroplasty in patients aged 20 and younger demonstrates excellent clinical outcomes and long-term survivorship, with minimal radiographic wear when modern bearing surfaces are used.

Mini-Optical Navigation Improves Leg Lengths and Acetabular Inclination; Anteversion Remains Elusive

Abstract ID: Paper 138

Matthew G. Robinson, M.D. / Chicago, IL
*Jason Y. Chen, M.D. / Chicago, IL
Nancy Cipparrone, M.A. / Morton Grove, IL
Ritesh R. Shah, M.D. / Morton Grove, IL

INTRODUCTION: Component position, leg length discrepancy (LLD), and offset restoration remain challenging in total hip arthroplasty (THA). Previous research has studied the ability of technology, such as fluoroscopy, robotics, and traditional navigation, to help surgeons perform a more accurate THA. Although the Lewinnek safe zone has been questioned compared to functional positioning, most surgeons still aim for inclination and anteversion within this safe zone. LLD has remained a significant cause of patient dissatisfaction and lawsuits. We sought to examine a 3D imageless mini-optical navigation sytem's accuracy for LLD, acetabular component positioning, and offset restoration.

METHODS: A retrospective review was conducted of 157 consecutive THAs using the same preoperative, intraoperative, and postoperative protocols, 78 with mini-optical navigation (navTHA) and 79 non-navigation (no-navTHA). Two independent reviewers measured acetabular component position, leg length, and offset using a standardized, validated radiographic method. Clinical endpoints collected were operative time, dislocation rates, and patient complaints of LLD.

RESULTS: There were no differences in age, gender, BMI, and mean change in offset (4.5±5.9 navTHA vs. 6.2±7.9 no-navTHA, p=.12). There was a significant improvement in acetabular component inclination within safe zone (77.9% navTHA vs. 51.9% no-navTHA; p<0.01). There was no difference in acetabular component placement within anteversion safe zone (35.1% navTHA vs. 40.5% no-nav THA, p=0.48) or Lewinnek safe zone (31.2% navTHA vs. 26.6% no-navTHA). There was a significant improvement in LLD (1.9 ± 6.3 mm navTHA vs. 5.4 ± 7.0 mm no-navTHA; p<.01). There was no difference in dislocation rates and no patient complaints of LLD in either group. The mean operative time was 9.1 minutes longer for navTHA (98.4±17.5 vs 89.3±15.5 p<.01).

CONCLUSION: 3D mini optical navigation is effective in improving radiographic leg length equality and acetabular component inclination, but did not demonstrate a reduction in dislocation rate.

Echocardiographic Changes in Metal-on-Metal vs. Non-Metal-on-Metal Total Hip Arthroplasty: Are Increased Metal Ion Levels Associated with Cardiomyopathy?

Abstract ID: Paper 139

Brian Darrith, M.D. / Detroit, MI
*Jonathan H. Shaw, M.D. / Detroit, MI
Tahsin Rahmin, B.S. / Detroit, MI
Karthikeyan Ananthasubramaniam, M.D., FACC / Detroit, MI
Nicholas B. Frisch, M.D., M.B.A. / Rochester, MI
Joshua J. Jacobs, M.D. / Chicago, IL
Craig D. Silverton, D.O. / Detroit, MI

BACKGROUND: The purpose of this study is to determine if there is a difference in echocardiographic results between patients with metal-on-metal (MoM) vs. non-MoM total hip arthroplasty and to determine if serum cobalt and chromium levels independently predict echocardiographic changes.

METHODS: Seventy-five patients with the same dual-modular total hip arthroplasty (THA) were enrolled in this prospective cohort study, and 49 of these patients had MoM bearings. Serum cobalt, chromium, and titanium levels were drawn twice during the study period, initially at ≥ 2 years postoperatively and again 3 to 5 years later. Patients underwent a transthoracic echocardiogram at the second study visit. Serum metal concentrations and echocardiographic parameters between MoM and non-MoM groups were compared with two-way t-tests. Pearson correlation coefficients and multiple linear regression analyses were used to identify any independent predictors of echocardiographic outcomes.

RESULTS: Mean serum cobalt and chromium levels were significantly greater in the MoM group compared to the non-MoM group at both the initial ($p<.001$) and subsequent visits ($p < 0.05$). Titanium levels were similar between groups ($p > 0.05$). When compared to the non-MoM group, MoM patients had significantly lower global longitudinal strain (18.4% vs. 20.2%; $p = 0.026$). Serum cobalt concentration was found to be an independent predictor of tricuspid annular plane systolic excursion ($p=0.004$).

CONCLUSIONS: Patients with MoM THAs had increased serum cobalt and chromium levels and decreased global longitudinal strain. This measure of left ventricular function remained within normal range for both groups, and therefore, the statistical difference does not imply clinical significance. Subsequent follow-up may reveal further decline indicative of pathologic left ventricular dysfunction. The clinical impact of the positive association between serum cobalt concentration and tricuspid annular plane systolic excursion, a marker of right ventricular function, remains less clear, and further studies are needed to better understand this relationship.

Incidence of Adverse Reactions to Metal Debris in Metal on Metal Total Hip System: A Single Cohort Study

Abstract ID: Paper 140

C. Kent Boese, M.D. / Council Bluffs, IA
*Christopher F. Deans, M.D. / Omaha, NE
Anna Schneider, B.S. / Council Bluffs, IA
Elizabeth Lyden, M.S. / Omaha, NE
Kevin L. Garvin, M.D. / Omaha, NE

INTRODUCTION: It has been observed that metal-on-metal (MoM) total hip arthroplasties (THA) have a significantly higher revision rate than other types of bearings, specifically MoM devices made after 2006. The purpose of this study was: (1) to determine the incidence of revision surgery for MoM THA; (2) to determine serum metal ion levels, ratios, and associations with clinical and radiographic findings; (3) to provide information for surgeons to use as guidance regarding the follow-up and care of patients with MoM implants.

METHODS: This retrospective/prospective single center cohort study included patients that received MoM THA between 2000 and 2009. Routine clinical follow-up, imaging, Chromium (Cr) and Cobalt (Co) ion level blood testing, and revision intraoperative findings were collected. Statistical analysis was performed by an experienced biostatistician.

RESULTS: 159 patients (128 without revision, 31 with revision) were preliminarily analyzed (of the 224 patients with 296 primary THAs in the total cohort). Overall revision rate was 19.5%. There was a greater revision rate of those MoM hips implanted before or including 2006 (26.1%) compared with after 2006 (10.4%; p=0.009). Significant difference was seen in Co:Cr ratio between primaries 2006 (1.86 vs. 2.18; p=0.009). No correlation between pain at night, pain during the day, pain with range of motion, swelling, tenderness, or imaging abnormalities with cobalt or chromium levels was seen. There were significantly higher Cr levels in the revision group compared to non-revision (mean 9.23 vs. 2.55; p=0.13), but no significant difference in Co or Co:Cr ratio. At time of revision, females had higher mean Co (8.5 vs. 5.04) and Cr (5.2 vs. 3.32) levels than men, with Co being statistically significant (p=0.044; p=0.08). There was no correlation of gender to revision. MRI abnormalities were noted in 6 of 128 non-revisions, and 13 of 31 revisions, with most manifesting as increased fluid in adjacent tissue or pseudotumor. X-ray abnormalities were seen in 23 of 128 non-revisions and 11 of 31 revisions, most noted as osteolysis or lucency.

CONCLUSION: This preliminary analysis of 10-18 year results of a single-cohort of single-surgeon MoM hips describes outcomes which may provide useful information for surgeons in the management of their own MoM patients. Final analysis will be performed at collection of remaining cohort data.

Risk Factors for a Failed Arthrocentesis in the Setting of Total Hip Arthroplasty

Abstract ID: Paper 141

---

*Richard W. Nicolay, III, M.D.
Pratik B. Patel, M.D.
Daniel J. Johnson, M.D.
Joshua P. Castle
Michael T. Peabody
Kevin D. Hardt, M.D.
David W. Manning, M.D.
Chicago, IL

INTRODUCTION: This study aims to identify risk factors for unsuccessful aspiration of total hip arthroplasty (THA).

METHODS: Cases of painful THA requiring image-guided arthrocentesis between 05/01/2008 and 05/01/2018 were identified in our institution's Enterprise Data Warehouse. Patient demographics, comorbidities, laboratory values, and surgical histories were assessed. Aspirations performed by musculoskeletal radiologists (MR) and arthroplasty surgeons (AS) (2:1 case match) were compared, controlling for body mass index (BMI). Continuous variables were compared using Student t-test, Wilcoxon, and analysis of variance; categorical variables with Pearson chi-square and Fisher's Exact test, as appropriate to identify variables associated with successful aspiration - defined as a procedure yielding greater than one milliliter (ml) of synovial fluid without lavage.

RESULTS: 467 patients required 600 arthrocenteses by 61 different providers. 82 aspirations were performed by an AS, 518 by a MR. In 41 cases, an AS performed the initial aspiration, these cases were matched with 82 MR cases. 65.9% of AS aspirations were right-sided vs. 64.6% of MR cases (p=0.99), 56.1% were male vs. 45.1% (p=0.25), and 65.9% were diagnosed with a prosthetic joint infection vs. 62.2% (p=0.69), respectively. The average BMI was 30.1 for both groups (p=0.99). MR aspiration was associated with an increased risk for failed aspiration compared to AS aspiration (OR: 2.64; 95% CI: 1.1-6.5; p=0.03). 24 failed MR aspirations required subsequent AS aspiration (66.7% successful). The median AS synovial fluid yield was 4.5 ml (interquartile range (IQR) 3,15) vs. 2 ml in MR cases (IQR 1,7.8) (p=0.0078). Anterior needle placement (MR 9.8%, AS 0.0%; p=0.008) had an increased proportion of failed aspiration compared to all other described needle positions (58.3% vs. 29.7%; p=0.044).

CONCLUSION: Successful aspiration was associated with provider type and needle location. Musculoskeletal radiologists performing image-based aspiration should be encouraged to avoid placing the needle tip anterior to the implant.

Does Presence of an Intramedullary Fixation Device Adversely Affect Durability of Cemented Femoral Fixation after Conversion Hip Arthroplasty for Failed Intertrochanteric Hip Fracture?

Abstract ID: Paper 142

Juan S. Vargas-Hernandez, M.D.
William W. Cross, III, M.D.
Kevin I. Perry, M.D.
Daniel J. Berry, M.D.
Matthew P. Abdel, M.D.
*Brandon J. Yuan, M.D.
Rochester, MN

BACKGROUND: Conversion hip arthroplasty in the presence of a previous femoral intramedullary device (IMD) is a complex procedure with elevated complication rates. Previous studies have demonstrated inferior outcomes when utilizing cemented femoral fixation in the revision hip arthroplasty setting where the cancellous bone bed is compromised. However, it is unknown if presence of an IMD, which also disrupts the cancellous bone bed, has the same deleterious effect on cemented femoral fixation. The purpose of this study was to determine outcomes of conversion hip arthroplasty in patients with a femoral IMD, focusing on durability of the femoral fixation.

METHODS: We retrospectively reviewed patients who underwent conversion hip arthroplasty with previous IMD between 1990 and 2017. After excluding infected intertrochanteric nonunions, osteomyelitis, and oncologic pathologic fractures, 101 hips were included. Femoral components were cemented in 39 hips and uncemented in 62. The mean age at conversion hip arthroplasty was 68 years, with 59% being female. The mean follow-up was 5.6 years.

RESULTS: Revisions due to femoral component loosening occurred once each in the cemented and uncemented groups (p= 0.76). The cemented group had 5 (13%) revisions and 7 (18%) reoperations for any reason, whereas, the uncemented group had 6 (10%) revisions and 10 (16%) reoperations for any reason. Ten-year survivorship free of revision and any reoperation was not statistically significantly different between groups: 75% cemented vs. 83% uncemented (p= 0.53), and 71% cemented vs. 76% uncemented (p=0.75), respectively. Radiographic analysis of unrevised stems did not reveal progressive radiolucencies or subsidence, suggesting stable femoral component fixation. Intraoperative and postoperative periprosthetic fracture rates between the groups were not significantly different (p-values > 0.5).

CONCLUSION: Femoral fixation method was not associated with different mid-term implant survival in patients with previous intramedullary devices. Radiographic analysis of fixation was concordant with these findings.

SUMMARY: Mid-term survivorship for conversion THA after intramedullary fracture fixation was similar for cemented and uncemented femoral implants.

Application of Neural Networks in Determining Implant Name from Total Hip Arthroplasty Radiograph

Abstract ID: Paper 143

Michael Murphy, M.D.
Cameron J. Killen, M.D.
*Robert R. Burnham, Jr., M.D.
Fahad Sarvari, B.S.
Karen Wu, M.D.
Nicholas M. Brown, M.D.
Maywood, IL

INTRODUCTION: Accurate identification of implants is a critical part of planning for revision surgery. Software accurate in identifying implants may prove beneficial for preparation and recognizing implant designs.

METHODS: 2,675 total hip arthroplasty (THA) operative notes were identified between January 2002 and January 2019 at Loyola University Medical Center. 1,594 operative notes contained mention of one of eight femoral stems. 2,116 AP Hip postoperative radiographs were identified to contain one of the eight femoral stems referenced in the operative note – Accolade (659), Summit (313), Corail (267), Restoration Modular (223), S-ROM (209), AML Solution (195), TriLock BPS (141), or Exeter (109). From these, a convolutional neural network was developed from 1,410 AP hip radiographs, and tested on a subsequent 706 AP hip radiographs. The neural network was then run on an iPhone 6 to evaluate its potential use in app design.

RESULTS: The convolutional neural network achieved 100.00% accuracy on the 1,410 learning radiographs. When tested on the novel 706 radiographs, the convolutional neural network achieved 95.15% accuracy in classifying femoral stem constructs. The convolutional neural network also displayed the probability (confidence) of the femoral stem classification for any input radiograph. This neural network averaged a runtime of 1.03 + 0.05 seconds for an iPhone 6 to calculate from a given radiograph.

CONCLUSIONS: Relatively simple convolutional neural networks may generate high accuracy in identifying implant design. They may run on a personal device and offer benefit to the learning resident or attending surgeon.

Cementing Liners into Well-Fixed Acetabular Components: Should We Be Concerned about Long-Term Fixation?

Abstract ID: Paper 144

---

*Nicholas A. Bedard, M.D. / Iowa City, IA
Matthew W. Tetreault, M.D. / Rochester, MN
Arlen D. Hanssen, M.D. / Rochester, MN
David G. Lewallen, M.D. / Rochester, MN
Robert T. Trousdale, M.D. / Rochester, MN
Daniel J. Berry, M.D. / Rochester, MN
Matthew P. Abdel, M.D. / Rochester, MN

INTRODUCTION: Cementation of a new liner into an existing well-fixed acetabular component is common during revision total hip arthroplasties (THAs) for many indications, but most commonly for lack of a modern compatible crosslinked polyethylene liner. However, little is known about the long-term durability of this strategy. The purpose of this study was to evaluate the long-term implant survivorship, risk of complications, clinical outcomes, and radiographic results of cementing a new highly cross-linked polyethylene (HXLPE) liner into a well-fixed acetabular component.

METHODS: We retrospectively identified 326 revision THAs where a non-constrained HXLPE liner was cemented into a well-fixed acetabular component. Mean age at revision THA was 63 years, with 50% being female. The most common indications for revision THA were wear and osteolysis (49%), aseptic femoral loosening (35%), and instability (8%). Mean follow-up was 10 years.

RESULTS: Polyethylene liner failure occurred in 15 cases (5%). In all cases, the cemented liner dissociated from the acetabular component. Survivorships free from any revision and any reoperation were 79% and 77% at 10 years, respectively. The most common reason for re-revision was dislocation (56% of re-revisions). The cumulative incidence of dislocation was 17% at 10 years. Hips revised at the index revision for instability were significantly more likely to have a subsequent dislocation when compared to those revised for polyethylene liner wear (HR 2.5, $p<0.01$). Harris hip scores significantly improved from a mean of 65 preoperatively to 88 postoperatively ($p < 0.01$).

CONCLUSIONS: Cementation of a non-constrained HXLPE liner into a well-fixed acetabular component during revision THA provided durable fixation at 10 years with only a small number of failures at the cement interface (5%). Instability after this procedure remains a concern, but this is likely multi-factorial in nature. These new long-term data support continued use of this technique, when necessary, during revision THAs.

Total Hip Arthroplasty in Patients with Lymphedema: A Matched Cohort Study

Abstract ID: Paper 145

---

*William G. Rainer, III, D.O.
Joshua M. Kolz, M.D.
Cody C. Wyles, M.D.
Kevin I. Perry, M.D.
Matthew T. Houdek, M.D.
David G. Lewallen, M.D.
Rochester, MN

BACKGROUND: Lymphedema is a chronic disease characterized by fluid buildup and swelling which can lead to skin and soft tissue fibrosis and recurring soft tissue infections. Literature regarding the increased risk of complications following surgery in patients with lymphedema is emerging, but the impact of lymphedema in the setting of primary total hip arthroplasty (THA) remains unknown. The purpose of this study was to review outcomes following primary THA performed in patients with lymphedema compared to a matched cohort without lymphedema.

METHODS: Review of our total joint registry identified 86 patients with a preceding diagnosis of ipsilateral lymphedema that underwent primary THA. This cohort was comprised of 58 (67%) females with a mean BMI of 35.9±9.5 kg/m^2 and mean follow-up of 5±3 years. For comparison, these patients were matched 1:2 (based on sex, age, date of surgery, and BMI) to a group of 172 patients without lymphedema undergoing primary THA for osteoarthritis. Subsequently, postoperative complications and implant survivorship were evaluated for each group.

RESULTS: In patients with a history of lymphedema, there was a significantly increased risk of complications (40% vs. 14%, P <0.001), including reoperation for any cause (HR 4.93, P<0.001), postoperative infection (HR 3.53, P=0.04), and delayed wound healing (P<0.001). Additionally, these patients trended towards increased risk of revision (HR 3.50, P=0.053). The 5-year infection free survival for patients with lymphedema was 91% compared to 98% in patients without lymphedema.

DISCUSSION: Beyond the effect of other known risk factors, patients with lymphedema are at significantly increased risk of complications, including reoperation and infection, following primary THA. This data emphasizes the importance of appropriate preoperative counseling in this population, and should encourage efforts to identify methods to improve outcomes including further investigation into the effects of pre- and postoperative optimization of lymphedema in the THA setting.

Level of Evidence: Therapeutic Level III

Keywords: Lymphedema; total hip arthroplasty; outcome; complications; infection

Does It Matter How We Define Obesity to Predict Perioperative Outcomes Following Total Joint Arthroplasty (TJA)?

Abstract ID: Paper 146

---

*Ramon A. Ruberte Thiele, M.D., M.S.
Nathaniel Scarberry, B.S.
Todd Kelley, M.D.
Theodore T. Le, M.D.
Cincinnati, OH

INTRODUCTION: Obesity is a growing epidemic, and obese patients as defined by body mass index (BMI), are at increased risk for complications following TJA. However, BMI does not differentiate between muscle and adipose mass, or account for its distribution. The purpose of this prospective cohort study was to identify which obesity definition as determined by BMI, percent body fat (PBF), waist circumference (WC), and waist-to-hip ratio (WHR) best predicted perioperative outcomes following TJA. We hypothesized that PBF would be a better predictor than BMI, WC, and WHR.

METHODS: Following IRB approval, prospective perioperative data was collected on adults undergoing primary elective TJA up to their acute hospitalization. Height, weight, anthropometric measurements, and PBF via bioelectrical impedance analysis were obtained preoperatively. Obesity was defined as BMI>30kg/m^2 (NIH), PBF: M>25%, and F>38% (ACSM), WC: M>40in and F>35in (NHLBI), WHR: M>0.90 and F>0.85 (WHO). Wilcoxon Sign Rank Test was used for continuous measures, and Chi-Square and Fishers analyses for categorical variables with significance set at $p<0.05$. Modeling analyses adjusting for age, gender, primary indication, and ASA score were performed.

RESULTS: The study included 170 patients, the majority female (n=102) and undergoing total knee arthroplasty (n=90). Mean age was 63.4 years and 75% had osteoarthritis as primary indication. Following obesity definition guidelines, 56% were obese per BMI, 74% per PBF, 79% per WC, and 76% per WHR. BMI, PBF, and WC were significant predictors of higher ASA score whereas WHR was not ($p<0.05$). BMI, but not PBF, WC, or WHR, was predictive of longer OR time ($p=0.03$). BMI, PBF, and WC were significant predictors of length of stay, but not WHR ($p<0.05$). No obesity definition correlated with blood loss, wound complications, adverse hospital events, or discharge to an extended care facility (ECF). Multivariate analyses demonstrated trends for increased risk for length of stay and discharge to an ECF with all obesity definitions, but none achieved statistical significance.

CONCLUSION: Our results demonstrate that obesity definitions based on PBF and WC may be an alternative to BMI when discussing perioperative TJA outcomes. Further studies evaluating which obesity definition best predicts short-term and long-term postoperative outcomes in TJA are currently ongoing at our institution.

Use of Natural Language Processing Tools to Identify and Classify Periprosthetic Femur Fractures

Abstract ID: Paper 147

---

*Meagan E. Tibbo, M.D.
Cody C. Wyles, M.D.
Sunyang Fu, M.H.I.
Sunghwan Sohn, Ph.D.
David G. Lewallen, M.D.
Daniel J. Berry M.D.
Hilal Maradit-Kremers, M.D., MSc.
Rochester, MN

BACKGROUND: Manual chart review is labor-intensive and requires specialized knowledge possessed by highly-trained medical professionals. The cost and infrastructure challenges required to implement this is prohibitive for most hospitals. Natural language processing (NLP) tools are distinctive in their ability to extract critical information from unstructured text in the electronic health records (EHR).

QUESTIONS/PURPOSES: As a simple proof-of-concept for the potential application of NLP technology in total hip arthroplasty (THA), we examined its ability to identify periprosthetic femur fractures (PPFFx) followed by more complex Vancouver classification.

METHODS: PPFFx were identified among all THA performed at a single academic institution between 1998 and 2016. A randomly selected training cohort (1538 THA with 89 PPFFx cases) was used to develop the prototype NLP algorithm and an additional randomly-selected cohort (2982 THA with 84 PPFFx cases) was used to further validate the algorithm. Keywords to identify, and subsequently classify, Vancouver type PPFFx about THA were defined. The gold standard was confirmed by experienced orthopedic surgeons using chart and radiographic review. The algorithm was applied to consult and operative notes to evaluate language used by surgeons as a means to predict the correct pathology in the absence of a listed, precise diagnosis. Given the variability inherent to fracture descriptions by different surgeons, an iterative process was used to improve the algorithm during the training phase following error identification. Validation statistics were calculated using manual chart review as the gold standard.

RESULTS: In distinguishing PPFFx, the NLP algorithm demonstrated 100% sensitivity and 99.8% specificity. All 6 cases that were falsely detected as PPFFx were complex, and hard to classify even by manual chart review. Among 84 PPFFx test cases, algorithm sensitivity and specificity for Vancouver classification were 78.6% and 94.8%, respectively. The performance of Vancouver B class was higher: sensitivity of 88.2% and a specificity of 94.0%. Except for operative notes, poor documentation in radiology reports and surgical consult notes is the primary reason for the low sensitivity.

CONCLUSIONS: NLP-enabled algorithms are a promising alternative to manual chart review for identifying THA outcomes. NLP algorithms applied to surgeon notes demonstrated excellent accuracy in delineating PPFFx, but accuracy was low for Vancouver classification subtype. This proof-of-concept study supports the use of NLP technology to extract THA-specific data elements from the unstructured text in EHR in an expeditious and cost-effective manner.

Total Hip Arthroplasty: National Bearing Surface Trends for 20, 30, and 40-Year-Olds

Abstract ID: Paper 148

---

*Ethan A. Remily, D.O. / Baltimore, MD
Wayne A. Wilkie, D.O. / Baltimore, MD
Iciar M. Dávila Castrodad, M.D. / Nutley, NJ
Nequesha S. Mohamed, M.D. / Baltimore, MD
Nicole E. George, D.O. / Canton, OH
Jennifer I. Etcheson, M.D., M.S. / New York, NY
Megha M. Abraham, M.D. / Baltimore, MD
Ashley L. Binau, B.S. / Baltimore, MD
James Nace, D.O. / Baltimore, MD
Ronald E. Delanois, M.D. / Baltimore, MD

INTRODUCTION: Total hip arthroplasty (THA) is becoming increasingly offered to a broader spectrum of patients that struggle with incapacitating hip disease. To date, no studies have recently evaluated the national trends of bearing surface utilization in younger THA recipients. This study aimed to explore the national bearing surface trends for young THA recipients. Specifically, we evaluated the bearing surface utilization in 20-, 30-, and 40-year-old THA recipients in the United States over an 8-year period.

METHODS: The National Inpatient Sample database was queried to identify patients aged 20-50 who underwent primary THA from 2009-2016 (n=279,190). Patients were grouped according to bearing surface type (metal-on-polyethylene [MOP], metal-on-metal [MOM], ceramic-on-ceramic [COC], and ceramic-on-polyethylene [COP]). Procedures performed with MOM or COC surfaces were labeled as hard-on-hard while procedures performed with MOP or COP surfaces were categorized as hard-on-soft. Chi-square analyses were used to assess the utilization of bearing surfaces by year.

RESULTS: The annual frequency of THA procedures for patients aged 20 to 50 increased from 33,003 in 2009 to 33,545 in 2016 ($p<0.001$). Overall, bearing surface type was reported in only 45.8% (n=127,876) of THAs with a rate of reporting remaining similar from 2009 to 2016 (46.9% vs. 46.9%). The use of MOP and MOM decreased between 2009 and 2016 (13.9 to 8.6% MOP; 18.6 to 2.0% MOM) ($p<0.001$). The use of COC slightly increased from 4.5% to 6.6% while the use of COP significantly increased 183% from 10.2% to 28.9% between 2009 and 2016 ($p<0.001$). After further stratification, hard-on-hard bearing surfaces decreased 62% from 22.4% to 8.6% between 2009 and 2016 ($p<0.001$) and hard-on-soft bearing surfaces increased 57% from 23.7% to 37.2% ($p<0.001$). By 2016, the most frequently used bearing surface type was COP, followed by MOP.

CONCLUSION: Over an 8-year period, a considerable shift in bearing surface trends has occurred across the United States among 20-50-year-old patients. Hard-on-hard bearing surfaces appear to be steadily phasing out. Respectively, hard-on-soft popularity has surged, mostly a reflection of the considerable increase in the use of COP. Ceramic femoral heads are characterized by having a lower risk of damage and higher wettability, which allows for less friction and in theory, less wear. This, along with the increased acceptance of highly-cross linked polyethylene, seems to be the reason for the selection of COP over other alternative bearing surfaces.

Identifying At-Risk Patients in the Transition to Bundled Payments: Disparities in Hip Arthroplasty Outcomes from 2016 to 2018

Abstract ID: Paper 149

Akash Adhia, B.S.
*Joseph A. Weiner, M.D.
Joseph Feinglass, Ph.D.
David W. Manning, M.D.
Linda I. Suleiman, M.D.
Chicago, IL

BACKGROUND: The Centers for Medicare and Medicaid Services (CMS) Comprehensive Care for Joint Replacement (CJR) model aims to support more efficient care for beneficiaries undergoing hip and knee arthroplasty. However, with more financial risk shifted to the providers, hospitals may choose to avoid high-cost patients. These include patients who have prolonged hospitalizations and discharge to skilled nursing facilities. Health disparities in hip arthroplasty may worsen as patients are “risk stratified” preoperatively to minimize the possibility for cost outliers in bundled care. We aimed to evaluate which patient characteristics are associated with extended length of stay (eLOS)—greater than two days—and non-home discharge in patients undergoing hip arthroplasty.

METHODS: The Illinois Hospital and Health Systems Association COMPdata administrative database was queried for total hip arthroplasties (41,832) from January 2016 to June 2018. Patient variables analyzed included age, sex, race, median household income by zip code, Illinois region, insurance status, principal diagnosis, Charlson comorbidity index (CCI), obesity, discharge disposition, and LOS. Hospital characteristics included bundled payment participation and arthroplasty volume. Using multiple Poisson regressions, we examined the association between these factors and non-home discharge and eLOS. Standard errors were adjusted for clustering within hospitals.

RESULTS: Median LOS was 2 days (range 0-41 days). 36% had LOS greater than two midnights. 25.3% of patients had non-home discharges. Female gender (IRR 1.35 [1.29-1.40]), black race (IRR 1.11[1.00-1.23]), age over 75 (IRR 1.88 [1.77-2.00]), obesity (IRR 1.21 [1.12-1.30]), Medicaid or uninsured status (IRR 1.30 [1.13-1.49]), high CCI (IRR 1.77 [1.63-1.91]), and hip arthroplasty for fracture (IRR 1.97 [1.81-2.15]) were associated with increased risk for non-home discharge. Female gender (IRR 1.35 [1.29-1.40]), age over 75 (IRR 1.47 [1.40-1.50]), obesity (IRR 1.16 [1.10-1.23]), Medicaid or uninsured status (IRR 1.35 [1.21-1.50]), high CCI (IRR 1.59 [1.48-1.70]), and hip arthroplasty for fracture (IRR 1.81 [1.65-1.99]) were associated with eLOS. IRR= incidence rate ratio.

CONCLUSIONS: Black race, female gender, obesity, Medicaid and uninsured status, age over 75, and high comorbidity scores were all risk factors for extended length of stay and non-home discharge disposition. With an emphasis on cost-containment in the Comprehensive Care for Joint Replacement model, patients at risk for extended stay or non-home discharge may be deemed “high-risk” and having difficulty accessing arthroplasty care. These are potentially vulnerable groups during the transition to the bundled payment model.

Is Spine Pathology an Independent Risk Factor for Prosthetic Hip Dislocations?

Abstract ID: Paper 150

---

*Andrew M. Schneider, M.D.
Cameron J. Killen, M.D.
Nicholas M. Brown, M.D.
Maywood, IL

INTRODUCTION: There is growing evidence that spine pathology, specifically lumbosacral spine pathology, alters the natural kinematics of the hip. Failure to recognize and correct for these changes may increase the risk for dislocation after total hip arthroplasty (THA). Recent literature has shown that lumbar spine disease alters movement in all planes, placing increasing requirements on the hip joints for completing activities of daily living. Given the growing cohort of patients with THA, and the abundant presence of lumbar degenerative changes in the aging population, understanding the risk as well as the effect of spine pathology on potential prosthetic hip dislocation is paramount. The goal of this study was to determine whether lumbar spine disease was an independent risk factor for prosthetic hip dislocation.

METHODS: After obtaining Institutional Review Board approval, the EPIC database was searched for all patients who underwent primary THA by one of four fellowship-trained arthroplasty surgeons at a single center between 2015 and 2018. Demographic data including age, sex, and medical comorbidities present prior to THA were recorded. The list of patients was searched by CPT codes representing prosthetic hip dislocation. This cohort was compared to an age and gender matched control group, which consisted of patients who underwent THA but did not have the aforementioned CPT codes. The case and control groups were investigated for concomitant lumbar spine disease, defined by prior diagnosis by a spine surgeon, imaging, or prior lumbar spine operations. The conditions examined included: lumbosacral spondylosis, lumbar disk herniation, acquired spondylolisthesis, degenerative disk disease, as well as prior fusion operations.

RESULTS: 1,150 patients underwent THA at our institution from 2015 to 2018. Of those, 62/1150 (5.4%) had a dislocation event at an average age of 64.6 years. These 62 patients were compared to 62 age- and gender-matched controls. Patients with a hip dislocation were more likely to have a diagnosis of lumbar spine disease (66.1% vs. 41.9%, p=0.01) (OR: 2.64 [95% CI: 1.27-5.47]), and more likely to have seen a spine surgeon for consultation prior to dislocation (34.4% vs. 15.9%, p=0.02) (OR: 2.73 [CI: 1.16- 6.44]).

CONCLUSION: In our patient population, lumbar spine pathology represented a significant risk factor for prosthetic hip dislocation when compared to an age and gender matched control group.

Preoperative Factors Are Minimally Associated with Weight Change Following Total Knee and Total Hip Arthroplasty

Abstract ID: Paper 151

---

*George J. Borrelli, M.D.
Patrick K. Strotman, M.D.
Amy Wozniak, M.D.
Nicholas M. Brown, M.D.
Maywood, IL

BACKGROUND: Previous studies exploring the relationship between primary total joint arthroplasty (TJA) and postoperative weight change are inconsistent. Additionally, there is little literature identifying demographic and comorbidity data that may predict weight change following TJA. The purpose of this study is to identify patient characteristics that are predictive of weight loss following TJA and to determine if a significant portion of post-arthroplasty patients experience clinically significant weight loss at two years after TJA.

METHODS: Patients who underwent elective total hip arthroplasty (THA) or total knee arthroplasty (TKA) by a single fellowship-trained surgeon and had a minimum two-year follow-up were queried. Patients were classified by arthroplasty procedure and stratified based on preoperative BMI (Body Mass Index) into groups: Normal weight (18.5-<25), Overweight (25-<30), Obese (30-<35), and Severely Obese (35 and higher). Baseline patient characteristics were identified using ICD 9/10 codes during surgical admission encounter. Preoperative functional status via metabolic equivalents (METs) score was also collected. Logistic regression was used to examine associations between patient characteristics and weight change.

RESULTS: There was no significant difference in average weight change two years after surgery between THA and TKA patients for any of the BMI categories. Seventeen percent of obese or severely obese patients experienced greater than a 5% decrease in weight 2 years after TJA compared to 10% of overweight or normal BMI patients. The obese and severely obese patient groups with a METs score between 4-7 were less likely to achieve a 5% decrease in weight 2 years after TJA when compared to a METs score of <4 (OR 0.41 [95% CI, 0.19 – 0.87], p=0.021). Rheumatoid arthritis was also associated with weight loss (OR 5.24 [95% CI, 1.45 – 19.02], p = 0.012).

CONCLUSION: There is no significant difference in average weight change between THA and TKA patients two years after TJA, regardless of preoperative BMI category. Patient demographics and comorbidities minimally predict weight change. Obese and severely obese patients with lower preoperative activity levels were the most likely to lose a clinically significant amount of weight two years after TJA.

Factors Affecting Access to Care Among Medicaid- and Privately-Insured Total Hip Arthroplasty

Abstract ID: Paper 152

Alan Hsu, M.D.
Adam Almaguer, M.D.
Jeffrey Pearson, M.D.
Haley M. McKissack, B.S.
James R. Jones, B.S.
*Joshua Washington, B.S.
Ashish Brahmbhatt, M.D.
Ashish Shah, M.D.
Sameer M. Naranje, M.D.
Birmingham, AL

INTRODUCTION: Medicaid provides health coverage to those beneath the federal poverty line. The literature shows that patients with Medicaid experience barriers to scheduling initial and follow-up visits, although this has not been studied in patients undergoing total hip arthroplasty (THA). The purpose of this study is to assess whether geographic location, Medicaid expansion, or academic affiliation affect access to care among Medicaid-insured patients undergoing THA.

METHODS: The AAOS directory was used to call a total of 100 practices. Five random private and five random academic medical facilities were called from each of five Medicaid-expanded and five non-expanded states representing different U.S. geographic regions. Calls were made by an investigator requesting the earliest available appointment for their fictitious parent to be evaluated for a THA. Half of the calls were made with the investigator reporting private insurance of Blue Cross Blue Shield (BCBS), and half reporting Medicaid. Appointment success rate and average time to appointment were compared. Further comparisons were drawn between Medicaid-expanded vs. non-expanded states, geographic regions, and private vs. academic affiliation.

RESULTS: Appointments were successful for 99 of 100 (99%) calls made with BCBS, and 72 (72%) with Medicaid ($p<0.001$). Success rates were significantly higher for BCBS, regardless of academic vs. private affiliation. In all geographic regions, appointment success rate was significantly lower with Medicaid than with BCBS ($p\leq0.01$). Average time to appointment was also significantly longer for Medicaid (26 days) than private (13 days) insurance ($p=0.020$). In the Medicaid group, appointment success rate was significantly greater for academically-affiliated practices compared to private practices (84.0% vs. 60.0%, respectively; $p=0.008$).

CONCLUSION: Patients with Medicaid seeking consultation for THA experience limits in access to care when compared to patients with private insurance, regardless of geographic region or academic affiliation.

SUMMARY: Patients with Medicaid seeking consultation for THA experience limits in access to care when compared to patients with private insurance, regardless of geographic region or academic affiliation.

Keywords: Access to Care; Medicaid; Private Insurance; Total Hip Arthroplasty

What are the Costs of Hip Osteoarthritis in the Year Prior to a Total Hip Arthroplasty (THA)?

Abstract ID: Paper 153

Azeem T. Malik, M.B.B.S.
John H. Alexander, M.D.
*Daniel Li, M.D.
Mengnai Li, M.D., Ph.D.
Safdar N. Khan, M.D.
Thomas J. Scharschmidt, M.D.
Columbus, OH

INTRODUCTION: Majority of the cost-minimization/cost-analysis literature on THAs has been focused around the perioperative and postoperative period. No study has evaluated costs associated with hip osteoarthritis in the year prior to THA.

MATERIALS AND METHODS: The 2007-2017 Humana Administrative Claims (HAC) database was queried using Current Procedural Terminology codes 27130 to identify patients undergoing elective THA for hip osteoarthritis. Patients undergoing THA for osteonecrosis, fracture, deformity, peri-prosthetic fracture, and/or bilateral replacements were excluded. The study sample was stratified into two groups (based on insurance plan) – Medicare advantage (MA) and Commercial beneficiaries. Total one-year costs and Per-Patient average reimbursements (PPARs) for the following preoperative healthcare resource categories were reported - office visits, x-rays, MRIs, CT scans, intra-articular steroid and hyaluronic acid injections, physical therapy, and pain medications (opioid and non-opioids). Trends in healthcare utilization for physical therapy, opioids, and steroid injections over the one-year preoperative period have also been reported.

RESULTS: A total of 41,625 MA and 5,965 Commercial beneficiaries undergoing a THA were included in the study. Total 1-year preoperative costs amounted to $21,022,883 (Average = $512/patient; Median = $349/patient) and $4,481,401 (Average = $764/patient; Median = $460/patient) for MA and Commercial beneficiaries, respectively. The largest proportion of total 1-year costs for both MA and Commercial beneficiaries was accounted for by office visits (35% in Commercial; 41% in MA) followed by pain medications (28% in Commercial; 35% in MA). Despite strong recommendations supporting the use of physical therapy, only 7-8% of patients utilized this conservative treatment modality with a total 1-year cost contribution of 3.8%-4.0%. Per-patient average reimbursements (PPAR) for each healthcare resource category were as follows: office visits (MA=$222, Commercial=$289), x-rays (MA=$63, Commercial=$111), MRIs (MA=$370, Commercial=$932), CT scans (MA=$187, Commercial=$765), Steroid injections (MA=$141, Commercial=$365), HA injections (MA=$399, Commercial=$1,020), physical therapy (MA=$287, Commercial=$339), and pain medications (MA=$234; Commercial=$288). A high healthcare utilization within the last 3 months prior to surgery was noted for physical therapy, opioids, steroid injections with up to 42-79% of 1-year PPARs being accounted for within this time period alone.

CONCLUSION: Around $500-$700/patient is spent on hip osteoarthritis-related care in the year prior to a THA. Despite strong recommendations, physical therapy appears to be a poorly

utilized conservative treatment modality. Despite their negative effects on postoperative outcomes, opioids and steroid injections are strongly utilized in the last three months prior to surgery.

Topical Tranexamic Acid Increases Early Postoperative Pain after Total Hip Arthroplasty

Abstract ID: Paper 154

Jeffrey Wurtz, B.S.
L. Daniel Wurtz, M.D.
*Mary Ziemba-Davis, B.A.
Evan R. Deckard, B.S.E.
R. Michael Meneghini, M.D.
Indianapolis, IN

BACKGROUND: Tranexamic acid (TXA) decreases blood loss and, therefore, may minimize painful postoperative hematomas after total hip arthroplasty (THA). This study evaluated early postoperative pain and blood loss in THA patients with and without the use of topical TXA.

METHODS: A consecutive series of 174 THAs performed without TXA were compared to a consecutive series of 156 THAs performed with topical TXA. Procedures were performed by a single surgeon using identical perioperative medical and pain control protocols. Inpatient pain scores (VAS 0 to 10), opioid consumption (morphine equivalents, Meq), time to first opioid, and drop in hemoglobin (Hgb) were evaluated. Univariate analysis of topical TXA and 20 potential covariates of pain and blood loss was performed, followed by logistic and linear regression with $p \leq 0.250$.

RESULTS: In multivariate analysis, THAs with TXA were independently associated with less hemoglobin loss than THAs without TXA (2.98 g/dL vs. 3.39 g/dL; p=0.001). Topical TXA use was associated with greater pain (3.41 vs. 1.71, p=0.001) and increased opioid consumption (44.2 vs. 24.2 Meqs, p<0.001) during the first 24 hours, and decreased time to first opioid (182 vs. 422 minutes, p=0.008). 33% of patients receiving TXA compared to 9% without TXA reported moderate-severe pain (p=0.021). Preoperative narcotic use (p=0.055 to 0.008) and fentanyl rather than morphine spinals (p=0.034 to 0.008) also independently increased postoperative pain.

CONCLUSION: Findings continue to support TXA in minimizing blood loss in THA; however, increased early postoperative pain with topical TXA was an unexpected discovery. This finding is reinforced by TXA affecting GABA and glycine receptors in the spinal dorsal horn, and TXA causing periarticular cell death in vivo at clinical concentrations. We currently avoid topical TXA use clinically, particularly in the outpatient early discharge setting, and are exploring whether similar findings are observed with intravenous TXA.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 25, 2020

Anterior Cervical Osteophyte Resection for Treatment of Dysphagia

Abstract ID: Paper 155

---

*Joshua M. Kolz, M.D., M.S.
Mohammed A. Alvi, M.B.B.S.
Atiq R. Bhatti
Mohamad Bydon, M.D.
Bradford L. Currier, M.D.
Brett A. Freedman, M.D.
Rochester, MN

INTRODUCTION: Anterior cervical osteophytes are usually asymptomatic, however, when large enough they can cause dysphagia. There is currently a paucity of work examining outcomes of anterior cervical osteophyte resection for dysphagia. The purpose of this study was to review demographics, clinical characteristics, preoperative assessment, swallowing outcome, need for cervical fusion, delayed cervical instability, and osteophyte regrowth following primary resection of anterior cervical osteophytes as a treatment of dysphagia.

METHODS: Using an internal medical record search tool, we identified 19 patients who underwent an anterior cervical osteophyte resection for a diagnosis of dysphagia between 1999 and 2017. There were 17 (89%) males, a mean age of 71 years, and mean BMI of 27 kg/m^2. Mean follow-up was 3.9 years. The most common spinal level operated on was C4. Surgeries were performed by either a spine fellowship-trained orthopedic surgeon or neurosurgeon with the assistance of an otolaryngologist. Preoperative work-up included videofluoroscopic swallowing exam (100%), CT scan (74%), MRI (73%,) cervical spine x-rays (37%), EMG (5%), and evaluation by Gastroenterology (47%), Physical Medicine and Rehabilitation/Speech (37%), and Neurology (11%).

RESULTS: Following anterior cervical osteophyte resection for a diagnosis of dysphagia,15 of the 19 patients (79%) had a significant improvement in their dysphagia. Six patients (32%) underwent cervical fusion in conjunction with the osteophyte resection. There were no episodes of delayed instability requiring fusion; however, there was one pseudoarthrosis that was lost to follow-up after two years. There was a single case of osteophyte regrowth at the index level along with the proximal level. Other complications included: one esophageal injury, one case of bilateral vocal cord dysfunction, one superior laryngeal nerve injury, one case of diskitis/osteomyelitis, and one case of aspiration pneumonia. Mean operative time was 178 minutes (33-561 minutes) and mean length of stay was 2.5 (1-8 days) days after surgery.

DISCUSSION: Anterior cervical osteophyte resection improves swallowing function in the majority of patients with symptomatic osteophytes. Prior to surgery, patients should undergo thorough swallow evaluation to ensure their anterior cervical osteophytes are the primary cause of dysphagia. Additionally, there is a relatively high complication rate (32%), which highlights the need for a multidisciplinary approach to the workup and treatment of these patients.

Does Marital Social Support Improve Post-Cervical Surgery Recovery? A Single Institutional Study of 394 Adult Patients

Abstract ID: Paper 156

---

*Gaurang Gupte, B.S. / St. Louis, MO
K. Daniel Riew, M.D. / New York, NY
Owoicho Adogwa, M.D., M.P.H. / St. Louis, MO
Colleen Peters, B.S., M.A. / St. Louis, MO
Lukas P. Zebala, M.D. / St. Louis, MO

INTRODUCTION: While prior studies have demonstrated a relationship between marital support and improved post-surgical outcomes, few studies have examined this relationship for spine surgery patients. Understanding this relationship is critical as we transition towards value-based reimbursements for spinal surgery. Our study goal was to determine if a relationship exists between martial support and the short- and long-term post-surgical outcomes of cervical spine surgery patients.

MATERIALS AND METHODS: The records of 394 patients (married, n = 304; divorced/separated/widowed, n = 53; single, n = 37) who had undergone elective cervical spine surgery with prospectively collected outcomes measures were reviewed. Patient demographics, comorbidities, and postoperative complications were collected and assessed with a one-way ANOVA. Between group differences were assessed with a post-hoc Tukey test. NDI assessments were completed before surgery and at six weeks, six months, and one year after surgery.

RESULTS: Demographic and comorbidity characteristics were similar in all cohorts except married and divorced patients, who were significantly older than single patients (mean ages: 54.0, 57.5, and 48.2 respectively, $p<0.01$). Divorced patients had a lower proportion of males than married and single patients (35.85%, 54.28%, and 45.95% respectively, $p=0.04$). Postoperative complications including infection, hematoma, persistent radiculopathy/neurological worsening, or dysphagia > 3 months did not differ between groups.

Divorced patients presented with worse baseline disability in contrast to their married and single counterparts (mean NDI: 22.87, 19.55, and 21.12 respectively, $p=0.04$). At 6 weeks postoperatively, divorced patients had more disability that the other two groups (mean NDI: 17.33, 13.53, and 15.89 respectively, $p=0.02$). With time, married patients continued to have less disability compared to divorced and single patients at 6 months (mean NDI: 24.35, 24.30, and 16.08 respectively, $p<0.01$) and at 1 year (mean NDI: 26.71, 26.03, and 18.45 respectively, $p<0.01$). NDI scores for radiculopathy patients showed similar postoperative outcomes compared to the entire cohort.

At 1 year postoperatively, neither divorced nor single patients were less likely than married patients to achieve Minimum Clinically Important Difference (NDI $\Delta = 7.5$, OR=0.60, 1.03 and $p=0.09$, 0.90 respectively) or Substantial Clinical Benefit (NDI $\Delta = 9.5$, OR=0.68, 0.90 and $p=0.21$, 0.74 respectively).

CONCLUSION: Increased social support did not appear to be associated with clinically significant differences in short- and long-term outcomes after cervical spine surgery. However,

single and divorced status may constitute risk factors for decreased post-surgical improvement in functional status.

Role of Sagittal Balance in Degenerative Spondylolisthesis

Abstract ID: Paper 157

Gurmit Singh, M.D.
*Jonathan N. Sembrano, M.D.
David W. Polly, M.D.
Minneapolis, MN

BACKGROUND: Spondylolisthesis is a degenerative spine disease that leads to forward slippage of a vertebral body. Different risk factors have been associated with the pathogenesis of spondylolisthesis including age, body mass index, sagittal alignment lumbar facet joints, and ligament hyperlaxity. Currently, there are limited studies that describe the lumbar lordosis angulation in these patients. This retrospective cohort study aims to determine if there is relative hypolordosis of the lumbar spine in degenerative spondylolisthesis.

METHODS: Patient encounters were identified using ICD codes for spondylolisthesis. After application of the exclusion criteria, each patient radiograph was measured for L4 slippage over L5, LI-S1 cobb angle, L4-S1 cobb angle, L5-S1 cobb angle, pelvic incidence, and pelvic tilt. Lumbar distribution index (LDI), ideal lumbar lordosis (PI x 0.62 + 29; IDL), pelvic incidence-lumbar lordosis (PI-LL) mismatch, and relative lumbar lordosis (LL-IDL; RLL) were calculated for each radiograph. Lastly, L5-S1 lordosis, defined as 40% of lumbar lordosis (LL), was evaluated using the following equations: L5-S1 lordosis/PI; L5-S1 lordosis/IDL; L5-S1 lordosis/measured LL.

RESULTS: The cohort that met the inclusion criteria consists of 117 participants (40 males, 77 females) with an average age of 67.2 years at the time of the radiograph. The evaluation of L5-S1 lordosis showed dominance of hypolordosis with maximum value of 73.5% when the lordosis is evaluated in relation to the IDL (L5-S1 lordosis/IDL). On the contrary, the L1-S1 lordosis, PI-LL mismatch, and RLL measurements demonstrated majority of the patients were adequately aligned while some showed evidence of hypolordosis (aligned 74.4%, 47%, 51.3%; hypolordosis 12%, 43.6%, 46.2%, respectively). Similarly, the L4-S1 sagittal alignment showed evidence of both adequate alignment and hypolordosis when evaluated using LDI and L4-S1 lordosis (aligned 59.8%, 65.8%; hypolordosis 35.9%, 29.9%, respectively).

CONCLUSIONS: The overall sagittal balance of the lumbar spine was not associated with degenerative spondylolisthesis. The high incidence of hypolordosis of L5-S1 in this cohort suggests the possibility that there may be compensatory L4-L5 hyperlordosis that may lead to development of spondylolisthesis while L4-S1 lordosis is within normal limits. The cohort does not show there is an association between lower lumbar hypolordosis and L4-L5 degenerative spondylolisthesis.

Major Depressive Disorders Increase Complications, Lengths of Stay, Readmissions, and Cost Following Lumbar Fusion

Abstract ID: Paper 158

---

*Rushabh M. Vakharia, M.D. / Ft. Lauderdale, FL
Joseph O. Ehiorobo, M.D. / New York, NY
Hiba Anis, M.D. / Cleveland, OH
Nipun Sodhi, M.D. / New York, NY
Michael W. Roche, M.D. / Ft. Lauderdale, FL
Michael A. Mont, M.D. / New York, NY
Afshin E. Razi, M.D. / Brooklyn, NY

INTRODUCTION: Major depressive disorder (MDD) is a common cause of morbidity and mortality following surgery. Studies have demonstrated the effects of MDD following orthopedic surgery, but not following primary 1- to 2-level lumbar fusion (1-2LF). Therefore, the purpose of this study was to investigate whether patients with MDD undergoing primary 1-2LF are at greater odds of (1) complications; (2) increased in-hospital lengths of stay (LOS); (3) readmission rates; and (4) costs of care.

METHODS: A retrospective query using an administrative claims database was performed. Patients undergoing 1-2LF with MDD were identified, and served as the study group. Study group patients were randomly matched in a 1:5 ratio to controls according to age, sex, general anxiety disorder, diabetes mellitus, hypertension, obesity, and tobacco use. The query yielded 313,421 patients with (n = 52,240) and without (n = 261,181) DD undergoing 1-2LF. Primary outcomes analyzed included 90-day medical complications, in-hospital lengths of stay (LOS), 90-day readmission rates, and 90-day costs of care between the cohorts. Pearson's chi-square analyses were used to compare patient demographics. Logistic regression analyses were used to calculate odds (OR) of medical complications and readmission rates between the cohorts. Welch's t-test were used to test for significance in LOS and cost between the cohorts. A p-value less than 0.004 was considered statistically significant.

RESULTS: Patients with depressive disorder had significantly higher incidence and odds (3.32 vs. 1.05%; OR: 3.23, $p<0.0001$) of medical complications. In-hospital LOS were significantly longer in study group patients (11-days vs. 9-days, $p=0.002$) compared to controls. Additionally, depressive disorder patients had higher incidence and odds (13.33 vs. 9.07%; OR: 1.53, $p<0.0001$) of 90-day readmission rates. Lastly, patients with depressive disorder incurred significantly higher 90-day cost of care compared to controls ($31,938.56 vs. $27,168.71, $p<0.0001$).

CONCLUSION: After adjusting for age, gender, and medical comorbidities, this study of over 300,000 patients demonstrated patients with depressive symptoms have increased complications, in-hospital LOS, readmissions, and cost of care. The study is important as it allows orthopedic surgeons to adequately educate and counsel patients with MDD regarding potential adverse events which may arise following their procedure.

Lateral Lumbar Interbody Fusion with Percutaneous Pedicle Screw Fixation (LLIF-PPS): Are We Getting the Sagittal Alignment Right?

Abstract ID: Paper 159

---

*Breana J. Siljander, M.D. / Minneapolis, MN
Nicholas R. Dick, B.S. / Minneapolis, MN
J. Alex Thomas, M.D. / Wilmington, NC
Jonathan N. Sembrano, M.D. / Minneapolis, MN

PURPOSE: LLIF-PPS is a circumferential minimally-invasive surgery (MIS) that achieves indirect decompression, stabilization, and interbody fusion for treatment of lumbar pathologies. Advantages of MIS include lower blood loss, less postoperative pain, and quicker recovery. The importance of sagittal balance in spinal fusion is increasingly recognized. This study evaluated the efficacy of LLIF-PPS in achieving optimal sagittal alignment using accepted alignment goals.

MATERIALS AND METHODS: Patients (84) who underwent LLIF-PPS (115 levels) by two surgeons at two institutions from 2009-2018 were included. Exclusion criteria included: concomitant ALIF/TLIF; corrective osteotomies; pre-psoas approach; planned anterior longitudinal ligament release; pelvic fixation; extension of fusion to the thoracic spine; and fusion for diskitis, osteomyelitis, or acute trauma. Preoperative and postoperative lumbar radiographs obtained within 6-12 weeks of the operation were reviewed. The following parameters were measured: lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), and L4-S1 lordosis. The frequency of meeting the following goals in preoperative and postoperative radiographs was determined: (1) PI minus LL (PI-LL) < 10 ; (2) PT < 20; and (3) L4-S1 ≥60% of PI.

RESULTS: We found no difference in achievement of accepted alignment goals preoperatively vs. postoperatively after LLIF-PPS ($p > 0.05$). The average number of alignment goals met was higher preoperatively than postoperatively (1.68 vs. 1.48, $p=0.03$). Postoperatively, 51% of patients met the same number of alignment goals compared to preoperative state, while 17% met more alignment goals and 31% of patients met fewer alignment goals.

CONCLUSION: Our results show no difference in the number of patients who met specific alignment goals before and after LLIF-PPS surgery. Fewer cumulative alignments goals were met after LLIF-PPS. These findings suggest that patients with preoperative sagittal malalignment should be considered for procedures that provide more significant correction of lordosis.

Unexpected Postoperative Clinical Encounters with Elective Lumbar Spine Surgery Patients: Can We Predict Them?

Abstract ID: Paper 160

---

*Jose H. Jimenez-Almonte, M.D., M.S.
Ifeanyi N. Nzegwu, M.D.
Syed K. Mehdi, M.D.
Jonathan D. Grabau, M.D.
Boshen Liu, M.D.
Zeeshan M. Akhtar, M.D.
Cale Jacobs, Ph.D.
Carter Cassidy, M.D.
Lexington, KY

INTRODUCTION: It is unclear if comorbid psychiatric disorders or opioid consumption impact the likelihood of an unscheduled, postoperative clinical encounter (ED visit or readmission) after lumbar spine surgery. The purpose of this study was to compare the (1) demographic factors, (2) psychiatric comorbidities, (3) pre- and postoperative patient-reported outcomes, and (4) pre- and postoperative opioid requirements for patients undergoing elective lumbar spine surgery requiring unscheduled, postoperative ED visits or readmissions and for patients without unscheduled, postoperative encounters.

METHODS: This is a retrospective review of 256 consecutive patients who underwent elective lumbar spine surgery at a single academic institution from 2014-2016 with a minimum of 2 years of follow-up. Patient baseline characteristics, mood disorders, operative variables, and surgical complications (superficial and deep infection, ED visits and readmissions within one year of surgery, repeat operations) were recorded. Additionally, preoperative ED visits, postoperative opioid requirements, and total opioid prescription quantities were recorded. Quantitative measurements of pain (VAS) and the Oswestry Disability Index score (ODI) were recorded preoperatively and three months after surgery. In addition, the Economic Innovation Group's 2017 Distressed Communities Index (DCI) was recorded for each patient's home zip code. Continuous variables were compared with two-tailed independent t-tests, and categorical variables were compared using chi-square or Fisher Exact tests.

RESULTS: Of the 256 patients involved in this study, 35 (13.7%) patients had a postoperative ED visit (without readmission) related to spine complaints and 24 (9.4%) patients had a postoperative readmission related to the spine procedure. Those with a postoperative ED visit were more likely to have chronic regional pain syndrome ($p=0.04$), and also were more likely to have a preoperative ED visit related to spine complaints within 1 year of the surgery (21/35 vs. 44/221; $p<0.001$). Patients requiring readmission after lumbar spine procedure were more likely to have a major depressive disorder ($p=0.02$) compared to patients that were not readmitted. In a regression model, the only variable predictive of a spine-related postoperative ED visit or readmission was a preoperative ED visit ($r2=0.15$, $p<0.001$). There were no significant differences between groups regarding baseline characteristics, surgical variables, pre- or postoperative opioid requirements, DCI scores, VAS pain scores, or ODI scores.

DISCUSSION/CONCLUSION: Approximately one-fourth of elective lumbar spine surgery patients will visit the ED or go on to be admitted within one year of surgery due to spine-related complaints. While unplanned care for spine-related complications may be related in part to

comorbid mood disorder or CRPS, patients with a history of utilizing emergency care appear to be at the greatest risk of complication and health care utilization in the postoperative period.

Retrospective Study of Donor-Site Morbidity Following Posterior Iliac Crest Bone-Graft Harvest in Lumbar Spinal Fusion Operations

Abstract ID: Paper 161

---

*Evan P. Larson, M.D.
Emmett J. Gannon, M.D.
Jake S. Long, B.S.
Tyler D. Evans, B.S.
Elizabeth R. Lyden, M.S.
Chris A. Cornett, M.D.
Omaha, NE

BACKGROUND: Historically, major complication rates reported in patients undergoing iliac crest bone graft harvest during spinal fusion operations have been as high as 26%. More recently, several reports have noted major complication rates of 3% to 10%, and minor complication rates of up to 40% of patients undergoing these procedures. This retrospective study was conducted to determine the prevalence of pain, complication rates, and pre- and postoperative SF-36 and VAS scores in patients undergoing one and two-level posterior lumbar spinal fusion operations.

PURPOSE: To investigate whether complication rates, pain, and overall health and quality of life were significantly affected following harvest of autogenous iliac crest bone graft by a single surgeon from the posterior iliac crest for use in posterior approach one- and two-level lumbar spinal fusion operations.

METHODS: Two groups, a study group composed of 50 patients who underwent one- and two-level posterior lumbar interbody fusion operations that involved posterior iliac crest harvest, and a control group composed of 50 patients who underwent similar surgeries for the same indications and did not undergo iliac crest harvest, were retrospectively enrolled. Demographic, surgical, and outcome data were collected. Descriptive statistics were summarized between the groups. Categorical variables were assessed using Fisher's exact test and continuous measurements were assessed using Mann-Whitney test. SAS statistical software was used for analysis.

RESULTS: No statistically significant differences were found between groups with respect to demographic data including BMI, presence of bleeding disorder, home anticoagulation, diabetes, smoking, or surgery type. No statistically significant differences were found between groups with respect to complications including infection, sensory changes, pain, and drainage. Preoperative SF-36, SF-36 at 6 months, 1 year, and 2 years postoperatively, and VAS preoperatively and at 6 months, 1 year, and 2 years postoperatively were found to be statistically equivalent between the groups.

CONCLUSIONS: In our study group, autogenous iliac crest graft harvest during one- and two-level posterior lumbar interbody fusion operations was not found to be associated with increased rates of infection, sensory changes, pain, or drainage when compared to patients undergoing similar surgeries without crest harvest. Pre- and postoperative SF-36 and VAS scores were found to be equivalent between groups. Based on the results of the current study, when performed using the senior author's technique, posterior iliac crest graft harvest should be considered as a safe means by which to obtain biologically robust bone graft during these operations.

The Effect of a Designated Children's Hospital on Surgical Efficiency of Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

Abstract ID: Paper 162

---

*Michael D. Russell, M.D.
Stuart L. Weinstein, M.D.
Joshua B. Holt, M.D.
Lori A. Dolan, Ph.D.
Iowa City, IA

INTRODUCTION: There has been a recent increase in the construction of stand-alone pediatric hospitals, however, little is known regarding their impact on operative case times and inpatient length-of-stays. The purpose of the current study was to determine the effect of performing posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) at a children's hospital on operative timing and inpatient length of stay.

METHODS: We queried an institutional database for all adolescent idiopathic scoliosis (AIS) procedures performed by the same surgeon over a four-year period of time. Surgeries during 2014-2016 were completed at the general hospital and those from 2017-2019 were performed at the newly-opened pediatric hospital (Cohort 2). Patients with syndromic or structural causes for their scoliosis were excluded, as were patients younger than 10 years of age. Specific outcomes of interest included percentage of procedures starting on time, procedure time, transfusion requirements, and hospital length of stay. Comparisons were evaluated using the chi-square and Wilcoxon two-sample test.

RESULTS: 103 patients were included in each cohort. The median procedure time was 200 minutes in both cohorts (p=0.91). Similarly, there was no statistical difference in transfusion rates between the two facilities (p=0.09).

The median length of stay was 0.5 days shorter in Cohort 2 relative to Cohort 1 (p=.0001). There was also a statistical difference in proportion of cases starting on time: 34% of cases started on time at the pediatric compared to 58% at the general hospital (p =0.0005).

DISCUSSION AND CONCLUSION: Performing AIS surgical procedures at a free-standing pediatric hospital did not result in improved efficiency as characterized by the percentage of cases starting on time or the similar procedure times. The lack of difference in transfusion rates and procedure times is likely due to the fact that all procedures were performed by the same, highly experienced surgeon at both facilities. More frequent late start times at the pediatric hospital could be attributed to the implementation of a multidisciplinary timeout prior to OR transport and we have suggested modifications that may speed this process. Notably, length of stay was reduced by a half day at the pediatric facility and over time, even this small reduction should have a significant financial impact.

Stability of the Sacral Table Angle in Pediatric Patients with Spinal Pathology

Abstract ID: Paper 163

---

*David G. Wallington, M.S.
Patrick D. Albright, B.S.
Alexandria I. Chrumka, B.S.
Rebecca D. Funk, B.S.
Dale E. Rowe, M.D.
Joseph K. Weistroffer, M.D.
Karen M. Bovid, M.D.
Kalamazoo, MI

INTRODUCTION: Pelvic incidence, lumbar lordosis, and pelvisacral angle are common radiographic measures used to evaluate sagittal alignment of the spine and pelvis to assist in clinical decision making. However, the natural history of the sacral table angle (STA) is not well characterized, and there remains uncertainty regarding STA progression over time. Previous studies have established that the STA is stable over time in adult patients, however, this question has not been answered for younger patients who have not reached skeletal maturity. In this study, we aim to determine sacral table angle stability over time in a younger patient population.

METHODS: We performed a retrospective cohort study of predominantly pediatric patients cared for at a single institution, 90% of whom had not yet reached skeletal maturity. Patients seen in the study institution's spine clinic with complete medical records and lateral radiographs were included in the study. The electronic spine database consisted of patient demographic information, spine pathology characteristics, and common spine radiographic measures. Relevant data was extracted, and analysis of association of demographic and radiographic measures with STA progression were assessed with generalized linear regression modeling.

RESULTS: We assessed the STA of 77 patients with a median age 13.1 years. The most common pathology was adolescent idiopathic scoliosis (AIS) (27.3%). Mean STA was 96.30 ± 10.51, and there was no change of STA over time with an average of 5-year follow-up. There was no significant association between STA and visit age, gender, lumbar lordosis, presence of vertebral anomalies, or skeletal maturity. When controlling for spinal pathology, there was lower variability of STA. Patients with AIS had a SD of 7.65 and juvenile idiopathic scoliosis an SD of 4.49, which is similar to the variability seen in previously published data on adult STA measurements.

CONCLUSIONS: The STA is stable over time in a largely pediatric population without spondylolysis or spondylolisthesis. There appears to be no association between STA and skeletal maturity. The STA may be a clinically useful marker of sagittal balance and lumbosacral stability in part due to its stability in pediatric and adult populations.

Level of evidence Level IV, prognostic

Can a Standardized Infection Reduction Bundle Decrease Pediatric Spinal Deformity Infections?

Abstract ID: Paper 164

---

*George H. Thompson, M.D.
Connie Poe-Kochert, CNP
Jilan Shimberg, M.D.
Christina K. Hardesty, M.D.
Jochen P. Son-Hing, M.D.
Justin Mistovich, M.D.
Cleveland, OH

INTRODUCTION: Surgical site infection (SSI) is a major concern in pediatric spinal deformity surgery. Can a standardized, hospital-wide care bundle decrease (SSI) rate in pediatric spinal deformity surgery?

METHODS: We performed a retrospective review of our primary scoliosis surgeries between 1999 and 2017. In 2008, we implemented a standardized infection reduction bundle. Interventions included preoperative nares screening for methicillin-resistant staphylococcus aureus or methicillin sensitive staphylococcus aureus two weeks preoperatively, and treatment with intranasal mupirocin when positive, a chlorohexidine bath or shower the night before surgery, a preoperative chlorohexidine scrub, timing of standardized antibiotic administration, standardized intraoperative re-dosing of antibiotics, limiting operating room traffic, and standardized postoperative wound care. In 2011, we added intrawound vancomycin powder at wound closure. Our inclusion criteria were patients 21 years of age or less with idiopathic, neuromuscular, syndromic, or congenital scoliosis who had a primary spinal fusion or a same day anterior and posterior spine fusion with segmental spinal instrumentation of 6 levels more.

We compared the incidence of early (within 90 days of surgery) and late (>91 days) SSI during the first postoperative year.

RESULTS: There were 804 patients who met inclusion criteria: 404 in the non-bundle group (NBG) for cases prior to protocol change and 400 in the bundle group (BG) for cases after the protocol change.

Postoperatively, there were 29 infections (7.2% of total cases) in the NBG: 9 early (2.2%) and 20 late (5.0%) while in the BG there were only 10 infections (2.5%): 6 early (1.5%) and 4 late (1.0%). The reduction in overall SSIs was statistically significant (p=0.01). There was a trend toward decreased early infections, but this did not reach statistical significance (p=0.14).

CONCLUSION: Standardized care bundles appear effective in reducing the incidence of postoperative pediatric spine SSIs.

Effect of Tranexamic Acid Dosing on the Percent of Total Blood Lost During Adolescent Idiopathic Scoliosis Surgery

Abstract ID: Paper 165

---

*Katherine M. Krenek, M.D.
Christopher S. Vara, M.D.
Kristen E. Jones, M.D.
Natalie Scholz, M.P.H.
Allison Wolf, M.P.H.
David W. Polly, Jr., M.D.
Minneapolis, MN

BACKGROUND: Posterior spinal fusion (PSF) for adolescent idiopathic scoliosis is associated (AIS) with significant intraoperative blood loss. Tranexamic acid (TXA) is an antifibrinolytic agent that is known to reduce the percent of total blood volume lost during posterior spinal fusion, however, the optimal dosing regimen has not been defined.

METHODS: Forty-seven AIS patients underwent PSF in 2011-2018; 18 received no-TXA, 18 received low dose TXA (30 mg/kg loading 10 mg/kg/hr infusion), and 11 received (10 mg/kg loading, 1 mg/kg/hr infusion). We retrieved relevant demographic, hematologic, intraoperative, and outcomes information from medical records. The primary outcome was percent total blood volume lost (%TBVL) per level fused, calculated from estimates of intraoperative blood loss, estimated total blood volume per patient (via Nadler's equations), and number of levels fused. Unadjusted outcomes were compared using standard statistical tests.

RESULTS: The %TBVL per level fused was significantly lower in the high dose TXA vs. no-TXA group (1% vs. 1.8%; p=0.03) and in the low dose TXA vs. no-TXA group (1.% vs. 1.8%; p=0.03). There was no significant difference in %TBVL per level fused between the high dose TXA and low dose TXA groups (1.1 vs. 1.0; p=1.0). The study power to detect a difference in %TBVL per level fused was 30%.

CONCLUSION: Both high and low dose TXA significantly reduced the percentage of total blood volume lost per level fused when compared to no-TXA in AIS patients who underwent PSF using a standardized blood loss measure. No significant difference in percentage of total blood volume lost per level fused was found when comparing high dose TXA to low dose TXA, however, the study did not have adequate power to detect a difference between the groups.

Hunger Games: Impact of Fasting Guidelines for Orthopedic Procedural Sedation in the Pediatric Emergency Department

Abstract ID: Paper 166

---

*Carson D. Strickland, M.D.
Robert J. Stewart, M.D.
Derek M. Kelly, M.D.
Jeffrey R. Sawyer, M.D.
Rudy J. Kink, M.D.
Padam Kumar
Busra Gungor
Memphis, TN

INTRODUCTION: Fasting guidelines for procedural sedation in the pediatric emergency department has historically been a topic of debate. Recent literature suggests that there is no difference in adverse events for procedural sedations regardless of fasting status. The goal of this study is to examine adverse outcomes and departmental efficiency when fasting guidelines are not considered during Pediatric ED sedations for orthopedic interventions.

METHODS: A retrospective chart review analysis was performed looking at patients that presented to a level one pediatric emergency department and required procedural sedation for orthopedic injuries from February 2011 to July 2018 (n=2,674). These patients were further categorized into 3 groups: (1) already within ASA fasting guidelines upon presentation to the emergency (n=671), (2) underwent procedural sedation not within the ASA guidelines (n=555), and (3) underwent procedural sedation after fasting in the ER to meet guidelines (n=1,448). Primary outcomes include length of stay, time from admission to start of sedation, length of sedation, time from end of sedation to discharge, and adverse events. Secondary outcomes are emesis in each group further complications of sedation in relation to procedural medications used, procedure complications, time to meet fasting guidelines for the second group, and insurance status.

DISCUSSION: There was a significant difference in the length of stay, which was 80 minutes longer, between the first 2 groups and those who underwent procedural sedation after fasting in the ER to meet ASA guidelines (p-value<2.2e16). There was also a significant difference between non-fasting and fasting groups for time from admission to sedation, which was also 80 minutes longer for the fasting groups (p<2.2e16). There was no significant difference in length of sedation or time to discharge following sedation for all groups (p=0.765 and p=0.716, respectively). Adverse events were uncommon, with only 55 total adverse events (0.02%). Vomiting was the most common complication of sedation (17; 0.006%), all of which occurred during recovery. Other notable complications include 9 hypoxic events (0.003%), 5 seizures (0.002%), and 0 aspiration events. There was no significant difference in complications among all of the groups (p=.254).

CONCLUSION: Emergency Department length of stay is roughly 80 minutes longer if current fasting guidelines are followed for children requiring sedation for orthopedic procedures. This poses a significant delay in a busy emergency department where beds and resources are at a premium. Overall, adverse events related to sedation are rare and are not related to fasting guidelines.

Comparison of Spica Casting by Pediatric-Trained Orthopedic Surgeons vs. Non-Pediatric-Trained Orthopedic Surgeons for Pediatric Femoral Shaft Fractures

Abstract ID: Paper 167

R. Garrett Steinmetz, M.D.
Margaret A. Baldwin, M.D.
Samuel F. Thompson, M.D.
Christian McCartney, M.D.
*Eric B. Johnson, M.D.
Dylan J. Cannon, B.S.
William R. Puffinbarger, M.D.
Oklahoma City, OK

PURPOSE: Femoral shaft fractures are common among the pediatric population and are commonly treated with spica casting. The purpose of this study is to determine differences in outcomes between casting performed by pediatric-trained orthopedic surgeons and non-pediatric-trained orthopedic surgeons.

METHODS: We performed a retrospective review of a consecutive series of 273 patients age 0-5 treated with a hip spica cast for isolated closed femoral shaft fracture over a 7-year period. The cohort of patients was subdivided based on if cast was applied by a pediatric- or non-pediatric fellowship-trained surgeon. After the casts were placed, all patients were followed in the pediatric orthopedic clinic. Clinical records and radiographs were reviewed, and data was collected for routine demographics, injury mechanism, fracture pattern, surgery length, intraoperative radiation exposure, length of hospital stay, time in cast, time to weight bearing, femur malunions and complications. Malunions were determined by values lying outside of previously published guidelines on acceptable angulation and shortening for pediatric femur fractures.

RESULTS: 61 patients were treated by non-pediatric-trained orthopedic surgeons and 213 by pediatric-trained surgeons. All casts were placed in the operating room under general anesthesia. Average operating room time was 37 minutes with non-pediatric-trained surgeons and 32.4 minutes by pediatric surgeons (p=.01). The malunion rate was 39% with non-pediatric-trained surgeons and 17.5% with pediatric-trained surgeons (p=.0013), however, none of these malunions required any further surgical intervention at final follow-up. There was no significant difference in the length of hospital stay, cast complications, need for cast wedging, need for revision surgery, time to weightbearing, or amount of radiation exposure.

CONCLUSION: Although pediatric orthopedic surgeons were found to have a shorter operating room time and lower malunion rate when compared to non-pediatric orthopedic surgeons, no patients that healed with a malunion required further surgical intervention for malunion or leg length discrepancy. This suggests that spica casting remains a reliable option for treating femur fractures for both pediatric-trained and non-pediatric-trained orthopedic surgeons.

Preoperative Characteristics and Outcomes after Excision of Osteochondromas of the Hand in Pediatric Patients

Abstract ID: Paper 168

---

*David Fralinger, M.D.
Kushal R. Patel, M.D.
Terry R. Light, M.D.
Chicago, IL

PURPOSE: Osteochondromas of the metacarpals and phalanges of the hand often are noted on clinical or radiographic examination in patients with Multiple Hereditary Exostoses (MHE). When symptomatic, these exostoses may be surgically excised. This study reviewed MHE patients with osteochondromas of the hand treated with surgical excision to define the preoperative characteristics and outcomes after surgery.

METHODS: Patients at a single institution who had undergone surgical excision of one or more hand osteochondroma were identified. Twelve patients were identified who had a total of 20 osteochondromas removed in a total of 15 operative procedures. Preoperative characteristics and postoperative outcomes including pain, residual angulation, and recurrence were recorded.

RESULTS: Each of the excised osteochondromas were located on phalangeal bones in patients with MHE. No lesions were excised from metacarpals. The age at time of surgery ranged from 4 months to 17 years. 83% of patients were male. 50% of the excised lesions were causing preoperative pain while 30% were associated with angular deformity, with the average deformity being 48.5 degrees. Other reasons for excision included nail deformity (2), tendon irritation (2), malrotation (1), and obstruction of full interphalangeal joint range of motion (3). Three of 12 patients underwent a second surgery, two for osteochondromas in different locations and one for recurrence. No patients reported residual pain at final follow-up. All patients with decreased preoperative range of motion had substantially improved postoperative range of motion.

CONCLUSION: Osteochondromas of the hands are most likely to be symptomatic when located on the phalanges. Although previous studies have shown the metacarpals to be the hand bones most commonly affected with radiographically visible osteochondromas, we did not identify patients requiring surgical excision of an osteochondroma from a metacarpal. The most common reasons for excision were preoperative pain and angular deformity. Surgical excision is useful for symptomatic lesions. Recurrence is uncommon, occurring in only 1 of 20 excised lesions in this series.

LEVEL OF EVIDENCE: IV

Do Obese Children Sustain More Severe Supracondylar Humerus Fractures?

Abstract ID: Paper 169

---

*Rachelle M. Metz, M.D.
Jasmin L. McGinty, M.D.
St. Louis, MO

INTRODUCTION: Literature on the impact of pediatric obesity on fracture risk and severity is conflicting. The purpose of our study was to determine whether overweight and obese children (>85th BMI-for-age-percentile) sustain more severe supracondylar humerus fractures.

METHODS: We conducted a retrospective review of children with supracondylar humerus fractures between the ages of 2-11 years old at a Level 1 pediatric trauma center from January 2012 to December 2015. A total of 318 patients met the inclusion criteria and were divided into two groups based on BMI percentile: (1) overweight and obese (BMI > 85th percentile), and (2) normal weight children (BMI <85th percentile). 25% (79/318) of patients were overweight or obese. 75% (239/318) of the patients were normal weight. Severity of fractures was classified using the Gartland classification system, with Gartland type 3 fractures indicating the most severe fracture pattern. Fracture severity and BMI were analyzed to determine association between obesity and severity of fracture.

RESULTS: There were 166 females (52.2%) and 152 males (47.8%). There were 142 (44.7%) right-sided injuries vs. 176 (55.3%) left-sided injuries. Overall, there were 113 Gartland type 1, 77 Gartland type 2, and 128 Gartland type 3 fractures, which represented 36%, 24%, and 40% of the total fractures respectively. The overweight and obese group sustained 42% (33/79) type 1, 29% (23/79) type 2, and 29%(23/79) type 3 fractures compared to 33% (80/239), 23% (54/239), and 44% (105/239) in the normal weight group. There was no significant difference detected in fracture severity according to BMI ($P = 0.102$). Post hoc power analysis showed 60% power to detect a difference of 10% between groups with $P < 0.05$.

CONCLUSIONS: We were unable to detect a significant difference in supracondylar humerus fracture severity according to BMI using the easily reproducible Gartland classification system. Further studies are needed to determine the role that pediatric obesity contributes to fracture risk and severity.

Gartland Type II Supracondylar Humerus Fractures: Outcomes of Closed Reduction in the Emergency Department

Abstract ID: Paper 170

---

*Christian C. McCartney, M.D.
Samuel F. Thompson, M.D.
Garrett Waller, M.D.
Scott H. Conant, M.D.
David Y. Chong, M.D.
Thomas Hart
John Parker
Oklahoma City, OK

PURPOSE: The optimal treatment of Gartland type II supracondylar humerus fractures remains controversial. There has been a recent trend towards closed reduction and percutaneous pinning over closed management with casting. We report the results of a series of patients with type II fractures who underwent closed reduction and immobilization using conscious sedation in the emergency department. Our goal was to determine the rate of successful reductions and to identify predictors of failure of non-operative management.

METHODS: This was a retrospective cohort study of pediatric patients who underwent closed reduction of type II supracondylar humerus fractures with the use of conscious sedation in the emergency department. The primary outcome measure was the need for operative intervention following reduction. Pre- and post-reduction radiographs were reviewed to determine degree of fracture extension, anterior humeral line index, Bauman's angle, and splint flexion angle.

RESULTS: A total of 54 patients (54 elbows) were included in this study. The mean overall age was 5.2 +/- 2.5 years. Median follow-up was 40 days. Following closed reduction in the emergency department, 38 (70%) patients were successfully managed non-operatively with casting and 16 (30%) patients required operative intervention. The degree of fracture extension on the injury radiograph was 13.2 +/- 8.4 degrees in the non-operative group compared with 19.8 +/- 7.5 degrees in the operative group ($p = 0.008$). The post-reduction degree of fracture extension was 3.0 +/- 3.4 degrees in the non-operative group and 10.0 +/- 7.2 degrees in the operative group ($p < 0.0001$). The mean anterior humeral line index on the injury radiograph was 0.34 in the non-operative group and 0.13 in the operative group ($p = 0.104$). The mean anterior humeral line index on the post-reduction radiograph was 1.2 in the non-operative group and 0.38 in the operative group ($p = 0.0002$). Patient age, pre- and post-reduction Bauman's angle, and the post-reduction splint flexion angle did not differ significantly between groups.

CONCLUSIONS: Closed reduction in the emergency department is a viable treatment option for Gartland type II supracondylar humerus fractures. Increasing fracture extension and decreasing anterior humeral line index can help predict failure of non-operative management following closed reduction.

Pediatric Supracondylar Humerus Fractures Can Be Safely Treated by Orthopedic Surgeons with and without Pediatric Fellowship Training

Abstract ID: Paper 171

---

*Kelly A. Harms, M.D.
Shannon M. South, B.A.
Karen M. Bovid, M.D.
Keith Kenter, M.D.
Kalamazoo, MI

PURPOSE: The purpose of this study was to compare the outcomes of pediatric patients who were surgically treated for a supracondylar humerus fracture by pediatric fellowship-trained orthopedic surgeons (PFT) to the outcomes of those surgically treated by orthopedic surgeons without pediatric fellowship training (NPFT). We hypothesized that there would be no differences in patient outcomes.

METHODS: After IRB approval, a retrospective review of all pediatric patients (aged 0-16 years) who underwent surgical treatment for a supracondylar humerus fracture with closed reduction and percutaneous pinning (CRPP) or open reduction and percutaneous pinning (ORPP) at a regional trauma center between January 1, 2013, and December 31, 2017, was performed. Exclusion criteria were inadequate follow-up or absence of postoperative radiographs. Patient demographics, operative details, radiographic outcomes at final follow up, and postoperative complications were recorded.

RESULTS: A total of 201 patients were surgically treated for supracondylar humerus fracture and met the inclusion criteria during the time period. Pediatric-fellowship trained orthopedic surgeons treated 15.9% of patients (n=32). The measured demographic variables were similar between PFT group and NPFT group. The average age was 5.4 (range 1.2-12.7) years and 49.3% were female. 1.5% of patients had open fractures. There was no statistically significant difference in carrying angle (11.75 vs. 11.24), Baumann's angle (74.16 vs. 75.18), or lateral rotation percentage (4.9 vs. 5.95) at final follow-up between PFT and NPFT groups. The amount of time in hours from admission to presentation to the operating room was similar between groups, as was the operative duration. Patients treated by NPFT were more likely to return to the operating room for pin removal (19.5% vs. 3.1%).

CONCLUSION: In this study, there was no difference in radiographic outcomes for patients with supracondylar humerus fractures treated by orthopedic surgeons without pediatric fellowship training compared to those treated by orthopedic surgeons with pediatric fellowship training. This suggests that pediatric supracondylar humerus fractures may be appropriately treated in communities without a pediatric-fellowship trained orthopedic surgeon without compromised outcomes. This surgical technique can be considered a general orthopedic surgery procedure and should be emphasized as part of an orthopedic residency. This approach could reduce the need for transfer to another facility, and decrease time between presentation and surgical treatment, thus reducing days of hospitalization and unnecessary costs in this patient population.

A Retrospective Study to Identify Factors Contributing to Pressure Ulcers in Pediatric Patients with Lower Extremity Splints

Abstract ID: Paper 172

---

*Kenton M. Barry
Robert R. Hoopes
Justin L. Thrush
Michael C. Albert, M.D.
Dayton, OH

BACKGROUND: Ulcers are a preventable splinting complication with lower extremity fractures that cause increases in patient morbidity and medical care costs. The primary purpose of this study was to identify factors that are involved in pressure ulcer development while assessing the incidence of pressure ulcers with lower extremity fractures splinted in a pediatric emergency department (ED).

METHODS: In this retrospective study, pediatric patients' charts from 2016-2019 were reviewed. Patients were under 11 years old, had a lower extremity injury splinted in an ED, and followed up with a pediatric orthopedist. Variables gathered included age, weight, gender, mechanism of injury, time from injury to orthopedic specialist visit, time in splint before seeing the specialist, pressure ulcer location and grading, and method of splinting.

RESULTS: In total, 250 patients' charts were reviewed. Univariate analysis showed age, weight, time from injury to specialist visit, and number of days in splint were highly correlated to the occurrence of pressure ulcers. Multiple logistic regression showed that for every 1-day increase in time from initial injury to the follow-up orthopedic visit, the odds of a pressure ulcer increased by 18% ($p < 0.05$). Neither age nor method of splinting (long leg vs short leg) were significantly related to pressure ulcer formation when controlled for other variables. Patients who did not go to the pediatric ER, but instead an outside ER, were 6.23 times likely to develop pressure ulcers (95% CI 2.2-17.9) after controlling for age, method of splinting, and time from injury to specialist visit (days).

CONCLUSION: Based on these findings, future efforts will be tailored towards educating ED providers about proper splinting techniques in order to decrease incidence of pressure ulcers.

Do We Need Orthopedic Follow-Up for Pediatric Clavicle Fractures?

Abstract ID: Paper 173

---

*Richard J. McLaughlin, M.D
Todd A. Milbrandt, M.D.
A. Noelle Larson, M.D.
Rochester, MN

INTRODUCTION: Clavicle fractures are one of the most common pediatric orthopedic injuries. The optimum number and frequency of follow-up visits and radiographs has not been fully explored. We sought to determine outcomes and practice variability for pediatric clavicle fractures.

METHODS: A retrospective review was performed from 7/2004 to 1/2014 at a level 1 pediatric trauma center identifying all acute clavicle fractures in patients less than 18 years old. Patient demographics, injury severity, and initial treatment were documented as were outcomes including refracture, mean number of follow-up visits, and mean number of total x-rays.

RESULTS: 368 unique clavicle fractures were identified in 359 patients. There were two cohorts. One was seen only in the emergency department (n=101) and discharged from care. The second cohort (n=265) had a mean of 5.4 (+/- 3.7) x-rays, and 2.5 (+/- 1.5) follow-up visits. Of the 894 x-rays taken for routine follow-up, only 6 (0.007%) resulted in a change of treatment plan in 3 patients, 2 of which required ORIF.

Additionally, there was no difference between those who had refractured (n=24) and those who did not (n=344) with respect to mean time off sports and activities (p=0.24). Comminution, patient age, and injury mechanisms were not associated with a singular ED visit. Those who underwent operative management (n=22) had a mean of 12.3 (+/- 3.9) x-rays ($p<0.001$), exclusive of fluoroscopy, and 5.2 (+/-1.2) follow-up visits. Injury severity, gender, and age were associated with operative intervention. Refracture occurred in 4 (18%) operatively-treated patients, necessitating revision ORIF in 1 patient. Reoperation occurred in 4 (18%) patients, two for revision ORIF and two for hardware removal. Patients who refractured (n=24) had no association with prolonged follow-up, prolonged return to sports, or operative intervention after index injury. Three patients (12.5%) refractured during the initial healing phase, but the remainder of refractures occurred at a median of 2.3 years.

CONCLUSIONS: Once follow-up had been recommended, there was wide variability in the number of visits, number of radiographs, and time to return to sports. Treatment guidelines may help standardize these practices. The decision for surgery was based on initial presenting radiographs. Further follow-up for routine visits and repeat x-rays rarely affected treatment decisions. One possibility would be radiographs at presentation and return to noncollision sports at 2 months and collision sports at 3 months.

The Frequency of Mediastinal Injury in Acute Posterior Sternoclavicular Dislocation: A Multicenter Study

Abstract ID: Paper 174

---

*Matthew N. Fournier, M.D. / Memphis, TN
Mark R. Sinclair, M.D. / Kansas City, MO
Evan Zheng, B.S. / Boston, MA
David A. Spiegel, M.D. / Philadelphia, PA
Anna Johnson, M.D. / Mobile, AL
Apurva Shah, M.D., M.B.A. / Philadelphia, PA
Anthony Riccio, M.D. / Dallas, TX
Marilyn Elliott, B.S. / Dallas, TX
Donald S. Bae, M.D. / Boston, MA
Jeffrey R. Sawyer, M.D. / Memphis, TN

BACKGROUND: Acute posterior sternoclavicular dislocations (APSCD) are rare injuries that historically have prompted concern for injury to the great vessels and other mediastinal structures from initial trauma or subsequent treatment, and the presence or availability of a vascular surgeon usually is recommended during the surgical treatment of these injuries. To our knowledge, however, there are no large studies characterizing the frequency of injury to vascular and mediastinal structures with APSCD. The purpose of this study was to determine the frequency and characteristics of vascular injury with APSCD in a large multicenter cohort.

METHODS: Following IRB approval, records of consecutive patients ≤ 25 years of age treated for APSCD were collected from each participating center. Patient demographic information, injury mechanism, associated mediastinal injuries, and need for vascular/general surgery intervention were recorded. Mediastinal structures that were injured or compressed by mass effect were specifically characterized by review of preoperative computed tomography (CT) imaging.

RESULTS: One hundred and twenty-five patients with a mean age of 14.7 years were identified; 88% were male. APSCD most commonly resulted from a sporting injury (74%); same-level falls and high-energy motor vehicle trauma accounted for 10% each. The most common findings on cross-sectional imaging were compression of the ipsilateral subclavian or brachiocephalic veins (35%). Eleven patients had successful closed reduction, and 114 (90%) had open reduction and internal fixation, with 25 failed or unstable closed reductions preceding open treatment. There were no vascular or mediastinal injuries during reduction or fixation that required intervention.

CONCLUSION: In this multicenter series of 125 APSCDs, which is the largest in the literature to date, no injuries to the great vessels/mediastinal structures requiring intervention were identified. While this study suggests vascular injuries following APSCD are quite rare, vascular complications are catastrophic when they do occur. Treating providers should consider this data and their own institutional resources to maximize patient safety during the treatment of APSCD.

Pediatric Elbow Dislocations: Which Ones Require Surgical Management?

Abstract ID: Paper 175

---

*Laura W. Lewallen, M.D. / Baltimore, MD
Marilyn Elliott, B.A. / Dallas, TX
Amy L. McIntosh, M.D. / Dallas, TX
Christine A. Ho, M.D. / Dallas, TX

INTRODUCTION: The purpose of this study was to examine pediatric patients with an acute elbow dislocation, and/or associated elbow fractures, to determine the number which require surgical intervention.

METHODS: This was a single institution, IRB approved retrospective review from 2008-2016. Pediatric patients who presented to the Emergency Department (ED) with an acute elbow dislocation were reviewed. Patients were identified using a fluoroscopy log from our institution's radiology department of all elbow injuries presenting to the Emergency Department.

Demographic data was obtained including: age, gender, mechanism of injury, initial treatment performed (whether closed reduction was attempted), number who went on to surgery, time from initial treatment (closed reduction) to surgery, procedure performed, and follow-up time.

Inclusion criteria were: age 18 years or younger at the time of injury, acute elbow dislocation injury with or without associated elbow fractures, with appropriate imaging.

RESULTS: 303 patients with acute elbow injuries were identified. 118 met the inclusion criteria.

37 patients had a simple elbow dislocation. 81 had an associated fracture (medial epicondyle 60, lateral condyle 9, radial head/neck 7, other 5). 74 (62.7%) were male, and 44 were female (37.3%). The average age at the time of injury was 10.3 years (range 4-17). The mechanisms of injury included: fall from height/playground equipment (39.8%, 47/118), sporting activity (48.3%, 57/118), and trampoline (11.9%, 14/118).

All except one of the 118 total patients underwent closed reduction with sedation in the ED. The one patient who did not undergo closed reduction in the ED had an open injury, and went immediately to surgery.

The 37 patients with a simple elbow dislocation were all successfully treated with closed reduction (one patient required this to be done in the operating room). Of the 81 patients with an associated fracture, 60 (74%) had a medial epicondyle fracture. 25/60 (41.7%) of the patients with a medial epicondyle fracture went on to open reduction internal fixation. Indication for surgery was the amount of fracture displacement in 76% (19/25), an incarcerated fracture fragment in 20% (5/25), and open injury in the remaining patient.

9 patients had a lateral condyle fracture. 5/9 (55.5%) of these patients underwent open reduction internal fixation. Indication for surgery was the amount of fracture displacement in 80% (4/5), an incarcerated fracture fragment in 20% (1/5). One patient was treated with closed reduction in the operating room, due to ongoing instability after initial reduction in the ED.

7 patients had a radial head/neck fracture. One of these patients underwent open reduction

internal fixation, due to entrapment of the fracture fragment within the joint.

5 patients had various other associated fractures (coronoid, olecranon). None of these patients were treated surgically.

The average time from initial treatment to surgery was 2.8 days (range 0-13 days, median 1 day). The average follow-up was 65 days (range 0-666 days, median 47 days).

DISCUSSION AND CONCLUSION: None of the patients who presented with a simple elbow dislocation required operative intervention, suggesting that these injuries may be treated successfully with a closed reduction in the ED. Nearly half of the patients with an elbow dislocation and associated medial epicondyle fracture or lateral condyle fracture underwent operative management. This calls to question the value of closed reduction in the ED in pediatric elbow dislocations with an associated medial epicondyle fracture or lateral condyle fracture.

MAOA BREAKOUT SESSION #13
Knee Arthroplasty
April 25, 2020

Work Relative Value Units Do Not Adequately Support the Burden of Infection Management in Revision Knee Arthroplasty

Abstract ID: Paper 176

---

*Linsen T. Samuel, M.D., M.B.A. / Cleveland, OH
Daniel Grits, B.S. / Cleveland, OH
Alexander J. Acuña, B.S. / Cleveland, OH
Nicolas S. Piuzzi, M.D. / Cleveland, OH
Carlos A. Higuera, M.D. / Weston, FL
Atul F. Kamath, M.D. / Cleveland, OH

BACKGROUND: Revision knee arthroplasty (rTKA) surgery for infection is challenging. Septic revisions, whether one-stage or two, may require more time and effort than comparable aseptic revisions. However, the burden of infection may not be reflected by Relative Value Units (RVU) assigned to septic revision surgery compared to aseptic. The purpose of this study was to compare the RVU of aseptic and septic rTKA, and to calculate the RVU/minute for work effort.

METHODS: The NSQIP database was analyzed for years 2006-2017. Aseptic rTKAs (n=12,907) were identified using CPT code 27487 with ICD-9 code 996.XX and excluding all 996.6X. CPT code 27487 with ICD-9 code 996.6X was used to determine one-stage septic rTKAs (n=889). The first-stage of a two-stage revision (n=293) was identified with CPT codes 27488 and 11981. CPT codes 27447 and 11982 were used to identify the second-stage of a two-stage revision (n=277). The aseptic two-component revision was used as control group for comparisons. RVU to dollar conversion was provided by CMS, and RVU dollar valuations were calculated.

RESULTS: After propensity score matching, 274 cases were identified. Using the current Medicare Payment per RVU ($36.0391), per minute valuations were: $7.89/minute for aseptic revision; $7.17/minute for septic one-stage revision; $5.66/minute for the first-stage of a two-stage revision, and $5.19/minute for the second-stage reimplantation. Mean RVU/minute values ($p<0.05$) and operating times ($p<0.05$) were significantly different between the four cohorts. Two-component aseptic rTKA was valued the highest.

CONCLUSION: The RVU/minute for septic revisions are lower compared to those for aseptic rTKA, despite longer operative times and more burdensome aftercare associated with the procedure. CPT code revaluation may be warranted to ensure adequate compensation to surgeons managing the burden of infection.

Management of Periprosthetic Joint Infection and Extensor Mechanism Disruption with Modular Knee Fusion: Clinical and Biomechanical Outcomes

Abstract ID: Paper 177

---

*Wesley H. Mayes, M.D.
Anna Severin, Ph.D.
Jeffrey B. Stambough, M.D.
Paul K. Edwards, M.D.
C. Lowry Barnes, M.D.
Erin M. Mannen, Ph.D.
Simon C. Mears, M.D.
Little Rock, AR

INTRODUCTION: Periprosthetic joint infection (PJI) combined with extensor mechanism disruption (EMD) is difficult to treat. Typical clinical outcomes are important to consider for patients with knee fusion, but quantitative functional measures, such as balance ability, may provide additional insight into the level of success of the surgery. The purpose of this study is to retrospectively review patients who have undergone modular knee fusion surgery and evaluate their balance using center of pressure (COP) analysis.

METHODS: Fourteen patients underwent two-stage reconstruction with modular knee fusion by three surgeons at a single institution. Indications for performing a modular knee fusion at our institution include PJI, EMD, and poor remaining bone stock. A static spacer is placed, followed by a modular knee fusion after completion of at least six weeks of intravenous antibiotics. A 60-second quiet standing task, where the patients stood on two force platforms, was conducted on patients with follow-up greater than 12 months (n=4). The COP parameters, including mediolateral (ML) excursion, anteroposterior (AP) excursion, 95% confidence ellipse area, and path length were analyzed. These patients also completed a knee injury and osteoarthritis outcome scores (KOOS) prior to testing.

RESULTS: At most recent follow-up, 14 patients were available for review. Of those excluded, one opted for amputation in the early postoperative period, and the other patient passed away after surgery. Average follow-up was 11.5 months for remaining cases (range 1.5 – 36 months). All were ambulating with some sort of assistive device (walker or cane), and none had recurrence of infection. The average length of the intercalary segment bridged by the modular knee fusion was 96 mm (range 30-270 mm). For the four patients who underwent biomechanical balance testing, the average KOOS score reported was 76.3±10.8, the ML excursion was 2.6±0.8, the AP excursion was 3.5±0.8, the area was 7.2±3.0 cm^2 and path length was 123.2±31.2 cm.

DISCUSSION AND CONCLUSION: Our results indicate that modular knee fusion is a reasonable surgical alternative to amputation and two-stage reconstruction for select patients. Further, the COP analysis showed that patients who had undergone modular knee fusion had a path length that was comparable to healthy, age-matched controls, while the AP and ML excursions were only slightly higher, indicating that the proprioception that modular knee fusion patients maintain may offer benefits to their ability to balance. Given the results from this study, the modular knee fusion shows promise to manage even large bone defects associated with PJI and extensor mechanism disruption.

Is Manipulation Under Anesthesia Effective in Improving Patient-Reported Outcomes after Total Knee Arthroplasty? A Matched Cohort Analysis

Abstract ID: Paper 178

---

*Alex Ciesielski, B.S.
Erik Holder, B.S., B.A.
Mary Ziemba-Davis, B.A.
Evan R. Deckard, BSE
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Manipulation under anesthesia (MUA) after total knee arthroplasty (TKA) is considered effective for postoperative stiffness. However, robust scientific justification for MUA improving outcomes after TKA is lacking. This study compared flexion and patient-reported outcomes (PROMS) in two matched cohorts: patients who underwent MUA and patients who met criteria but did not undergo MUA.

METHODS: Retrospective review of a prospectively collected database of consecutive TKAs from three arthroplasty surgeons. 36 MUAs were matched to 36 TKAs that did not undergo MUA. Indications for MUA was <90° flexion at 4 weeks and was performed within 12 weeks of the index TKA. Those not undergoing MUA met the same flexion stiffness criteria, but were alternatively treated with aggressive flexion exercises, frequent follow-up, and pain control modalities. Covariates affecting outcomes include intraoperative pain management, fibromyalgia, lumbar spine disease, depression, and preoperative narcotic use.

RESULTS: The overall MUA incidence during the time period was 1.9%. Lumbar spine disease was more prevalent in non-MUA group ($p=0.025$). In MUA and non-MUA patients, mean preoperative flexion was 112° and 99° ($p=0.002$) and 4-week flexion was 76° and 86° ($p<0.001$), respectively. At latest follow-up, mean flexion was greater in non-MUA (112°) compared to MUA (103°) patients ($p=0.053$). MUA patients had significantly greater walking and stair pain, and lower activity levels ($p\geq0.049$). 52% of MUA compared to 11% of non-MUA patients reported their knee never feels normal ($p=0.003$), and non-MUA patients were more satisfied than MUA patients (89% vs. 52%, $p=0.001$).

CONCLUSION: Improvement in motion was equivalent in stiff TKA patients with <90° flexion at 4 weeks, regardless of whether an MUA was performed or not. Further, those patients who avoided an MUA had significantly better PROMS than MUA patients. These findings question the true effectiveness of MUA as a legitimate treatment for postoperative TKA stiffness.

Is There a Difference Between One Dose and Two Doses of Tranexamic Acid in Total Joint Arthroplasty?

Abstract ID: Paper 179

Andrew G. Golz, M.D.
Heather Yee, B.S.
*Benjamin J. Davis, M.D.
Nicholas M. Brown, M.D.
Maywood, IL

INTRODUCTION: Despite its widespread use, a single formulation or dosing regimen of tranexamic acid (TXA) has not been universally agreed upon. Comparisons of various single-dose and two-dose regimens have yielded variable results. The purpose of this study is to compare previously uninvestigated single-dose and two-dose regimens used at our institution in terms of maximum change in preoperative to postoperative hemoglobin level and secondary outcomes of transfusion requirement, hospital length of stay, and postoperative complications occurring within 30 days of the procedure. We hypothesized there would be no differences between groups for any of these variables.

METHODS: A retrospective search of our institution's database of patients who underwent primary total knee arthroplasty and primary total hip arthroplasty between 1/1/2017 and 12/31/2018 was performed. One group received a 1 gram (g) intravenous bolus of TXA just prior to incision and another 1 g intravenous bolus during wound closure, and the second group received a single 1 g intravenous bolus of TXA just prior to incision. The two-dose regimen was replaced by the single-dose regimen at our institution in September 2018. The change in hemoglobin level was calculated by subtracting the baseline, preoperative hemoglobin from the nadir hemoglobin level on postoperative days one through five.

RESULTS: For the overall cohort, 875 patients received two 1 g doses of TXA, and 301 patients received a single dose. Subgroup analyses were performed on patients who underwent primary TKA and primary THA. For the overall cohort and both sub-group analyses, there was a smaller drop in hemoglobin for patients receiving a single dose of TXA compared to patients receiving two doses. This was confirmed using a hierarchical regression analysis that controlled for age, sex, body mass index, preoperative hemoglobin level, and length of procedure. There were no differences between groups in the rates of postoperative transfusion, wound complications related to hematoma, or other 30-day postoperative medical complications. Length of stay was shorter for TKA patients who received a single dose.

CONCLUSION: Compared to using two doses of TXA during total knee arthroplasty and total hip arthroplasty, administering a single dose prior to incision resulted in a smaller decrease in hemoglobin, similar hospital length of stay, and no difference in the rate of transfusion or postoperative complications.

Outcomes of Patellar Component Revisions in Total Knee Arthroplasty

Abstract ID: Paper 180

---

*Travis W. Turner
Arlen D. Hanssen, M.D.
Matthew P. Abdel, M.D.
Kevin I. Perry, M.D.
Rochester, MN

INTRODUCTION: Patellar complications are a well-documented cause of failure in primary total knee arthroplasty (TKA), but the need and number of patellar revisions at the time of revision TKA has been underreported. The goal of this study was to investigate the revision rate of the patellar component at time of aseptic revision; the rates of survivorship free from patellar complication, revision, and reoperation after revision TKA; and to compare outcomes in patients that underwent patellar component revisions at time of index revision to those who did not.

METHODS: We identified 2864 aseptic revision TKAs performed on 2674 patients at a single institution from 2000-2015. Complications were defined as patellar loosening, instability, wear, fracture, impingement, or clunk/crepitus that lead to revision or reoperation. Mean BMI was 32 kg/m^2 , 55% of patients were female, and mean age at index surgery was 67 years. Mean follow-up was 6 years. Risk factors for each outcome were analyzed using a Cox proportional hazards regression model.

RESULTS: At time of index revision, 4.2% of patients underwent patellar component revisions. Among these patients, ten year survivorship free from patellar complication was 94%. Ten year survivorship free from patellar component revision and reoperation were 93% and 91%, respectively. Among the patients that did not undergo a patellar component revision at the index surgery, ten year survivorship free from patellar complication, revision, and reoperation were 97%, 94%, and 93%, respectively. Multivariable analysis controlling for age, sex, and BMI found no significant differences in survivorship free from patellar complication, revision, and reoperation among patients that underwent patellar revisions at the time of index revision (HRs 1.6, 1.5, 1.3, all $p>0.05$).

CONCLUSIONS: Excellent ten year survivorship free from patellar complication, revision, and reoperation were observed following aseptic revision TKA. No significant differences in outcome were observed between patients that underwent patellar revisions at the time of aseptic revision and those that did not at the time of aseptic revision.

SUMMARY: In a cohort of 2864 aseptic revision TKAs, 4.2% underwent a patellar component revision at the time of index revision. Overall, excellent survivorship free from patellar complication, revision, and reoperation was observed, and no significant difference was seen in the patients that underwent a patellar revision at time of index revision.

The Relationship Between Degree of Preoperative Opioid Use and Total Knee Arthroplasty Complications

Abstract ID: Paper 181

Charles Qin, M.D.
*Cody S. Lee, B.S.
Aravind Athiviraham, M.D.
Chicago, IL

INTRODUCTION: While recent attention has been paid to preoperative opioid use in total knee arthroplasty (TKA), the relationship between degree of opioid use and perioperative outcomes is unknown. This study aims to compare perioperative complications following TKA among naïve, sporadic, and chronic preoperative opioid users.

METHODS: Patients undergoing total knee arthroplasty were identified by Current Procedural Terminology (CPT) codes in the Humana Claims Dataset. Patients were stratified by their level of preoperative use based on the number of times they filled an opioid prescription within 6 months of surgery (naïve 0; sporadic 1; chronic 2 or greater). 90-day outcomes were compared among groups via chi-square tests for categorical variables and t-test for continuous variables. Complications of interest included Center for Medicare and Medicaid Services (CMS)-reportable complications (myocardial infarction, pneumonia, venous thromboembolism, sepsis, postoperative bleeding, wound infection, septic arthritis), need for postoperative supplemental oxygen, and hospital length of stay. Logistic regression analysis was used to determine the association between preoperative opioid use and perioperative complications. In all statistical analysis, significance was defined as $P<.05$.

RESULTS: A total of 52,061 patients were identified in our study, 34,286 of whom were opioid naïve, 7,474 were sporadic users, and 10,301 were chronic users. Rates of CMS complications (6.2% vs 5.5% vs 8.0%; $p<.01$), need for supplemental oxygen postoperatively (2.4% vs 2.5% vs 4.2%; $p=.03$), and mean length of stay (2.8 vs 3.1 vs 3.8; $p<.01$) were significant different among the groups. On logistic regression, only the chronic opioid use group was associated with significantly increased likelihood of both CMS complications and need for postoperative supplemental oxygen.

CONCLUSION: Patients who filled an opioid prescription twice or more within 6 months of their total knee arthroplasty were associated with increased likelihood of adverse events following surgery. Efforts to mitigate perioperative morbidity in this higher risk group are warranted.

Blood Loss in Contemporary Revision Total Knee Arthroplasty: A Retrospective Matched Cohort Analysis

Abstract ID: Paper 182

---

*Honglin Xiao, B.S.
Evan R. Deckard, B.S.E.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Modern blood conservation protocols have minimized blood loss in primary TKA and facilitated early discharge and outpatient TKA. However, there are minimal comparative data in contemporary revision TKA. The purpose of this study was to compare blood loss between matched cohorts of aseptic revision and primary TKAs.

METHODS: A consecutive series of 290 revision TKAs performed between 2010 and 2017 by two surgeons at a suburban academic center were retrospectively reviewed and matched to primary TKAs on surgeon, age, sex, BMI, and ASA Score. Potential covariates affecting blood loss were compiled from the electronic medical record. Outcomes including total blood loss, closed suction drain output rate, and change in preoperative to postoperative hemoglobin (Hgb) were evaluated.

RESULTS: After exclusions for confounds, 216 aseptic revision TKAs matched to 216 primary TKAs were analyzed. Mean total blood loss (-1048, -977 mL), mean drain output rate (20.6, 18.1 mL/hour), and mean change in Hgb levels (-2.5, -2.4 g/dL) showed no statistical difference between groups. Multivariate analysis of each outcome and covariates revealed that the lack of topical TXA (not intravenous TXA) was a significant predictor for increased total blood loss, drain output, and change in Hgb levels in both primaries and revisions ($p \leq 0.015$). Similarly, increased tourniquet time predicted increased total blood loss and change in Hgb levels ($p \leq 0.034$) in primaries and revisions but not drain output rate ($p = 0.384$).

CONCLUSION: Matched cohorts of aseptic revision and primary TKAs showed no difference in three blood loss metrics. However, topical TXA and decreased surgical time minimized total blood loss, drain output, and drop in hemoglobin for both groups. These data support emphasizing procedural efficiency and TXA use in revision TKA. The data further support that select healthy patients may ultimately undergo revision TKA in an appropriate early discharge and outpatient setting with contemporary protocols.

Outcomes of a Novel Technique Combining Diaphyseal Impaction Grafting and Metaphyseal Cones for Severe Bone Loss in Revision Total Knee Arthroplasties

Abstract ID: Paper 183

Nicholas A. Bedard, M.D. / Iowa City, IA
*Robert A. Cates, D.O. / Rochester, MN
David G. Lewallen, M.D. / Rochester, MN
Arlen D. Hanssen, M.D. / Rochester, MN
Daniel J. Berry, M.D. / Rochester, MN
Matthew P. Abdel, M.D. / Rochester, MN

INTRODUCTION: Metaphyseal cones with cemented stems are frequently used in revision total knee arthroplasties (TKAs). However, if the diaphysis has been previously violated (as in revision of a failed stemmed implant), the resultant sclerotic canal can impair cemented stem fixation, which is vital for cone ingrowth and long-term fixation. We report the outcomes of our novel solution to this problem, in which impaction grafting and a cemented stem in the diaphysis was combined with an uncemented metaphyseal cone for revision TKAs with severely compromised bone.

METHODS: A metaphyseal cone was combined with diaphyseal impaction grafting and cemented stems in a novel fashion for 35 revision TKAs. Mean age at revision TKA was 70 years, with 63% being male. Patients had a mean of 4 prior knee arthroplasty procedures. Indications for the revision with this construct were aseptic loosening (80%) and two-stage re-implantation for periprosthetic infection (PJI; 20%). Mean follow-up was 3 years.

RESULTS: Survivorship free from revision of the cone/impaction grafting construct due to aseptic loosening was 100% at 5 years. Survivorships free from any revision of the cone/impaction grafting construct and free from any reoperation were 92% and 73% at 5 years, respectively. Six knees (17%) required a reoperation (4 for infection/wound issues and 2 for periprosthetic fractures). Radiographically, 97% of cones were ingrown (1 loose cone in setting of PJI). In all but one case, impacted diaphyseal bone graft appeared to have incorporated radiographically.

CONCLUSIONS: When presented with a sclerotic diaphysis and substantial metaphyseal bone loss, this innovative technique combining diaphyseal impaction grafting with a metaphyseal cone provided near universal success in regard to implant fixation. Moreover, radiographs revealed incorporation of the bone graft, and ingrowth of the cones. While long-term follow-up is required, this novel technique provides an excellent option in the most difficult of revision TKAs.

One vs. Two-Year Patient-Reported Outcomes after Total Knee Arthroplasty: Determining Minimum Required Follow-Up

Abstract ID: Paper 184

---

*Peter Surace, M.D.
Marcelo B. Siqueira, M.D.
Alison K. Klika, M.S.
Isaac Briskin, M.S.
Gregory J. Strnad, M.S.
Kurt P. Spindler, M.D.
Carlos A. Higuera, M.D.
Nicolas S. Piuzzi, M.D.
Cleveland, OH

INTRODUCTION: Since the implementation of the bundled payment model implemented by the Comprehensive Care for Joint Replacement (CJR), the voluntary use of patient-reported outcome measures (PROMs) has been incentivized. As payment models transition to mandatory reporting of PROMs, the use of these metrics have increased even further. Although the CJR only requires 9-12 months postoperative scores, most orthopedic journals require minimum 2-year PROMs. The goal of this study was to test for equivalence between PROMs obtained at 1- and 2-years following primary TKA.

METHODS: Between July 2015 and June 2016, n=419 patients underwent TKA at a single academic institution. Of these, a prospective cohort of n=414 were enrolled and baseline PROMs collected. Patients who underwent revision or had contralateral arthroplasty (n=35) or died prior to the 2-year follow-up (n=4) were excluded. Clinical, demographic and PROMs data were collected at 1- and 2-years postoperatively. PROMs included the Veterans Rand 12-item (VR-12), Knee Injury and Osteoarthritis Outcomes Score (KOOS) Pain subscore, and KOOS-Physical Function Shortform (KOOSPS). Equivalence testing was used to compare 1- and 2-year scores. An equivalence margin of 10 points was selected for all PROMs based on minimal detectable change and minimal clinically important difference thresholds reported in literature.

RESULTS: A total of 240 patients (of 375, 64%) followed-up at 1 year and 174 patients (of 227 with 1 year, 76%) followed-up at 2 years after exclusions and lost to follow-up. Mean KOOS pain score at 1 and 2 years were 83.8 and 85.0, respectively ($p<0.001$), thereby confirming equivalency. Equivalence at 1 and 2 years was also demonstrated for KOOS-PS scores ($p<0.001$), VR-12 PCS ($p<0.001$), and VR-12 MCS scores ($p<0.001$). Comparison between the 1-year TKA cohort who followed-up at 2 years with those who were lost to follow-up between the 1- and 2-year mark revealed increased presence of non-white patients ($p=0.008$) and decreased VR-21 MCS ($p=0.003$) in the group lost to follow-up.

DISCUSSION: PROMs were equivalent at 1- and 2-year time points for all subscales analyzed. Only two variables reached statistically significant difference between patients who were lost to follow-up at 2 years and those who were not (race and VR-12 MCS), suggesting minimal selection bias. This study supports a 1-year minimum follow-up for PROMs following TKA. One-year PROMs appears to provide similar metrics to 2-year PROMs with the added benefit of reduced costs potentially increasing output of meaningful practice-changing publications when the primary outcome are PROMs.

Impact of Inpatient Advanced Practice Nurse (APN) Role on Postoperative Outcomes and Patient Satisfaction within a Total Joint Arthroplasty Perioperative Surgical Home

Abstract ID: Paper 185

---

*Daniel A. Hu
Ryan E. Harold, M.D.
Albert D'Heurle, M.D.
Kevin D. Hardt, M.D.
David W. Manning, M.D.
Chicago, IL

INTRODUCTION: Primary total joint arthroplasty (TJA) accounts for a large portion of the American annual healthcare expenditure and utilization is expected to continue to rise. In response, payers have created value-based reimbursement models that incentivize providers and institutions to reduce costs and optimize quality. The perioperative surgical home (PSH) is designed to manage value via coordination of care, efficiencies, and quality monitoring but is associated with unreimbursed administrative and personnel costs. This study analyzes the impact of the inpatient APN role on postoperative outcomes and patient satisfaction within a TJA-PSH.

METHODS: Retrospective review of patients undergoing primary and revision unilateral THA and TKA at a large, urban, tertiary academic center 6 months prior (389 patients) and following (446 patients) implementation of inpatient APN position. Outcomes of interest included hospital length of stay (LOS), 30-day readmission rate, CMS-reportable complications, discharge disposition, and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) satisfaction surveys. Statistical models accounted for demographic, medical comorbidity, and surgical variables between the groups. Continuous variables were analyzed using a 2-sample Student t test, while categorical variables utilized a Chi-squared test or Fisher exact test for counts <5. Significance level was set to 0.05.

RESULTS: No significant demographic or medical comorbidity differences were observed between the groups. Post-APN patients had significantly shorter LOS (P=0.029), decreased frequency of postoperative complications (P=0.009), and higher rate of being discharged to home (P=0.021) compared to pre-APN patients. There was no difference in 30-day readmission. Post-APN implementation patients reported significantly better scores in 5 of 8 HCAHPS survey domains, including higher overall hospital rating (P=0.049) and higher likelihood of recommending the hospital to friends and family (P=0.001).

CONCLUSION: TJA patients with inpatient APNs on their healthcare team had decreased LOS, fewer postoperative complications, more likely to be discharged home without increase in 30-day readmission, and had greater overall satisfaction with their care. The inpatient APN role provides value within the construct of bundled care and public reporting of outcomes for TJA patients.

Simplified Low-Cost Revision Knee System Patient Outcomes are Not Different than Outcomes with High-Cost Premium Implants

Abstract ID: Paper 186

---

*Abhi Seetharam, M.D.
Mary Ziemba-Davis, B.A.
Evan R. Deckard, B.S.E.
Lucian C. Warth, M.D.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Implants utilized in revision total knee arthroplasty (rTKA) are approximately three times more costly and are a substantial portion of revision TKA procedure costs. We examined patient-reported outcomes (PROMS) in matched cohorts of rTKA patients with lower and higher cost revision knee systems.

METHODS: 39 aseptic rTKAs performed by a surgeon using a low-cost simplified revision system (limited sizing, options and trays; 1/3 cost) were matched to 39 rTKAs performed by the same surgeon (surgeon 1) using a premium revision system, and 39 revisions by a second surgeon (surgeon 2) using another premium system. Procedures were at the same academic institution using identical protocols. Cases were tightly matched on sex, BMI, ASA classification, Anderson Bone Classification, and revision etiology. Preoperative and minimum 1-year PROMS included the modern Knee Society Score, UCLA Activity Score, and Likert Patient Satisfaction.

RESULTS: No matching variables ($p \geq 0.321$) differed among the three rTKA systems with numbers available. Between surgeon 1 low-cost and premium rTKA systems, preoperative and minimum one-year walking and stair pain, activity level, proportion reporting their knee never feels normal, and knee satisfaction did not differ ($p \geq 0.118$). Similarly, PROMS did not differ between low-cost and surgeon 2 premium rTKAs ($p \geq 0.140$). No low-cost rTKA had been revised, a surgeon 1 premium rTKA was revised for tibial loosening at 4 years; a surgeon 2 premium rTKA was revise for polyethylene dislocation at 16 months. Mean revision follow-up months were 30±8, 60±14, and 51±20 for the low-cost, surgeon 1 premium, and surgeon 2 premium rTKAs, respectively.

CONCLUSION: In the era of healthcare cost reduction, PROMS are substantially equivalent in revision TKA performed with an implant system with simplified instrumentation, limited sizing and one-third the cost of premium systems. It is probable that surgical technique, fixation, and balance are the most critical factors to optimize outcomes.

Determining Risk Factors for Extended Length of Stay after Total Knee Arthroplasty: Results from a Large Urban Health System

Abstract ID: Paper 187

---

*Peter F. Helvie, M.D.
Daniel J. Johnson, M.D.
Joseph A. Weiner, M.D.
David W. Manning, M.D.
Chicago, IL

BACKGROUND: Total knee arthroplasty (TKA) performed in the United States has trended towards shorter in-hospital stays. In 2018, the Medicare Outpatient Prospective Payment System rule removed TKA from the Medicare inpatient-only (IPO) procedure list. In addition, Centers for Medicaid Services deemed TKA patients staying longer than two midnights as inpatients. The aim of our study is to determine, within a large urban health care system, patient characteristics that place one at risk for an extended length of stay.

METHODS: Electronic medical records were queried for patients undergoing total knee arthroplasty from 2016-2018 in the Northwestern University Health Systems Hospitals in Chicago, IL and surrounding area. Variables analyzed included demographic variables including age, gender, race, body mass index, social factors including tobacco, alcohol and illicit drug use, preoperative prescription narcotic, preoperative comorbidities and postoperative complications. Outpatient eligibility was defined as length of stay less than 2 midnights. We examined the association of these factors with stay of 2 midnights or greater.

RESULTS: 72.3% of knee arthroplasties had a length of stay greater than 2 midnights in our cohort. Increase age (OR 1.03, 95% CI 1.02-1.04; $p<0.0001$), female sex (OR 1.63, 95% CI 1.36-1.96; $p<0.0001$), black (OR 7.32, 95% CI 4.28-12.52; $p<0.0001$), or other (OR 2.02, 95% CI 1.43-2.84; $p<0.0001$) race, pre-operative narcotic use (OR 1.37, 95% CI 1.13-1.66; $p=0.0013$), and increasing Charlson Comorbidity Index (OR 1.28, 95% CI 1.16-1.41; $p<0.0001$) were associated with increasing risk for length of stay greater than 1 midnight. Patients staying greater than 2 midnights also had a higher proportion of postoperative complications and a lower minimum hemoglobin.

CONCLUSIONS: Asians, blacks, females, Medicaid and uninsured patients, patients older than 75, and patients with higher comorbidity score, preoperative narcotic use, and obesity are at greater risk for eLOS and non-home discharge. These are vulnerable groups given the recent CMS legislation.

What are the Pain and Functional Outcomes of Aseptic Total Knee Arthroplasty Revision and Can We Predict Improvement?

Abstract ID: Paper 188

Jared A. Warren, D.O. / Cleveland, OH
Olivia Krebs, B.S. / Cleveland, OH
Hiba Anis, M.D. / Cleveland, OH
Alison K. Klika, M.S. / Cleveland, OH
Greg Strnad, M.S. / Cleveland, OH
Jonathan L. Schaffer, M.D. / Cleveland, OH
Robert M. Molloy, M.D. / Cleveland, OH
*Carlos A. Higuera, M.D. / Weston, FL
Nicolas S. Piuzzi, M.D. / Cleveland, OH

INTRODUCTION: Patient-reported outcome measures (PROMs) are increasingly incorporated into evaluations of orthopedic surgeries. However, there is limited research predictors of PROM in revision total knee arthroplasty (rTKA). Therefore the aims of this study were to determine: (1) PROMS improvements at one year, and (2) what risk factors have an effect on PROMs related to pain and function following aseptic rTKA.

METHODS: A prospective cohort of aseptic rTKA (n=356) were performed between January 2016 and December 2017. Baseline and one-year postoperative PROMs were completed for 246 (69%) patients. The PROMs included in this study were Knee injury and Osteoarthritis Outcome Score (KOOS) pain and KOOS-Physical Function Shortform (KOOS-PS). Mean 1-year change in PROMS and the percent of that improved or worsened, or did not change 10 points, were calculated. Using baseline available risk factors and preoperative PROMs, multivariable linear regression models were created for predicting scores of one-year postoperative KOOS-Pain and KOOS-PS. The mean patient age was 64.9 (Standard Deviation [SD] ±9.63) years, female patients comprised 57.3%, and the mean BMI was 33.1 (SD±7.65) kg/m^2.

RESULTS: Mean one-year postoperative PROMS improvement for overall aseptic revisions were 30.3 (±24.5) (79.5% improved) for KOOS- Pain and -19.15 (±22.5) (66.2% improved) for KOOS-PS. Multivariate analyses demonstrated that one year postoperative KOOS-Pain increased (better) with age, not normal extension and flexion, baseline KOOS-Pain, and non-Medicare/Medicaid insurance, but decreased with multiple prior surgeries and instability compared to implant failure. KOOS-PS was increased (worsen) by baseline KOOS-PS, multiple prior surgeries and length-of-stay, but decreased by female gender, not normal extension and flexion, and instability.

CONCLUSION: Patient baseline characteristics such as multiple previous surgeries, instability, and female gender may be indicative of lower scores for short-term postoperative PROMs in patients receiving aseptic revision total knee arthroscopy.

Demographic Data is More Predictive of Component Size than Digital Templating in Total Knee Arthroplasty

Abstract ID: Paper 189

---

*Michael P. Murphy, M.D.
Stephen J. Wallace, M.D.
Corey J. Schiffman, M.D.L
William H. Adams, Ph.D.
Nicholas M. Brown, M.D.
William J. Hopkinson
Maywood, IL

INTRODUCTION: Preoperative templating for total knee arthroplasty (TKA) attempts to predict component size before implantation. Multiple studies have shown the digital templating is inaccurate. Patient demographic data such as gender, height, weight, age, and race may be more predictive of implanted component size in total knee arthroplasty.

METHODS: Patient demographic data from 382 consecutive patients undergoing TKA were collected. A general linear model was formulated using approximately half of the patient database, then tested prospectively on the remaining patient population to predict both femoral and tibial component sizes. Wilcoxon signed-rank test and Paired Student's t-test were used to compare the general linear model with routine digital templating in their ability to predict true intraoperative implanted femoral and tibial component size.

RESULTS: Patient gender, height, weight, age, and race were most predictive of implanted component size in TKA. The GLM more accurately predicted implanted component size compared to digital templated sizes for both the femur ($p = 0.04$) and tibia ($p < 0.01$) components. The general linear model exactly predicted both the femur and tibia sizes 44% of the time. Digital manual templating matched the femur 35% of the time and tibia 36% of the time. The model was predictive within one size of the implanted femur and tibia components 90% and 96% of the time, respectively, compared to 86% and 85% with templating. The model predicted the femoral and tibial components within two sizes in every case. Templated sizes varied up to four and three sizes from the size implanted for the femur and tibia, respectively.

CONCLUSIONS: The general linear model calculates femoral and tibial component sizes based on patient demographic data and is more predictive of component size than digital templating. The use of this model could have beneficial implications for increasing preoperative efficiency and decreasing implant inventory.

Factors Affecting the Risk of Patellar Complications in Primary Total Knee Arthroplasty

Abstract ID: Paper 190

---

*Afton K. Limberg, B.S. / Rochester, MN
Meagan E. Tibbo, M.D. / Rochester, MN
Matthieu Ollivier, M.D. / Marseille, France
Cathy D. Schleck, B.S. / Rochester, MN
Matthew P. Abdel, M.D. / Rochester, MN
Nattapol Tammachote, M.D., M.S. / Bangkok, Thailand
Daniel J. Berry, M.D. / Rochester, MN

INTRODUCTION: Patellar complications are an important cause of failure in primary total knee arthroplasty (TKA). This study sought to evaluate the association of demographic factors and the long-term risk of patellar complications as a function of time in a large series of primary TKA. The study provides a benchmark against which modified surgical methods and newer implants may be compared.

METHODS: We identified 26,957 all-polyethylene resurfaced patellae in primary TKAs performed at a single institution from 1977-2015. We defined complications as loosening, instability, wear, fracture, or clunk/crepitus. Mean BMI was 32 kg/m^2, with 57% of patients being female. The primary diagnosis was osteoarthritis for 83% of patients. TKA design was posterior stabilized in 70% of knees. Mean follow-up was 8 years. Risk factors for each outcome were evaluated with Cox regression models.

RESULTS: 1518 knees with all-polyethylene patellae developed patellar complications. Survivorship free from any patellar complication was 88% at 20 years. Twenty-year survivorship free from any patellar component revision was 92%. Univariate analysis of patellar complication risk demonstrated HRs of 1.4 for males, 1.3 for patients <65 years of age, and 1.2 for those with a BMI ≥30 kg/m^2 (all $p<0.05$) Additionally, patellae implanted after the year 2000 were found to have decreased overall risk of any complication, aseptic loosening, and patellar fracture (HRs 0.8, 0.2, 0.4, $p<0.01$). Patellar reoperations and revisions significantly decreased after the year 2000 (HRs 0.5 and 0.5, $p<0.01$). Posterior stabilized designs were associated with fewer patellar reoperations and revisions (HRs 0.6 and 0.6, $p<0.01$) overall, but a higher risk of reoperation for patellar clunk/crepitus (HR 7.1, $p=0.03$).

CONCLUSIONS: The 20-year survivorship free from any patellar complication in this series of all-polyethylene patellae was excellent at 88%. Significant risk factors for patellar complications were male sex, age <65, BMI ≥30 kg/m^2 and patellae implanted before 2000.

Successful Results of Primary TKA in Patients with Severe Flexion Contracture

Abstract ID: Paper 191

---

*Samuel W. Carlson, M.D.
Chad W. Parkes, M.D.
Robert T. Trousdale, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Data regarding the outcomes of primary TKA in patients with severe flexion contractures (FC) is limited. The purpose of this study was to determine the outcomes of primary TKA in patients with severe FCs, with specific emphasis on recurrence of contracture and long-term survivorship.

METHODS: We retrospectively reviewed our institution's total joint registry from 1970-2018 for all primary TKAs in patients with FCs greater than 30 degrees. There were 87 patients (101 knees) with preoperative FCs greater than 30º. There were 78 patients (90 knees) with minimum 6 months of follow-up available for analysis. Mean follow-up was 6 years (range, 0.5-20.2 yrs.). There were 43 females (50 knees), mean BMI was 31 kg/m^2 (range, 17-50), and mean age at surgery was 41 (range, 30-90 yrs.). There were 3 cruciate-retaining implants (3%), 52 posterior-stabilized (63%), 18 rotating hinge (RH) (22%), 9 varus-valgus constrained (VVC) (3%), and one distal femoral replacement (1%). Survivorship free of reoperation for any reason and free of component revision was determined using Kaplan-Meier analysis. Clinical outcomes were assessed using Knee Society Knee and Function Scores.

RESULTS: Preoperative FCs measured a mean of 41º (range, 30-90º) short of full extension with a mean arc of motion of 50º (range, 10-90º). Postoperative FCs measured a mean of 8º (range, 0-90º) short of full extension with a mean arc of motion of 91º (range, 0-130º). The degree of FC and total arc of motion improved significantly following TKA ($p<0.0001$). Five patients (5 knees) underwent secondary procedures for postoperative stiffness at a mean of 9 months (range, 0.6-22 mos.), including four manipulations under anesthesia and one posterior capsule release.16 knees (18%) underwent reoperation at a mean of 1.6 years (range, 0-6.6 years with survivorship free of reoperation of 78% at 20 years. Six knees (6.7%) underwent component revision, with a survivorship of 92% at 20 years. Both postoperative Knee and Function scores were significantly improved compared to preoperative values ($p<0.0001$). Postoperative functional outcomes did not differ based on implant type.

DISCUSSION AND CONCLUSION: This study demonstrates that the recurrence of flexion contractures greater than 30º in this cohort was less than 10%. The risk of reoperation for a persistent flexion contracture was low (6%). Both pain and functioned improved significantly in this cohort, the functional results were poor as rated by the KS function scale.

Refuting Dogma with Science: Posterior Cruciate Ligament Resection Does Not Consistently Increase the Flexion Space

Abstract ID: Paper 192

Lucian C. Warth, M.D.
*Evan R. Deckard, B.S.E.
R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: It is accepted dogma in total knee arthroplasty (TKA) that resecting the posterior cruciate ligament (PCL) increases the flexion space by approximately 4 mm, which significantly affects intraoperative decisions and surgical techniques. Unfortunately, this doctrine is based on historical cadaveric studies of limited size. This study purpose was to more accurately determine the effect of PCL resection on the tibiofemoral flexion gap dimension in vivo in a large sample.

METHODS: Tibiofemoral joint space measurements were made during 127 standardized TKAs by two arthroplasty surgeons. A medial parapatellar approach, computer navigation and provisional tibial and femoral bone cuts were performed in all cases with particular attention to preserving PCL integrity. Cases with an incompetent or damaged PCL were excluded. The tibiofemoral gap dimension was measured with a calibrated tension device at full extension, 45°, and 90° before and after complete PCL resection.

RESULTS: 52% of patients were female (66/127), with mean age and BMI of 69.4 years and 34.3 kg/m^2, respectively. After PCL resection, the mean joint space dimension increased 0.3 mm (range, 0-3 mm) at extension, 0.9 mm (range, 0-4 mm) at 45°, and 1.7 mm (range, 0-5 mm) at 90° ($p<0.001$). The 90-degree flexion space opened ≤1 mm in 48% of patients and >3 mm in only 10%. Dividing the flexion gap change by the femoral implant dimension to account and calibrate for patient size, the joint space at 90° increased more in females (0.031 vs. 0.023, $p=0.022$).

CONCLUSION: The tibiofemoral joint space increases progressively from extension, to mid-flexion through 90° flexion after PCL resection, yet is substantially less than reported in historical studies. However, large variation in the degree of flexion space opening was observed with some patients failing to increase their flexion space whatsoever with PCL resection. This runs counter to conventional TKA understanding and should be considered in modern surgical techniques and education.

Total Knee Arthroplasty is a Better Choice than Unicompartmental Knee Arthroplasty for Morbidly Obese Patients: A Two-Year Minimum Follow-Up Study

Abstract ID: Paper 193

John F. Nettrour, M.D.
Robert T. Ellis, M.D.
Benjamin J. Hansen, M.D.
*James A. Keeney, M.D.
Columbia, MO

INTRODUCTION: Morbidly obese patients (BMI > 40 kg/m^2) are not typically seen as ideal candidates for knee arthroplasty surgery. Despite this, with more than two-thirds of adults in the United States being overweight, circumstances sometimes necessitate consideration of knee replacement in this patient population. The aim of this investigation was to evaluate whether medial unicompartmental knee arthroplasty (UKA) or total knee arthroplasty (TKA) provides more predictable and durable results for morbidly obese patients.

METHODS: After IRB approval, a retrospective review was undertaken of all morbidly obese patients who underwent TKA or medial UKA from January 2012 to May 2015. A minimum of 2-year follow-up was required, however, all occurrences of additional surgery were included regardless of length of follow-up. A detailed medical record review was performed to identify patient age, gender, BMI, laterality, and ASA classification. Surgical outcome data included the causes and frequency of: (1) major revision procedures (components revised), (2) minor secondary procedures (components not revised), and (3) infection procedures. Univariate statistical analysis was performed using unpaired Student's t -tests and Pearson's chi-squared test using $p< 0.05$ to denote statistical significance.

RESULTS: 246 morbidly obese patients (290 knees) met criteria for inclusion. The medial UKA cohort comprised 71 patients (89 knees), while the TKA cohort comprised 175 patients (201 knees). Overall follow-up for both groups averaged 3.6 yrs. (range: 2.0-7.1 yrs.). Patient demographic characteristics were similar for both groups. Major revision surgery occurred more frequently in the UKA cohort than the TKR cohort (15.7% UKA vs 2.5% TKA, $p< 0.001$). Minor secondary surgery rates were comparable at 3.4% UKA vs. 2.0% TKA, ($p=0.300$). Infection rates for the two procedures were also similar at 2.2% UKA and 3.0% TKA ($p= 0.723$).

DISCUSSION AND CONCLUSION: At 3.6 years follow-up, we found the rate of major (component revision) surgery to be six times higher for medial UKA than TKA in morbidly obese patients. Our findings suggest that if a knee arthroplasty procedure is considered for a morbidly obese patient, TKA will provide more predictable and durable results than UKA.

Robotic-Assisted vs. Manual Unicompartmental Knee Arthroplasty: Equivalent Functional Outcomes in Contemporary Systematic Literature Review and Meta-Analysis

Abstract ID: Paper 194

---

*Michael A. Gaudiani, B.A. / Cleveland, OH
Linsen T. Samuel, M.D., M.B.A. / Cleveland, OH
Atul F. Kamath, M.D. / Cleveland, OH
P. Maxwell Courtney, M.D. / Philadelphia, PA
Gwo-Chin Lee, M.D. / Philadelphia, PA

INTRODUCTION: Robotic-assisted unicompartmental knee arthroplasty (RA-UKA) has been developed to improve accuracy of component placement. Studies have shown improvement in radiographic positioning and alignment with RA-UKA, but whether RA-UKA results in better clinical outcomes has yet to be addressed in the literature. The purpose of this study was to determine if RA-UKA is associated with improved revision rates and functional outcomes when compared to manual UKA.

METHODS: A systematic review was conducted to identify all English language articles from 1999-2019 on RA-UKA using the Medline, EMBASE, Scopus, and Web of Science databases. Of the 277 initial studies in our search, 7 articles met the inclusion criteria and were included in the review, including 3 randomized controlled trials. We pooled data for comparative analysis of revision rates and functional outcome scores between RA-UKA and manual UKA. Data was then extracted and aggregated using inverse variance and Mantel-Haenszel fixed effects meta-analysis.

RESULTS: The 7 articles included an aggregate 363 RA-UKA patients and 425 manual UKA patients. Mean age was 66±3.5 and 65±4.0 years, and mean body mass index (BMI) was 26.8±2.1 and 27.1±1.5 kg/m^2 for RA-UKA and manual UKA patients, respectively. Mean follow-up for the RA-UKA patients was 25.5 months (4.5-48) and 29.1 months (4.5-48) for the manual UKA patients. At latest follow-up, RA-UKA patients had a 26%±12 improvement in clinical outcome scores versus 24%±12 improvement for manual UKA patients ($p=0.6$). The revision rate was 3% for both RA-UKA and manual UKA groups ($p=0.8$). RA-UKA had improved return to sport and early postoperative pain scores compared to manual UKA ($p<0.01$ and $p<0.001$).

DISCUSSION: Both robotic and conventional UKA had positive early outcomes, with a low revision rate and high functional outcome scores. We found no clear advantage between robotic and conventional UKA at short-term follow-up. The effect of duration of follow-up, potential ceiling effects of clinical outcome measures, and surgeon volume/experience with the particular techniques is unknown. Longer term follow-up in direct comparison studies may inform the clinical advantages of robotic and manual UKA, along with any important differences with respect to long-term component durability and functional improvement.

Do Intra-Articular Corticosteroid Injections Prior to TKA Increase Complication Rates?

Abstract ID: Paper 195

David Rhode, B.S.
*Matthew Siegel, B.S.
Elan Volchenko, B.S.
Deena Kishawi, B.S.
Michael Patetta, M.D.
Anshum Sood, M.D.
Garrett Schwarzman, M.D.
Alfonso Mejia, M.D., M.P.H.
Mark H. Gonzalez, M.D., Ph.D.
Chicago, IL

BACKGROUND AND OBJECTIVES: There has been controversy surrounding the use of intra-articular injection before total joint replacements. The American Academy of Orthopaedic Surgeons has indicated that the use of injections before THA or TKA can contribute to the increased risk of infections and post-operative complications. Some studies published prior to, and after, the AAOS recommendation, indicated that there was no difference in surgical outcomes; whereas other reports agreed with the recommendation of AAOS. Thus, it would serve beneficial to do a systematic review of all the TKA operations performed at a large urban hospital and to analyze the effects of intra-articular injections on the outcomes. Further analysis of the temporal relationship between injections and the date of operation may provide important evidence for future patient care.

METHODS: We retrospectively reviewed over 1,190 patients who received TKA from a group of fellowship-trained orthopedic surgeons between 2009 to 2016 at a single academic medical center. The patients were separated into two groups: those who received an injection and those who did not receive an injection. We further divided injected patients into subgroups: most recent injection within 0-3 months, 3-6 months, 6-9 months, 9-12 months, and 12+ months before TKA. After controlling for confounding variables, demographics, and comorbidities, we analyzed the differences between the groups using a chi-square test.

RESULTS: In our patient population, we did not observe statistically significant variance in rates of infection (p=.582), the later need for revision TKA (p=.837), the later need for manipulation under anesthesia (MUA) (p=.348), or prolonged postoperative pain (p=.889) in patients who had intra-articular corticosteroid injections compared to patients who received no injections prior to TKA . Timing between most recent injection and TKA, was also not associated with statistically significant variance in rates of infection (p=.409), the later need for revision TKA (p=.985), the later need for MUA (p=.732), and prolonged postoperative pain (p=.582).

CONCLUSIONS: This study revealed no association between injections and complications after TKA, such as infection and stiffness. Because intra-articular corticosteroid injections are a common treatment modality used prior to TKA, further studies should be conducted on a nationwide basis to draw concrete conclusions regarding its relationship with postoperative complications after TKA.

Isolated Tibial Insert Exchange in Aseptic Revision TKA: Reliable and Durable for Wear; Less so for Instability, Insert Fracture/Dissociation, or Stiffness

Abstract ID: Paper 196

---

*Matthew W. Tetreault, M.D.
Jeremy T. Hines, M.D.
Daniel J. Berry, M.D.
Mark W. Pagnano, M.D.
Robert T. Trousdale, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

INTRODUCTION: Modularity in total knee arthroplasties (TKAs) allows for isolated tibial insert exchange with retention of well-fixed and well-aligned components. Simplicity makes this technique appealing, but published results for non-infectious indications are mainly small series. This study determined outcomes of isolated tibial insert exchange during aseptic revision TKA in a large, consecutive cohort.

METHODS: From 1985-2016, 270 isolated tibial insert exchanges (among 7121 revision TKAs the same years) were performed at one institution for non-infectious indications, including polyethylene wear (39%), instability (55%), insert fracture/dissociation (5%), or stiffness (1%). Patients with component loosening, implant malposition, infection, or extensor mechanism problems were excluded. Mean age was 65 years with 62% females. Mean follow-up was 6 years.

RESULTS: At 10 years, Kaplan-Meier survivorship free of re-revision was 68%. For diagnosis of insert wear, revision-free survivorship at 5 & 10 years was 89% and 74%. Re-revisions were more frequent for index diagnoses other than wear (HR 1.9; p=0.01) with 5 and 10-year survival of: 74% and 69% for instability; and 49% and 37% for liner fracture/dissociation. After exchanges for wear, the most common reason for re-revision was aseptic loosening (33%). After all other index diagnoses, the most common reason for re-revision was recurrence of that diagnosis. Other factors associated with re-revision were younger age (HR 1.4 per 10 years; p<0.01) and prior revision (HR 1.9; p<0.01). Mean Knee Society Scores improved from 54 preoperatively to 72 at 5 years and 78 at 10 years.

CONCLUSIONS: After isolated tibial insert exchange the risk and reasons for re-revision correlated with preoperative indication. Best results were for polyethylene wear with 5 and 10-year survival of 89% and 74%. For other diagnoses, failure rate was higher and failure mode was most commonly recurrence of original diagnosis. TKA failures often are multi-factorial, and we advise some caution with this simplistic strategy.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 25, 2020

Acute Surgical Management of Proximal Humerus Fractures: ORIF vs. Hemiarthroplasty vs. Reverse Shoulder Arthroplasty

Abstract ID: Paper 197

---

*B. Israel Yahuaca, M.D.
Peter Simon, Ph.D
Kaitlyn N. Christmas, B.S., C.C.R.C.
Shaan Patel, M.D.
R. Allen Gorman, II, M.D.
Mark A. Mighell, M.D.
Mark A. Frankle, M.D.
Tampa, FL

BACKGROUND: Proximal humerus fracture (PHF) treatment varies by surgeon preference and patient factors. This study compares patient and fracture characteristics, with outcomes between current surgical treatment options.

METHODS: Between 1999-2018, 425 PHF underwent acute surgical management, ORIF (n=211), HA (n=108), or RSA (n=106). Patient and fracture characteristics included age, ASA, and fracture classification. Postoperative motion at 3, 6, and minimum 12 months (avg 20±21 months), radiographic outcomes, and postoperative falls were analyzed.

RESULTS: Average age for treatment groups was 65±13 years (range: 18-93). Fractures were classified as 2- (11%), 3- (41%), or 4-part (48%). Age, ASA, and fracture classification were associated with selected surgical management ($p<0.0001$, $=0.001$, <0.0001, respectively). Outcomes showed significant improvement in forward flexion from 3 months to 6 months in all groups ($p<0.0001$). Only significant difference in final motion was between ORIF and HA ($p=0.002$). Radiographic union was higher in ORIF (89%), and similar between HA (79%), and RSA (77%, $p=0.005$). Rate of reoperation was RSA 6.6%, ORIF 17.5%, Hemi 15.7% ($p=0.029$). Postoperatively, 23% patients had at least one fall, of which 73% resulted in fractures.

CONCLUSION: Older patients with high ASA were treated with arthroplasty, younger patients with lower ASA were treated with ORIF. All groups showed improvements in motion. At minimum 1 year of follow-up, there was only difference between ORIF and HA. ORIF and HA showed significantly more reoperations compared to RSA. Recurrent falls and fractures are a tremendous public health concern, patients should be counseled about reoperation, fall risk, and prevention.

LEVEL OF EVIDENCE: Level III, Retrospective Cohort

Does Early Mobilization Rehabilitation Protocol Affect Pain Scores and Opioid Consumption in Reverse Shoulder Arthroplasty?

Abstract ID: Paper 198

Mauricio Drummond, Jr., M.D. / Weston, FL
*John Merriam, B.S. / Boca Raton, FL
Bhavya Sheth / Miami, FL
Gregory Gilot, M.D. / Weston, FL
Vani J. Sabesan, M.D. / Boca Raton, FL

INTRODUCTION: Reverse shoulder arthroplasty (RSA) has demonstrated exponential growth in the US over the past two decades due to its success in providing pain relief and improved function for patients. Recent literature suggests that early range of motion (ROM) may provide more rapid return of function and prevent stiffness, however, no studies have looked specifically at how this may impact pain and opioid consumption. This is of significant interest due to the current opioid abuse climate. The purpose of this study was to evaluate the impact of an immediate mobilization rehabilitation program on pain and opioid consumption following RSA.

METHODS: A retrospective case-controlled study was performed on 65 patients who underwent RSA at a single institution by two fellowship-trained shoulder surgeons. Two groups included: immediate mobilization (IM) group (n=29) and delayed mobilization (DM) group which started PT progression after 4-6 weeks (n=36). Pain scores (NRS and ASES), time to return to work, opioid dependency, and opioid consumption were compared using total morphine equivalents (TME) per day from the state prescription drug monitoring database. Statistical analyses included Chi-squared, independent, and paired t tests.

RESULTS: The average patient age was 72.6 (± 7.6) and the average BMI was 30.4 ± 6.45. Preoperatively, there was no significant difference seen between groups in age (p=0.81), gender (p=0.58), BMI (p=0.72), insurance type (p=0.40), NRS (5.77 vs 6.35) (p=0.48), ASES for pain (24.2 vs 17.8) (p=0.15), opioid dependence (IM=13% vs DM=11%) (p=0.82), and opioid consumption (IM=69.93TME vs DM=78.69 TME) (p=0.88). Postoperatively, there was no significant difference in opioid dependence (IM=13% vs DM=19%) (p=0.48), opioid consumption (IM=102.39TME vs 155.39TME) (p=0.41), and ASES for pain (p=0.06) between the groups, however there was a significant difference in NRS with lower scores for the IM group (0.61) compared to DM group (2.79) (p=0.02) at 3 months postoperatively.

CONCLUSION: In the setting of the opioid crisis, especially with painful procedures like RSA, our study showed that the immediate mobilization rehab can achieve lower reported pain scores postoperatively, however, this advantage did not translate to less opioid consumption or lower rates of dependence. When surgeons are deciding on proper rehab progression for a patient following RSA, they can focus on function and intraoperative assessments of the repair as immediate or delayed rehabilitation does not significantly affect patient pain levels or opioid consumption.

Dexamethasone Improves Postoperative Pain and Nausea after Total Shoulder Arthroplasty: A Prospective, Randomized Controlled Trial

Abstract ID: Paper 199

---

*Elizabeth A. Klag, M.D.
Joseph S. Tramer, M.D.
Noah Kuhlmann
Stephanie J. Muh, M.D.
Detroit, MI

PURPOSE: Preoperative administration of dexamethasone has been shown to decrease postoperative nausea and vomiting and improve pain control in patients undergoing hip and knee arthroplasty. There are few studies showing the effectiveness of dexamethasone in shoulder arthroplasty. Our aim was to perform a prospective, randomized controlled trial on the effect of dexamethasone on postoperative pain, morphine use, and nausea in shoulder arthroplasty patients.

METHODS: Ninety patients undergoing primary shoulder arthroplasty were evaluated for inclusion in the study. Patients were randomized to receive 10 mg intravenous dexamethasone with 90 minutes of surgery versus no dexamethasone. All patients received local infiltration analgesia intraoperatively with a cocktail of ropivacaine, ketorolac, and epinephrine. Patients were followed for 24 hours postoperatively and primary outcomes included visual analog scale (VAS) scores, morphine equivalent usage, and anti-emetic use. Secondary outcomes included patient-reported nausea and length of hospital stay.

RESULTS: Preliminary results of this study show lower VAS scores in the dexamethasone group compared to the control group, 3.56 vs 5.44, respectively ($p<0.001$). Morphine equivalent use was also lower in the dexamethasone group, 3.02 vs 4.43 ($p=0.010$) in the control group. The dexamethasone group has significantly lower anti-emetic use compared to controls, 0.058 vs 0.260 ($p=0.047$) respectively. There was no significant difference in length of stay or blood glucose elevation.

CONCLUSION: Preoperative administration of intravenous dexamethasone leads to improved pain control and decreased nausea and vomiting in patients undergoing shoulder arthroplasty.

The Accuracy of the Superomedial Approach for Glenohumeral Injections

Abstract ID: Paper 200

---

*Matthew F. Dilisio, M.D. / Omaha, NE

INTRODUCTION: Intra-articular glenohumeral injections are an important diagnostic and therapeutic modality for the treatment of a variety of pathologic conditions about the shoulder. However, the ability to direct the needle accurately into the glenohumeral joint can be challenging. Image guided injections, often with fluoroscopy or ultrasound, can improve the accuracy of the injections but can be time, cost, and/or resource prohibitive in many situations. A superomedial approach to the glenohumeral joint is another option for intra-articular access. This trajectory, sometimes referred to as the “Nevaiser’s portal” approach, is useful to achieve access to the superior glenoid during shoulder arthroscopy. However, there is limited published evidence investigating the accuracy of this approach for glenohumeral injections. The purpose of this study is to investigate the accuracy of achieving intra-articular needle placement of the superomedial approach for non-image guided glenohumeral injections using a standard 1.5 inch needle. The hypothesis is that the superomedial approach is an accurate technique to penetrate the glenohumeral joint.

METHODS: A superomedial injection through “Nevaiser’s portal” was performed during routine shoulder arthroscopy after introduction of the arthroscope through a standard posterior viewing portal prior to saline insufflation of the glenohumeral joint. A standard 22 gauge 1.5 inch needle was utilized angled 20 degrees anterolaterally towards the central aspect of the humeral head. 30 ml of saline was then injected through the syringe. The primary outcome measure is direct intra-articular needle visualization.

RESULTS: 43 patients with a mean age of 51 years were included in the study. Successful intra-articular glenohumeral injection was directly visualized arthroscopically in 35 of the 43 patients included (81.4%). The needle was visualized penetrating the superior capsule medial to the rotator cable in all patients with an intact rotator cuff. The tip of the needle reached the humeral head in 11 patients (25.6%).

CONCLUSION: The superomedial approach can accurately penetrate the glenohumeral joint for diagnostic and therapeutic intra-articular shoulder injections utilizing a standard 1.5 inch needle. Utilizing a longer needle may improve the ability to penetrate the joint. This approach could be a useful alternative to traditional anterior or posterior glenohumeral injections.

Intraoperative Efficiency in Contemporary Total Shoulder Arthroplasty: Is Manual Pressure During Cement Curing Still Necessary with Interference Fit Pegged Glenoids?

Abstract ID: Paper 201

---

*Rebecca G. Burr, M.D.
Andrew M. Schneider, M.D.
Nickolas G. Garbis, M.D.
Dane H. Salazar, M.D.
Maywood, IL

INTRODUCTION: There has been no prior data demonstrating the effect of manual pressure during cement curing on glenoid peg fixation in total shoulder arthroplasty. The operating room time (OR) spent holding manual pressure represents a potential opportunity cost and area for improved efficiency in this procedure. In this study, we compared implant seating using two different methods of securing the glenoid implant to cemented peg holes: a manual pressure technique versus a pressureless technique.

METHODS: Sixteen cadaveric scapulae were harvested and their glenoids were prepared for component insertion. Glenoids with an interference-fit central peg were cemented into the peripheral holes and fully seated. Two techniques were employed during cement curing: a (1) “manual pressure” technique (8 glenoids), which used a static 70N load application to each implant for 10 minutes, and a (2) “no pressure” technique (8 glenoids), which used no pressure application and the implant was left to set without intervention. Each glenoid was subsequently imaged via micro-computed tomography and analyzed for differences in cement morphology characteristics.

RESULTS: The average incongruity in the first group was 1.0 mm. The average incongruity of the second group was 0.63 mm. A linear mixed effects model with a Kenward-Roger correction was used to compare the two groups. No significant difference was found between the two groups. (Mdiff = -0.386, 95% CI: -0.978 to 0.206; p = .17)

DISCUSSION: Manual pressure of the glenoid during cement curing yielded no difference in final seating and cortical contact of the implant compared to a pressureless technique. This knowledge could potentially benefit both the surgeon and the patient by increasing efficiency in total shoulder arthroplasty and decreasing time under anesthesia for the patient.

Effect of 24 Hour vs. Single Dose Antibiotic Prophylaxis on Infection and Revision Rate Among Patients Undergoing Anatomic and Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 202

---

*Charles T. Fryberger, III, M.D.
Thomas W. Throckmorton, M.D.
SaeRam Oh, B.S.
Jim Wan, Ph.D.
Frederick M. Azar, M.D.
Tyler J. Brolin, M.D.
Memphis, TN

BACKGROUND: Perioperative prophylactic antibiotic administration is a well-established strategy to reduce periprosthetic joint infection. There is a paucity of literature to guide surgeons on perioperative antibiotic dosing of outpatient total shoulder arthroplasty performed in the ambulatory surgical setting. This study evaluates infection and revision rates of 24 hour (24hr) versus single dose (SD) intravenous (IV) antibiotic prophylaxis in the setting of total shoulder arthroplasty.

METHODS: Institutional database query of patients undergoing primary anatomic or reverse total shoulder arthroplasty (rTSA) returned 896 and 126 patients who received 24hr perioperative IV antibiotics in an inpatient setting or SD preoperative IV antibiotics in an ambulatory setting, respectively. Demographics including body mass index, age, average follow-up, procedure, indication, history of surgery on the operative limb, employment, smoking status, comorbidities, and chronic immunosuppression were examined. Infection and revision rates were measured. Wilcoxon rank sum and chi-square or Fisher exact tests were used to compare continuous and categorical variables, respectively. P-values of less than 0.05 were considered statistically significant.

RESULTS: Patients in the 24hr group were 10.3 years older (67.6 years vs 57.3 years, p=<0.0001), more likely to undergo rTSA (61.5% vs 29.4%, p=<0.0001), have diabetes (23.0% vs 0.3%, p=0.001) or hypertension (69.3% vs 47.6%, p=<0.0001), and less likely to have undergone previous shoulder surgery (16.5% vs 23.8%, p=0.04). Employment status (p=<0.0001) and procedure indication (p=0.001) varied significantly. Length of follow-up was 23.0±21.0 months for the 24hr group and 17.8±15.6 months for the SD group. No difference in overall infection rate (24hr: 1.5% vs SD: 1.6%, p=0.71), revision rate (24hr: 4.6% vs SD: 3.2%, p=0.47), rate of superficial (24hr: 0.2% vs SD: 0%) or deep infection (24hr: 1.2%, SD 1.6%, p=0.73), timing of infection (24hr: <3months=0.6%, >3months=0.9% vs SD: <3months=0%, >3months=1.6%, p=0.53), and revision indication (infection 24hr: 1.1% vs SD: 0.8% and non-infectious 24hr: 4.6% vs SD: 3.2%, p=0.92) was found.

CONCLUSIONS: Both SD and 24hr protocols resulted in low and statistically insignificant postoperative infection and revision rates. One deep infection in the SD group refused revision surgery and elected for chronic suppression. The single dose group was younger, healthier, and more likely to have undergone previous surgery than the 24hr group. This suggests stricter patient selection for outpatient total shoulder arthroplasty compared to hospital-based total shoulder arthroplasty. Ultimately, this study shows that single dose IV antibiotic prophylaxis protocols can be safely used in patients undergoing total shoulder arthroplasty in an ambulatory center.

Cost Analysis and Complication Profile of Primary Shoulder Arthroplasty at a High-Volume Institution

Abstract ID: Paper 203

---

*Erick M. Marigi, M.D.
Justin C. Kennon, M.D.
Chad E. Songy, M.D.
Sue L. Visscher, Ph.D.
Bijan J. Borah, Ph.D.
Cathy D. Schleck
Robert H. Cofield, M.D.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
John W. Sperling, M.D., M.B.A.
Rochester, MN

INTRODUCTION: Paralleling the increased utilization of shoulder arthroplasty, bundled payment reimbursement is becoming increasingly common. A central component of risk-based reimbursement is a clear understanding of costs for each of the components of care. Therefore, the purpose of this study was to perform a comprehensive and detailed analysis of complications, readmission rates, and cost of primary shoulder arthroplasty at a high-volume institution.

METHODS: Between 2012 and 2016, 1794 consecutive patients underwent primary total shoulder arthroplasty at a single institution: 636 total shoulder arthroplasties (TSA), 1081 reverse shoulder arthroplasties (RSA), and 77 hemiarthroplasties (HA). Cost analysis was designed to include a period 60 days preoperatively, the index surgical hospitalization, and 90 days postoperatively, including costs for any readmission or re-operation. Costs during the perioperative period included preoperative medical evaluation, orthopedic consultation, standard shoulder radiographs, and computed tomography (CT). The 90-day postoperative period typically entailed one clinic visit, an average of 4 physical therapy sessions, and a single shoulder radiograph session. Ninety-day postoperative complications and hospital readmissions were reviewed to determine the cumulative incidence.

RESULTS: The 90-day success rates free of complication, reoperation, and readmission were 97.66%, 99.37%, and 98.18% respectively. There was no significant difference in complication, reoperation, or readmission rates with regard to gender or BMI (> or < 30). There were 9 shoulder and implant-related causes for readmission including dislocation (n=4), periprosthetic joint infection (n=2), periprosthetic fracture requiring reoperation (n=1), implant loosening (n=1), and hematoma (n=1). Non-shoulder related complications accounted for the 22 other readmissions. Median standardized costs for our cohort were as follows: preoperative evaluation $481, index surgical hospitalization $15,758, and postoperative care $183. Preoperative and postoperative costs did not vary significantly based on the type of arthroplasty performed. However, index surgical hospitalization median standardized costs were affected by the procedure type: TSA $14,010, RSA $16,741, and HA $12,709.

CONCLUSION: In a healthcare system with standardized preoperative and postoperative protocols and high-volume shoulder surgeons, primary shoulder arthroplasty yielded low 90-day reoperation and complication rates of 0.63% and 2.34%, respectively. Median standardized costs for primary total shoulder arthroplasty inclusive of 60-day preoperative work-up and 90-

day postoperative recovery were $14,675 and $17,407 for TSA and RSA, respectively. This retrospective cost analysis and complication profile may serve as a useful reference as surgeons consider engaging in bundled payment for shoulder arthroplasty.

Total Shoulder Arthroplasties in Physician-Owned Hospitals: Is it Time to Reconsider the Restrictions of the Affordable Care Act (ACA)?

Abstract ID: Paper 204

Azeem T. Malik, M.B.B.S.
*Mathangi Sridharan, B.S.
Julie Y. Bishop, M.D.
Safdar N. Khan, M.D.
Andrew S. Neviaser, M.D.
Gregory L. Cvetanovich, M.D.
Columbus, OH

INTRODUCTION: Due to concerns regarding higher cost, low quality of care, and “cherry-picking” of patients in physician-owned hospitals, the Affordable Care Act (ACA) imposed restrictions that prevented the formation of new physician-owned hospitals and limited expansion of current physician-owned facilities. With an increasing trend in the utilization of total shoulder arthroplasties (TSA) across the United States, there is a need for re-evaluation and assessment of quality and cost of TSAs performed at these physician-owned hospitals.

METHODS: The 2011-2014 Medicare 100% Standard Analytical Files (SAF100) was queried using International Classification of Diseases 9th Edition (ICD-9) procedure code for patients undergoing a reverse TSA/RTSA or anatomic TSA. The Medicare Hospital Compare database was used to identify physician-owned hospitals. Multi-variate logistic and linear regression analyses were used to assess significant differences in 90-day and 1-year rates of postoperative stiffness, dislocation, periprosthetic fracture, revision arthroplasty, medical complications, all-cause readmissions, charges, and costs between the two groups.

RESULTS: A total of 1,626 (2.2%) patients received a TSA at a physician-owned hospital (N=50; 1.9% of all facilities) whereas 72,937 (97.8%) received surgery at non-physician owned hospital (N=2,645; 98.1% of all facilities). After controlling for age, gender, region, hospital factors (socio-economic status area, urban vs. rural location and volume), type (ATSA vs. RTSA), diagnosis (avascular necrosis, rheumatoid arthritis, fracture, unspecified arthropathy, and osteoarthritis) and ECI, no significant differences were noted between physician owned vs. non-physician owned hospitals with regards to 90-day rates of infections (p=0.645), dislocation (p=0.068), peri-prosthetic fractures (p=0.556), revision arthroplasty (p=0.114), pulmonary embolism (p=0.155), deep venous thrombosis (p=0.208), acute myocardial infarction (p=0.219), sepsis (p=0.288), urinary tract infections (p=0.186), and all-cause readmissions (p=0.427). No significant differences were observed between physician-owned vs. non-physician-owned hospitals for 1-year rates of dislocations (p=0.475), periprosthetic fractures (p=0.697), and revision arthroplasties (p=0.225). However, TSAs performed at physician-owned facilities did have higher odds of experience postoperative stiffness at 90-day (OR 1.39; p<0.001) and 1-year follow-up points (OR 1.51; p<0.001). TSAs being performed at physician-owned hospitals vs. non-physician owned hospitals also had significantly lower risk-adjusted inpatient charges (-$9,842), inpatient costs (-$1,723), 90-day charges (-$8,904), and 90-day costs (-$1,659).

CONCLUSION: Patients undergoing TSAs at physician-owned hospitals (vs. non-physician owned hospitals), are not at a higher risk for experiencing adverse events, while having lower costs of care. The findings call into the need for revaluation of the ACAs restriction on the expansion of these physician-owned hospitals.

The Impact of Healing after Lesser Tuberosity Osteotomy and Medial Calcar Bone Resorption in Total Shoulder Arthroplasty on Outcomes

Abstract ID: Paper 205

---

*Teja S. Polisetty, B.S. / Ft. Lauderdale, FL
Paul Devito, D.O. / Ft. Lauderdale, FL
Derek Berglund, M.D. / Ft. Lauderdale, FL
Hyrum Judd, D.O. / Miami, FL
Rushabh Vakharia, M.D. / Ft. Lauderdale, FL
Andrew Malarkey, D.O. / Ft. Lauderdale, FL
Emmanuel McNeely, M.S., M.H.A. / Ft. Lauderdale, FL
Rushabh M. Vakharia, M.D. / Ft. Lauderdale, FL
Molly Moor, M.S. / Ft. Lauderdale, FL
Scott Polansky, D.O. / Ft. Lauderdale, FL
Jonathan C. Levy, M.D. / Ft. Lauderdale, FL

INTRODUCTION: Lesser tuberosity osteotomy (LTO) has gained popularity in anatomic total shoulder arthroplasty (TSA); however, healing rates have not been universally high. With etiologies including stress shielding, debris-induced osteolysis, and infection, the clinical impact of medial calcar resorption has also not been specifically examined. This study examined differences in outcomes based on variations in LTO healing and calcar resorption in TSA patients.

METHOD: A retrospective review identified 189 primary TSA patients with 2-year minimum follow-up treated with an LTO. Postoperative radiographs classified LTO healing as “bony union,” “nondisplaced nonunion,” “displaced nonunion,” and “not seen,” creating 4 cohorts. Comparisons were made among patient-reported outcome measures (PROMs), motion, and radiographic evidence of component loosening. A novel calcar resorption grading system was introduced to quantify the degree of resorption and assess the progression.

RESULTS: Patients with LTO displaced nonunion had lower postoperative SST ($p<0.01$) and ASES scores ($p<0.01$), with higher postoperative VAS Pain ($p<0.01$) Yet, 85.7% of patients reported they would have the same procedure again, with only one patient with an unsatisfied outcome. Patients with LTO nondisplaced nonunion showed no differences in postoperative PROMs or ROM when compared to those with LTO union. There were also no significant differences amongst patients with and without calcar resorption. Subgroup analysis noted that Grade 3 resorption had a higher incidence of glenoid radiolucencies (50%, $p=0.001$), and progression from Grade 1 to Grade 3 had higher incidence of glenoid (50%, $p=0.003$) and humeral (9%, $p=0.039$) radiolucencies.

CONCLUSION: Patients with a displaced nonunion LTO site have lower functional scores and higher pain scores but still achieve substantial clinical improvement and high satisfaction rates. Moreover, there were no differences in PROMs or radiographic loosening when compared to patients without calcar resorption. However, grade 3 calcar resorption and more dramatic progression of resorption should raise the suspicion of prosthetic loosening.

Acute vs. Delayed Reverse Total Shoulder Arthroplasty for Proximal Humerus Fractures in the Elderly

Abstract ID: Paper 206

Noah A. Kuhlmann, M.S., B.S. / West Bloomfield, MI
*Kevin A. Taylor, M.D. / West Bloomfield, MI
Sreten Franovic, M.S., B.S. / West Bloomfield, MI
Christopher P. Roche, M.B.A. / Gainesville, FL
Pierre-Henri Flurin / Bourdeaux, France
Bradley S. Schoch, M.D. / Gainesville, FL
Bradley C. Carofino, M.D. / Virginia Beach, VA
Thomas W. Wright, M.D. / Gainesville, FL
Joseph D. Zuckerman, M.D. / New York, NY
Stephanie J. Muh, M.D. / West Bloomfield, MI

BACKGROUND: Treatment of proximal humerus fractures (PHFs) via reverse total shoulder arthroplasty (RTSA) has shown early promise when compared to historical treatment modalities. Ideal surgical timing remains unclear. The purpose of this study was to compare the outcomes of early versus delayed RTSA for PHF. We hypothesized that acute RTSA would display superior outcomes compared to those receiving delayed surgical intervention.

METHODS: This multicenter study retrospectively analyzed 142 patients who underwent RTSA for fracture. Patients treated within 4 weeks of injury were placed in the acute group (n=102), and patients treated longer than 4 weeks after injury were placed in the chronic group (n=38). A comprehensive panel of patient-reported outcome measures, VAS pain scores, range of motion, and patient satisfaction were evaluated.

RESULTS: The acute group had significantly better final follow-up SPADI scores (20.8 ± 23.9 vs. 30.7 ± 31.7) ($p<0.05$). The acute group demonstrated higher passive external rotation compared to the chronic group (47.8 ± 16.5 vs. 40.4 ± 16.1) ($p<0.05$). No further differences were detected in other postoperative range of motion measurements, subjective outcomes, or VAS scores.

CONCLUSIONS: Our results suggest that patients treated acutely display similar mid-term outcomes to those who receive delayed treatment. With this in mind, surgeons may first give consideration to a period of nonoperative treatment.

LEVEL OF EVIDENCE: LEVEL III

Association Between Rotator Cuff Fatty Infiltration and Posterior Glenoid Wear in Glenohumeral Osteoarthritis

Abstract ID: Paper 207

Matthew J. Hartwell, M.D.
Ryan E. Harold, M.D.
*Patrick T. Sweeney, M.D.
Amee L. Seitz
Guido M. Marra, M.D.
Matthew D. Saltzman, M.D.
Chicago, IL

BACKGROUND: Recent studies have suggested a correlation between posterior-superior rotator cuff fatty infiltration and posterior glenoid wear using CT scan data. However, other studies report a poor correlation between Goutallier classification as measured on MRI versus CT scan, with MRI having increased sensitivity for identifying fatty infiltration. Therefore, we sought to investigate the association between Goutallier classification of rotator cuff fatty infiltration and glenoid morphology in the setting of glenohumeral osteoarthritis, using both MRI and CT scans. In particular, we sought to evaluate the relationship between Goutallier classification, and glenoid version and Walch classification of glenoid wear.

METHODS: We identified patients that had both CT and MRI scans within 6 months of each other, in preparation for total shoulder replacement. Three of the authors assigned Goutallier classification to all four rotator cuff muscles using MRI, Walch classification to the glenoid and measured glenoid version on CT scan. A Modified Goutallier classification was used, where grades 0 and 1 were combined into one group, grade 2 remained as a second group, and grade 3 and 4 were combined into a third group. Multivariate statistical analysis was used to determine correlations (r-values) and statistical significance; inter-rater agreement kappa values were also determined between authors' measurements.

RESULTS: 15 patients had both CT and MRI imaging available for review between the years 2015-2018. Their average age was 60.1 years (range 52-68) and 5 (33%) were female. There was a moderate correlation ($r=0.65$, $p=0.008$) between increasing supraspinatus fatty infiltration and increasing glenoid version angle. The correlation was not significant between infraspinatus ($r=0.32$, $p=0.23$), teres minor ($r=0.33$, $p=0.22$), and subscapularis ($r=0.11$, $p=0.68$) fatty infiltration and glenoid version angle. Furthermore, when Walch classification was simplified into either type A or B, there was no significant correlation of Goutallier classification to any of the four rotator cuff muscles (all $p>0.05$). Additionally, there was no correlation between increasing body mass index (BMI) and rotator cuff fatty infiltration (all $p>0.05$).

DISCUSSION/CONCLUSION: In our patient population, fatty infiltration of the supraspinatus on MRI correlated with increasing glenoid version and posterior wear on CT. However, there was no correlation between posterior rotator cuff fatty infiltration on MRI and posterior glenoid wear on CT, contrary to recently published data. We additionally found no correlation between increasing BMI and rotator cuff fatty infiltration.

Correlation Between Goutallier Classification, Glenoid Version Angle, and Walch Classification on MRI Versus CT Scan in Glenohumeral Osteoarthritis

Abstract ID: Paper 208

---

*Ryan E. Harold, M.D.
Matthew J. Hartwell, M.D.
Patrick T. Sweeney, M.D.
Amee L. Seitz
Guido Marra, M.D.
Matthew D. Saltzman, M.D.
Chicago, IL

BACKGROUND: Bony glenoid morphology and the quality of rotator cuff musculature play important roles in the long-term outcomes of anatomic total shoulder arthroplasty. Glenoid morphology is most commonly defined using the Walch classification and glenoid version angle, while rotator cuff muscle quality is defined using the Goutallier classification. These classification systems are known to have variable inter-rater reliabilities, but the correlation and inter-rater reliability between classifications as assigned using MRI versus CT scan remains to be further elucidated.

METHODS: We identified 15 patients preparing for total shoulder replacement surgery that had both CT and MRI scans completed within 6 months of each other. Three of the authors assigned Goutallier classification to all four rotator cuff muscles, Walch classification to the glenoid and measured glenoid version on CT and MRI. A Modified Goutallier classification was also used, where grades 0 and 1 were combined into one group, grade 2 remained as a second group, and grades 3 and 4 were combined into a third group. Multivariate statistical analysis was used to determine correlations (r-values) and statistical significance; inter-rater agreement kappa values were also determined between authors' measurements.

RESULTS: 15 patients had both CT and MRI imaging available for review between the years 2015-2018. Their average age was 60.1 years (range 52-68) and 5 (33%) were female. There was a strong correlation (r=0.71) between glenoid version as measured on CT scan versus MRI; Walch classification reached significance in agreement between CT and MRI ($p<0.001$). Both Goutallier and Modified Goutallier were weakly correlated ($r<0.50$) on CT and MRI. Lastly, inter-rater agreement between graders was fair on MRI (r=0.14, 0.17, 0.42, and 0.13) and moderate on CT scan (r=0.39, 0.38, 0.54, and 0.33). Inter-rater agreement improved on both MRI (0.17, 0.26, 0.62, 0.14) and CT scan (0.65, 0.93, 0.93, 0.43) when switching to the Modified Goutallier classification.

DISCUSSION/CONCLUSION: Glenoid version angle measurement and Walch classification assignment are significantly correlated using MRI and CT scan, thus either imaging modality can provide adequate information related to bony glenoid morphology. Goutallier classification, using either the original classification system or a more simplified grading system with three groups, is poorly correlated between MRI and CT. Further, the inter-rater agreement was only fair using both MRI and CT.

Natural History of Glenoid Bone Loss in Primary Glenohumeral Osteoarthritis: How Does Bone Loss Progress Over a Decade?

Abstract ID: Paper 209

---

*Anthony L. Logli, M.D.
Ayoosh Pareek, M.D.
Ngoc Tram V. Nguyen, B.S.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
Rochester, MN

INTRODUCTION: The modified Walch classification is most commonly used to describe bone loss and subluxation in primary glenohumeral osteoarthritis (GHOA). However, very few studies have evaluated patterns of bone loss over time. The purpose of this study was to compare subluxation and glenoid bone loss in radiographs obtained 5 to 15 years prior in shoulders that eventually underwent arthroplasty.

METHODS: A retrospective review of our Institution's imaging database identified 47 patients (30 males, 17 females) with radiographs of the same shoulder both prior to arthroplasty and at least once 5 to 15 years earlier. Axillary radiographs were used to classify glenoid morphology using the modified Walch classification and to digitally measure humeral head subluxation (HHS) using Friedman's Index (FI) on the oldest, most recent, and all intervening x-rays. Mean interval time between the oldest and most recent radiographs for each shoulder was 8.9 years (range 5-15). 19 patients had a single intervening x-ray (mean, 6.7 years from most recent radiographs; range 4.4-8.9), 6 patients had two (mean, 5.6 years; range 0.2-13.9), 3 had three (mean, 5 years; range 2.4-8.3), 2 had five (mean, 3.4 years; range 1.1-5.7), and 1 had six (mean, 0.5 years).

RESULTS: On initial presentation, there were 20 A1, 11 A2, 2 B1, 8 B2, 2 B3, and 4 D glenoids. Prior to arthroplasty there were 2 A1, 14 A2, 2 B1, 10 B2, 9 B3, and 10 D glenoids. Pathologic progression is demonstrated. Mean FI for each subtype was 0.48 for A1, 0.49 for A2, 0.53 for B1, 0.59 for B2, 0.51 for B3, 0.42 for D.

CONCLUSION: The future pattern of GHOA is difficult to predict in a concentric glenohumeral joint with little to no bone loss. While the majority of A2 glenoids continue to wear concentrically, evolution to an asymmetric wear pattern can occur. If B-type glenoids progress, the pattern of progression appears predictable. Anterior or posterior HHS appears to correlate with the wear pattern seen in GHOA.

Osteoporosis is Common and Undertreated Prior to Elective Shoulder Arthroplasty

Abstract ID: Paper 210

---

*James T. Bernatz, M.D.
Andrew E. Brooks, M.D.
Benjamin P. Nguyen, B.S.
Edward D. Shin, B.S.
Neil C. Binkley, M.D.
Paul A. Anderson, M.D., M.S.
Brian F. Grogan, M.D.
Madison, WI

INTRODUCTION: Osteoporosis is common in patients with shoulder arthritis and rotator cuff tear arthropathy. However, the prevalence of osteoporosis in patients undergoing elective shoulder arthroplasty is inadequately studied. We hypothesize that preoperative osteoporosis is under-recognized and undertreated in this population. The purpose of this study is to report preoperative osteoporosis screening rates, osteoporosis prevalence prior to surgery, and rates of pharmacologic osteoporosis treatment in the shoulder arthroplasty population.

METHODS: This is a retrospective case series of all adults age 50 years or older who underwent elective shoulder arthroplasty (anatomic total shoulder arthroplasty, reverse total shoulder arthroplasty, or hemiarthroplasty) at a single tertiary care center over an eight-year period (May 2011 – May 2019). Charts were retrospectively reviewed to determine preoperative osteoporosis risk factors, prior dual-energy x-ray absorptiometry (DXA) testing, and prior osteoporosis pharmacotherapy. Fracture risk was estimated using the Fracture Risk Assessment Tool (FRAX) and the National Osteoporosis Foundation (NOF) criteria for screening and treatment was applied to all patients.

RESULTS: Two hundred fifty-one patients met inclusion criteria. Of the 251 patients, 171 (68%) met criteria for DXA testing. Of those 171 patients, 31 (18%) had DXA testing in the two years prior to surgery and 52% had osteopenia or osteoporosis by T-score. Eighty patients (32%) met NOF criteria for pharmacologic osteoporosis treatment and 17 of those 80 received a prescription for pharmacotherapy within 6 months before or after surgery.

CONCLUSION: One in three elective shoulder arthroplasty patients meet criteria to receive osteoporosis medications, but only 7% receive therapy pre- or postoperatively. This lack of preoperative osteoporosis screening and treatment may contribute to component subsidence, aseptic loosening, need for revision surgery, and periprosthetic fracture risk.

Correlation Between Resilience and Clinical Outcomes Following Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 211

---

*Alex R. Dombrowsky, B.S. / Birmingham, AL
Graham Kirchner, B.S. / Birmingham, AL
Jonathan Isbell, M.D. / Birmingham, AL
Eugene W. Brabston, M.D. / Birmingham, AL
Brent A. Ponce, M.D. / Birmingham, AL
John M. Tokish, M.D. / Phoenix, AZ
Amit Momaya, M.D. / Birmingham, AL

INTRODUCTION: Little evidence exists on how psychometric properties affect patient outcomes following reverse total shoulder arthroplasty. The objective of this study is to examine the relationship between resilience, characterized by the ability to recover from a stressful event, and outcomes after reverse total shoulder arthroplasty.

METHODS: Seventy-three patients were identified that had undergone primary reverse total shoulder arthroplasty with minimum 2-year follow-up. These patients completed a phone survey that included the Brief Resilience Scale (BRS) along with American Shoulder and Elbow Surgeon (ASES), Penn, and Single Assessment Numerical Evaluation (SANE) scores. Twenty-five patients also underwent a physical exam to assess postoperative strength and range of motion (ROM). Patients were stratified into low resilience (LR), normal resilience (NR), and high resilience (HR) groups based upon deviation from mean BRS score. Mean outcome scores, ROM, and strength were calculated to identify any correlation between resilience and clinical outcomes.

RESULTS: The mean BRS score was 23.8 ± 4.8 (range 12-30), with 41 patients classified as NR, 17 patients as LR, and 15 as HR. Postoperative BRS scores correlated with ASES (P=0.008), Penn (P=0.03), and SANE score (P=0.007). The mean ASES score was 14.0 points lower in the LR group (77.0 points) compared to the HR group (91.0 points; P=0.04). Similarly, the LR group had a mean SANE score that was 18.6 points lower than the HR group (73.4 and 91.9 points, respectively; P=0.021). There were no significant differences in range of motion or strength between the HR and LR groups.

DISCUSSION AND CONCLUSION: Patients with low resilience may have worse outcomes after reverse shoulder arthroplasty. However, strength and ROM do not appear to correlate with resilience. Resilience may be a useful predictor of outcomes following reverse total shoulder arthroplasty.

Similar Outcomes for Rotator Cuff Intact and Rotator Cuff Deficient Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 212

Zachary K. Pharr, M.D.
Jordan D. Walters, M.D.
*Ryan Eads, M.D.
Ryan N. Walsh, B.S.
Richard A. Smith, Ph.D.
Tyler J. Brolin, M.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

INTRODUCTION: Reverse total shoulder arthroplasty (RTSA) is a reliable treatment for multiple end-stage shoulder pathologies including conditions with rotator cuff deficiency and/or with advanced glenoid bone loss. Controversy exists regarding the biomechanical and clinical effects of RTSA in shoulders with an intact versus a deficient rotator cuff (RC). We compared clinical and radiographic outcomes of RTSA performed for rotator cuff intact versus cuff deficient conditions at a minimum of two years follow-up.

METHODS: Retrospective review of an institutional database revealed 182 patients with at least two years of clinical and radiographic follow-up after primary RTSA. Thirty-two patients had an intact rotator cuff but advanced glenoid bone loss, and 150 patients had rotator cuff deficiency. From these 150 patients, an age and co-morbidities matched cohort was created to compare the 32 RTSAs with an intact rotator cuff to 32 RTSAs performed in the setting of cuff deficiency. Assessments included preoperative and postoperative visual analog pain scores (VAS), American Shoulder and Elbow Surgeons (ASES) scores, postoperative narcotic use, strength, range of motion (ROM), complications, and revisions. Radiographs were analyzed for signs of loosening or mechanical failure. Chi-square tests were performed for categorical data, independent student T-tests were performed for continuous data, and Related-Samples Wilcoxon Signed Rank tests were performed to determine preoperative to postoperative differences. P-values less than 0.05 defined statistically significant differences.

RESULTS: The mean patient age for the overall cohort was 71.7 years old (range 61-82 years), and the mean follow-up time was 2.7 years (2.0-5.5 years). Preoperatively, the RC deficient and intact groups were similar in almost every functional category except that RC deficient patients had greater internal rotation ROM (34° vs. 44°, $p<0.05$). No differences were found between groups regarding gender, laterality, age, preoperative narcotic use, body mass index, or other co-morbidities. At most recent follow-up, both groups showed significant improvements in all categories measured (all $p<0.05$) except for a trend toward significance in the cuff deficient group regarding external rotation ROM ($p=0.077$). However, no significant differences were found between the RC intact or RC deficient groups regarding VAS, ASES, ROM, strength, complication rate, revision rate, rate of postoperative narcotic use, loosening, or mechanical failure (all $p>0.05$).

CONCLUSIONS: RTSA is a versatile tool that provides reliable improvements in functional outcomes in indicated patients regardless of the preoperative status of the rotator cuff. Though the pathophysiology of glenohumeral osteoarthritis with advanced glenoid bone loss differs from

cuff deficient conditions, shoulders with both disease processes perform similarly following RTSA at minimum two years follow-up.

Deltoid Volume Effects on Range of Motion and Outcomes Following Reverse Total Shoulder Arthroplasty in Rotator Cuff Intact and Deficient Conditions

Abstract ID: Paper 213

---

*S. Gray McClatchy, M.D.
Griffin M. Heise, B.S.
William M. Mihalko, M.D.
Frederick M. Azar, M.D.
Richard A. Smith, Ph.D.
Dexter H. Witte, III, M.D.
John G. Stanfill, M.D.
Thomas W. Throckmorton, M.D.
Tyler J. Brolin, M.D.
Memphis, TN

BACKGROUND: Deltoid muscle function is paramount to the success of reverse total shoulder arthroplasty (RTSA). The purpose of this study was to investigate the role of deltoid volume on shoulder range of motion and outcomes following RTSA in both rotator cuff intact and deficient conditions.

METHODS: Records of patients who underwent primary RTSA were retrospectively obtained and reviewed. Inclusion criteria were at least 2 years of postoperative clinical follow-up, patient-reported outcome scores including ASES and SANE scores, preoperative CT and/or MRI, and were performed for indications that did not disrupt proximal humeral anatomy. The rotator cuff integrity was evaluated by two musculoskeletal-trained radiologists. Volumetric deltoid measurements were calculated from preoperative CT or MRI scans using digital image processing software. Satisfactory outcomes were defined as FE of at least 135°, ER of at least 35°, ASES and SANE scores of at least 70.

RESULTS: Final analysis consisted of 107 patients who met inclusion criteria. Mean total deltoid muscle volume was significantly higher in patients with satisfactory FE (57.8 cm^3 ± 18.1 cm^3) versus unsatisfactory FE (48.6 cm^3 ± 19.5 cm^3) ($p = 0.013$). Similarly, deltoid muscle volume adjusted for BMI was significantly higher in patients with satisfactory postoperative FE (1.9 cm^3 ± 0.5 versus 1.6 cm^3 ± 0.6) ($p = 0.013$). When separated into rotator cuff deficient and intact conditions, total deltoid volume was significantly higher ($p = 0.030$) in patients who achieved satisfactory FE in the deficient group but not the intact group ($p = 0.533$). Total deltoid volume positively correlated (Pearson correlation coefficient 0.278, $p = 0.014$) with improved FE in rotator cuff deficient patients. When subdivided by individual deltoid heads, anterior and middle heads had no effect on ROM or outcome scores. The mean posterior deltoid volume was significantly higher in the ASES satisfactory group in patients with rotator cuff deficient conditions but not rotator cuff intact conditions ($p = 0.005$ versus 0.166).

CONCLUSION: Preoperative deltoid volume directly correlated with achieving satisfactory forward elevation after RTSA in rotator cuff deficient conditions. Deltoid volume had a more direct effect on FE and outcomes in rotator cuff deficient conditions. Preoperative deltoid volume may be one factor in determining the ability to achieve satisfactory outcomes postoperatively in the rotator cuff deficient patient.

Does Acromion Anatomy Affect Acromion Stress Fracture after Reverse Shoulder Arthroplasty?

Abstract ID: Paper 214

Vani J. Sabesan, M.D. / Boca Raton, FL
Yang Yang, Ph.D. / Detroit, MI
*Diego J. L. Lima, M.D. / Weston, FL
Ravi T. Rudraraju / Weston, FL
Matthew Stankard, B.S. / Boca Raton, FL
William Liou, Ph.D. / Detroit, MI

INTRODUCTION: Acromial fractures after reverse shoulder arthroplasty (RSA) have been reported to leave patients with inferior clinical outcomes and greater risk of revision surgery. Because RSA alters normal anatomic relationships, the resulting forces of the deltoid alter physiologic stress patterns in the acromion. Other reasons for reaching this critical stress could be altered stress patterns in an osteoporotic patient, wear to the acromion before surgery, or patient specific anatomic factors. The purpose of this study was to evaluate the effect of acromion size on the stress levels and increased risk of fracture at the acromion after RSA.

METHODS: A lateralized RSA design was used for all four different acromial sizes (ranging from -5.0 mm to +5.0 mm) and compared to standard normal shoulder model (acromial size 0). An FEA model was then constructed for each case with the information obtained from the kinematic analysis. The quasi-static analysis was carried out to determine the highest minimum principal stress for each case and this was used to predict fatigue life percentage of the acromion under the compressive cyclic loading.

RESULTS: For smaller acromion sizes of – 5 mm and -2.5 mm, the HMPS was found to be 1.87 and 1.24 times higher than the standard, respectively. The HMPS for the +2.5 mm acromial size was 0.95 times compared to the standard and 1.04 times higher for the +5 mm acromial size. According to our model, the highest FLP was seen when the acromion size was +2.5 mm (case 4 - 178%) when compared to the normal and the lowest FLP was seen when it was -5 mm (-0.06%).

CONCLUSION: Our results suggest there is a bell-shaped curve for acromion size associated with fatigue life and fracture risk, with the optimal size being +2.5 mm larger than average sized male acromion. In addition, there is a critical association between acromial sizes that may lead to increased fracture risk. Surgeons must be aware of acromion size as a critical factor in deltoid tensioning and risk of acromial fracture when selecting optimal implant designs and sizes for RSA.

Revision Reverse Shoulder Arthroplasty for Anatomic Glenoid Component Loosening was not Universally Successful: A Detailed Analysis of 129 Consecutive Shoulders

Abstract ID: Paper 215

---

*Douglas W. Bartels, M.D.
Erick Marigi, M.D.
John W. Sperling, M.D.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
Rochester, MN

INTRODUCTION: Glenoid component loosening is the most common reason for long-term failure after anatomic total shoulder arthroplasty. Revision to a reverse prosthesis is commonly considered in these circumstances. However, most studies to date on the outcome of revision shoulder arthroplasty have reported on multiple diagnosis, and the outcome of revision to a reverse prosthesis specifically for loosening of anatomic glenoid components is largely unknown.

METHODS: Between 2010 and 2017, 129 consecutive revision reverse shoulder arthroplasties were performed at a single institution for failure of an anatomic shoulder arthroplasty with loosening of the glenoid component. Most shoulders (111 [86%]) had associated cuff insufficiency or severe soft-tissue imbalance at the time of revision surgery. Glenoid bone grafting was utilized in 92 shoulders, morselized cancellous allograft in 75 shoulders and structural corticocancellous graft in 17 shoulders. A retrospective review of the medical records and radiographs was conducted to determine reoperation and complication rates as well as overall outcomes.

RESULTS: At most recent follow-up, 23 shoulders (18%) had required a reoperation for glenoid loosening (14), deep infection (3), dislocation (2), humeral loosening (1), diagnostic arthroscopy for unexplained pain (2), and drainage of a hematoma (1). One additional glenoid component was considered to be radiographically loose. Five patients were recommended chronic suppression with antibiotics for unexpected positive cultures at the time of revision surgery. One shoulder experienced a postoperative acromial stress fracture. The most common intraoperative complication was fracture of the greater tuberosity (20 shoulders) at the time of humeral component removal or exposure. Bone graft had been required in 10 of the 15 shoulders that eventually developed loosening of the revision reverse glenoid component (cancellous chips in 7 shoulders, structural allograft in 3 shoulders).

CONCLUSION: Durable glenoid component fixation was achieved in 88% of the shoulders revised to a reverse prosthesis for failure of an anatomic shoulder arthroplasty with a loose glenoid component. In addition to the 12% glenoid failure rate, other less frequent complications included deep infection, dislocation and humeral loosening, for an overall reoperation rate of 18%. Failed glenoid components had commonly been implanted in conjunction with bone graft, likely indicating more severe bone loss. Despite not being universally successful, revision to a reverse prosthesis did improve pain and overall outcomes in the majority of the patients.

The Effect of Compression Stockings on Cerebral Desaturation Events in Obese Patients Undergoing Shoulder Arthroscopy in the Beach-Chair Position: A Randomized Prospective Study

Abstract ID: Paper 216

---

*Andrew G. Golz, M.D.
Michael W. Perry, M.D.
William Davis, B.S.
Nickolas G. Garbis, M.D.
Douglas Evans, M.D.
Pietro M. Tonino, M.D.
Nicholas M. Brown, M.D.
Dane H. Salazar, M.D.
Maywood, IL

INTRODUCTION: Despite the advantages of performing shoulder arthroscopy in the beach chair position (BCP), ophthalmologic and neurologic complications have been reported. The high cost and limited availability of cerebral perfusion monitoring may not be cost-effective given the rare incidence of postoperative neurocognitive deficits. More cost-effective measures are being investigated to determine if they limit the incidence of CDEs. Currently, the data is limited on the efficacy of compression stockings, especially for obese patients, who are at increased risk for CDEs. We hypothesized that thigh-high compression stockings would decrease the incidence, frequency, and magnitude of CDEs in obese patients undergoing shoulder arthroscopy in the BCP.

METHODS: Using block randomization, 66 obese (body mass index, BMI > 30 kg/m^2) patients were randomized into two groups: 33 patients in the treatment group wore thigh-high compression stockings with sequential compression devices (SCDs) over them, and the remaining 33 patients in the control group wore SCDs alone. Cerebral oximetry was monitored during surgery using near-infrared spectroscopy. A CDE was defined as a decrease in the rSO_2 of 20% or greater from the preoperative baseline.

RESULTS: The incidence of CDEs was equal between groups, with 9 patients (27%) in each experiencing desaturation events. The median number of CDEs per patient was 3 for the control group and 1 for patients wearing compression stockings ($p = 0.286$). There were no differences between groups in the median time from induction of anesthesia to onset of CDE ($p=0.791$) and median time from upright positioning to onset of CDE ($p=0.596$). The mean CDE duration was 4.4 minutes per patient for the control group and 2.6 minutes for the treatment group ($p = 0.216$). Although there was a trend toward higher median cumulative CDE duration for patients in the control group, 16.8 minutes versus 2.6 minutes, the difference did not meet statistical significance ($p = 0.185$). The median maximal desaturation from baseline was also not different between groups: 27.6% in the control group and 24.3% in the treatment group ($p = 0.354$).

CONCLUSIONS: Thigh-high compression stockings do not decrease the incidence, frequency, or magnitude of CDEs in patients undergoing shoulder arthroscopy in the BCP. Further research is required to identify cost-effective methods of decreasing the incidence of CDEs during this common surgical procedure.

Risk Factors for Postoperative Blood Transfusion after Shoulder Arthroplasty

Abstract ID: Paper 217

Kyle J. Kopechek, B.S.
Joshua S. Everhart, M.D., M.P.H.
Travis L. Frantz, M.D.
Richard Samade, M.D., Ph.D.
Julie Y. Bishop, M.D.
Andrew S. Neviaser, M.D.
*Gregory L. Cvetanovich, M.D.
Columbus, OH

BACKGROUND: Transfusion after shoulder arthroplasty can increase hospital stay and postoperative complications. The purpose of the current study is to identify risk factors for transfusion after shoulder arthroplasty for various indications.

METHODS: A total of 274 shoulder arthroplasties from a 3-year period were analyzed. Risk factors for perioperative blood transfusion were assessed including patient demographics, surgical indication, history of prior surgeries, and preoperative laboratory values.

RESULTS: A total of 25 patients (9%) received blood transfusions. Twenty-two percent of infection cases required transfusion, 18% for fracture, 0% for osteoarthritis (cuff intact), 4% for osteoarthritis (cuff deficient), 3.5% for revisions, non-infected. The mean preoperative hemoglobin was 13.3 g/dl (SD 1.6) without fracture or infection, 12.4 SD 1.8 with fracture >4 weeks old, 11.6 SD 2.3 with fracture <4 weeks, and 12.2 SD 2.2 with chronic periprosthetic infection ($p<0.001$) with no differences between other surgical indications. Independent risk factors for transfusion included lower preoperative hemoglobin ($p<0.001$), surgery for periprosthetic infection ($p=0.02$) and surgery for fracture ($p=0.02$) with no difference for fracture greater than 4 weeks old or less than 4 weeks ($p=0.53$). Preoperative hemoglobin, surgery for periprosthetic infection, and surgery for fracture (acute or chronic) together had good discriminatory capability at predicting need for blood transfusion (area under receiver-operator curve: 0.81). Age, sex, primary versus revision status, history of prior procedures, and procedure performed (anatomic n=52, reverse n=151, or humeral head replacement n=36) were not predictive of need for blood transfusion.

CONCLUSION: Decreased preoperative hemoglobin and arthroplasty for fracture or infection are risk factors for post-shoulder arthroplasty blood transfusion.

MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
April 25, 2020

Clinical Tests Used to Diagnose Anterior Cruciate Ligament Tear are Less Accurate in Obese Patients: A Retrospective Study

Abstract ID: Paper 218

---

*Sravya P. Vajapey, M.D., M.B.A.
Timothy L. Miller, M.D.
Columbus, OH

BACKGROUND: Anterior cruciate ligament (ACL) rupture is a common athletic injury both in the pediatric and adult patient population. Multiple clinical studies have evaluated the accuracy of physical examination tests—Lachman, anterior drawer, pivot shift—used to diagnose ACL injury. Though there is still debate regarding the most accurate test, all three physical examination maneuvers have demonstrated fairly high sensitivity and specificity, especially when used in combination.

OBJECTIVE: To determine if the accuracy of these clinical tests is affected by a patient's body habitus.

HYPOTHESIS: The accuracy of the Lachman, anterior drawer, and pivot shift tests is lower in obese patients than in patients with a normal body mass index (BMI).

METHODS: This is a retrospective cohort study comparing the sensitivity of three clinical tests— Lachman, anterior drawer, and pivot shift—in obese patients versus non-obese controls. A total of 181 adult patients who had undergone ACL reconstruction by a single surgeon at a tertiary care center from November 2011 to December 2017 were included in the study.

RESULTS: The sensitivity of the Lachman test was 87.3% in obese patients versus 94.1% in nonobese controls. The sensitivity of the anterior drawer test was 76.3% in obese patients compared to 88.2% in controls. The sensitivity of the pivot shift test could not be accurately assessed because pain and swelling prevented the physician from performing this test in most patients on their initial presentation to the clinic.

CONCLUSION: The sensitivity of common clinical tests used to diagnose ACL tear—Lachman, anterior drawer, and pivot shift—is decreased in obese patients compared to non-obese controls. This study suggests that a clinician may need to have a lower threshold to perform advanced imaging in an obese patient with a suspected ligamentous injury of the knee even if the physical examination is not fully indicative of ligamentous injury.

Differences in Outcomes after Anterior Cruciate Ligament Reconstruction According to Gender: A Review of the Multicenter Orthopedic Outcomes Network (MOON) Literature

Abstract ID: Paper 219

---

*Christina J. Hajewski, M.D. / Iowa City, IA
Robert W. Westermann, M.D. / Iowa City, IA
Kyle R. Duchman, M.D. / Iowa City, IA
Matthew J. Bollier, M.D. / Iowa City, IA
Kurt P. Spindler, M.D. / Cleveland, OH
MOON Knee Group
Brian R. Wolf, M.D., M.S. / Iowa City, IA

INTRODUCTION: Females have a higher incidence of native anterior cruciate ligament (ACL) injury. Although gender has been controlled for in large cohort studies using multivariate analysis, few investigations have a primary objective of studying differences between males and females with ACL injuries.

METHODS: Results of studies published from the Multicenter Orthopedics Outcomes Network (MOON) were evaluated for differences according to gender. Outcomes were classified as patient-reported outcomes (PROs), anatomic or intra-articular differences, or re-rupture.

RESULTS:
PROs
Female patients were found to have lower Marx activity scores at all time points including baseline, 2, 6, and 10 years postoperatively. There were lower IKDC scores among females at baseline and six and ten years postop. Females had lower baseline KOOS Pain, Symptoms, and Knee Related Quality of Life scores and lower KOOS Sports and Recreation scores at 10 years postop. Several studies reported no differences at two and six years between genders, but one study showed lower KOOS Pain scores in males at six years. In terms of return to sport, females were shown to be less likely to return to soccer after ACLR.

Anatomic/Intra-Articular
A lower incidence of meniscal tears was reported in females in one study, while another demonstrated no difference in un-treated meniscal injuries at the time of index ACLR. There was no difference in the incidence of reported chondral injury at the time of ACLR nor a difference in radiographic joint space narrowing at 2-3 years postop. Females had a higher odds of having a high grade pivot shift during exam under anesthesia at the time of their ACLR, and although high-grade laxity was found to be predictive of graft failure, gender did not influence graft failure within the high grade laxity group.

Re-Rupture
Multiple studies within the MOON cohort showed no difference according to gender for ipsilateral re-rupture or contralateral ACL injury at two years and six years after index ACLR.

CONCLUSIONS: Female patients tended to have lower PROs that gauge activity level (Marx, IKDC) both at baseline and up to 10 years postoperatively. Females had higher laxity during EUA, but there was no consistent difference between males and females in terms of meniscal or chondral injury at the time of ACL reconstruction, radiographic joint space narrowing, or

ipsilateral graft rupture or contralateral ACL injury. Given these findings, further targeted research investigating differences between the genders after ACL reconstruction is warranted.

Asymmetries in Functional Lower Extremity Movements in Professional Baseball Players

Abstract ID: Paper 220

---

*Lucas T. Buchler, M.D. / Denver, CO
Charles A. Thigpen, Ph.D., P.T., A.T.C. / Greenville, SC
Ellen Stanley, Ph.D., P.T., O.C.S. / Greenville, SC
Matthew Nabers, P.T.A. / Denver, CO
Michael J. Kissenberth, M.D. / Greenville, SC
Thomas J. Noonan, M.D. / Denver, CO

OBJECTIVES: Lower extremity functional tests are a common tool for assessing the kinetic chain of an overhead athlete. It is thought that lack of lower extremity and core control may increase stress on the upper extremity and as a result increase arm injury risk. The objective of this study was to examine lower extremity functional movement tests in professional baseball pitchers and position players to assess for asymmetry and differences between positions.

METHODS: Professional pitchers for a single Major League Baseball (MLB) organization underwent a series of lower extremity functional tests measured by the Physimax™ system. The stance and stride extremity were evaluated for each catcher (10), infielder (24), outfielder (16), and pitcher (79) for a total of 258 limbs evaluated. Tasks completed were the (1) Dorsiflexion lunge (DL), (2) Single leg squat (SLS), (3) Drop jump (DJ), and (4) Countermovement jump (CMJ). Trunk, hip, and knee kinematics were captured for each player and then exported for statistical analysis. A mixed model ANVOA was used to compare each variable (α=0.05).

RESULTS: When performing SLS, significant differences were noted when comparing maximal knee flexion (stride = 85±12; stance=80±12; P=0.003), pelvic/hip drop (stride =6±4; stance=3±3; P<0.01), trunk rotation (stride 5±4; stance=2±4; P<0.001), and maximal hip flexion (stride = 58±12; stance= 54±12; P=0.01) between the stride and stance legs. There were no significant differences noted in trunk flexion, anterior knee displacement, or medial knee displacement during the SLS (P>0.05). Outfielders performing SLS demonstrated greater trunk flexion (p=0.033) compared with other positions. When evaluating DJ, outfielder/infielders jumped higher than pitchers/catchers (p=0.025). There were no other significant differences noted across the DJ, CMJ, or DL (P>0.05).

CONCLUSIONS: Our results demonstrate that professional baseball players demonstrate asymmetry in functional lower extremity movements during a SLS – but not noted in double leg assessments. This suggests that a SLS may elucidate side to side differences in baseball players where double leg tasks do not. No significant differences were noted when comparing between each position group. Future studies are needed to determine if these functional motion asymmetries place baseball players at any increased or decreased risk for injury.

Incidence of Displaced Posterolateral Tibial Plateau and Lateral Femoral Condyle Impaction Fractures in the Setting of Primary ACL Tear

Abstract ID: Paper 221

---

*David L. Bernholt, M.D. / Germantown, TN
Nicholas N. DePhillipo, M.S., A.T.C., O.T.C. / Edina, MN
W. Jeffrey Grantham, M.D. / Lexington, KY
Zachary S. Aman, B.A. / Philadelphia, PA
Matthew D. Crawford, M.D. / Austin, TX
Robert F. LaPrade, M.D., Ph.D. / Edina, MN

INTRODUCTION: Bone bruising of the posterolateral tibial plateau and of the lateral femoral condyle have a well-established association with ACL tear. Impaction fractures may occur in these locations as well; however, there is a paucity of literature describing these lesions.

METHODS: Patients with available MRI images who were treated for primary ACL tear by a single surgeon were retrospectively identified and images were reviewed for displaced posterolateral tibial plateau and lateral femoral condylar impaction fractures. Measurements were taken for displaced lateral tibial plateau fractures in order to characterize the size and location of the lesion. We analyzed for associations of these impaction injuries with concomitant meniscal or ligamentous injuries using chi-square testing.

RESULTS: Displaced posterolateral tibial plateau impaction fractures were present in 407 knees (49.3%) and displaced lateral femoral condylar impaction fractures were present in 214 knees (25.9). Patients with posterolateral tibial plateau impaction fractures were older than patients without these fractures (42.6 vs 32.7, $p < .001$) while patients with lateral femoral condylar impaction fractures were younger (23.8 vs 32.7, $p < .001$). Seventy-one knees (8.6%) had a posterolateral tibial plateau impaction fracture with greater than 10% loss of lateral tibial plateau depth.

Medial meniscus ramp lesions occurred more frequently in knees with tibial, femoral, and bipolar impaction fractures. Femoral impaction fractures showed the strongest association with incidence of lateral meniscal tears (66.7% vs. 53.9%, $p = .001$), while bipolar impaction fracture also had a significant association with lateral meniscal tears. Femoral impaction fractures showed significant correlations with lateral meniscus posterior root tears, but the largest differential in incidence was in patients with greater than 10% lateral tibial plateau depth bone loss percentage (22.1% vs. 12.0%,$p = .02$). Posterolateral corner injuries were less frequent in the setting of tibial, femoral and bipolar impaction fractures.

DISCUSSION: Displaced posterolateral tibial plateau impaction fractures occur with high incidence (49.3%) in patients with primary ACL injuries and demonstrate increased association with lateral meniscus posterior horn root tears as their size increases. Lateral condylar impaction fractures occurred in 25.9% of patients with primary ACL injuries, were more likely to occur in relatively younger patients, and showed increased incidence of lateral meniscus tears and medial meniscal ramp lesions.

Risk for Re-Rupture after ACL Reconstruction with Relative Workload Changes in NBA Players

Abstract ID: Paper 222

Lafi Khalil, M.D.
Robert N. Matar, M.D.
Tahsin Rahman
Luke Hessburg, B.S.
*Sreten Franovic, B.S.
Erika Carter
Nima Mehran, M.D., M.S.
Kelechi R. Okoroha, M.D.
Detroit, MI

BACKGROUND: Anterior cruciate ligament (ACL) tears continue to demonstrate improved return to play (RTP) in the National Basketball Association (NBA). The purpose of this study was to investigate whether relative workload after primary ACL surgery conferred any increased risk of re-tear in NBA players.

METHODS: Since 1975, we identified eight NBA players who underwent primary ACL reconstruction and subsequently required reoperation and compared them to 80 NBA players who underwent only primary ACL reconstruction without revision surgery. Games played, minutes played, and in-game statistics were evaluated three years before the primary reconstruction and three seasons after RTP. Statistical analysis compared the re-tear and primary only groups to identify relative workload differences.

RESULTS: NBA players in the re-tear group did not show significant differences in age, BMI, or number of seasons before primary injury as compared to primary group, $p>0.05$. Players in the re-tear group played in more games (59.6+/-26.9 versus 43.5+/-25.3, $p = 0.092$) during their first season returning from primary surgery. Players who never required a reoperation showed a relative decrease in minutes played per game (MPG) in their three post-injury seasons as compared to their three pre-injury seasons (19.16+/-1.06 versus 23.74+/-1.19, $p>0.05$), while those in the re-tear group showed an increased MPG relative to pre-injury (25.08+/-3.21 versus 21.89+/-4.26, $p>0.05$). When comparing the change in MPG over time between the primary and re-tear groups, there is a significant difference in relative workload ($p = 0.042$). Pairwise comparison showed that for the primary only group, the MPG post-injury was significantly less than prior to initial injury ($p < 0.0001$).

CONCLUSIONS: This study's findings suggest that after ACL reconstruction, NBA players who sustained a re-tear played increased MPG relative to their pre-ACL reconstruction workload, whereas decreasing relative MPH may be protective of reinjury.

LEVEL OF EVIDENCE: Level III; Retrospective Cohort Design

Medial Meniscus Posterior Root Tear Treatment: A Matched Cohort Comparison of Nonoperative Management, Partial Meniscectomy, and Repair

Abstract ID: Paper 223

Christopher D. Bernard, B.S.
Nicholas I. Kennedy, M.D.
Adam J. Tagliero, M.D.
*Matthew D. LaPrade, B.S.
Lucas K. Keyt, B.S.
Christopher L. Camp, M.D.
Daniel B. F. Saris, M.D., Ph.D.
Bruce A. Levy, M.D.
Michael J. Stuart, M.D.
Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: There is limited data comparing the outcomes of similarly matched patients with a medial meniscus posterior root tear treated with non-operative management, partial meniscectomy, or repair. The purpose of this study is to compare treatment failure, clinical outcome scores, and radiographic findings for a matched cohort of patients who underwent either non-operative management, partial meniscectomy, or transtibial pull-through repair for a medial meniscus posterior root tear (MMPRT). Our hypothesis is that patients who underwent meniscus root repair will have lower rates of progression to arthroplasty than patients who were treated with non-operative management or partial meniscectomy.

METHODS: The purpose of this study is to compare treatment failure, clinical outcome scores and radiographic findings for a matched cohort of patients who underwent either non-operative management, partial meniscectomy, or transtibial pull-through repair for a medial meniscus posterior root tear (MMPRT). Our hypothesis is that patients who underwent meniscus root repair will have lower rates of progression to arthroplasty than patients who were treated with non-operative management or partial meniscectomy.

RESULTS: Forty-five patients were included in this study (15 non-operative, 15 partial meniscectomy, 15 root repair). Progression to arthroplasty demonstrated significant differences among treatment groups at a mean 74 months (non-operative 4/15, partial meniscectomy 9/15, meniscus repair 0/15, p=.0003). The meniscus root repair group had significantly less arthritic progression, as measured by change in K-L grade from preop to postop (non-operative 1.0, partial mensicectomy 1.1, and meniscus repair 0.1, p=.001).

DISCUSSION AND CONCLUSION: Meniscus root repair leads to significantly less arthritis progression and subsequent knee arthroplasty compared to non-operative management and partial meniscectomy in a demographically matched cohort.

The Timing and Factors Behind Sport Specialization in Major League Soccer Athletes

Abstract ID: Paper 224

---

*Derrick M. Knapik, M.D. / Cleveland, OH
Katherine H. Rizzone, M.D. / Rochester, NY
James E. Voos, M.D. / Cleveland, OH

BACKGROUND: Soccer is one of the most popular youth sports. Current culture in youth sports is trending towards early sport specialization, defined by intense year round training in a single sport at the exclusion of other sports. While early specialization is believed to be necessary to develop and attain sufficient skill to achieve elite status, specialization has not been validated as being essential to attain collegiate scholarships or attain future professional status. The purpose of this study was to survey Major League Soccer (MLS) athletes to examine factors influencing the timing of single sport specialization in soccer.

METHODS: An anonymous 12-question survey was distributed to three MLS organizations and completed by MLS athletes during preseason physicals. Survey questions evaluated the age and reason(s) behind athlete's decision to specialize in soccer, while also determining the influence of birth location (United States versus international), geographic high school location for US-born athletes (West, South, Midwest Northeast), participation in a developmental league, receiving a college scholarship, years in the MLS, and position played on specialization timing. Surveys were collected and responses were analysed. Continuous data was analyzed using an unpaired Student's t-test while a one-way analysis of variance (ANOVA) was performed to compare three or more response variables with post hoc comparisons using the Tukey test.

RESULTS: Sixty-four athletes returned completed surveys. Athletes reported beginning soccer at a mean age of 5.1 ± 2.1 years and specializing at age 12.6 ± 4.3 years. Athletes who participated in no other sports prior to specialization ($p<0.001$), athletes reporting soccer to be their first sport played at an advanced level ($p<0.001$), and athletes receiving a college scholarship ($p=0.02$) specialized at a significantly younger age. Internationally-born athletes specialized at significantly younger ages when compared to US-born athletes ($p<0.001$). No significant impact was appreciated based on high school region ($p=0.89$), developmental league participation ($p=0.92$), years of experience in the MLS ($p=0.31$), or primary position ($p=0.13$).

CONCLUSION: The timing of sport specialization in professional MLS athletes was associated with the absence of multisport participation prior to specialization, playing soccer at an advanced level prior to other sports, receiving a college scholarship and being born outside the United States. Future prospective investigations are required to determine the differences in specialization between US-born and international athletes, as well as the effect of specialization timing on prospective MLS performance, career length, and injury risks.

Isolated Meniscus Extrusion and the Role of the Meniscotibial Ligament

Abstract ID: Paper 225

Christopher D. Bernard, B.S.
Devin P. Leland, B.S.
*Lucas K. Keyt, B.S.
Matthew Laprade, B.S.
Christopher L. Camp, M.D.
Adam Johnson, M.D.
Jonathan Finnoff, M.D.
Michael J. Stuart, M.D.
Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: The purpose of this study was to describe meniscus extrusion, present imaging characteristics, and provide clinical correlations for patients with isolated meniscus extrusion.

METHODS: Of the 3,244 MRI reports identified as having meniscus extrusion, 20 patients were identified to have isolated meniscus extrusion (0.62%). Patients with moderate to severe chondromalacia, meniscus tears, intra-articular fractures, tumors, and ligament tears were excluded. Radiographs were reviewed and graded using Kellgren-Lawrence (K-L) scores. MRIs were reviewed for the extent of extrusion and whether or not the meniscotibial ligament was intact. Clinical presentation and management were recorded.

RESULTS: The study population consisted of 12 females and 8 males with a mean age of 40.5, diagnosed with meniscus extrusion and minimal concomitant knee pathology. 68% of patients were considered symptomatic as their knee pain correlated with the side of their meniscus extrusion and no other reason for pain was identified. The mean amount of meniscus extrusion was 2.5 mm (SD, ± 1.1 mm) with 45% (9 of 20) having 3+ mm of extrusion. Meniscotibial ligament abnormality was identified in 65% of cases (13 of 20). Patients with 3+ mm of meniscus extrusion were much more likely to have associated meniscotibial ligament abnormality (100%, 9 of 9) compared to those with <3 mm of extrusion (36%, 4 of 11) (RR 2.75, P = .048). The mean K-L grade obtained at the initial visit was 0.9 (95% CI, 0.7-1.4) and the mean K-L grade obtained on final follow-up was 1.3 (95% CI, 0.8-2.8) (P = 0.52) at a mean of 44.7 months. No correlation was found between K-L grade, gender, age, acute injury, and BMI in relation to meniscotibial ligament abnormality or amount of meniscal extrusion.

DISCUSSION AND CONCLUSION: Meniscus extrusion often occurs in the presence of significant knee pathology, predominantly with meniscus tears or osteoarthritis. Isolated meniscus extrusion is a rare occurrence that may present clinically with knee pain, commonly to the side in which the extrusion occurs. In patients with three or more millimeters of meniscus extrusion, an intact meniscus and minimal knee pathology, meniscotibial ligament abnormality is likely.

Performance and Return to Sport after Open Fracture in National Football League Players

Abstract ID: Paper 226

Michael O. Cotton, M.D.
Joseph M. Sliepka, M.D.
Robert A. Jack, M.D.
*Derek M. Klavas, M.D.
Joshua D. Harris, M.D.
Houston, TX

BACKGROUND: Open fractures can be debilitating injuries for athletes, including National Football League (NFL) players.

PURPOSE: To determine the (1) return to sport (RTS) rate of NFL players following open fracture, (2) post-injury career length and games per season, (3) pre- and post-injury performance, and (4) post-injury performance compared with control players matched by position, age, years of experience, and performance.

METHODS: Publicly available records were used to identify NFL players who sustained an open fracture, both outside of and during competition. Forty players were analyzed (mean age 27.3±3.6; mean 4.5 ± 3.6 years in NFL at time of injury). Demographic and performance data were collected, and controls selected by similar position and pre-injury performance to case players. RTS was defined as playing in at least one NFL regular season game after open fracture. Comparisons between cases and control groups and pre-injury and post-injury time points were made using paired-samples Student's t-tests.

RESULTS: Thirty-two (80%) players were able to RTS in the NFL at a mean of 293±244.7 days following open fracture. Four (12.5%) players were not surgically managed, all of whom sustained hand/finger open fractures. There was no significant difference ($p>0.05$) in career length between controls (103.1±66.2 career games) and players who sustained an open fracture (104.1±59.4 career games). There were 18 (45%) players with upper extremity open fractures, and 22 (55%) with lower extremity open fractures. There was no significant difference ($p>0.05$) in games played in subsequent seasons following open fracture (10.9±4.5) compared with controls (11.4 ± 3.8). Post-injury performance was not significantly different ($p>0.05$) than pre-injury performance. Similarly, post-injury performance scores were not significantly different ($p>0.05$) versus control players by position group.

CONCLUSIONS: Following open fracture, 80% of players returned to play at least one regular season game in the NFL. Post-injury career length and games per season were not significantly different in players who returned to sport following open fracture when compared to controls. Post-injury performance scores were also not significantly different relative to both pre-injury performance of the injured players, and post-injury performance of matched controls.

LEVEL OF EVIDENCE: Level III, retrospective comparative series

The Effect of Staging Associated Procedures on Outcomes in the Multiligament Injured Knee: A Matched Cohort Analysis

Abstract ID: Paper 227

---

*Nicholas I. Kennedy, M.D.
Benjamin Freychet, M.D.
Devin P. Leland, B.S.
Thomas Sanders, M.D.
Nate Levy, B.S.
Aaron J. Krych, M.D.
Michael J. Stuart, M.D.
Bruce A. Levy, M.D.
Rochester, MN

BACKGROUND: Multiple-ligament knee injuries are rare and complex. Whether to perform single versus staged surgery and their effects on patient outcomes remains debated.

HYPOTHESIS: Patients with staged surgery will demonstrate lower functional knee scores compared to patients who underwent a single surgery for MLKI.

STUDY DESIGN: Retrospective case control study. Level of Evidence III

METHODS: This study was performed at an academic sports medicine center between September 1992 and December 2015. Patients were included if they sustained a MLKI (defined as injury ≥2 ligaments), were treated with surgical ligament reconstruction/repair, and had a minimum of 2 surgical procedures between injury and final reconstruction/repair. Patients treated with staged surgeries were matched with patients who did not undergo staged procedures for a control cohort. Matching was based on age at injury, sex, knee dislocation (KD) grade, and primary or revision cases. Lysholm and International Knee Documentation Committee (IKDC) subjective scores were obtained at final follow-up. A Wilcoxon rank-sum test was used to compare mean values of continuous variable and Spearman's correlation coefficients were used to test for correlation between different continuous variables effect on IKDC and Lysholm scores.

RESULTS: Thirty-eight staged patients were matched (38 staged, 38 control) according to age at injury, sex, and knee dislocation (KD) grade at the time of injury with 38 "control" patients. There were no significant differences in functional knee scores between staged surgery and single surgery cohorts for both Lysholm (p=.99) and IKDC (p=.83) scores. Peroneal nerve, vascular, meniscal, and cartilage lesions all demonstrated no statistically-significant effect on objective outcome scores.

CONCLUSION: This study demonstrates that both staged surgery and single surgery cohorts reported good to excellent IKDC and Lysholm outcome scores at minimum 2-year follow-up in a wide array of multi-ligament knee injuries. Surgical timing, the need for staged surgery, and the order of ligamentous reconstruction should be individualized based on specific knee and patient-related factors.

The Contrasting Impacts of an Orthopedic Procedure on Major League Baseball Pitchers and Position Players

Abstract ID: Paper 228

---

*Gurmit Singh, M.D. / Minneapolis, MN
Andrew D. Schneider, M.D. / Chicago, IL
Graham Englert / Chicago, IL
Sumender Sharma / Chicago, IL
Duy K. Nguyen / Chicago, IL
Matthew D. Saltzman, M.D. / Chicago, IL
Stephen M. Gryzlo, M.D. / Chicago, IL
Wellington K. Hsu, M.D. / Chicago, IL

BACKGROUND: Multiple studies have examined outcomes of Major League Baseball (MLB) players after an individual orthopedic procedure, yet, no study has previously compared outcomes among these procedures. This is a retrospective cohort study that evaluates performance outcomes in MLB players after common orthopedic procedures.

METHODS: Professional athletes who underwent a common orthopedic procedure were identified using publicly available archives. Demographic, performance, and career longevity statistics were evaluated for each athlete prior to and after an orthopedic procedure. Successful “return to play” was defined as returning to an active roster for at least one professional league game. The pre- and postoperative performance was evaluated using multiple previously established position based measures including earned run average (ERA), walks and hits per inning pitched (WHIP), strikeouts divided by number of base on ball (SO/W), on-base plus slugging (OPS), runs batted in (RBI), and batting average (BA).

RESULTS: A total of 518 MLB athletes successfully returned to play at a rate of 82.7% after a total of 602 procedures. The average time to RTP after an orthopedic procedure was 247.8 days. While athletes who had hand/wrist soft tissue tendon repair (97% position players) had a significantly higher RTP (100%, $P < 0.05$), players undergoing a shoulder arthroscopy (70% pitchers) had the worst RTP rate (64%, $P < 0.05$). Overall, postoperative performance was comparable to pre-injury statistics except for players in the knee arthroscopy cohort (79% position players) who had a significant decrease in game participation and performance scores. Athletes undergoing hip arthroscopy also had significant decrease in performance score in seasons 2-3 postoperatively in terms of OPS and BA (-10%, -10%, respectively, $P < 0.01$).

DISCUSSION AND CONCLUSIONS: While MLB athletes exhibited a high RTP rate, performance-based outcomes varied based on the orthopedic procedure. Pitchers undergoing shoulder arthroscopy and position players undergoing knee or hip arthroscopy had the worst performance after surgery. These findings can likely be explained by the critical nature of these respective joints to the success of such precise and complex motions in pitching and batting.

A Qualitative Assessment of Return to Sport Following Ulnar Collateral Ligament Reconstruction

Abstract ID: Paper 229

---

*Mitesh P. Mehta, B.A.
Joshua G. Peterson, B.S.
Robert A. Christian, M.D.
Vehniah K. Tjong, M.D.
Stephen M. Gryzlo, M.D.
Chicago, IL

BACKGROUND: The rate of ulnar collateral ligament (UCL) reconstruction has been increasing at all levels of play. With excellent outcomes, UCL reconstruction has allowed many overhead athletes to return to their preinjury sport. However, the subjective factors influencing this decision to return to sport have yet to be studied.

PURPOSE: To understand the factors influencing an athlete's decision to return to preinjury level of sport after primary UCL reconstruction.

STUDY DESIGN: Case series; LOE, 4.

METHODS: An experienced interviewer conducted qualitative, semi-structured interviews of patients aged 18-35 years who had undergone primary UCL reconstruction by one fellowship-trained, MLB team orthopedic surgeon. All subjects were throwing athletes prior to injury and had a minimum two-year follow-up with no revisions. Qualitative analysis was then performed to derive codes, categories, and themes. Patients were surveyed to assess familiarity with UCL reconstruction as well as to obtain WOMAC, KJOC, and ASES scores highlighting preinjury and current activity and function levels along with sport participation.

RESULTS: Twenty-two athletes were interviewed to elucidate three predominant themes motivating their return to sport: trust in surgeon reputation, innate drive and optimism, and misconceptions regarding postoperative athletic ability. Subjective outcome measurements of patient familiarity with UCL reconstruction indicated that, compared to three years and one year prior to surgery, a majority of players felt they would have superior postoperative athletic ability. Athletes who did not return to sport cited lifestyle changes and years of eligibility as limiting factors.

CONCLUSION: Patients chose to return to their preinjury level of sport after primary UCL reconstruction based on trust in their surgeon's reputation, intrinsic personality traits, and anecdotal evidence about postoperative outcomes. This study emphasizes the importance for health care providers to educate patients toward realistic expectations upon return to sport. On a larger scale, this study illustrates the effects the media and anecdotal experiences of a growing population of players undergoing UCL reconstruction have had on the game of baseball and players' decisions to return to sport.

Adductor Canal Nerve Block vs. Intra-Articular Anesthetic in Knee Arthroscopy: A Prospective Randomized Trial

Abstract ID: Paper 230

Michael W. Perry, M.D.
*Ryan LeDuc
Steven Stakenas, P.A.
Audrice Francois, M.D.
Douglas A. Evans, M.D.
Maywood, IL

BACKGROUND: Effective perioperative pain control following knee arthroscopy allows patients to reduce narcotic intake, avoid side effects of these medications, and recover more quickly. Adductor canal nerve blockade has been described as an alternative for postoperative pain control following surgery of the knee. Intra-articular injection of local anesthetic has also been shown to reduce pain and narcotic use for a variety of orthopedic procedures in the knee. There are currently no studies directly comparing these two methods of perioperative pain management for knee arthroscopy.

METHODS: Patients undergoing knee arthroscopy were blinded and randomized to receive either an adductor canal nerve block or intra-articular injection of local anesthetic. Outcome measures were VAS pain scores as reported by the patient at 1, 2, 4, 8, 16, 24, 36, 48 hours, and 1 week and total narcotic consumption at 12, 24, and 48 hours postoperatively. All patients were discharged home with a prescription for 7.5/325mg tabs of hydrocodone/acetaminophen.

RESULTS: 140 patients met inclusion criteria and were enrolled in the study. There were 54 patients randomized to the adductor canal nerve block and 60 to the intra-articular injection whom completed follow-up. Average VAS scores for the intra-articular group were 1.37 lower at 1 hour (2.47 vs. 3.83) and 1.20 lower at 2 hours (2.59 vs. 3.15), which was statistically significant (p=0.01). The difference in average VAS score at 2 hours, 4 hours, 8 hours, 16 hours, 36 hours, 48 hours, and 1 week postoperatively was not statistically significant (P>0.05). By 1 week postoperatively, the VAS score average for the intra-articular group was 0.48 higher than the adductor canal block group (2.33 vs. 1.85, p=0.08). Total narcotic consumption for the adductor canal block group was 1.27 tabs at 12 hours, 2.20 tabs at 24 hours, and 3.29 tabs at 48 hours. For the intra-articular injection group, these values were 1.30 tabs at 12 hours, 2.53 tabs at 24 hours, and 4.30 tabs at 48 hours. (p>0.05)

CONCLUSIONS: At 1 and 2 hours post-procedure, there were lower VAS scores with intra-articular injection compared to adductor canal blockade. The two methods of pain management following knee arthroscopy were equal at all other time points. While there are many modalities of pain management following knee arthroscopy, intra-articular local anesthetic may provide additional benefit in the perioperative period compared to adductor canal nerve block.

Hamstring Autograft Anterior Cruciate Ligament Reconstruction with and without Internal Brace Augmentation: A Matched Cohort Comparison

Abstract ID: Paper 231

Chad W. Parkes, M.D. / Rochester, MN
*Devin P. Leland, B.S. / Omaha, NE
Bruce A. Levy, M.D. / Rochester, MN
Michael J. Stuart, M.D. / Rochester, MN
Diane L. Dahm, M.D. / Rochester, MN
Aaron J. Krych, M.D. / Rochester, MN

INTRODUCTION: Re-injury is a major concern in patients undergoing anterior cruciate ligament reconstruction (ACLR). Recently, the use of suture tape for ligament augmentation with hamstring autograft ACLR has been described in order to provide biomechanical support during graft healing phases. The purpose of this study was to compare (1) rates of complication and reoperation, (2) rate of ACL failure, and (3) patient-reported outcomes (PRO) among matched patients following hamstring autograft ACLR with and without internal brace augmentation at a minimum 2-year clinical follow-up.

METHODS: A 2:1 matched cohort comparison was performed on patients who underwent hamstring autograft ACLR with and without internal brace augmentation at a single institution between August 2011 and April 2017. Patients were matched by age (±2 years), sex, and concomitant meniscus injury. Medical records were reviewed for patient demographics, additional injuries, intraoperative details, and concomitant procedures. Physical exam findings at latest follow-up were recorded. PRO consisting of Tegner Activity Score, Lysholm score, and International Knee Documentation Committee (IKDC) score were collected preoperatively and at a minimum of 2 years postoperatively.

RESULTS: Thirty-six patients (mean age 25.3 years, range 13-44) who underwent ACLR with internal brace augmentation and 72 patients (mean age 24.3 years, range 13-43) without internal brace augmentation were included in this study. Overall, 5/36 (14%) internal brace patients and 8/72 (11%) matched control patients underwent reoperation. One patient in each group experienced ACL failure and underwent revision ACLR. There were no statistically significant differences between the internal brace and control groups for preoperative and postoperative Tegner activity scores (7.2 to 7.1, 6.9 to 6.6), postoperative IKDC scores (94.4 and 94.1), and Lysholm scores (95.6 and 94.8) at an average follow-up of 26.1 and 33.7 months, respectively.

DISCUSSION AND CONCLUSION: Hamstring autograft ACLR with and without internal brace augmentation resulted in excellent clinical and PRO at a minimum two-year follow-up. In this matched-cohort comparison, no significant differences were observed in rates of complication and reoperation, rate of ACL failure, and PRO between cohorts. Additional larger studies are required to determine the potential clinical benefit of internal brace augmentation in ACLR.

Graft Preparation with Intraoperative Vancomycin Decreases Infection after Anterior Cruciate Ligament Reconstruction: A Review of 1,640 Cases

Abstract ID: Paper 232

---

*Jacqueline E. Baron, B.A. / Marlboro, NJ
Alan G. Shamrock, M.D. / Iowa City, IA
William T. Cates, B.S. / Iowa City, IA
Robert A. Cates, M.D. / Iowa City, IA
Qiang An, M.B.B.S., M.P.H. / Iowa City, IA
Brian R. Wolf, M.D., M.S. / Iowa City, IA
Matthew J. Bollier, M.D. / Iowa City, IA
Kyle R. Duchman, M.D. / Iowa City, IA
Robert W. Westermann, M.D. / Iowa City, IA

BACKGROUND: Septic arthritis is a rare but devastating complication following anterior cruciate ligament (ACL) reconstruction. Reported infection rates following ACL reconstruction are low, but associated with high morbidity including reoperation and inferior clinical outcomes. The purpose of the current study was to investigate the rate of infection after ACL reconstruction with and without graft preparation with vancomycin irrigant.

METHODS: All ACL reconstructions performed from May 2009-August 2018 at a single, large academic institution were reviewed and categorized based on vancomycin use. Those with <90 day follow-up, intraoperative graft preparation with an antibiotic other than vancomycin, or previous ipsilateral knee infection were excluded. Infection was defined as a return to the operating room for irrigation and debridement within 90 days of ACL reconstruction. Descriptive and inferential statistical analysis using t-tests and Poisson regression were performed, with statistical significance defined as $p<0.05$.

RESULTS: In total, 1,640 patients (952 males; 58.0%) with a mean age of 27.7 ± 11.4 years underwent ACL reconstruction (1,379 primary procedures; 84.1%). Intraoperative vancomycin was used in 798 cases (48.7%) while 842 ACL reconstructions (51.3%) were performed without intraoperative vancomycin. There were 11 total infections (0.7%), with 10 infections occurring in patients without vancomycin-soaked grafts (1.2%) and one infection occurring in grafts soaked in vancomycin (0.1%; $p=0.008$). Age ($p=0.571$), gender ($p=0.707$), smoking ($p=0.407$), surgeon ($p=0.124$), and insurance type ($p=0.616$) were not associated with postoperative infection. There was an 89.5% relative risk reduction with the use of intraoperative vancomycin. Increased body mass index (BMI) ($p=0.029$), increased operative time ($p=0.001$), and absence of ACL graft preparation with vancomycin ($p=0.032$) independently predicted postoperative infection.

CONCLUSION: The use of vancomycin-soaked grafts was associated with a ten-fold reduction in postoperative infection after ACL reconstruction (0.1% versus 1.2%; $p=0.032$). Other risk factors for postoperative infection after ACL reconstruction included increased BMI and increased operative time.

Defining the Minimal Clinically Important Difference and Patient Acceptable Symptom State for Microfracture: A Psychometric Analysis at Short-Term Follow-Up

Abstract ID: Paper 233

---

*Kyle N. Kunze, B.S. / Chicago, IL
Matthew R. Cohn, M.D. / Chicago, IL
Tracy Tauro, B.A., B.S. / Chicago, IL
Joshua Wright, M.D. / New York, NY
Alexander Beletsky, B.A. / Chicago, IL
Brady T. Williams, B.S. / Chicago, IL
Brian J. Cole, M.D., M.B.A. / Chicago, IL
Jorge Chahla, M.D., Ph.D. / Chicago, IL

BACKGROUND: Several studies have investigated failure rates and magnitude of change in patient-reported outcome measures after microfracture surgery for focal chondral defects of the knee; however, what constitutes clinically significant outcome improvement in this patient population is poorly understood.

PURPOSE: To (1) establish the MCID and PASS thresholds for microfracture surgery including the time-dependent nature of these thresholds, and (2) identify predictors of achieving the MCID and PASS in this specific cohort.

STUDY DESIGN: Case series; Level of evidence, IV

METHODS: A secure institutional cartilage preservation repository was queried for all patients who underwent microfracture between 2004 and 2017. The distribution method was used to calculate MCID thresholds, while an anchor-based method utilizing the Youden Index to maximize threshold sensitivity and specificity was used for the PASS. Pearson and Spearman Rank analyses were performed to identify correlations between pre- and intraoperative variables and the MCID and PASS to identify final variables to incorporate into the final logistic regression models. Variables demonstrating statistically significant correlations were incorporated into multivariate logistic regression models to determine predictors of achieving clinically significant outcome improvement for the microfracture-specific cohort.

RESULTS: A total of 206 patients with a mean (± standard deviation) age of 33.7±13.2 years and body mass index of 26.9±5.3 kg/m^2 were included. All thresholds for the MCID and PASS increased over time except the MCID thresholds for the KOOS symptoms subscale. The proportion of patients who achieved the MCID (6 months: 78.4%; 12 months: 83.9%; 24 months: 88.6%) and PASS (6 months: 67.7%; 12 months: 79.2%; 24 months: 76.1%) changed over time accordingly. Older age and greater lesion size were negative independent predictors of the MCID. Male sex and greater preoperative KOOS Symptoms and Pain scores were positive independent predictors of the PASS, while increasing age was a negative predictor.

CONCLUSIONS: The current study established the MCID and PASS values for the IKDC and KOOS in a specific patient population undergoing microfracture. The MCID and PASS thresholds were dynamic, with an increasing number of patients achieving the MCID and a decreasing number of patients achieving the PASS across all time points. Independent predictors of achieving the MCID were lesion size and age at surgery, while predictors of

achieving the PASS included lesion size, male sex, and greater preoperative KOOS Symptoms and Pain scores.

The Difference in Failure Risk When Using Platelet-Rich Plasma for Isolated Meniscus Repairs Compared to Meniscal Repairs with Anterior Cruciate Ligament Reconstruction

Abstract ID: Paper 234

Parker A. Cavendish, B.S.
Alexander Eikenberry, B.S.
Robert A. Magnussen, M.D.
Christopher C. Kaeding, M.D.
Joshua S. Everhart, M.D., M.P.H.
*David C. Flanigan, M.D.
Columbus, OH

BACKGROUND: The effect of platelet-rich plasma (PRP) on the risk of meniscal repair failure is unclear. Current evidence is limited to small studies without comparison between isolated repairs and meniscal repairs with concomitant anterior cruciate ligament reconstruction (ACLR). It is also unclear whether the efficacy of PRP differs between preparation systems.

PURPOSE: To determine whether intraoperative PRP affects the risk of meniscal repair failure and to determine whether the effect of PRP on meniscal failure risk is influenced by ACLR status or by PRP preparation system.

METHODS: The study entailed 550 patients (mean ± SD age, 28.8 ± 11.2 years) who underwent meniscal repair surgery with PRP (n = 203 total; n = 148 prepared with GPS III system, n = 55 prepared with Angel system) or without PRP (n = 347) and with (n = 399) or without (n = 151) concurrent ACL reconstruction. The patients were assessed for meniscal repair failure within 3 years. The independent effect of PRP on the risk of meniscal repair failure was determined by multivariate Cox proportional hazards modeling with adjustment for patient variability.

RESULTS: Failures within 3 years occurred in 17.0% of patients without PRP and 14.6% of patients with PRP (P = .60) (Angel PRP, 15.9%; GPS III PRP, 14.2%; P = .58). Increased patient age was protective against meniscal failure regardless of ACL or PRP status (per 5-year increase in age: adjusted hazard ratio [aHR], 0.90; 95% CI, 0.81-1.0; P = .047). The effect of PRP on meniscal failure risk was dependent on concomitant ACL injury status. Among isolated meniscal repairs (20.3% failures at 3 years), PRP was independently associated with lower risk of failure (aHR, 0.18; 95% CI, 0.03-0.59; P = .002) with no difference between PRP preparation systems (P = .84). Among meniscal repairs with concomitant ACL reconstruction (14.1% failures at 3 years), PRP was not independently associated with risk of failure (aHR, 1.39; 95% CI, 0.81-2.36; P = .23) with no difference between PRP preparation systems (P = .78).

CONCLUSION: Both PRP preparations used in the current study had a substantial protective effect in terms of the risk of isolated meniscal repair failure over 3 years. In the setting of concomitant ACL reconstruction, PRP does not reduce the risk of meniscal repair failure.

Factors Predicting Lesion Expansion and New Lesion Formation Following Biopsy in Two Stage Cartilage Restoration Procedures

Abstract ID: Paper 235

---

*Robert J. Pettit, M.D.
Alex C. DiBartola, M.D.
Joshua S. Everhart, M.D., M.P.H.
Robert A. Magnussen, M.D.
Christopher C. Kaeding, M.D.
David C. Flanigan, M.D.
Columbus, OH

INTRODUCTION: Autologous Chondrocyte Implantation (ACI) and Matrix Autologous Chondrocyte Implantation (MACI) involve a two-stage surgical approach from cartilage biopsy to chondrocyte implantation. There are several reasons for a delay between biopsy to implantation. The purpose of this study was to determine factors associated with cartilage lesion expansion and formation of new cartilage lesions in the timeframe between biopsy and implantation of ACI or MACI.

METHODS: Retrospective chart review of ACI and MACI cases (CPT 27412) by a single surgeon over a ten-year period. Operative notes and arthroscopic images were reviewed to record measurements (cm^2), characteristics of cartilage lesions at time of biopsy and time of implantation, and new high-grade cartilage lesions noted at second stage. Statistical analysis was performed with multivariate linear and logistic regression models.

RESULTS: The average size of the largest high-grade lesion in each knee was 4.50 cm^2

Mean time to surgery (from biopsy) was 155 days

RESULTS: LESION EXPANSION: Lesion expansion increased an average 0.11 cm^2 (SE 0.03) per month delay from biopsy to implantation (p=0.001; R-square=0.085). Independent predictors of lesion expansion were male sex, smaller initial lesion size, and greater time delay from biopsy to implantation (adjusted mean 0.15 cm^2 per month delay).

RESULTS: RISK OF NEW HIGH-GRADE DEFECT FORMATION: A total of 16.2% of patients (n=18/111) had a new high-grade lesion at time of re-implantation (n=22 lesions in 18 patients) which occurred in the patella in 10/22, trochlea in 5/22, MFC in 4/22, and LFC in 3/22. In the multivariate linear regression analysis, independent predictors of development of a new high-grade lesion was presence of grade 2 changes opposite or ‘kissing’ a high-grade lesion and increased time today from biopsy to implantation (per 1.0-month increase, adjusted Odds Ratio 1.21, 95% CI 1.01, 1.44; p=0.036).

DISCUSSION AND CONCLUSION: The results of the study demonstrate the importance of minimizing delay from time of biopsy to implantation in ACI and MACI procedures. Each additional month leads to defect expansion of 0.11 cm^2 and in 16.2% of patients, a new high-grade lesion. Male sex, initial lesion size, and time delay to implantation predict lesion expansion. Presence of a kissing lesion and time delay to implantation are predictive of developing a new high-grade lesion. These results assist the surgeon in counseling patients on the timeliness of implantation especially in high risk patients.

Factors that Influence Quadriceps Recovery after ACL Reconstruction: A Systematic Review

Abstract ID: Paper 236

Jacqueline E. Baron, B.S. / Newark, NJ
Kyle R. Duchman, M.D. / Iowa City, IA
*Emily A. Parker, B.A. / Iowa City, IA
Robert W. Westermann, M.D. / Iowa City, IA

BACKGROUND: Quadriceps atrophy following anterior cruciate ligament (ACL) reconstruction is a common sequela which impairs the recovery of knee function and can delay return to sport. A number of modifiable perioperative factors may impact the severity of quadriceps atrophy, including intraoperative tourniquet use and duration, intraoperative nerve block administration, perioperative blood flow restriction training, and perioperative supplement use.

PURPOSE: To perform a systematic review of the literature to evaluate the impact of the four target perioperative interventions on postoperative quadriceps atrophy following ACL reconstruction.

STUDY DESIGN: Systematic review.

METHODS: A systematic review was performed in accordance with PRISMA guidelines to evaluate randomized controlled trials and prospective cohort studies (level I and II studies) which employed perioperative interventions in ACL reconstruction that influenced quadriceps volume. The included studies had to have quantifiable postoperative quadriceps measurements such as thigh circumference, quadriceps cross-sectional area, isokinetic quadriceps strength, or quadriceps EMG testing.

RESULTS: Our review identified 15 studies which met the inclusion and exclusion criteria: 3 utilizing postoperative blood flow restriction training, 3 utilizing perioperative supplements, 5 utilizing intraoperative tourniquets, and 4 utilizing intraoperative nerve blocks. Blood flow restriction training resulted in less quadriceps cross-sectional area loss in 2 out of the 3 studies. 4 out of the 5 intraoperative tourniquet studies showed detrimental quadriceps changes. 1 intraoperative nerve block study showed persistent weakness with femoral nerve block, but length of follow-up was notably shorter for these 4 studies. One supplement study on leucine showed increased thigh circumference, but supplement use was not implemented until 6 months postoperatively.

CONCLUSION: These studies show that, among the modifiable perioperative ACL reconstruction factors, blood flow restriction training and limiting intraoperative tourniquet use currently have the most consistent evidence on quadriceps recovery. Postoperative blood flow restriction training appears to improve postoperative quadriceps recovery, while intraoperative tourniquet use appears to have a detrimental effect on postoperative quadriceps recovery. Regional anesthesia/nerve block administration and perioperative supplement use require further investigation.

Incidence of Meniscal Ramp Lesions in a Pediatric Population with Acute Anterior Cruciate Ligament Ruptures

Abstract ID: Paper 237

Jacob Stirton, M.D.
*Kyle T. Boden, M.D.
Burak Altintas, M.D.
Darren L. Johnson, M.D.
Lexington, KY

INTRODUCTION: Meniscal ramp lesions have been reported to be present in 9% to 17% of all anterior cruciate ligament (ACL) tears. Risk factors associated with ramp lesions are age less than 30 years, male sex, and increased time from injury. Due to the low sensitivity of detection (77%) by magnetic resonance imaging (MRI) and the difficulty of detection using the standard anterolateral viewing portal during arthroscopy, it is our hypothesis that these lesions may be underdiagnosed and have a higher incidence than initially reported, especially in the pediatric high-risk population.

METHODS: The design of this research study is a retrospective case series. All pediatric patients (age <18 years) who underwent an arthroscopic reconstruction of an acute ACL rupture over a four-month period with a single surgeon were retrospectively reviewed. A single surgeon was blinded to the arthroscopic findings of each patient and reviewed the MRIs for presence of all associated ACL injuries, including ramp lesions and bone bruising patterns. The incidence of ramp lesions associated with acute ACL ruptures and the sensitivity of MRI to preoperatively diagnose them were then calculated.

RESULTS: In a series of 39 ACL reconstructions performed in a pediatric population with a mean age of 15.3 (range, 11-17 years), and within six weeks of injury, 7 patients (3 male, 4 female) were diagnosed with a medial meniscal ramp lesion at arthroscopic evaluation (17.95% incidence). The sensitivity of MRI for ramp lesions was 85.7% based on the preoperative MRI compared to the arthroscopic finding.

CONCLUSION: Medial meniscal ramp lesions were present in approximately 18% of 39 pediatric patients undergoing acute ACL reconstruction, slightly higher than the 9-17% incidence reported in the general population. The surgeon should be aware of this high-risk population while reviewing preoperative MRIs and while performing his/her diagnostic arthroscopy.

LEVEL OF EVIDENCE: Level IV

Aspirin May Not Be Effective in Prevention of Deep Vein Thrombosis after Meniscus Root Repair

Abstract ID: Paper 238

Robert J. Pettit, M.D.
Scott A. Smith, M.D.
*Alex C. DiBartola, M.D.
David C. Flanigan, M.D.
Robert A. Magnussen, M.D.
Columbus, OH

BACKGROUND: Meniscus root repair is being performed with increased frequency. While the incidence of deep vein thrombosis (DVT) in simple knee arthroscopy is low, the risk of DVT may be elevated in this population compared to those undergoing other arthroscopic procedures due to underlying patient factors and postoperative restrictions. The ideal DVT prophylaxis in this population is unknown.

PURPOSE: The purpose of this study was to determine the incidence of symptomatic DVT in patients after meniscal root repair and determine the effectiveness of aspirin versus other anticoagulants in the prevention of DVT in this population. The authors hypothesize that there is no difference in the incidence of DVT following meniscus root repair when aspirin is used for prophylaxis versus low molecular weight heparin (LMWH) or apixaban.

METHODS: Retrospective chart review was performed to identify patients who underwent medial or lateral meniscus root repair over a three-year period by two surgeons at a single institution. Three outcome measures were identified: presence of a symptomatic DVT diagnosed by venous duplex ultrasound, wound complications (defined as requiring a course of antibiotics or operative debridement), or bleeding events (defined as the decision to stop anticoagulation for excess bleeding, bruising, etc) in the first 90 days postoperatively. Patients were grouped based upon receiving either aspirin or other anticoagulants (apixaban or low molecular weight heparin) for DVT prophylaxis.

RESULTS: Fifty-eight patients who underwent root repair (39 medial, 19 lateral) were identified. Symptomatic DVT occurred in 3 of 16 patients (19%) who received aspirin and 0 of 42 patients (0%) who received LMWH or apixaban ($p = 0.018$). No significant differences in patient sex or body mass index, medial versus lateral repair, concurrent procedures, or smoking status were noted between the two prophylaxis groups. There was no statistical difference in the incidence of bleeding events or wound complications between the two groups. Patients in the aspirin group were older (mean: 49 years) than those in the other anticoagulant group (mean: 39 years)

CONCLUSION: Postoperative DVT prophylaxis with aspirin following meniscus root repair results in a significantly increased risk of symptomatic DVT when compared with prophylaxis with LMWH or apixaban. Further research is needed to further evaluate the ideal method for prophylaxis in this population.

HIP

Total Hip Arthroplasty Costs Vary Among 20, 30, and 40-Year-Old Patients

Abstract ID: Poster 001

*Ethan A. Remily, D.O. / Baltimore, MD
Wayne A. Wilkie, D.O. / Baltimore, MD
Iciar M. Dávila Castrodad, M.D. / Nutley, NJ
Nequesha S. Mohamed, M.D. / Baltimore, MD
Nicole E. George, D.O. / Canton, OH
Mirlande Jean-Pierre, M.B.A. / Baltimore, MD
Nancy Jean-Pierre, M.S.N., M.B.A. / Baltimore, MD
Margaret N. Kelemen / Baltimore, MD
Michael A. Mont, M.D. / New York, NY
Ronald E. Delanois, M.D. / Baltimore, MD

INTRODUCTION: Many reports claim that total hip arthroplasty (THA) costs can range from as little as $11,317.00 to as much as $73,987.00. These disparities are in part due to regional variations in implant prices, hospital, and post-acute care costs. However, no studies have focused attention on identifying whether economic disparities exist between younger THA patients. This study aimed to explore the differences in national outcomes among young THA recipients. We evaluated: (1) discharge dispositions; (2) lengths of stay (LOS); (3); charges, and (4) and costs of inpatient stays among 20, 30, and 40-year-olds who underwent primary THA between 2009 and 2016.

METHODS: The National Inpatient Sample database was queried for patients aged 20-50 who underwent primary THA from 2009-2016 (n=279,190). Patients were then grouped according to bearing surface (metal-on-polyethylene (MOP), metal-on-metal (MOM), ceramic-on-ceramic (COC), and ceramic-on-polyethylene (COP)). Hospital LOS was measured as time from hospital admission until discharge. All charges and costs were adjusted using the January 1, 2018, consumer price index. Chi-square analyses were used to analyze discharge destinations, whereas analyses of variance were utilized to compare LOS, costs, and charges.

RESULTS: Most patients were discharged to home health care (49.4%) or home (39.3%). When stratified by age, more 20-year-olds were discharged home while more 30- and 40-year-olds were discharged to home health care. Mean LOS decreased from 3.26 to 2.18 days between 2009 and 2016 ($p<0.001$). When stratified by year, 20-year-olds had the longest LOS while 40-year-olds had the shortest LOS. Charges among all groups significantly increased for MOP ($56,771.54 vs. $65,594.97), MOM ($58,340.77 vs. $70,558.84), COC ($57,465.30 vs. $72,434.51) and COP ($61,160.55 vs. $66,144.02) between 2009 and 2016 ($p<0.001$). Over time, mean costs decreased by $257.87 for MOP ($18,518.61 vs. $18,260.74), but slightly increased by $79.73 for MOM ($19,100.15 vs. $19,179.88). Also, mean costs decreased by $733.83 for COC ($19,100.01 vs. $18,366.18), and by $341.57 for COP ($18,698.59 vs. $18,357.02). When stratified by age, mean charges and costs were highest among 20-year-olds and lowest among 40-year-olds.

CONCLUSION: Younger individuals are increasingly being treated with THA for debilitating hip disease such as early-onset osteoarthritis and avascular necrosis. Despite decreasing cost for all bearing surface types, the highest THA charges and costs are associated with 20-year-olds, suggesting that patients undergoing THA in this age group may have serious underlying diseases complicating their stay. Their compromised health may account for their increased healthcare utilization.

Irrigation and Debridement with Chronic Antibiotic Suppression for the Management of Acutely Infected Previously Aseptic Revision Total Joint Arthroplasties

Abstract ID: Poster 002

---

*Jacob W. Bettencourt, B.S.
Cody C. Wyles, M.D.
Douglas R. Osmon, M.D.
Arlen D. Hanssen, M.D.
Daniel J. Berry, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

INTRODUCTION: There are limited data regarding irrigation and debridement with component retention (IDCR) for acute periprosthetic joint infections (PJIs) following aseptic revision total hip arthroplasties (THAs) and total knee arthroplasties (TKAs). This study aims to assess the outcomes of IDCR when combined with chronic antibiotic suppression following aseptic revision THA and TKA.

METHODS: From 2000-2016, we identified 37 first-time aseptic revision TJAs (15 hips, 12 knees) at a single institution treated with IDCR and chronic antibiotic suppression for acute PJI. Acute PJIs occurring within four weeks were defined as acute postoperative infections (78%) and those occurring after four weeks, with symptoms less than three weeks, were defined as hematogenous infections (22%). Two-thirds of infections were Staphylococcal species. All patients were treated with 4-6 weeks of IV antibiotics followed by chronic antibiotic suppression. Mean age was 71 years, with 56% being female. Mean BMI was 31 kg/m^2. Mean follow-up was 3 years.

RESULTS: 5-year survivorship free from recurrent PJI was 61%. Re-infection occurred in 29% of the hematogenous group compared to 33% in the acute postoperative group. Of these patients, 1 was host type A, 3 were host type B, and 4 were host type C. 63% of the subsequent infections were caused by the same Staphylococcal species as the initial infection. 5-year survivorship free of component removal was 80%, all within the 90 days after the IDCR. The 5-year survivorship free from death was 67%.

CONCLUSIONS: Aseptic revision THAs and TKAs have an increased risk of PJI. IDCR with chronic antibiotic suppression is frequently considered. While there was only a 61% survivorship free from recurrent PJI, 80% of components were in situ at 5 years. This study showed that in a very select group of patients, IDCR with chronic antibiotic suppression was a viable option after aseptic revision THA and TKA.

Primary and Revision Total Hip Arthroplasty in Patients with Pulmonary Hypertension: High Mortality and Perioperative Complication Rates

Abstract ID: Poster 003

---

*Courtney E. Baker, M.D.
Brian P. Chalmers, M.D.
Michael J. Taunton, M.D.
Adam W. Amundson, M.D.
Daniel J. Berry, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

INTRODUCTION: While perioperative medical management during total hip arthroplasty (THA) has improved, there remains a paucity of literature on the outcomes of patients with pulmonary hypertension (PHTN). As such, this study analyzed mortality, complications, revision rates, and clinical outcomes in this medically complex cohort.

METHODS: We identified 650 patients with PHTN who underwent 512 primary THAs and 192 revision THAs from 2000-2016. Hemiarthroplasties and THAs for oncologic indications or fractures were excluded. Mean age was 73 years with 54% of patients being female. We utilized a competing risk statistical analysis with death as a competing risk. Mean follow-up was 6 years.

RESULTS: 90-day mortality was 3.9% and 4.7% in primary and revision THAs, respectively; two patients died prior to discharge due to cardiac arrest. The cumulative incidences of death at 2 and 10 years were 12% and 66% in primaries and 22% and 77% in revisions, respectively. 10-year cumulative incidence of revision was 8.5% and 14.2% for primaries and revisions, respectively, and not notably different than for cohorts without PHTN. Excluding revisions and reoperations, complications – mostly medical - occurred in 13% of primaries and 18% of revisions. These included cardiac arrhythmias (3%), myocardial infarctions (1.5%), venous thromboemboli (1%), respiratory failures (1%), and cerebrovascular events (1%). Overall, 14 patients (2.2%) required ICU admission postoperatively. Hip Society scores improved significantly from a mean of 46 preoperatively to a mean of 81 postoperatively ($p<0.001$) in primaries and a mean of 54 to 72 in revisions ($p<0.001$).

CONCLUSION: Patients with PHTN undergoing primary and revision THA had a significant 90-day and 10-year incidence of mortality at ~4% and ~70%, respectively. While there was reliable improvement in clinical outcomes, there was a high rate of perioperative medical complications, namely cardiopulmonary. Patients with pulmonary hypertension undergoing THA should be thoroughly medically optimized and managed perioperatively.

SUMMARY: Patients with pulmonary hypertension undergoing primary or revision THA have a 90-day and 10-year mortality rate of ~4% and ~70%, respectively; moreover, perioperative complications are common (~15%).

Radiographic Risk Factors for Periprosthetic Hip Dislocation: Examining Pelvic Inclination and Acetabular Component Position

Abstract ID: Poster 004

---

*William G. Rainer, III, D.O.
Michael J. Taunton, M.D.
Matthew P. Abdel, M.D.
Brett A. Freedman, M.D.
Daniel J. Berry, M.D.
Rochester, MN

INTRODUCTION: Periprosthetic dislocation after total hip arthroplasty (THA) remains a significant postoperative complication. While many risk factors for dislocation are well described, the effects and relationships of spino-pelvic alignment and acetabular component positioning remain unclear. The purpose of this study was to radiographically examine pelvic inclination and acetabular component position in patients both with and without a history of dislocation to describe their effects in regards to risk of dislocation.

METHODS: Over a 10-year period, 177 patients who underwent primary THA experienced a subsequent dislocation. For comparative analysis, these patients were matched 1:1 based on age, sex, BMI, and date of surgery to a control group without a history of dislocation. Patients with certain known risk factors for dislocation such as infection, polyethylene wear, and preoperative dislocation were excluded from both groups. AP radiographs were reviewed to obtain the distance from the pubic symphysis to the sacrococcygeal junction (PSCD) and calculate pelvic tilt using a gender specific equation as well as for individual analysis. Acetabular component position was assessed via the ischiolateral angle (ILA), as a surrogate for component version, obtained from cross-table lateral radiographs. The data were then reviewed to determine if any of these criteria, individually or in relation to one another, had a significant association with dislocation.

RESULTS: Among those who dislocated, 128 (72%) were female and the average age and BMI was 63.3 and 29.4, respectively. Pelvic tilt among dislocators was significantly less than that among controls (56.6° vs 59.5°, p=0.023). The ischiolateral angle was not significantly different between groups. Review of the PSCD revealed that patients with a distance <0 (symphysis above the sacrococcygeal junction) had nearly 9 times the odds of dislocation compared to those with a PSCD >50 (OR 8.7, p=0.006). Among these patients specifically, non-dislocators had ILAs that were notably higher than dislocators, but the number of non-dislocators in this group was too low for statistical analysis.

CONCLUSION: As dislocation continues to be a significant complication, defining risk factors and continued research is essential. The data presented here not only identifies a specific population at significantly greater risk, such as those with a PSCD <0, but also demonstrates that in patients with a low pelvic tilt, higher ILAs may be protective — both of which are important for both preoperative planning and counseling.

Total Hip Arthroplasty in Patients with Osteogenesis Imperfecta

Abstract ID: Poster 005

---

*Samuel W. Carlson, M.D.
Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Osteogenesis imperfecta (OI) comprises a spectrum of disorders that result in bone fragility. This presents unique challenges when performing total joint arthroplasty in patients with OI. The purpose of this study was to determine the survivorship and clinical outcomes of total hip arthroplasty (THA) in patients with OI.

METHODS: We retrospectively reviewed our institution's total joint registry from 1969-2018 for all primary THAs in patients with a history of OI. There were 11 patients (13 hips) with a mean follow-up of 13 years (range, 6-20 years). Survivorship free of component revision was determined using Kaplan-Meier analysis. Patient reported clinical outcomes were assessed using Harris Hip Scores.

RESULTS: At final follow-up, the status of the implant was known in all 13 hips. One patient (one hip) was deceased. Four hips (31%) underwent revision surgery at a mean of 9 years (range, 5-17 years). Survivorship free of component revision was 52% at 20 years. Mean Harris Hip Scores at final follow-up were fair (75, 47-97), but significantly improved compared to available preoperative scores (p=0.0015). No intraoperative complications occurred during the 13 primary THAs.

DISCUSSION AND CONCLUSIONS: THA in patients with OI is associated with high revision rates and low survivorship at long-term follow-up. Although this is a very challenging patient population, THA provided these patients with improved functional outcomes. This is the largest series of primary THA in patients with OI reported in the literature and therefore provides surgeons with important data regarding the expected outcomes following THA in this unique patient population.

Anatomic Factors Affecting Turnout

Abstract ID: Poster 006

---

*Angelina M. Vera, M.D.
David Dong, B.S.
Bradley S. Lambert, Ph.D.
Leif E. Peterson, Ph.D.
Kevin E. Varner, M.D.
Patrick C. McCulloch, M.D.
Joshua D. Harris, M.D.
Houston, TX

BACKGROUND: Turnout is the foundation of ballet and all ballet dancers strive to obtain perfect turnout. In theory, dancers with decreased femoral version, increased pelvic incidence, higher neck shaft angle, longer femoral neck, and greater femoral offset should have greater turnout due to a greater arc of motion before impingement occurs. However, turnout is a complex movement which is likely determined by multiple osseous and soft tissue factors around the hip, knee, and ankle.

PURPOSE: To determine the influence of age, gender, height, BMI, Beighton score, femoral version, pelvic incidence, neck shaft angle, femoral neck length, and femoral offset on magnitude of turnout in professional ballet.

METHODS: Professional dancers from a large metropolitan ballet company underwent clinical assessment of turnout via rotation board measurements and plain radiographic evaluation of multiple hip measurements via EOS 2D and 3D imaging. Femoral version, pelvic incidence, neck shaft angle, femoral neck length, and femoral offset were measured in all dancers. Basic demographics and Beighton score were also obtained. Statistical analysis was used to determine the contribution of each measurement to turnout values. Multiple linear regression with stepwise removal was used to determine the best prediction model with the data available. Model selection was based on the highest adjusted R2 with the lowest amount of co-linearity due to variance inflation.

RESULTS: Twenty-one (10 male, 11 female; mean age 25.4±4.8 years) dancers participated. Mean femoral offset was 38.6±5.3 mm, femoral neck length 51.1±4.6 mm, neck shaft angle 131.6±5.2°, femoral torsion 12.4±8.5°, and pelvic incidence 46.6±11.5°. In decreasing correlation strength body mass index (r=-0.442), age (r=-0.415), femoral neck length (r=-0.316), and femoral version (r=-0.275) were inversely correlated with turnout ($p<0.05$). Female sex (r=0.383) and Beighton score (r=0.311) were directly correlated with turnout ($p<0.05$). Height, pelvic incidence, femoral offset, and neck shaft angle were not found to be correlated with turnout.

CONCLUSION: The model suggests that female sex and Beighton score is predictive of greater turnout while age, neck length, neck shaft angle, and torsion are inversely predictive of turnout. Soft tissue laxity and osseous morphology both have significant contributions to turnout.

Constrained Liners Implanted Simultaneously at the Time of Acetabular Shell Revision with a Highly Porous Implant: Surprisingly Good Fixation at 10 Years

Abstract ID: Poster 007

---

*Nicholas A. Bedard, M.D. / Iowa City, IA
Timothy S. Brown, M.D. / Iowa City, IA
David G. Lewallen, M.D. / Rochester, MN
Robert T. Trousdale, M.D. / Rochester, MN
Daniel J. Berry, M.D. / Rochester, MN
Matthew P. Abdel, M.D. / Rochester, MN

INTRODUCTION: Many surgeons are reluctant to use a constrained liner at the time of acetabular component revision given concerns this might result in early acetabular component loosening. We hypothesized that with appropriate initial implant stabilization of highly porous acetabular components with supplemental screw fixation, constrained liners could be safely used at the time of acetabular revision.

METHODS: We retrospectively identified 148 revision total hip arthroplasties (THAs) where a constrained liner of one design was cemented into a newly placed highly porous acetabular component fixed with supplemental screws (mean 5 screws). Mean age at revision THA was 69 years, with 68% being female. The most common indications for revision were two-stage reimplantation (33%), recurrent dislocation (30%), and aseptic loosening (22% acetabular; 9% acetabular/femoral component). Mean follow-up was 8 years.

RESULTS: There were no failures at the bone-implant interface, and there were no revisions for aseptic loosening of the acetabular component. Furthermore, all acetabular components were bone ingrown on radiographic analysis. The 10-year survivorships free from any acetabular revision and free from any reoperation were 75% and 67%, respectively. Overall, 33 hips (22%) required revision or reoperation for infection/wound complications (n=12), dislocation (n =11), periprosthetic femur fracture (n=4), femoral loosening (n=3), and other (n=3). The 10-year survivorship free from dislocation was 84% overall, which was similar to the 85% 10-year survivorship free from dislocation for those specifically revised for instability (p=0.9).

CONCLUSIONS: Implanting a constrained liner at the time of acetabular revision in high-risk patients resulted in no cases of aseptic acetabular component loosening in this large series. This is likely related to the fact that a highly porous acetabular component was utilized with a large number of supplemental screws in each case. Such information is valuable as these data favor a paradigm shift when compared to some traditionally-held tenets.

Routine Femoral Head Histopathologic Analysis in Hip Arthroplasty

Abstract ID: Poster 008

---

*Michael W. Perry, M.D. / Chicago, IL
Cameron J. Killen, M.D. / Chicago, IL
Daniel Schmitt, M.D. / Chicago, IL
Edwin Chaharbakhshi / Maywood, IL
Nicholas M. Brown, M.D. / Chicago, IL

BACKGROUND: Histopathologic analysis of femoral head specimen is common practice for many arthroplasty surgeons to identify diagnoses that differ from the clinical diagnosis and indication for hip arthroplasty. This routine practice represents a significant use of health care resources. Cases of undiagnosed lymphomas discovered by this practice have been reported in the literature. These cases are exceedingly rare, and the question remains, is the routine histopathologic analysis of femoral head specimen justified?

METHODS: Patients undergoing primary hip arthroplasty between 2007 and 2017 were queried. Surgeon preoperative and postoperative diagnosis as well as the histopathologic diagnosis was compared. If the clinical and histopathologic diagnosis differed, a review was performed to determine whether or not this resulted in a change in management of the patient's condition.

RESULTS: 2,166 total hip arthroplasties or hemiarthroplasties were reviewed. The primary diagnosis was osteoarthritis in 80.5%, AVN in 7.6%, fracture in 7.8%, RA in 1.3%, and metastasis in 0.9%. The pathologic diagnosis matched the clinical diagnosis 95.1% of the time. There were 106 (4.9%) cases of discrepant diagnosis in which the management of the patient was not altered. 105 of these diagnoses were discrepancies between AVN and OA. There was 1 case of a discordant diagnosis in which lymphoma was diagnosed and subsequently treated.

CONCLUSION: The routine practice of histopathologic analysis of femoral head specimen in all hip arthroplasty does not appear to be indicated. Histopathologic analysis of the femoral head should be the exception rather than the rule in cases in which the operative surgeon has reason to be concerned for a discordant diagnosis as a result of clinical or intraoperative findings.

Abductor Reconstruction Using Achilles Tendon Allograft with or without Gluteus Maximus Transfer in Native and Replaced Hips

Abstract ID: Poster 009

Adam Hart, M.D.
Juan S. Vargas-Hernandez, M.D.
*Cody C. Wyles, M.D.
Benjamin M. Howe, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

BACKGROUND: Hip abductor tendon tears may lead to debilitating lateral hip pain in both native and prosthetic total hip arthroplasties (THAs). They can be managed conservatively or operatively. Open surgical repair results are scarcely reported in the literature. This study sought to assess the functional outcomes of patients who underwent open abductor tendon reconstruction and correlate them to magnetic resonance imaging (MRI) findings.

METHODS: We retrospectively reviewed a single surgeon consecutive series of 55 hips (38 native, 17 prosthetic) in 54 patients with abductor tendon tears who underwent open abductor reconstruction from 2007-2017. Gluteus medius tendon repair to the trochanter was performed in all patients. Repair augmentation with gluteus maximus occurred in 20 cases and Achilles allograft in 37 cases. Augmentation was incorporated based on surgeon intraoperative muscle atrophy assessment. The Goutallier-Fuchs score (GFS) was used to assess the degree of atrophy in the preoperative MRI. Mean GFS for gluteus medius and minimus was 2.1 and 2.9, respectively. Mean age was 66 years and 89% were female. Mean follow-up was 40 months.

RESULTS: Mean hip disability and osteoarthritis outcome score (HOOS) significantly improved from 42.5 preoperatively to 71.3 at final follow-up ($p<0.01$). Mean VAS pain scores (6.3 to 2.6, $p<0.01$) and abduction motor strength (3.1 to 3.7, $p<0.01$) significantly improved after surgery, as well as gait abnormality (92% to 64%, $p<0.0.1$). There was no relationship between the degree of atrophy of the gluteus medius or minimus and the change in functional outcomes assessed with the HOOS (all p-values>0.5).

CONCLUSION: Open abductor tendon repair significantly improved functional and pain scores. There was no significant association between the GFS of the gluteus medius and minimus, and functional outcomes. Our preference is to use Achilles allograft augmentation on most repairs and add a gluteus maximus transfer or augmentation tor patients with significant muscle atrophy.

SUMMARY: This study demonstrates significant improvement in patient-reported outcomes following abductor repair in both native and replaced hips; however, half of patients still report a gait abnormality.

A Randomized Clinical Trial of Articulating and Static Spacers in the Management of Chronic Periprosthetic Hip Infection

Abstract ID: Poster 010

---

*Cindy R. Nahhas, B.S. / Chicago, IL
Peter N. Chalmers, M.D. / Salt Lake City, UT
Javad Parvizi, M.D., FRCS / Philadelphia, PA
Scott M. Sporer, M.D. / Chicago, IL
Gregory K. Deirmengian, M.D. / Philadelphia, PA
Antonia F. Chen, M.D., M.B.A. / Boston, MA
Chris Culvern, M.S. / Chicago, IL
Mario Moric, M.S. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: The purpose of this randomized clinical trial was to compare perioperative complications and postoperative outcomes between static and articulating spacers for the treatment of periprosthetic joint infection (PJI) complicating hip arthroplasty.

METHODS: 52 patients undergoing resection arthroplasty as part of a two-stage exchange for PJI at three centers were randomized to receive either a static (23 patients) or articulating spacer (29 patients). Operative time at the time of reimplantation was the primary endpoint and a power analysis determined that 22 patients per group were necessary to detect a 20-minute difference between groups with 80% power and alpha=0.05. 47 patients (90.4%) were available for follow-up at a mean 2.9 years (range, 1.0 to 7.0 years); four were never reimplanted and one died before discharge after reimplantation. Statistical analyses included Wilcoxon Rank Sum test for continuous variables and the Fisher's Exact Test for categorical variables.

RESULTS: For the stage 1 procedure, there were no differences in operative time (163 minutes static vs. 174 minutes articulating, p=0.088) or need for extensile exposure (39% static 24% articulating, p=0.365). For the 2nd stage reimplantation, there were again no differences in operative time (144 minutes static vs. 148 minutes articulating, p=0.796) or need for extensile exposure (0% static vs. 4% articulating, p=1.0). Length of stay, however, was significantly longer in the static cohort after stage 1 (8.3 vs. 6.4 days, p=0.048) and stage 2 (6.2 vs. 3.8 days, p<0.001). Three patients in each cohort required a second operative debridement and spacer exchange prior to reimplantation. At final follow-up, there was no difference in the modified Harris Hip Score (mHHS) between cohorts with the numbers available for study (73.3 vs. 65.6 points, p=0.214) and likewise no difference in the change from preoperative to postoperative scores (23.8 vs. 27.0 points, p=0.679). Similarly, with the numbers available for study, there was no difference in the reinfection rate (22.7% static vs. 11.5% articulating, p=0.442) or dislocation rate (9.5% static vs. 4.2% articulating, p=0.592) between groups.

CONCLUSIONS: This randomized study demonstrated that the perioperative and postoperative outcomes of a static spacer are similar to those of an articulating spacer in the treatment of PJI complicating hip arthroplasty. The longer length of hospital stay associated with the use of static spacers may have an important impact on the healthcare system. When differences were present, they generally favored the articulating group.

Are Postoperative Hip Precautions Necessary after Primary Total Hip Arthroplasty Using a Posterior Approach? Preliminary Results of a Prospective Randomized Trial

Abstract ID: Poster 011

---

*Matthew W. Tetreault, M.D. / Rochester, MN
Faisal Akram, B.S. / Chicago, IL
Jefferson Li, M.D. / Chicago, IL
Denis Nam, M.D., MSc / Chicago, IL
Tad L. Gerlinger, M.D. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL
Brett R. Levine, M.D., M.S. / Chicago, IL

BACKGROUND: Postoperative hip precautions may be burdensome without proven benefit. An appropriately powered prospective randomized trial is needed to clarify whether posterior hip precautions after primary total hip arthroplasty (THA) reduce the incidence of early dislocation.

METHODS: We performed a prospective randomized study to evaluate the effect of postoperative hip precautions on incidence of early dislocation following primary THA through a posterior approach. Between 1/2016 and 4/2019, 587 patients (594 hips) were consented and randomized into a restricted or an unrestricted group. There were no significant demographic or surgical differences between groups. The restricted group was instructed to refrain from hip flexion >90°, adduction across midline, and internal rotation for 6 weeks postoperatively. The unrestricted group had no range of motion restrictions. 98.5% (585/594) of hips were available for minimum 6-week follow-up (291 restricted, 294 unrestricted). Power analysis showed that 579 hips per group are needed to demonstrate an increase in dislocation rate from 0.5% to 2.5% with 80% power.

RESULTS: At average follow-up of 14.7 weeks (range, 6-88 weeks), there were a total of 5 dislocations (incidence, 0.85%). Three posterior dislocations occurred in the restricted group at a mean of 26 days (range, 18-42 days) and two posterior dislocations occurred in the unrestricted group at a mean of 78 days (range, 21-135 days), with no difference in dislocation rate between groups (1.03% vs. 0.68%; OR=0.658, 95% CI=0.11-3.96, p=0.647). All dislocations were managed with closed reduction. At 6 weeks, unrestricted patients endorsed less difficulty with activities of daily living, earlier return to driving, and more time spent side-sleeping ($p<0.05$).

CONCLUSIONS: Preliminary analysis suggests that removal of posterior hip precautions after primary THA through a posterior approach was not associated with increased risk of early dislocation and facilitated return to daily functions. Continued investigation to appropriate power is warranted.

Robotic-Arm Assisted Total Hip Arthroplasty Short-Term Clinical Outcomes - A Pair Match-Controlled Study

Abstract ID: Poster 012

Itay Perets, M.D. / Jerusalem, Israel
John P. Walsh, B.A., M.A. / Des Moines, IA
Brian H. Mu, B.A. / North Chicago, IL
Yosif Mansor, M.D. / Ramat Gan, Israel
David R. Maldonado, M.D. / Des Plaines, IL
Ajay C. Lall, M.D., M.S. / Des Plaines, IL
*Jacob Shapira, M.D. / Des Plaines, IL
Benjamin G. Domb, M.D. / Des Plaines, IL

INTRODUCTION: Recent advances have made robotic assistance a viable option in total hip arthroplasty (THA). However, the clinical outcomes of this procedure relative to manual THA are limited in the current literature. The purpose of this study was to compare robotic-arm assisted (RAA) THA and manual THA at minimum two-year follow-up. We compared the following patient-reported outcomes: Harris Hip Score (HHS), Forgotten Joint Score (FJS-12), pain on a visual analog scale (VAS), and satisfaction. Complication rates and subsequent surgeries were also compared.

METHODS: Data were prospectively collected on all THAs performed from July 2011 to January 2015. Patients were included if they underwent RAA primary THA treating idiopathic osteoarthritis and were eligible for minimum two-year follow-up. Outcomes were measured using HHS, FJS-12, VAS for pain, and satisfaction from 0-10. Postoperative radiographs were analyzed for cup inclination, cup version, leg length discrepancy, and global offset. Patients who underwent THA with RAA were matched 1:1 with manual THA patients for age, sex, BMI, and surgical approach.

RESULTS: There were 85 patients in each study group. There were no significant differences in the demographic factors that were matched between groups. Both HHS and FJS-12 were significantly higher in the RAA group at minimum two-year follow-up. VAS was lower in the RAA group, but this result was not statistically significant ($p = 0.120$). A significantly higher proportion of patients were in both the Lewinnek and Callanan safe zones for cup orientation ($p < 0.001$). Average leg length discrepancy was significantly lower for the RAA group ($p = 0.013$). However, this difference may not be of clinical importance since no patients in either group had >1 cm leg length discrepancy. There was no difference in patient satisfaction. There was no significant difference in the rate of complications or subsequent revision surgeries between groups.

CONCLUSION: Performing THA with RAA yielded improved short-term patient outcomes compared to manual THA, and higher likelihood of cup placement in the safe zones. There were no differences found regarding VAS, satisfaction, the rate of complications, or subsequent revisions between groups.

Can We Help Patients Forget Their Joint? Determining a Threshold for Successful Outcome for the FJS

Abstract ID: Poster 013

Philip J. Rosinsky, M.D.
Jeffrey W. Chen, B.A.
Ajay C. Lall, M.D., M.S.
*Jacob Shapira, M.D.
David R. Maldonado, M.D.
Benjamin G. Domb, M.D.
Des Plaines, IL

INTRODUCTION: Clinically important thresholds improve interpretability of patient-reported outcomes (PROs). A threshold for a successful outcome does not exist for the Forgotten Joint Score (FJS). The purpose of this study was to determine a threshold score for the FJS, 12 and 24 months after total hip arthroplasty (THA).

METHODS: A retrospective analysis of 247 primary THA recipients between May 2012 and May 2017 was performed. A binary “successful treatment” was created from a composite of pain levels, functional capacity, and satisfaction. A receiver operator characteristic (ROC) analysis was performed to determine a threshold for successful outcome at 1 and 2 years, and sub-analyzed by demographics. The ROC findings were compared to findings from the 75th centile approach. The ceiling effect of FJS was also assessed.

RESULTS: The ROC analysis of 1-year and 2-year outcomes of 247 produced excellent areas under the curve (AUC). The threshold values were 73.96 and 69.79 at each respective time-point. The ROC The 75th centile approach yielded thresholds of 71 and 85. The 16% and 23% of cases met the ceiling effect respectively.

CONCLUSION: The FJS threshold for success at 1- and 2-years postoperatively is 73.96 and 69.79, respectively. The higher rates of success at 2 years, along with a rise in the mean FJS, may indicate continued improvement up to 2 years after THA. Although this study improved the clinical interpretability of the FJS by defining clinical thresholds for success, it also found a significant ceiling effect which may impair the content validity of this score, especially in healthier and younger individuals.

Modern Short Fit-and-Fill Stems with Highly Porous Metal are Protective Against Under-Sizing and Obesity Compared to Traditional Stems

Abstract ID: Poster 014

Nathan Duncan, M.D.
Evan R. Deckard, BSE
*R. Michael Meneghini, M.D.
Indianapolis, IN

INTRODUCTION: Aseptic femoral loosening due to under-sizing is increasing in frequency as the direct anterior approach becomes increasingly utilized. The purpose of this study was to radiographically evaluate the anatomic fit and subsidence in a modern shortened fit-and-fill highly porous coated titanium femoral stem design compared to a traditional design.

METHODS: A retrospective cohort study of 213 consecutive cementless THAs was performed. Traditional fit-and-fill hydroxyapatite-coated (TFNF) stems were implanted in 61 hips and 152 received a modern shortened fit-and-fill stems with proximal highly porous metal coating (ShortFNF). Preoperative bone morphology was radiographically assessed by the canal flare index. Canal fill and subsidence was measured digitally on immediate and 1-month postoperative radiographs. Statistical analysis was performed with $p<0.05$ significant.

RESULTS: Demographics were similar between groups ($p>0.5$). The ShortFNF patient group had a smaller mean native bone canal flare index ($p<0.001$). The total overall percentage of femoral canal fill, and canal fill individually at all measured locations, was substantially less with the ShortFNF stem compared to the TFNF stem ($p < 0.001$). Despite this relative under-sizing, there was significantly less subsidence in the ShortFNF (0.5 mm) compared to TFNF stem (1.2 mm) ($p < 0.001$). Subsidence significantly increased as BMI increased in the TFNF stems, a finding not observed in the ShortFNF stem ($p = 0.018$).

CONCLUSION: A modern shortened fit-and-fill highly porous coated femoral stem design demonstrated greater axial stability and decreased subsidence with increasing BMI compare to a traditional fit-and-fill stem, despite being relatively under-sized. The resistance to subsidence, irrespective of BMI and relative under-sizing, is likely due to the optimal proximal geometry and highly porous titanium coating.

Simplified Tönnis Classification: A Binary Modification Demonstrates Better Reliability and Agreement with Treatment

Abstract ID: Poster 015

---

*Jacob Shapira, M.D.
Jeffrey W. Chen, B.A.
Ajay C. Lall, M.D., M.S.
Philip J. Rosinsky, M.D.
David R. Maldonado, M.D.
Benjamin G. Domb, M.D.
Des Plaines, IL

INTRODUCTION: The presence of osteoarthritis is a critical factor in a surgeon's decision between arthroscopy and arthroplasty. Despite its extensive use both in clinical practice and medical literature, the Tönnis classification has drawbacks. A two-grade classification could potentially be more reliable and reproducible without compromise to clinical relevance. The purpose of this study is to validate a simplified binary Tönnis classification that removes excessive complexity and better captures the dual nature of the surgical decision-making. Specifically, this study (1) compares the inter- and intra-reliability of the Tönnis and a simplified Tönnis system for grading osteoarthritis and (2) evaluates the clinical applicability of both systems, notably its agreement with the clinician's decision for either arthroscopy or arthroplasty.

METHODS: Forty consecutive patients were selected to participate for this study. Patients were included in the study if they were between the ages of 35 and 60 years old. Patients were excluded if they had prior ipsilateral or contralateral surgeries, or had prior hip conditions. All radiographs were randomized and blinded by a non-observer. The Tönnis system and a binary system of radiographs were graded by five hip surgeons from a single center in a fully-crossed design. Intra- and inter-observer reliability were calculated using the Cohen's κ coefficient. Multi-rater κ was calculated using the weighted Fleiss method.

RESULTS: The study sample contained 40 anterosuperior hip radiographs. There were 15 males and 25 females (age 35.05 – 59.25 years). The Tönnis the weighted κ inter-observer reliability showed fair reliability (κ = 0.474) and excellent intra-observer reliability (κ_{mean} = 0.866, range = 0.780 – 0.907). The simplified Tonnis inter-observer reliability was (κ = 0.858) and intra-observer reliability was (κ = 0.928, range = 0.892 – 0.948). On average, the simplified system correctly captured 87% of cases. When the Tönnis classification was dichotomized, the capture rate was 84%.

CONCLUSION: A simplified, two-level, Tönnis classification demonstrates better reliability and clinical implementation than the traditional Tönnis.

Effect of Marital Status on Patient-Reported Outcomes Following Total Hip Arthroplasty: A Group Matched Control Analysis with Minimum Two-Year Follow-Up

Abstract ID: Poster 016

Ajay C. Lall, M.D., M.S. / Des Plaines, IL
Garrett R. Schwarzman, M.D. / Chicago, IL
Muriel R. Battaglia, B.A. / Chicago, IL
Sarah L. Chen, B.A. / Des Plaines, IL
David R. Maldonado, M.D. / Des Plaines, IL
*Jacob Shapira, M.D. / Des Plaines, IL
Benjamin G. Domb, M.D. / Des Plaines, IL

BACKGROUND: Mental health and patient expectation have been identified as key predictors of recovery following THA; however, there is limited literature examining the effects of social support and marital status on patient-reported outcomes (PRO).

METHODS: Data were prospectively collected and retrospectively reviewed for patients who underwent THA between July 2008 and January 2016. Patients were included if they underwent primary THA during this period and if they had documented preoperative marital status of married, divorced, or never married. Married patients were group matched to non-married patients (divorced or never married) with similar sex, age, body mass index (BMI), gender distribution, and frequency of surgical approach.

RESULTS: There were 414 married patients and 98 non-married patients who were eligible and had minimum two-year follow-up. Mean patient-reported outcomes were significantly worse in the non-married group than the married group for the following measures: modified Harris Hip Score (P = 0.002), Harris Hip Score (P= 0.002), Forgotten Joint Score (P = 0.04), and the physical portions of the Veterans RAND (P = 0.025) and Short Form (P = 0.02) surveys.

CONCLUSION: Our study demonstrated inferior absolute PRO scores at latest follow-up for patients who were non-married compared to married following THA. These results show that while total hip replacement may still yield clinical benefit in all patients, non-married patients may ultimately achieve an inferior functional status, and expectations should be adjusted accordingly. Physicians should assess levels of psychosocial support in their patients prior to undergoing hip arthroplasty in order to optimize results.

Performance of PROMIS in Patients with Hip Dysplasia Treated with Periacetabular Osteotomy

Abstract ID: Poster 017

Malynda S. Wynn, M.D.
Alan G. Shamrock, M.D.
Zain M. Khazi, B.S.
Robert W. Westerman, M.D.
*Michael C. Willey, M.D.
Iowa City, IA

INTRODUCTION: Hip dysplasia is known to lead to pain, disability, depression, and eventually secondary hip osteoarthritis in young adults. While validated in other orthopedic procedures, the performance of the Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function (PF) Computer Adaptive Test (CAT) in patients with hip dysplasia indicated for periacetabular osteotomy (PAO) is unknown. The aim of this investigation was to validate and compare responsiveness of PROMIS PF CAT with currently accepted patient-reported outcome (PRO) instruments in young adults with hip dysplasia indicated for PAO.

METHODS: Individuals indicated for PAO to treat symptomatic hip dysplasia were consented to complete the PROMIS PF CAT, Hip disability and Osteoarthritis Outcome Score (HOOS), modified Harris Hip Score (mHHS), International Hip Outcome Tool (iHOT), and pain Visual Analog Scale (VAS) questionnaires during their preoperative clinic appointments. The relationship between PRO instruments was compared using Spearman or Pearson correlation coefficients. Correlation between PRO instruments was defined as high (>0.7), high-moderate (0.61-0.69), moderate (0.4-0.6), moderate-weak (0.31-0.39), and weak (≤0.3). Statistical significance was defined as $p<0.05$. Floor and ceiling effects were determined as significant if 15% or more of patients reported the lowest or highest possible total score, respectively.

RESULTS: A total of 41 individuals scheduled to undergo PAO were enrolled in the study. The PROMIS PF CAT had a high correlation with mHHS ($r=0.72$, $p<0.0001$). High-moderate correlation strength was demonstrated with iHOT ($r=0.62$, $p<0.0001$), mHHS function ($r=0.62$, $p<0.0001$), and mHHS_pain ($r=0.61$, $p<0.0001$) surveys. Moderate correlation strength was demonstrated for the remaining PRO measures. There were no observed ceiling or floor effects. Average number of questions answered was lowest in the PROMIS Pain (3.93 + 0.47) and highest in the iHOT (12) survey.

DISCUSSION: PROMIS PF CAT is an efficient and valid tool for preoperative clinical assessment of pain and disability in hip dysplasia patients undergoing PAO. It correlates well with legacy PRO instruments with no ceiling or floor effects and has a decreased question burden.

More Patients are Discharging Home after Total Hip Arthroplasty: Improvement Varies Between Databases

Abstract ID: Poster 018

---

*David E. DeMik, M.D., PharmD
Nicholas A. Bedard, M.D.
Christopher N. Carender, M.D.
Natalie A. Glass, Ph.D.
John J. Callaghan, M.D.
Iowa City, IA

INTRODUCTION: There have been significant advancements in perioperative total hip arthroplasty (THA) care and it is essential to quantify the efforts made to better optimize patients and improve outcomes. Additionally, different health systems may vary in overall success with these measures. The purpose of this study was to assess trends in discharge destination, length of stay (LOS), and postoperative events following primary THA using two large databases.

METHODS: Patients undergoing THA were identified using ICD and CPT codes in the ACS NSQIP and Humana administrative claims databases. Years available for query in NSQIP were 2011-2017 and 2007-first quarter 2017 in Humana. Discharge destinations were assessed and categorized as home or not home. Changes in discharge destination, LOS, readmissions, and comorbidity burden were assessed.

RESULTS: In NSQIP, 155,638 patients underwent THA and the percentage of patients discharging home increased from 72% in 2011 to 87% in 2017 ($p<0.0001$). 93,322 THA patients were identified in Humana, with 56% discharging home in 2007 to a peak of 65% in 2014 ($p<0.0001$). Mean LOS decreased from 3.4 to 1.9 days ($p=0.001$) for those going home in Humana and from 3.1 to 2.0 days ($p<0.0001$) for NSQIP patients during the study period. For both Humana and NSQIP patients, readmission significantly decreased. The proportion of Humana patients with a Charlson Comorbidity Index ≥2 increased, as did the proportion of NSQIP patients with an American Society of Anesthesiologists classification ≥3 ($p<0.0001$).

CONCLUSIONS: Over the study period, patients undergoing THA were more likely to discharge home, had shorter hospital LOS, and significantly lower readmission rates. These trends persisted despite an increasingly comorbid patient population. Notably, NSQIP hospitals, in which participation is voluntary and may indicate a particular interest in quality improvement, performed better than those from Humana. It is likely these changes in disposition, LOS, and postoperative complications have resulted in significant cost savings for both payers and hospitals. The efforts necessary to create and maintain such improvements should be considered when changes to reimbursement are being evaluated. Additionally, the source of data used to benchmark hospitals should be taken into account.

Risk of Dislocation by Surgical Approach Following Modern Primary Total Hip Arthroplasty

Abstract ID: Poster 019

---

*Cody C. Wyles, M.D.
Adam Hart, M.D.
Mario Hevesi, M.D.
Kevin I. Perry, M.D.
Matthew P. Abdel, M.D.
Mark W. Pagnano, M.D.
Michael J. Taunton, M.D.
Rochester, MN

INTRODUCTION: There is renewed interest in dislocation after surgical approach with popularization of the direct anterior approach. The purported advantage of both the lateral and direct anterior approaches is decreased risk of dislocation. The purpose of this study was to assess the risk of dislocation by approach following modern primary THA.

METHODS: All primary THAs at a single academic institution from 2010 to 2017 were analyzed through our institutional total joint registry. There were 7023 THAs including 3754 posterior, 1732 lateral, and 1537 direct anterior. Risk of dislocation was assessed against the competing risks of revision surgery and death as well as by individual patient and surgical factors including surgical approach. Risk of revision surgery was considered as a secondary outcome. Step-wise selection was utilized to develop multivariable models. Clinical outcomes were documented with the Harris Hip Score (HHS). Mean age was 63 years, 51% were female, and mean body mass index (BMI) was 30 kg/m^2. Minimum follow-up was 2 years.

RESULTS: The cumulative incidence of dislocation at 1 year and 5 years by approach was as follows: posterior (2.1%; 3.0%), lateral (0.7%; 0.7%), direct anterior (0.4%; 0.4%) ($p<0.001$). Compared to the posterior cohort, the adjusted risk of dislocation was decreased for the lateral (hazard ratio [HR]=0.28, $p<0.001$) and direct anterior cohorts (HR=0.18, $p<0.001$). The cumulative incidence of revision for instability at 1 year and 5 years by approach was as follows: posterior (0.8%; 1.0%), lateral (0.6%; 0.6%), direct anterior (0%; 0%) ($p=0.09$). The adjusted risk of all-cause revision surgery was increased among the lateral cohort compared to posterior (HR=1.75, $p=0.003$) and direct anterior (HR=2.44, $p=0.002$) and among patients with diagnoses other than osteoarthritis (HR=2.89, $p<0.001$). Among patients who dislocated, 69 (83%) had anteversion >25°. Mean increase in HHS from preoperative assessment to final follow-up was greatest among direct anterior patients (37 points), followed by posterior patients (33 points), followed by lateral patients (29 points) ($p<0.05$, all comparisons).

CONCLUSIONS: This study documents the risk of dislocation by surgical approach among a large contemporary cohort undergoing primary THA. The risk of dislocation was higher following the posterior approach, whereas all-cause revision surgery was found to be higher following the lateral approach.

A Multi-Center Randomized Clinical Trial of Tranexamic Acid in Revision Total Hip Arthroplasty: Does the Dosing Regimen Matter?

Abstract ID: Poster 020

Robert A. Sershon, M.D. / Chicago, IL
Yale A. Fillingham, M.D. / Lebanon, NH
Matthew P. Abdel, M.D. / Rochester, MN
Arthur L. Malkani, M.D. / Louisville, KY
Douglas E. Padgett, M.D. / New York, NY
Thomas P. Vail, M.D. / San Francisco, CA
Denis Nam, M.D., MSc / Chicago, IL
Cindy R. Nahhas, B.S. / Chicago, IL
*Chris Culvern, M.S. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: The purpose of this multicenter, randomized clinical trial was to determine the optimal dosing regimen of tranexamic acid (TXA) to minimize perioperative blood loss for revision total hip arthroplasty (THA).

METHODS: Six centers prospectively randomized 155 revisions to one of four regimens: 1g of intravenous (IV) TXA prior to incision, a double dose regimen of 1g IV TXA prior to incision and 1g IV TXA during wound closure, a combination of 1g IV TXA prior to incision and 1g intraoperative topical TXA, or three doses of 1950 mg oral TXA administered 2 hours preoperatively, 6 hours postoperatively, and on the morning of postoperative day one. Randomization was based upon revision subgroups to ensure equivalent group distribution, including: femur only, acetabulum only, both component, explant/spacer, and second stage reimplantation. Patients undergoing an isolated modular exchange were excluded. A priori power analysis (alpha = 0.05; beta = 0.80) determined 40 patients per group were required to identify a 1g/dL difference in postoperative hemoglobin reduction between groups. Per-protocol analysis involved an analysis of variance, Fisher's exact tests, and two one-sided t-tests for equivalence.

RESULTS: Demographic and surgical variables were equivalent between groups. No significant differences were found between TXA regimens when evaluating reduction in hemoglobin (single IV = 3.6 g/dL, double IV = 3.6 g/dL, combined = 3.4 g/dL, and oral = 3.6 g/dL; p = 0.87), calculated blood loss (p = 0.67), or transfusion rates (single IV = 14%, double IV = 20%, combined = 17%, oral = 21%; p = 0.85). Equivalence testing revealed all possible pairings were statistically equivalent, assuming greater than a 1g/dL difference in hemoglobin reduction as clinically relevant.

CONCLUSIONS: All TXA regimens tested had equivalent blood-sparing properties in the setting of revision THA. Surgeons should consider the lowest effective dose and the most economical regimen.

Are We Speaking the Same Language? Systematic Review of Spino-Pelvic Terminology in the Hip-Spine Syndrome

Abstract ID: Poster 021

Nicole B. Keller, B.S.
*Linsen T. Samuel, M.D., M.B.A.
Assem A. Sultan, M.D.
Atul F. Kamath, M.D.
Cleveland, OH

INTRODUCTION: Hip-spine syndrome has been increasingly used to describe patient pain generated from lumbar and hip pathology. It is postulated that patients with hip-spine syndrome may have unique perioperative considerations and postoperative complications following total hip arthroplasty. Spino-pelvic parameters may provide a means to extrapolate susceptibility to complications following THA. This systematic review evaluates the various definitions of spino-pelvic parameters in clinical trials to help provide standardization in the literature. Additionally, we evaluated sub-types of hip-spine syndrome and different presenting scenarios.

METHODS: A systematic literature review was performed in PubMed using the following key words with Boolean AND/OR: “spine-hip”, “spino pelvic”, “spino pelvic alignment”, “hip spine syndrome”, “pelvic tilt”, “pelvic incidence”, “sacral slope” and “total hip arthroplasty.” Inclusion criteria were (1) provided spino-pelvic parameters and (2) reported outcomes of THA in the setting of native or iatrogenic spine deformity. The search yielded 150 articles; then reduced to 12 articles with further evaluation, and an additional 7 articles added from citation reviews. The full texts of 19 articles were reviewed.

RESULTS: Eleven articles defined spino-pelvic parameters: sagittal balance, pelvic incidence, pelvic tilt, sacral slope, and lumbar lordosis. Pelvic tilt (PT) definitions differed in a spine- versus hip-focused article. Spine literature, PT is the angle of the line drawn from the hip axis to the midpoint of the upper sacral endplate and the vertical axis. Hip literature, PT is defined as the difference between anterior pelvic plane and the vertical axis. Other spino-pelvic parameters were consistent amongst the literature; however, tended to be discussed mainly in spine-focused articles. Clinical outcomes of patients with hip-spine syndrome included increased hip dislocations incidence post THA in patients with native spine pathology. Other outcomes of hip-spine syndrome included increased incidence of complications, reoperations, and revisions.

DISCUSSION AND CONCLUSION: This review sought to compile current spino-pelvic definitions to evaluate standardization across fields and found variation remains in pelvic tilt definitions amongst spine- and hip-focused articles. Other spino-pelvic definitions such as lumbar lordosis and pelvic incidence are more consistent throughout the literature. Lastly, this paper compiled outcomes showing poorer clinical outcomes after THA in patients with overt hip-spine syndrome. Further work is needed to create consensus on the definitions of hip-spine syndrome parameters, as well as the relation to THA outcomes.

Detailing Postoperative Pain and Opioid Utilization after Periacetabular Osteotomy with Automated Mobile Messaging

Abstract ID: Poster 022

---

*Christina J. Hajewski, M.D.
Christopher A. Anthony, M.D.
Edward O. Rojas, B.S.
Robert W. Westermann, M.D.
Michael C. Willey, M.D.
Iowa City, IA

PURPOSE: Periacetabular osteotomy (PAO) reorients the acetabulum and reduces the mechanical stress in the hip joint to improve pain and prevent osteoarthritis. This investigation sought to (1) describe patient-reported pain scores and opioid utilization in the first six weeks following surgery and (2) evaluate the effectiveness of postoperative communication using a robotic mobile messaging platform in the setting of PAO.

METHODS: Subjects indicated for PAO were enrolled from a young adult hip clinic. For the first two weeks after surgery, subjects received daily mobile messages inquiring about pain level on a 0-10 scale and the number of opioid pain medication tablets they consumed in the previous 24 hours. Messaging frequency decreased to three per week in weeks 3-6. Pain scores, opioid utilization, and response rates with our mobile messaging platform were quantified for the 6-week postoperative period.

RESULTS: Twenty-nine subjects underwent PAO. Twenty-one had concurrent hip arthroscopy. Average daily pain scores decreased over the first four postoperative days. Average pain scores reported were 5.9±1.9, 4.1±3.3, and 3.0±3.5 on day one, day 14, and week six respectively. Reported opioid tablet utilization was 5.0±3.2, 2.2±2.0, and 0.0±0.0 on days one, 14, and at six weeks. Response rate for participants completing the 6-week messaging protocol was 84.1%.

CONCLUSIONS: Patient-reported pain scores decreased over the first two postoperative weeks following PAO before plateauing in weeks 3-6. Opioid pain medication utilization increased in the first postoperative week before gradually declining to no tabs consumed at six weeks after PAO. Automated mobile messaging is an effective method of perioperative communication for the collection of pain scores and opioid utilization in patients undergoing PAO.

Association Between Sadness and Symptom Severity in Pediatric and Adolescent Patients with Hip Pain

Abstract ID: Poster 023

---

*K. John Wagner, III, B.S. / Frisco, TX
Meagan J. Sabatino, B.A. / Frisco, TX
Heather M. Richard, PsyD / Dallas, TX
David A. Podeszwa, M.D. / Dallas, TX
Daniel J. Sucato, M.D. / Dallas, TX
Henry B. Ellis, Jr., M.D. / Frisco, TX

INTRODUCTION: Patient-reported outcome measures (PROMs) are used to assess treatment outcomes. The purpose of this study was to evaluate patient-reported sadness and its association with perceived pain, symptoms, and clinical disease severity in patients with hip pain.

METHODS: A review of PROMs from patients presenting with hip pain was performed. PROMs were completed at baseline, one year, and two years post-treatment. Those who reported feeling 'downhearted and blue' sometimes, often, or always on a baseline SF-12 (SAD) were compared to those who did not (NOT SAD). A subset of patients diagnosed with femoroacetabular impingement (FAI) was assessed for radiographic and intraoperative disease severity. Radiographic measures consisted of baseline alpha angle and lateral center edge angle. Intraoperative disease severity of the femoral head, labrum, acetabulum, and capsule was determined by an orthopedic surgeon using a standardized ranking system. A Mann-Whitney Test was used to compare groups.

RESULTS: Of 378 participants, the mean age was 15.3 (range 7-19) and 64.6% were female. Sixty-four participants (16.9%), of which 78.1% were female ($p=0.013$ compared to male) reported feeling SAD at baseline. SAD participants scored worse on the HOOS at baseline (55.8 vs. 66.1, $p<0.001$), with significantly lower scores on every subscale. Additionally, SAD participants demonstrated worse perceived outcomes one year post-treatment. While not significant, SAD participants also demonstrated a trend towards lower HOOS scores two years post-treatment.

Of 121 participants diagnosed with FAI (mean age 15.8; 72.7% female), SAD participants reported worse quality of life (29.1 vs. 44.5, $p<0.001$), pain (52.2 vs. 60.1, $p=0.049$), physical function (59.7 vs. 68.8, $p=0.028$), and scored lower overall on the HOOS at baseline (53.8 vs. 62.0, $p=0.023$). However, SAD participants did not demonstrate worse radiographic or intraoperative disease severity. One year post-treatment, SAD participants reported worse pain on the HOOS (68.0 vs. 87.6, $p=0.033$). There were no significant differences between the SAD and NOT SAD groups at two years post-treatment, but lower scores were noted.

CONCLUSION: The question of feeling 'downhearted or blue', perhaps a symptom of underlying depression, may be associated with patient reported symptom severity at baseline and one year post-treatment. However, no differences were found in radiographic or intraoperative disease severity of hip impingement between the groups, indicating that symptoms of underlying depression may be a risk factor for poor treatment outcomes.

KNEE

A Randomized Clinical Trial of Articulating and Static Spacers in the Management of Chronic Periprosthetic Knee Infection

Abstract ID: Poster 024

---

*Cindy R. Nahhas, B.S. / Chicago, IL
Peter N. Chalmers, M.D. / Salt Lake City, UT
Javad Parvizi, M.D., FRCS / Philadelphia, PA
Scott M. Sporer, M.D. / Chicago, IL
Keith R. Berend, M.D. / New Albany, OH
Antonia F. Chen, M.D., M.B.A. / Boston, MA
Matt Austin, M.D. / Philadelphia, PA
Gregory K. Deirmengian, M.D. / Philadelphia, PA
Michael J. Morris, M.D. / New Albany, OH
Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: The purpose of this multi-center, randomized clinical trial was to compare static and articulating spacers in the treatment of periprosthetic joint infection (PJI) complicating total knee arthroplasty (TKA).

METHODS: 68 patients undergoing resection arthroplasty as part of a two-stage exchange for PJI at three centers were randomized to receive either a static (32 patients) or articulating spacer (36 patients). 50 patients (73.5%) were available for follow-up at a mean 3.3 years (range, 1.8 to 6.4 years); 6 patients died, 6 were lost to follow-up, 3 were screen failures, 2 withdrew after surgery, and 1 patient cancelled prior to surgery. Power analysis determined that 28 patients per group (56 total) were necessary to detect a 13° difference in range of motion (ROM) between groups with 80% power and alpha=0.05.

RESULTS: Patients in the static spacer group had significantly longer mean hospital length of stay (LOS, 6.1 vs. 5.1 days; p=0.020). At final follow-up, the mean arc ROM in the articulating spacer cohort was significantly higher at 114.0° compared to 100.2° in the static spacer cohort ($p<0.001$). The mean Knee Society Score (KSS) was significantly higher in the articulating spacer cohort (80.4 vs 69.8 points; p=0.026). Patients in the static spacer cohort had a greater need for an extensile exposure at the time of reimplantation (16.7% vs. 3.8%), and higher rates of reoperation (29.2% vs. 11.5%) and reinfection (12.5% vs. 7.7%). However, the latter differences did not reach statistical significance with the sample size studied.

CONCLUSIONS: This randomized study demonstrated that the use of an articulating spacer, compared to a static spacer, during the first stage of a two-stage exchange provided higher ROM, shorter LOS, and higher KSS. When the soft tissue envelope allows and if there is adequate bony support, an articulating spacer is associated with improved outcomes.

Which Nonoperative Treatments Do Patients Feel are Most Effective for Hip and Knee Arthritis?

Abstract ID: Poster 025

---

*Cindy R. Nahhas, B.S.
Brian Fuller, M.D.
Charles P. Hannon, M.D.
Chris Culvern, M.S.
Tad L. Gerlinger, M.D.
Denis Nam, M.D., MSc
Craig J. Della Valle, M.D.
Chicago, IL

BACKGROUND: The purpose of this study is to determine which non-operative treatments patients feel are most effective for managing pain secondary to hip and knee arthritis.

METHODS: 565 consecutive patients referred to three arthroplasty surgeons at a single institution were administered an anonymous preoperative questionnaire developed in consultation with a center with expertise in survey design. Statistical analyses included Student's T-test, Fisher's Exact, Wilcoxon Rank-Sum test, and generalized cost effectiveness analysis.

RESULTS: 436 patients completed the questionnaire (response rate 77.2%). Patients tried an average of 4.1 non-operative treatments. When asked to pick the most effective of treatments they've tried, patients selected narcotics (52 of 118; 44.1%), over the counter (OTC) NSAIDs (77 of 330; 23.3%), prescription NSAIDs (67 of 200; 33.5%), and steroid injections (87 of 260; 33.5%). Platelet rich plasma (PRP) and stem cell injections were selected by 3 of 15 (19.5%) and 3 of 12 (25.0%), respectively while physical therapy (PT) was chosen by 50 of 257 (19.5%). 27% of respondents received narcotics, which were most commonly prescribed by primary care providers (48.2%) and orthopedic surgeons (39.5%). The use of narcotics correlated with lower patient-reported effectiveness of physical therapy, Tylenol, steroid injections, and viscosupplementation ($p<0.05$ for all). The most cost-effective treatments were OTC and prescription NSAIDs, narcotics, and acetaminophen (mean Cost Effectiveness Ratio CER 2.2, 3.7, 4.0, and 5.4, respectively). The least cost-effective treatments were stem cell injections, PRP injections, and PT (mean CER 1966.7, 520.8 and 138.6 respectively).

CONCLUSIONS: Intra-articular steroids, NSAIDs, and narcotics were reported to be the most effective and least costly treatments surveyed. PRP, stem cells, and PT were the least effective and most expensive. While a significant proportion of those receiving narcotics reported them to be effective, additional patient and physician education is needed to caution against the dangers of their use for the non-operative treatment of arthritis.

Anesthesia and Analgesia Practices in Total Joint Arthroplasty: A Survey of the AAHKS Membership

Abstract ID: Poster 026

Charles P. Hannon, M.D. / Chicago, IL
*Timothy C. Keating, M.D. / Chicago, IL
Jeffrey K. Lange, M.D. / Boston, MA
Benjamin F. Ricciardi, M.D. / Rochester, NY
Bradford S. Waddell, M.D. / New York, NY
Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: Every year in the United States over 1 million elective total joint arthroplasties are performed. Increasing use of multimodal pain medication protocols in the perioperative period have improved pain control while decreasing opioid use. In order to better guide clinical practice guidelines and study the optimization of available protocols, we must first understand the patterns of current practice. The purpose of this study was to survey the current analgesia and anesthesia practices used by total joint arthroplasty surgeon members of the American Association of Hip and Knee Surgeons (AAHKS).

METHODS: A survey of 28 questions was created and approved by the AAHKS Research Committee. The survey was distributed to all 2,208 board-certified adult reconstruction surgeon members of AAHKS in November 2018.

RESULTS: There were 622 responses (28.2%) to the survey. A majority of respondents (93.2%, n=576) use preemptive analgesia prior to total joint arthroplasty (TJA). Most respondents use a spinal for total knee arthroplasty (TKA) (74.4%) and for total hip arthroplasty (THA) (72.6%). A peripheral nerve block is routinely used by 68.7% of respondents in primary TKA. Periarticular injection or local infiltration anesthesia is routinely used by 80.3% of respondents for both TKA and THA patients. The average number of opioid pills prescribed postoperatively after TKA is 49 pills (range 0 - 200) and after THA is 44 pills (range 0 - 200). Most surgeons (58%) expect this prescription should last for 2 weeks. A majority of respondents (74.0%) use multimodal analgesics in addition to opioids.

CONCLUSION: There is no consensus regarding the optimal multimodal anesthetic and analgesic regimen for TJA among surveyed board-certified arthroplasty surgeon members of AAHKS. Understanding current practice patterns in anesthesia, analgesia, and opioid prescribing may serve as a platform for future work aimed at establishing best clinical practices of maximizing effective postoperative pain control and minimizing the risks associated with prescribing opioids.

Excellent Survivorship of 3-D Printed Metaphyseal Cones in Revision Total Knee Arthroplasties: An Expeditious and Safe Milling System

Abstract ID: Poster 027

---

*Matthew W. Tetreault, M.D.
Kevin I. Perry, M.D.
Mark W. Pagnano, M.D.
Arlen D. Hanssen, M.D.
Matthew P. Abdel, M.D.
Rochester, MN

INTRODUCTION: Metaphyseal fixation during revision total knee arthroplasties (TKAs) is important, but potentially challenging with historical cone designs. Material and manufacturing innovations have improved the size and shape of cones available, and simplified requisite bone preparation. In a very large series, we assessed implant survivorship, radiographic results, and clinical outcomes of new porous 3-D printed titanium metaphyseal cones featuring a reamer-based system.

METHODS: We reviewed 142 revision TKAs using 202 cones (134 tibial and 68 femoral) from 2015 to 2016. Sixty cases involved tibial and femoral cones. Most cones (149 of 202; 74%) were used for Type 2B or 3 bone loss. Mean age was 66 years, with 54% females. Mean BMI was 34 kg/m^2. Patients had a mean of 2.4 prior surgeries and 48% had a history of periprosthetic infection. Mean follow-up was 2 years.

RESULTS: At 2 years, survivorship free of cone revision for aseptic loosening was 100% and free of cone revision for any reason was 98%. Survivorships free of any component revision and any reoperation were 90% and 83%. Five cones had been revised at latest follow-up: 3 for infection, 1 for periprosthetic fracture, and 1 for aseptic tibial loosening. Radiographically, three unrevised femoral cones appeared loose in the presence of hinged implants, while the remainder of cones appeared stable. All cases of cone loosening occurred in Type 2B or 3 defects. Mean Knee Society scores improved from 50 preoperatively to 87 at latest follow-up ($p<0.001$). Three intraoperative fractures with cone impaction (two femoral, one tibial) all healed uneventfully.

CONCLUSION: Novel 3-D printed titanium cones, with an efficient mill system, yielded excellent early survivorship and few complications in difficult revision TKAs with severe bone loss. The diversity of cone options, relative ease of preparation, and outcomes rivaling prior cone designs support the continued use of these modern cones.

MIXED TOPICS

Is There a Safety Difference? A Comparison of Complication Rates Following Outpatient Total Joint Arthroplasty at a Hospital and Ambulatory Surgery Center

Abstract ID: Poster 028

Ritesh R. Shah, M.D. / Morton Grove, IL
*Stephanie Kaszuba, B.S. / Chicago, IL
Erdan Kayupov, M.D. / Chicago, IL
Nancy E. Cipparrone, M.A. / Morton Grove, IL

INTRODUCTION: With the popularity of outpatient total joint arthroplasty (TJA) growing and projections of explosive growth, concerns about safety remain. In a large 169,400 patient national database study, complication rates from hospital-based outpatient versus inpatient TJA were 8% and 16%, respectively. Recently, same day discharge following TJA from an ambulatory surgery center (ASC) has been shown to be safe. With an increasing emphasis on value-based care and bundled payment models and as surgeons choose an appropriate site of surgery for their risk-stratified patients, there are limited studies comparing the safety of same day discharge TJA in the hospital versus ASC. The aim of this study is to assess 30-day and 90-day complications, unplanned readmissions, and reoperations in patients who underwent outpatient THA and TKA at a freestanding ASC or in a hospital outpatient setting (HOP).

METHODS: A retrospective review was conducted of 222 outpatient TJAs performed by one orthopedic surgeon at an ASC (n=104) and in a hospital (n=118) with same-day discharge home using the same preoperative, intraoperative, and postoperative protocols. All complications, comorbidities, readmissions, and reoperations were recorded.

RESULTS: There were 132 THAs (HOP 66 and ASC 66) and 90 TKAs (HOP 52 and ASC 38). Gender, BMI, comorbidities, laterality, and operative times were similar. ASC group had a significantly lower and less variable postoperative recovery time in minutes to discharge home (141 ± 37 vs. 285 ± 114; $p < .01$), younger age (57 ± 9 vs. 63 ± 9 years; $p < .01$), and no ASA class 3 patients ($p < .01$; HOP had 15). There was no significant difference in overall 30-day and 90-day rates of complications, readmissions, or reoperations between HOP or ASC groups.

CONCLUSION: For a similar patient population, same day discharge TJA is equally safe in the hospital and free-standing ambulatory surgery center.

Mepivacaine vs. Bupivacaine Spinal: Urinary Retention, Pain, and Opioid Consumption after Primary Total Joint Arthroplasty

Abstract ID: Poster 029

---

*Julian Dilley, M.D.
Christian Sikoski, B.S.
Mary Ziemba-Davis, B.A.
Mark Nielson, M.D.
David Conrad, M.D.
R. Michael Meneghini, M.D.
Indianapolis, IN

BACKGROUND: Mepivacaine in intrathecal analgesia has recently been purported to reduce postoperative urinary retention (POUR) in total joint arthroplasty; however, existing studies are limited and the effect on pain control is inconclusive. The purpose of this study was to determine if mepivacaine reduces POUR in total hip (THA) and knee (TKA) arthroplasty compared to traditional bupivacaine, and if there are subsequent effects on pain control.

METHODS: 340 TKAs and 200 THAs consecutively performed by a single surgeon using identical pain control protocols, including intrathecal anesthesia were retrospectively reviewed. Outcomes included POUR, PACU pain per hour (PainPH), and morphine equivalents per hour (MeqH). Fifteen covariates including sex, history of urinary retention, kidney disease, BPH, chronic narcotic use, and spinal fentanyl dosage were controlled for. Univariate analysis of predictors was performed, followed by logistic or linear regression with $p \leq 0.25$.

RESULTS: 263 bupivacaine and 277 mepivacaine spinals resulted in POUR rates of 4.6% and 7.2%, respectively. POUR was unrelated to mepivacaine vs. bupivacaine spinal analgesia in univariate analysis of hips ($p=0.277$) and knees ($p=0.772$). PainPH was higher for mepivacaine in hips ($p=0.023$), but not knees ($p=0.147$). MeqH were greater for mepivacaine hips ($p=0.007$), but less for mepivacaine knees ($p=0.019$). In multivariate analysis controlling for other predictors, neither anesthetic was related to PainPH or MeqH in hips ($p \geq 0.611$) or knees ($p \geq 0.765$). POUR was greater in hips (12%) compared to knees (2.4%), with sex and age ($p<0.018$) predicting POUR in hips, with history of urinary retention ($p=0.016$) predicting POUR in knees.

CONCLUSION: Based on these data derived from robust multivariate analysis, mepivacaine does not decrease POUR after THA or TKA and has a negligible, if any, effect on early postoperative pain. Further study is warranted to determine the optimal perioperative anesthesia and analgesia that minimizes POUR, likely the single greatest barrier to outpatient arthroplasty.

Filling Opioid Prescriptions Preoperatively is a Risk Factor for Prolonged Postoperative Opioid Prescription Filling after Elbow Arthroscopy

Abstract ID: Poster 030

---

*Edward O. Rojas, B.S.
Zain M. Khazi, B.S.
Trevor R. Gulbrandsen, M.D.
Alan G. Shamrock, M.D.
Christopher A. Anthony, M.D.
Kyle R. Duchman, M.D.
Robert W. Westermann, M.D.
Brian R. Wolf, M.D., M.S.
Iowa City, IA

BACKGROUND/PURPOSE: The purpose of this study was to (1) report the frequency of postoperative opioid prescriptions following elbow arthroscopy, (2) evaluate if filling opioid prescriptions preoperatively puts patients at increased risk of requiring more opioid prescriptions after surgery, and (3) to determine patient factors associated with postoperative opioid prescription needs.

METHODS: A national claims-based database was queried for patients undergoing primary elbow arthroscopy. Patients with a history of total elbow arthroplasty or septic arthritis of the elbow were excluded from the study. Subjects who filled one or more opioid prescriptions between one and four months prior to surgery were defined as the preoperative opioid group. Monthly relative risk ratios for filling an opioid prescription were calculated for the first year following surgery. Multiple logistic regression analysis was used to identify factors associated with opioid use at 3, 6, 9, and 12 months after elbow arthroscopy.

RESULTS: There were 1,138 patients who underwent primary elbow arthroscopy and were included in the study. The preoperative opioid group consisted of 245 patients (21.5%), while 61 of these patients (24.9%) were still filling opioid prescriptions 12 months after surgery. The multivariate analysis determined that the preoperative opioid group was at increased risk for postoperative opioid prescription filling at three months (OR, 9.02, 95% CI:5.98-13.76), six months (OR, 8.74, 95% CI:5.57-13.92), nine months (OR, 7.17, 95% CI:4.57-11.39) and 12 months (OR, 6.27, 95% CI:3.94-10.07) following elbow arthroscopy. Patients younger than 40 years of age exhibited a decreased risk for filling a postoperative opioid prescription at 3 months (OR, 0.49, 95% CI:0.25-0.91), 6 months (OR, 0.19, 95% CI:0.06-0.50), 9 months (OR, 0.48, 95% CI:0.22-0.97), and 12 months (OR, 0.44, 95% CI:0.19-0.94) postoperatively.

CONCLUSIONS: Preoperative filling of opioid medication prescriptions is associated with increased risk of prolonged postoperative opioid prescription filling in the first year following elbow arthroscopy. Patient age less than 40 years old is associated with decreased risk of postoperative opioid prescription filling within the first postoperative year.

High Prevalence of Connective Tissue Gene Variants in Professional Ballet

Abstract ID: Poster 031

---

*Angelina M. Vera, M.D.
Leif E. Peterson, Ph.D.
David Dong, B.S.
Varan Haghshenas, M.D.
Thomas R. Yetter, B.S.
Domenica A. Delgado, B.S.
Patrick C. McCulloch, M.D.
Kevin E. Varner, M.D.
Joshua D. Harris, M.D.
Houston, TX

BACKGROUND: There is a high prevalence of hypermobility spectrum disorder (HSD) in dancers. While there is no known genetic variant for HSD, Hypermobile Ehlers-Danlos Syndrome (hEDS) is a genetic disorder that exists within HSD. There are many connective tissue disorders (CTD) with known (and unknown) genes associated with hypermobility. Hypermobility has distinct advantages for participation in flexibility sports, including ballet.

PURPOSE: To determine the prevalence of gene variants associated with hypermobility in a large professional ballet company.

METHODS: In this cross-sectional investigation, 51 professional male and female dancers from a large metropolitan ballet company were offered participation after informed consent. Whole blood was obtained from peripheral venipuncture and deoxyribonucleic acid (DNA) was isolated. Isolated DNA was subsequently enriched for the coding exons of 60 different genes associated with CTD that included hypermobility as a phenotype including: Ehlers-Danlos syndromes, osteogenesis imperfecta, Marfan's syndrome, and others. Genes were targeted using hybrid capture technology. Prepared DNA libraries were then sequenced using Next Generation Sequencing technology. The genetic database search tool (http://useast.ensembl.org/) was used to query specific variants. Descriptive statistics were calculated.

RESULTS: Thirty-two dancers (32/51=63%) agreed to participate in DNA analysis (mean age 24.3±4.4 years; 18 male, 14 female). The remaining 19 declined the blood draw. Twenty-eight dancers (28/32) had at least one variant in the 60 genes tested, 88% prevalence. A total of 80 variants were found. A variant in 26 of the 60 genes were found in at least one dancer. Sixteen variants in the TTN gene; ten in ZNF469; five in RYR1; four in COL12A1; three in ABCC6 and COL6A2; two in ADAMTS2, CBS, COL1A2, COL6A3, SLC2A10, TNC, and TNXB; and one in ATP6V0A2, B4GALT7, BMP1, COL11A1, COL5A2, COL6A1, DSE, FBN1, FBN2, NOTCH1, PRDM5, SMAD3, and TGFBR1 were found in 28 dancers. Nine variants found in this population have never been reported. No identified variant was identical to any other variant. No identified variant was known to be disease-causing. In the general population, the prevalence of each variant ranges from never reported to 0.33%. In the study population, the prevalence of each variant was 3.13%. There was no association between hypermobility scores and genetic variants.

CONCLUSION: Genetic variants in hypermobility associated genes are highly prevalent (88%)

in professional ballet dancers. This may significantly account for the high degree of motion in this population.

Factors Influencing Subspecialty Choice of Orthopedic Residents: Effect of Gender, Year in Residency, and Presumptive Subspecialty

Abstract ID: Poster 032

Bennet A. Butler, M.D.
Daniel J. Johnson, M.D.
Robert A. Christian, M.D.
*Stephen D. Bigach, M.D.
Matthew D. Beal, M.D.
Terrance D. Peabody, M.D.
Chicago, IL

OBJECTIVE: Subspecialty training is a common part of orthopedic surgical training. The factors which influence resident subspecialty choice have important residency design and workforce implications. Our objective was to present survey data gathered from orthopedic residents regarding their fellowship plans and relative importance of factors which influence those plans.

DESIGN: An anonymous online survey tool was developed and distributed to orthopedic residents through their program directors.

SETTING: Academic institutions across the country with orthopedic surgery residency programs.

PARTICIPANTS: Orthopedic surgery residents.

RESULTS: 227 residents completed the survey. 97% planned to pursue fellowship training after residency. The most common presumptive subspecialties were sports (29.7%), joints (17.3%), and shoulder/elbow (12.8%). The majority of senior residents (57%) reported that their subspecialty choice had changed during residency. When making their choice of subspecialty, residents were most influenced by their experiences working on the subspecialty service in question, their experiences working with a mentor, and intellectual interest. The factors influencing their choice were affected by gender, residency year, and presumptive subspecialty.

CONCLUSIONS: The most critical factors influencing subspecialty choice of orthopedic residents included experiences in rotations as a resident, intellectual interest, and mentors in certain subspecialties. Factors influencing subspecialty choice changes over the course of residency and differ between male and female residents. This information may be useful for residency design, mentorship structuring, career counseling, and for addressing subspecialty surpluses or shortages which arise in the future.

Perceptions of Polymethylmethacrylate (PMMA) Cement Exposure Among Female Orthopedic Surgeons

Abstract ID: Poster 033

---

*Rachel Bratescu, M.D.
David Dong, B.S.
Shari Liberman, M.D.
Stephen Incavo, M.D.
Katharine Harper, M.D.
Houston, TX

BACKGROUND: Polymethylmethacrylate (PMMA) cement is a commonly used polymer in orthopedic surgery, prevalent in joint arthroplasty and trauma. The current belief is that exposure to vapors of this polymer are dangerous to the growing fetus and pregnant women should avoid exposure. There exists a very small number of vapor exposure studies performed on fetuses in animal models. These investigations found no increase in birth defects, concluding that exposure is unlikely to be teratogenic.

PURPOSE: To investigate how PMMA cement exposure during pregnancy for female orthopedic surgeons influences (1) currently held beliefs and practices and (2) whether or not these contribute to clinical and career choices.

METHODS: A 23-question survey collected via SurveyMonkey© was distributed via e-mail to all active members of the Ruth Jackson Orthopaedic Society (RJOS) and a private internet-based social media platform group for women in orthopedics. Questions consisted of age, level of training, current usage of PMMA, previous exposure during pregnancy and/or breastfeeding, and beliefs regarding current or future willingness of exposure during pregnancy. Questions were also asked regarding specific PMMA training and whether personal beliefs influenced specialty choice. Spearman's rank correlation coefficient was utilized to assess statistical dependence between survey responses.

RESULTS: Two-hundred and forty female orthopedic surgeons completed the study (48% of respondents were between 35-44 years of age; 74.1% were attending surgeons). 73.1% currently utilize PMMA in training/practice, and 90.6% of survey respondents reported awareness of risks surrounding PMMA in pregnancy. PMMA training was found to have a weak positive correlation ($r=0.226$, $p=0.014$) with those that chose to leave the operating room during a previous pregnancy. Level of training had a weak positive correlation ($r=0.308$, $p=0.002$) with covering a case that utilized PMMA, meaning that seniority did not have an effect on whether respondents chose to leave when cement was being utilized.

CONCLUSIONS: Surgeons that received PMMA training were more likely to remain in the operating room during its use, while those that did not were more likely to leave. Experience level did not have an effect on whether respondents chose to leave when cement was being utilized. There is no data currently available to support the recommendation of pregnant or breastfeeding women to leave the operating room during PMMA use.

Use of Natural Language Processing Algorithms to Identify Common Elements in Operative Notes for Total Hip Arthroplasty

Abstract ID: Poster 034

---

*Cody C. Wyles, M.D.
Meagan E. Tibbo, M.D.
Sunyang Fu, M.H.I.
Yanshan Wang, Ph.D.
Sunghwan Sohn, Ph.D.
Daniel J. Berry, M.D.
David G. Lewallen, M.D.
Hilal Maradit-Kremers, M.D., MSc
Rochester, MN

BACKGROUND: Manual chart review is labor-intensive and requires specialized knowledge possessed by highly-trained medical professionals. Natural language processing (NLP) tools are distinctive in their ability to extract critical information from raw text in electronic health records (EHR). As a proof-of-concept for the potential application of this technology in orthopedic surgery, we examined its ability to correctly identify common elements described by surgeons in operative notes for total hip arthroplasty (THA).

METHODS: We initially evaluated 1,842 randomly selected primary THA performed at a single academic institution from 2000-2015. A training sample (n=1,017) of these operative reports was selected to develop prototype NLP algorithms and the remaining (n=825) operative reports were used as the test sample. Three separate algorithms were created with rules aimed at capturing (1) operative approach, (2) THA fixation method, and (3) bearing surface category. Training and testing cohorts included a representative sample of all surgical approaches, fixation methods, and bearing surface categories present in our total joint registry. The algorithms were then applied to operative notes for evaluating language used by surgeons to identify the three outcomes of interest (for example, posterior approach; uncemented fixation; ceramic-on-polyethylene bearing surface).The algorithms were applied to operative notes for evaluating language used by 29 different surgeons at our center and validated with application to EHR data from 422 operative notes derived from outside facilities to determine external validity. Accuracy statistics were calculated with 95% confidence intervals (CI) using manual chart review as the gold standard.

RESULTS: Evaluation of operative approach demonstrated an accuracy of 99.2% (CI=97.1%-99.9%). Evaluation of THA fixation technique demonstrated an accuracy of 90.7% (CI=86.8%-93.8%). Evaluation of THA bearing surface demonstrated an accuracy of 95.8% (CI=92.7%-97.8%). Additionally, the NLP algorithms applied to operative reports from other institutions yielded comparable performance with an accuracy of 94.4% for operative approach, 95.6% for fixation technique, and 98.0% for bearing surface, demonstrating external validity.

CONCLUSION: NLP-enabled algorithms are a promising alternative to the current gold standard of manual chart review for identifying common data elements from orthopedic operative notes. NLP algorithms demonstrated excellent, although not perfect accuracy in delineating common elements that are typically described in THA operative notes. This study provides a proof-of-concept for use of NLP techniques in clinical research studies and registry development

endeavors to reliably extract data of interest from very large unstructured data sets in an expeditious and cost-effective manner.

Review of Clinical Outcomes in Patients Requiring Long-Term Antibiotic Treatment for the Management of Orthopedic Infections in Patients with a History of Recreational Intravenous Drug Use (RIVDU)

Abstract ID: Poster 35

---

*Erin L. Stockwell, M.D.
Kent Rinehart, M.D.
Angela Hewlett, M.D.
Philipp Streubel, M.D.
Omaha, NE

INTRODUCTION: Treatment of bone and joint infections generally requires prolonged intravenous antibiotic therapy, which is traditionally administered in an outpatient setting. There is a paucity of data addressing outpatient antibiotic therapy in recreational IV drug users (RIVDU). This study aims to review clinical outcomes in RIVDU who require long-term antibiotics to treat orthopedic infections and to compare outcomes between those who received exclusively inpatient antibiotic therapy and those who received outpatient antibiotic therapy.

METHODS: A retrospective review of all patients admitted to a single academic medical center between 01/01/2011 and 12/31/18 with a diagnosis of one infection of interest (epidural abscess, osteomyelitis, prosthetic joint infection, septic arthritis) as well as a diagnosis of substance use (n=291). Only patients with a history of RIVDU were included in the study (n=41). Five cohorts were established based on location of antibiotic administration: exclusively inpatient IV therapy (n=12), home with home healthcare IV therapy (n=3), home with oral medications (n=11), infusion center IV therapy (n=9), skilled nursing facility IV therapy (n=6). These five cohorts were then compared by evaluating mean hospital length of stay, resolution of infection at 6 or 12 months, compliance with therapy, readmission rates, catheter complications, and loss to follow up.

RESULTS: The inpatient therapy cohort had a median length of stay (LOS) of 41 days, which was significantly longer than all other cohorts ($p<0.0001$). At 6 month follow-up, the inpatient cohort had 100% resolution of infection, which was significantly better than the resolution of all other cohorts ($p=0.0019$). The inpatient cohort also had lower readmission rates in the seven-year study period (n=1/12) compared to the other cohorts (p.0013). There was no difference in the five patient cohorts with regards to resolution of infection by 12 months, catheter complications, or loss to follow-up.

DISCUSSION: RIVDU who suffer from bone or joint infections have not been given adequate attention in the orthopedic or infectious disease literature. They demand more complex medical decision making and suffer from more severe medical comorbidities. This study shows that patients who use IV drugs have better clinical outcomes when they remain inpatient for the duration of their treatment. However, this places an increased cost burden on the healthcare system. This study demonstrates that more research is needed to determine how this patient population can achieve equivalent clinical outcomes while still discharging from the hospital in a timely manner.

Industry Payments in Orthopedic Surgery: A Four-Year Analysis of the Open Payments Database

Abstract ID: Poster 036

---

*Neil Pathak, B.S.
Vineet Tyagi, M.D.
Logan S. Petit, M.D., M.P.H.
Rohil Malpani, B.S.
Ari S. Hilibrand
Arya G. Varthi, M.D.
Lee E. Rubin, M.D.
Jonathan N. Grauer, M.D.
New Haven, CT

INTRODUCTION: The Open Payments Database (OPD) is a national registry of physician-industry transactions, classified as General, Ownership, or Research. There has been a lack of investigations studying orthopedic surgeon-industry payment trends over the years of OPD data available. The present study aims to characterize and investigate trends in industry payments to orthopedic surgeons from 2014-2017.

METHODS: All orthopedic surgeon payments were characterized by number of transactions, cumulative total, and category (General, Ownership, Research). General payments were analyzed for number of compensated surgeons, median payment per surgeon, top strata of compensated surgeons, sub-type, and census region by year. Research and Ownership payments were assessed annually for median payments. Mann Whitney-U tests were performed for payment trend analyses.

RESULTS: In total, 1.2M General, Research, and Ownership payments to orthopedic surgeons were reported from 2014-2017 (cumulative total: $2.1B). The majority were classified as General (81%), followed by Ownership (18%) and Research (1%).

From 2014 to 2017, the number of orthopedic surgeons receiving General industry payments increased (22,270 to 23,135). When using the 2014 median payment per surgeon ($385) as a baseline, there was an increase in median payment in later years: $405 in 2015 ($p=0.188$); $480 in 2016 ($p<0.001$); $460 in 2017 ($p<0.001$). The top 0.1% of compensated orthopedic surgeons received 61% of the total General industry dollars (averaged across 2014-2017).

The median General payment increased over the four years for education ($p<0.001$), gifts ($p<0.001$), entertainment ($p=0.047$), honoraria ($p<0.001$), consulting fees ($p<0.001$), speaker fees/serving as faculty ($p=0.024$), and travel/lodging ($p=0.025$) sub-types. Median payments in the Midwest, Northeast, and South census regions increased from 2014-2017.

Fewer Research and Ownership payments were made. The median Research payment per surgeon increased from 2014-2017 ($p<0.001$), while the median Ownership payment per surgeon remained stable ($p=0.056$).

CONCLUSION: Many expected industry compensation to surgeons to decrease after the public release of OPD. However, the present study showed an increase in median General and Research payment, and no change in median Ownership payment per compensated orthopedic

surgeon from 2014-2017. These findings are important to note in the current era of increased transparency between physicians and industry.

Certain Irrigation Solutions Negatively Affect the Viability and Function of Human Fibroblasts: An In-Vitro Study

Abstract ID: Poster 037

---

*David C. Markel, M.D. / Southfield, MI
Therese Bou-Akl, M.D., Ph.D. / Southfield, MI
Wei-Peng Ren, M.D., Ph.D. / Southfield, MI
Paula Dietz / Southfield, MI
David A. Sosnoski, Jr. / Royal Oak, MI

INTRODUCTION: Multiple irrigation solutions used within orthopedic surgeries have been used universally, with limited studies on their lasting effects on human tissues. The purpose of this work is to investigate the cytotoxic effect of irrigation solutions Bacitracin, Clorpactin (sodium oxychlorosene), Irrisept (0.05% chlorhexidine gluconate), and Bactisure on 3D cultures of human fibroblasts.

METHODS: Three independent experiments with 6 replicates for each condition were tested: control (normal saline), Bacitracin (33 IU/ml), Clorpactin (0.2%), IrriSept (0.05%CHG), and Bacitracin. Human fibroblast cells were cultured for two weeks to form sheets. Each treatment solution was applied for 4 minutes, then washed 3 consecutive times with warm normal saline, followed by supplementation with fresh medium. After 48 hours, the culture medium was replaced with 10 vol% AlamarBlue medium and incubated for 1 hour. Absorbance was measured at 570nm using 600nm as a reference and percent reduction of AlamarBlue was then calculated. Cells were supplemented with fresh medium thereafter, and repeated after another 48 hours.

RESULTS: All results were compared to the control. Percent reduction of AlamarBlue was similar to the control for the Bacitracin group, and slightly reduced for the Clorpactin group (by 18-20%). In the Irrisept and Bactisure-treated groups, the percent reduction was over 95% less than the control (Irrisept p=8.02x10-30, Bactisure p=1.01x10-30). Day 5 post-treatment was congruent as well (Irrisept p=2.21x10-24, Bactisure p=1.35x10-23).

CONCLUSIONS: Using percent reduction calculations as a measure of cell function, the Bacitracin group demonstrated similar cell function to the saline control group. Clorpactin-treated fibroblasts had slightly inhibited cell function; however, cell function of Irrisept and Bactisure groups was severely inhibited. These findings demonstrate significant dysfunction of cells following the use of certain perioperative washing solutions, potentially playing a role in the recovery of cells following surgery.

Aerobic Synovial Cultures Provide Greatest Diagnostic Value for Adult Septic Arthritis: A Retrospective Review of 596 Patients

Abstract ID: Poster 038

---

*Brian D. Wahlig, B.S.
Dustin Rinehart, M.D.
Joshua J. Sun, B.S.
Alejandro Diaz de Leon
Brigham Au, M.D.
Michael H. Huo, M.D.
Dallas, TX

INTRODUCTION: Septic arthritis is an urgent orthopedic problem. Definitive diagnosis of septic arthritis has relied on the synovial fluid culture results. Previous reports in the pediatric patient population demonstrated that the yield of the non-aerobic synovial fluid cultures was poor. The purpose of this study was to assess the validity of the standardized culture protocol in a large adult patient population.

METHODS: Synovial fluid samples are routinely processed for four standard cultures at our institution, including: aerobic, anaerobic, fungal, and acid-fast bacilli (AFB). In some cases, blood cultures were obtained as well. Data from the cultures, synovial fluid analysis, and patient characteristics were collected from the patients who were treated surgically for septic arthritis at our institution from 2010-2018. A Poisson regression was used to compare the positive culture rates among the different sites of the septic joints, as well as among the various culture methods. False Discovery Rate (FDR) procedure was used to control for the false positive results.

RESULTS: 596 patients were included in the study. There were 3689 cultures processed including: 1002 aerobic, 998 anaerobic, 822 fungal, 603 AFB, and 264 blood cultures. Positive culture results were documented in 615 of 1002 aerobic (61.4%), 38 of 998 anaerobic (3.8%), 6 of 822 fungal (0.7%), 4 of 603 AFB (0.7%), and 125 of 264 blood (47.3%) cultures, respectively. Oxacillin-sensitive Staphylococcus aureus was the most frequency isolated organism from synovial cultures (34.9%) followed by methicillin-resistant Staphylococcus aureus (21.5%) and Streptococcus agalactiae (9.6%). Those patients with a positive anaerobic, fungal, or AFB culture were identified to have certain risk factor characteristics: immunosuppression, existing implant hardwares, or sustaining a penetrating injury into the joint.

CONCLUSION: Our data confirmed what had been previously reported in the pediatric septic arthritis patient population: the anaerobic, fungal, and AFB cultures were not necessary in most of the patients suspected of septic arthritis if there are no risk factors. Selective use of the other culture methods may reduce the costs, resource utilization, and potential false positive results.

Pre-Aspirate Predictors of Adult Septic Arthritis of the Knee, A Retrospective Review of Suspected Septic Arthritis of the Knee

Abstract ID: Poster 039

---

*Adam M. Holzmeister, M.D. / Maywood, IL
William D. Lack, M.D. / Seattle, WA
Frank F. N. Yuan / Maywood, IL
Joseph J. Frazzetta / Maywood, IL

BACKGROUND: Diagnosis and workup of suspected native septic arthritis in the adult population is challenging. While there is established and validated diagnostic criteria in the pediatric population for septic arthritis of the hip, none such exists in the adult population. Additionally, in this population, little has been written about risk for septic arthritis prior to obtaining a synovial fluid aspirate. We investigated pre-aspirate risk factors for septic arthritis.

METHODS: A total of 455 cases of suspected native septic arthritis of the knee in the adult population from 2012-2017 were evaluated for risk factors associated with a confirmed diagnosis of native septic arthritis of the knee. Demographic, history, physical, and laboratory data as well as comorbidities based on the Charlston Comorbidity Index (CCI) were collected for each case. Each diagnostic variable underwent univariate analysis for risk of septic arthritis. Variables with a significant univariate association were then analyzed in a multivariate analysis.

RESULTS: After a multivariate analysis, the following pre-aspirate variables had a significant association with adult native septic arthritis of the knee: history of prior septic arthritis ($p < 0.001$), no evidence or history of crystal arthropathy ($p < 0.001$), total range of motion less than 90 degrees or painless range of motion less than 75 degrees ($p < 0.001$), erythrocyte sedimentation rate (ESR) greater than 39, or C-reactive protein (CRP) greater than 7 ($p < 0.003$), history of a fever ($p < 0.052$), clinical effusion ($p < 0.009$). The use of a multivariate risk assessment calculator allowed the identification of three groups with differential risks for septic arthritis of the knee; a low risk group (1/189, 0.53%), an intermediate risk group (19/179, 12.5%), and a high risk group (35/87, 40.23%).

CONCLUSION: We identified risk factors for native septic arthritis of the knee in the adult population prior to aspirate analysis. This important diagnostic information provides insight into which patients are at risk for septic arthritis and thus necessitate further diagnostic workup of orthopedic consultation and aspirate analysis.

Patient Preferences for Orthopedic Surgeon Greetings

Abstract ID: Poster 040

---

*Andrew G. Golz, M.D.
Andrew Kim, M.S.
Michael Murphy, M.D.
Dane H. Salazar, M.D.
Maywood, IL

INTRODUCTION: Communication behaviors and presentation are an integral part of the patient-physician relationship and in determining satisfaction. Several studies have investigated greeting preferences in various medical specialties. However, no such study has been performed on patient preferences for greetings and handshakes in the orthopedic outpatient setting. The purpose of this study was to determine patient preferences for greetings by their orthopedic surgeon and if there is an association with demographics.

METHODS: A survey was generated with ranking and Likert scale questions concerning the initial patient-orthopedic surgeon outpatient interaction. Questions concerning demographics included age, gender, ethnicity, education, employment status, insurance status, and urban versus rural zip code. The survey was offered to new patients at an urban, academic outpatient orthopedic surgery clinic.

RESULTS: Completed surveys were collected from 160 patients. Overall, patients deemed their orthopedic surgeon's introduction as moderately important, with Hispanic and African American patients placing a higher priority on the greeting than Caucasian patients ($p = 0.001$ and $p = 0.019$, respectively). The physician introduction was deemed more important than appearance and attire ($p < 0.001$), but ranking of introduction was not related to any demographic variable. Subjects preferred a more formal introduction by their physician, with the use of title and first and last name preferred to the physician's first name only ($p< 0.001$), first and last name ($p < 0.001$), and title and last name only ($p < 0.001$). Patients strongly preferred their physician address them by their first name only compared to first and last name ($p < 0.001$), title and last name ($p <0.001$), and title and first and last names ($p < 0.001$). African American and Hispanic patients preferred to be addressed more formally compared to Caucasian patients ($p<0.001$ and $p=0.016$, respectively). Unemployed patients also preferred to be addressed in a more formal manner compared to fully employed subjects ($p=0.028$). Shaking hands was determined to be moderately important and did not vary by any demographic category.

CONCLUSION: Patients considered their orthopedic surgeon's greeting less important than medical knowledge but more important than their appearance and attire. Subjects preferred their orthopedic surgeon introduce themselves with their title, first name, and last name but use the patient's first name only. Hispanic and African American patients placed a higher priority on their initial greeting with their orthopedic surgeon and wished to be addressed in a more formal manner than Caucasian patients.

Implementation and Maintenance of an Established Clinical Decision Support Tool Algorithm: Challenges and Recommendations

Abstract ID: Poster 041

Michelle A. Padley, M.S.
*Tyler S. Madden, B.S.
Joseph T. Brown, D.O.
Jacob Hall, B.S.
Matthew J. Pate, B.S.
Parin Kothari, B.S.
Grand Rapids, MI

BACKGROUND: Computerized clinical decision support systems (CDSS) offer predictive statistical measurements of patient outcomes to clinicians through the use of amalgamated data. This information guides diagnosis and treatment discussion, which may lead to improved patient outcomes and may serve as a reliable indicator of how a patient will fare following treatment. Currently, CDSS have several issues that prevent them from being optimized in practice. The focus of this study is to investigate the usability and reliability of an established CDSS at a pilot site and to assemble recommendations in order to implement a CDSS at other organizations.

METHODS: This was a prospective cohort study involving the use of a clinical decision support tool algorithm (CDSTA) in managing patients with lumbar degenerative spondylolisthesis (LDS) (grades I-II). The CDSTA was originally developed at an outside institution and correlates patient demographics, risk factors such as comorbidities, and pre-surgical pain scores with post-surgical outcomes. The CDSTA was incorporated at the pilot site in collecting the same pre- and post-surgical information. Patients were asked to complete surveys via phone, online portal, and/or in-person at 6 weeks, 3 months, 6 months, and 12 months following the initial diagnosis of LDS. The primary measurement was provider and patient feedback on the practical usability and reliability of the CDSTA.

RESULTS: A total of 50 patients were enrolled in the study. Physicians reported that in 100% of patients, the CDSTA could help discuss surgical options. In 78% of patients, physicians agreed that it could help make the decision to recommend surgery. Physicians agreed with CDSTA outcome predictions in 96% of patients. Various challenges have been identified concerning CDSTA usability. The main stumbling point remains communication between the clinical and IT staff. This was demonstrated through technical language barriers, reluctance of clinicians to adapt to the CDSTA in addition to typical daily workflow, standard of care clinical documentation integration, and CDSTA backend updating without sufficient notification to the users.

CONCLUSION: CDSS provide an opportunity for innovative discussions with patients in predicting surgical outcomes. Although the CDSTA at the pilot site demonstrated reliability in enhancing these discussions, several challenges arose with incorporating it into practice. The most significant lesson is to maintain open lines of dialogue between the developer and pilot site to allow for seamless CDSS integration into practice and minimize technical downtime.

SPORTS

Preoperative Performance of Patient Reported Outcomes Measurement Information System in Patients with Meniscal Root Tears

Abstract ID: Poster 042

---

*Trevor R. Gulbrandsen, M.D. / Iowa City, IA
Zain M. Khazi, B.S. / Iowa City, IA
Matthew J. Bollier, M.D. / Iowa City, IA
Brian R. Wolf, M.D., M.S. / Iowa City, IA
Christopher M. Larson, M.D. / Minneapolis, MN
Kyle R. Duchman, M.D. / Iowa City, IA
Qiang An, M.B.B.S., M.P.H. / Iowa City, IA
Robert W. Westermann, M.D. / Iowa City, IA

INTRODUCTION: Meniscal root tears (MRT) are a subset of meniscal injuries with recent advancements in diagnosis and treatment. The Patient-Reported Outcome Measurement Information System (PROMIS) was developed by the National Institute of Health as a dynamic patient reported outcome tool that incorporates real time comparison of responses to individual questions and relationships between health domains. This allows for more selected questions, which reduces time, cost, and question burden. The purpose of this study is to establish the preoperative validity of PROMIS physical function computer adaptive test (PF-CAT) for patients with MRT.

METHODS: 51 patients (52 knees) with MRT were enrolled and completed the PROMIS PF-CAT, Short Form 36 Health survey (SF-36 physical function [PF]), pain, general health), Knee Injury and Osteoarthritis Outcome Score (KOOS pain, symptoms, activities of daily living [ADLs], sports, and quality of life [QOL]), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC pain, stiffness, and function), and EuroQol-5 dimensions (EQ-5D) questionnaires at their preoperative visit. Correlations between PROMIS PF-CAT and patient-reported outcome modalities were evaluated along with floor and ceiling effects. Relationships were compared using Spearman's correlation with guidelines consisting of a correlation coefficient of 0.2-0.39 for weak, 0.4-0.59 for moderate, 0.6-0.79 for strong, and 0.8-1.0 for very strong.

RESULTS: Of the 51 patients, 31 (60.8%) were female with a mean age of 38.9 ± 17.9 years and a mean BMI of 30 ± 7.3. There were 37 medial, 14 lateral, and 1 multi-compartmental MRT. 0-2 Outerbridge classification of the given compartment was most common consisting of 81% of the given knee compartments, while 19% were 3-4. Preoperative data showed that the PROMIS PF-CAT had a strong correlation with SF36-PF, KOOS ADL, WOMAC Function, and EQ-5D and a moderate-correlation with KOOS Sports, KOOS Pain, KOOS Symptoms, KOOS QOL, WOMAC Pain, and WOMAC Stiffness. On average, 4.15 ± 0.72 PROMIS PF-CAT questions were answered. PROMIS PF-CAT had the fewest ceiling or floor effects of all instruments tested.

CONCLUSIONS: The PROMIS PF-CAT is a valuable tool to assess physical function in preoperative patients with meniscus root tears. It correlates strongly with other well-established patient-reported outcome modalities including the SF36-PF, EQ-5D, and various domains of the KOOS questionnaire. It also demonstrated no floor or ceiling effects. PROMIS PF-CAT may

prove as a valuable and more efficient patient-reported outcomes instrument.prove as a valuable and more efficient patient-reported outcomes instrument.

Education Pilot Study: Perceptions of Overlapping Surgery in an Orthopedic Sports Medicine Population

Abstract ID: Poster 043

---

*Robert N. Matar, M.D.
Brian Johnson
Brian M. Grawe, M.D.
Cincinnati, OH

PURPOSE: To determine the understanding and changes in perception of overlapping surgery practices in orthopedic sports medicine patients at a single institution.

METHODS: This is an ongoing study at a tertiary academic medical center. After IRB approval, all patients who visit the clinic with a chief complaint of shoulder pain are given a 15-question survey adopted from Evans et al. The initial 15-question survey will be meant to assess demographics, pre-existing knowledge on the practice of overlapping surgery, and their perception of it. They will immediately read a statement on the practice of overlapping surgery. After reading the statement, patients will be re-evaluated on their level of concern.

RESULTS: A total of 38 patients (23 females, 15 males) completed the survey. Mean age was 53.8 years (range, 21-80). 16 out of the 38 patients (42.1%) had no knowledge on the practice of overlapping surgery. 11 out of 38 (28.9%) reported their level of concern as a 1, corresponding to the lowest level of concern. Overall, 30 out of the 38 (79.0%) patients reported a level of concern of 3 (median) or lower, indicating a low mean level of concern. 35 out of the 38 (92.1%) patients reported either a decrease or no change in level of concern after reading an educational statement on overlapping surgery practices. 27 out of 30 (71.0%) believed there would be no impact if overlapping surgery was performed. If a patient reported concern, the most common reasons cited were that the attending physician may not be available during the whole case (25%), that a Resident, Fellow, or Physician Assistant may jeopardize the patient's care (38%), or that a critical step will be missed (31%).

CONCLUSION: This ongoing study demonstrates that nearly half of the participants had no familiarity with the practice of overlapping surgery and that the majority had a relatively low level of concern. Furthermore, the vast majority of patients had reported a reduction in the level of concern after reading an educational statement. Education and disclosure of its practice may prove to be an integral part of the routine perioperative counseling.

Preoperative Opioid Use is Associated with Postoperative Opioid Use and Inferior Clinical Outcomes after Shoulder Stabilization Surgery

Abstract ID: Poster 044

Zain M. Khazi, B.S.
*Alan G. Shamrock, M.D.
Christina J. Hajewski, M.D.
Natalie A. Glass, Ph.D.
Kyle R. Duchman, M.D.
Matthew J. Bollier, M.D.
Robert W. Westermann, M.D.
Brian R. Wolf, M.D., M.S.
Iowa City, IA

INTRODUCTION: The purpose of this study was to investigate the association of preoperative opioid consumption and patient reported outcomes while identifying risk factors for postoperative opioid use in patients undergoing shoulder stabilization surgery.

METHODS: A retrospective analysis of 123 patients undergoing shoulder stabilization surgery with a minimum of 2 years of follow-up was performed using a prospectively collected shoulder instability registry. Patients were categorized as opioid naïve (n=103) if they did not use opioids within 3 months before surgery or preoperative opioid users (n=20) if they did. Postoperative opioid use was assessed for all patients at 2 and 6 weeks after surgery. Western Ontario Shoulder Instability (WOSI) index questionnaire was administered at baseline as well as 6 months and 2 years after surgery.

RESULTS: There was no difference between the two groups in gender ($p=0.7189$), age ($p=0.4121$), or body mass index ($p=0.3764$). Preoperative opioid use was identified as an independent risk factor for postoperative opioid use at 2 weeks ($p=0.0001$) and 6 weeks ($p<0.0001$) following surgery. Preoperative opioid use was associated with lower WOSI scores at baseline ($p=0.0001$, 6 months ($p=0.0004$), and 2 years ($p<0.0001$) postoperatively. Both groups significantly improved from baseline WOSI scores at 6 months ($p<0.0001$) and 2 years ($p<0.0001$) postoperatively. Regardless of preoperative opioid use, opioid use at 6 weeks after surgery was associated with inferior WOSI scores at 6 months ($p<0.0001$) and 2 years ($p<0.0001$) postoperatively.

CONCLUSION: In patients undergoing shoulder stabilization surgery, preoperative opioid use was an independent risk factor for postoperative use. Additionally, preoperative opioid use was associated with worse WOSI scores up to 2 years postoperatively.

Does Preoperative Patella Alta Affect the Outcomes of Patellofemoral Arthroplasty?

Abstract ID: Poster 045

Christopher D. Bernard, B.S
Ayoosh Pareek, M.D.
Orlando D. Sabbag, M.D.
Chad W. Parkes, M.D.
*Lucas K. Keyt, B.S.
Matthew D. LaPrade, B.S.
Aaron J. Krych, M.D.
Nancy Cummings, M.D.
Diane L. Dahm, M.D.
Rochester, MN

INTRODUCTION: The purpose of this study was to evaluate the effect of preoperative patella alta on clinical outcomes, survivorship, and complication and reoperation rates on patellofemoral arthroplasty (PFA).

METHODS: All patients who underwent PFA for isolated patellofemoral arthritis by a single surgeon at our institution were identified. Preoperative radiographs were measured by two independent observers for patellar height using the Caton Deschamps (CD), Insall-Salvati (IS), and Blackburne-Peele (BP) methods. Patients were classified as either “patella alta” or “non-patella alta” for all three measurement methods. Clinical scores including KSS Pain, KSS Function, and Tegner Activity Scores were collected pre- and postoperatively. Failure was defined as conversion to total knee arthroplasty (TKA). Clinical outcomes and survivorship were compared between patients with “patella alta” and “non-patella alta” height measurements.

RESULTS: There were 119 patients with 153 knees (86% female) included in the study with a mean age of 55.8 years. Outcome scores improved from preoperative to postoperative for both patella alta and non-patella alta patients for Tegner, KSS pain, and KSS function scores. The mean change in Tegner scores for patella alta and non-patella alta patients were not significantly different for CD (p=0.24), IS (p=0.25), or BP measurements (p=0.39). The mean change in KSS pain scores between groups were not significantly different for CD (p=0.33) or IS measurements (p=0.22), but was improved more significantly in patella alta patients vs non-patella alta patients (21.2 and 14.4; p=0.02) for BP measurement. The mean change in KSS function scores between groups was not significantly different for CD (p=0.61) IS (p=0.90), or BP measurements (p=0.79). The overall survivorship from conversion to total knee arthroplasty (TKA) was 94.1% at a mean follow-up time of 5.0 (SD 2.6) years. There were no significant differences in survivorship from TKA between patella alta and non-patella alta groups (CD: p = .72, IS: p = .63, BP: p = .6).

DISCUSSION AND CONCLUSION: This study suggests that there are no significant differences in clinical outcome scores or survivorship from TKA between patella alta and non-patella alta patients who underwent PFA. Both patella alta and non-patella alta patients demonstrated excellent improvement in outcome scores from preoperative to postoperative.

A Long-Term Analysis of Anterior Shoulder Instability in a Geographic Population-Based Cohort Under 40 Years Old

Abstract ID: Poster 046

Devin P. Leland, B.S.
Christopher D. Bernard, B.S.
*Lucas K. Keyt, B.S.
Aaron J. Krych, M.D.
Diane L. Dahm, M.D.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
Christopher L. Camp, M.D.
Rochester, MN

BACKGROUND: While a large volume of literature has focused on risk factors for anterior shoulder instability, the rates of recurrence are inconsistent and require additional population based epidemiologic data.

HYPOTHESIS/PURPOSE: To report the impact of patient age on severity of pathology, treatment strategies, recurrent instability, and progression to osteoarthritis in patients <40 years old with anterior shoulder instability utilizing an established U.S. geographic database.

STUDY DESIGN: Retrospective Case Series

METHODS: An established geographic database of more than 500,000 patients was used to identify patients <40 years of age with anterior shoulder instability between 1994 and 2016. Medical records were reviewed to obtain demographics, history, imaging, surgical details, and outcomes. Patients were divided into 5 groups based upon age (≤ 15 years, 16-20, 21-25, 26-30, and 31-40) at initial instability. Comparative analysis was performed to identify differences between groups.

RESULTS: The study population consisted of 654 patients with a mean follow-up of 11.1 years (range 2-25.2). This resulted in 118 patients (18%) ≤ 15 years of age at initial instability, 250 (38%) 16-20, 110 (17%) 21-25, 80 (12%) 26-30, and 96 (15%) patients 31-40. Forty-seven percent of patients ≤ 15 years old at initial instability presented with 3+ instability events compared to 12% of patients 31-40 (P<.001). At 10 years follow-up, patients ≤ 15 and 16-20 years old demonstrated the highest recurrent instability rates of 38.5% and 43.5%, respectively. Patients 16-20 years old demonstrated the highest rates of both surgical intervention (40.4%) and recurrence after surgery (24.8%). Patients 31-40 years old were significantly more likely to develop clinically symptomatic osteoarthritis (15.6%) than all other age groups.

CONCLUSIONS: In a US epidemiologic population of patients < 40 years old, the rate of recurrent anterior shoulder instability was roughly one-third following initial physician consultation. Younger patients, particularly those ≤ 15 and 16-20 years old, were more likely to have experienced multiple instability events at the time of initial presentation, require surgery, and experience recurrent instability compared to older patients. For every year decrease in age at initial instability, the risk of recurrent instability or surgical intervention following physician consultation increased by 4% and 2.8%, respectively.

Does Prescription Size Affect Opioid Utilization Following Hip Arthroscopy? A Prospective, Surgeon-Blinded, Randomized Control Trial

Abstract ID: Poster 047

---

*Ryan S. Selley, M.D.
Matthew J. Hartwell, M.D.
Michael A. Terry, M.D.
Vehniah K. Tjong, M.D.
Chicago, IL

INTRODUCTION: There remains no accepted standard regarding the number of opioids to prescribe following many surgical procedures. Previous literature has indicated that the number of opioids prescribed influences the total number of pills consumed. The goal of this study was to determine if prescribing less opioids following hip arthroscopy alters total postoperative utilization. Further, we aimed to identify potential preoperative variables that predict a patient's risk for increased narcotic consumption.

METHODS: We randomized 40 consecutive patients to receive either 30 or 60 tablets of hydrocodone/acetaminophen 10-325 mg following hip arthroscopy in addition to a multi-modal pain control strategy. Demographic information, the International Hip Outcome Tool (iHOT-12), the Pain Catastrophizing Scale (PCS), and preoperative pain scores were collected preoperatively. Postoperatively, patients were contacted five times over the course of three weeks to determine their Numeric Pain Rating Scale (NPRS), total number of tablets taken/leftover, and the last day that they required narcotic pain medications, which were calculated and compared for each group. We then assessed for preoperative variables that increased the risk for higher narcotic pain medication requirements.

RESULTS: 21 patients were randomized to the 30-tablet group and 19 were randomized to the 60-tablet group. Overall, patients had an average age of 37.1 ± 10.4, 62.5% were female, and had an average body mass index of 27.9 ± 4.7. Demographic information was similar between groups and there were no significant differences in scores on the preoperative questionnaires (iHOT-12 scores of 42.6 vs 38.6, $p=0.40$ and PCS scores of 11.7 vs 17.9, $p=0.11$). Patients in the 60-tablet group had significantly more tablets leftover than the 30-tablet group (48.6 vs 20.3, $p<0.0001$) and had no significant difference in NPRS scores at final follow-up (2.6 vs 2.0, $p=0.32$). The 30 and 60 tablet groups demonstrated no significant difference in average number of tablets required (9.7 and 11.4, $p=0.68$), respectively. Overall, 65% of patients required 10 tablets or less. Patients with an iHOT-12 score of ≥ 40 were less likely to utilize more than 10 tablets (RR 0.23, 95% confidence interval 0.06-0.88).

CONCLUSION: The number of leftover tablets following hip arthroscopy can be significantly reduced by prescribing 30 tablets compared to 60 tablets, without affecting postoperative pain control. Further, the iHOT-12 predicts postoperative narcotic consumption and could be used to tailor specific prescription amounts to patients.

SHOULDER

What is the Optimal Dilution of Liposomal Bupivacaine in Multimodal Pain Management for Shoulder Surgery?

Abstract ID: Poster 048

Vani J. Sabesan, M.D. / Boca Raton, FL
Ravi T. Rudraraju, M.D. / Weston, FL
Mauricio Drummond, M.D. / Weston, FL
Levonti Ohanisian, B.S. / Boca Raton, FL
Wilfredo J. Borroto / Ponce, PR
Diego J. L. Lima, M.D. / Weston, FL
*Matthew Wilneff, B.S. / Boca Raton, FL
Kiran Chatha, M.D. / Miami, FL

BACKGROUND: Shoulder arthroplasty (SA) is the fastest growing joint replacement surgery in the United State States and it has been estimated that postoperative pain management is not adequately controlled in up to 80% of patients. Liposomal bupivacaine has been an addition to this multimodal pain management that has been shown to be effective in reducing pain and narcotic consumption but there has been some controversy on its efficacy in the literature which may be attributed to the various dilutions and multimodal protocols used in these studies. The purpose of this study was to compare different titrated formulations of LB to assess the optimal dilution for pain control and opioid consumption.

METHODS: A prospective RCT was conducted with patients randomized into 40mL, 60mL, or 80mL dilution of LB with saline. All patients received the same multimodal pain management protocol and patient education for postoperative pain control. Patient-reported pain scores, opioid consumption, and opioid related side-effects were recorded at 24, 48, and 72 hours, and 7 days. Opioid consumption was converted to total morphine equivalents (TMEs) and ANOVA was performed to compare between groups.

RESULTS: A total of 75 patients were assigned into the three dilution groups. There were no significant differences in pain scores between the groups at 24 and 72 hours. The 80mL dilution group reported significantly lower pain scores at 7 day follow-up compared to the 60mL group ($p<0.016$). There were no significant differences in average morphine equivalents consumed at any point. ($p>0.05$). The average morphine equivalent was 7.91 for the 40mL group, 8.61 for the 60mL group and 10.01 for 80mL group during the 7-day period following surgery ($p>0.05$).

CONCLUSION: Our results demonstrated all three dilution groups achieved adequate pain control and minimal opioid usage postoperatively after SA. Our study suggests that overall if orthopedic surgeons consider using liposomal bupivacaine to optimize postoperative pain control after shoulder surgery, then they should use the 80 ml dilution.

Current DRG-Based Bundling for Upper Extremity Arthroplasty: A Case of Insufficient Risk-Adjustment and Misaligned Incentives

Abstract ID: Poster 049

Azeem T. Malik, M.B.B.S.
*Mathangi J. Sridharan, B.S.
Julie Y. Bishop, M.D.
Andrew S. Neviaser, M.D.
Safdar N. Khan, M.D.
Gregory L. Cvetanovich, M.D.
Columbus, OH

INTRODUCTION: The current Center for Medicare and Medicaid Services Bundled Payment for Care Improvement model relies on the use of diagnosis-related groups (DRGs) to trigger bundled payment episodes. The current DRG codes 483/484 for upper extremity arthroplasty do not differentiate between the type/location of arthroplasty (ATSA vs. RTSA vs. total elbow arthroplasty [TEA] vs. total wrist arthroplasty [TWA]) or the diagnosis/indication of surgery (fracture vs. degenerative osteoarthritis vs. inflammatory arthritis). Using a national dataset, we have reported the individual marginal cost impacts of various patient-level, procedure-level, diagnosis-level, and state-level factors on 90-day costs for patients undergoing upper extremity arthroplasty under DRG-483 and 484.

MATERIALS AND METHODS: The 2011-2014 Medicare 5% Standard Analytical Files (SAF5) was queried to identify patients undergoing upper extremity arthroplasty under DRG 483 and DRG 484. Multivariate linear regression modeling was used to assess the independent marginal cost impact (decrease/increase) in US dollars ($) of each patient-level, procedure-level, diagnosis-level, and state-level factors on average 90-day costs while controlling for other co-variates.

RESULTS: A total of 6,101 patients (DRG-483=2,250 and DRG-484=3,851) were included in the study. The 90-day risk-adjusted cost of a female patient, aged 65-69, with no/minimal comorbidities, undergoing an ATSA for degenerative osteoarthritis was $14,704 ± $655. Patient-level factors associated with higher 90-day costs were male gender (+ $777; p=0.002), age 75-79 years (+ $740; p=0.030), age 80-84 years (+ $1,140; p=0.002) and age ≥85 years (+ $984; p=0.046). Undergoing a TEA (+ $2,175; p=0.009) was associated with higher costs, whereas a shoulder HA (- $1,000; p=0.011) was associated with lower costs. Patients undergoing surgery for a fracture (+ $2,354; p<0.001) had higher 90-day costs. Among co-morbidities, malnutrition (+ $10,673), alcohol use/dependence (+ $6,273), Parkinson's disease (+ $4,892), CVA/stroke (+ $4,637), and hyper-coagulopathy (+ $4,463) had the highest marginal 90-day cost increases. The top 5 states with the highest marginal cost increase, in comparison to the state of Michigan, were Alaska (+ $11,292), Maryland (+ $10,300), California (+ $10,040), District of Columbia (+ $8,315), and Connecticut (+ $6,121).

CONCLUSIONS: Under the proposed DRG-based model, providers and hospitals would be reimbursed the same amount regardless of the type of surgery (ATSA vs. HA vs. TEA), the patient co-morbidity burden and the diagnosis/indication of surgery (fracture vs. degenerative pathology), despite each of these factors having different resource utilization and associated costs. Our findings also question the practice of grouping all shoulder, elbow, and wrist arthroplasties into one DRG for defining payments.

The Relationship of Current and Former Tobacco Use on Outcomes after Primary Reverse Total Shoulder Arthroplasty

Abstract ID: Poster 050

Jordan D. Walters, M.D. / Memphis, TN
L. Watson George, M.D. / Greenville, SC
*S. Gray McClatchy, M.D. / Memphis, TN
Ryan N. Walsh, B.S. / Memphis, TN
Jim Y. Wan, Ph.D. / Memphis, TN
Tyler J. Brolin, M.D. / Memphis, TN
Frederick M. Azar, M.D. / Memphis, TN
Thomas W. Throckmorton, M.D. / Memphis, TN

BACKGROUND: This study's purpose was to determine the influence of current and former tobacco use on minimum two-year clinical and radiographic outcomes following reverse total shoulder arthroplasty (RTSA).

METHODS: Retrospective review of primary RTSA patient data revealed 186 patients with at least two-year follow-up. Patients were classified as nonsmokers (76 pts), former smokers (89 pts), or current smokers (21 pts). Assessment included preoperative and postoperative visual analog pain scores (VAS), American Shoulder and Elbow Surgeons (ASES) scores, strength, range-of-motion (ROM), complications, revisions, and narcotic use. Radiographs were analyzed for signs of loosening or mechanical failure.

RESULTS: Overall mean patient age was 70 years old (range 48-87 years), and mean follow-up time was 2.6 years (2.0-5.7 yr). Smokers (62.1yr) were significantly younger than nonsmokers (70.7yr) and former smokers (70.8yr, $p=0.00002$). No differences existed between groups regarding preoperative clinical data. Postoperatively, smokers had greater VAS pain scores (mean 2.5) than nonsmokers (mean 1.8) or former smokers (mean 1.0, $p=0.014$). Otherwise, no differences were found for smokers compared to nonsmokers or former smokers regarding any of the postoperative parameters, including ASES, ROM, strength, complication/revision rates, narcotic use, radiographic lucency, or mechanical failure (all $p>0.05$).

CONCLUSIONS: Aside from increased patient-reported pain, current tobacco use does not appear to negatively impact outcomes after primary RTSA. RTSA bypasses the need for a functioning rotator cuff, possibly mitigating tobacco's negative effects known for rotator cuff repair and anatomic TSA. Former users obtained outcomes similar to nonsmokers, suggesting tobacco use is a modifiable risk factor to achieve optimal pain relief after RTSA.

Hemiarthroplasty for Proximal Humerus Fracture, Nonunion, or Malunion: Effect of Acute vs. Delayed Intervention

Abstract ID: Poster 051

Jonathan D. Barlow, M.D.
*Douglas W. Bartels, M.D.
William Aibinder, M.D.
Scott P. Steinmann, M.D.
Robert H. Cofield, M.D.
John W. Sperling, M.D.
Joaquin Sanchez-Sotelo, M.D., Ph.D.
Rochester, MN

INTRODUCTION: Controversy continues regarding management of proximal humerus fractures and their sequelae. The role of hemiarthroplasty in this setting remains in question. The purpose of this study was to determine the outcome of hemiarthroplasty for proximal humerus fractures and their sequelae.

METHODS: Chart review was performed on patients undergoing hemiarthroplasty for fracture or fracture sequelae between 2000 and 2016 at a single institution. 122 shoulder hemiarthroplasties were performed for either acute fracture (70) or proximal humerus nonunion/malunion (52). Mean age of the patients was 65 years (Range: 26-97). Average follow-up was 4.6 years.

RESULTS:

Complications/Reoperations

In the acute fracture group, the rate of complications was 29% (20 complications in 19 patients) and the rate of reoperation was 11%. In the nonunion/malunion group, the rate of complications was 33% (17 complications in 16 patients) and the rate of reoperation was 19%.

Functional Outcome

At most recent follow-up, postoperative visual analog pain scores averaged 2.2 (± 2.1) [2.5 in delayed (D) vs 2.0 in acute (A), p=0.52]. Average postoperative elevation was 96° [93° (D) vs 97° (A), p=0.62]. Average postoperative external rotation was 28° [23° (D) vs. 30° (A), p=0.21]. Postoperative internal rotation was not significantly different between groups and averaged L5 (p=0.59). Average ASES score was 61 (±17) [57 (D), 64 (A), p=0.16].

Survivorship

Overall survivorship free of revision/reoperation at 1 year, 5 years, and 10 years was 92%, 85%, and 85%. For the delayed group, survivorship free of revision was 85%, 79%, and 76%, respectively. For the acute group, this was 97%, 90%, and 90%. The difference in survivorship was not statistically significant (p=0.1).

Radiographic Analysis

No statistically significant correlation was found between Neer fracture classification, vertical/horizontal tuberosity reduction, tuberosity resorption, or glenoid erosion and postoperative pain scores, ASES scores, or need for revision surgery.

CONCLUSIONS: Similar clinical outcomes were observed when shoulder hemiarthroplasty was

performed for an acute proximal humerus fracture, nonunion, or malunion. Hemiarthroplasty in this setting provides reasonable pain relief but limited motion and low ASES scores. Survivorship rates were modest and not significantly different between groups. The role of hemiarthroplasty for fracture and fracture sequelae still remains to be defined.

The Beach Chair and Lateral Decubitus Positions are Associated with Baseline Operative Repair Characteristics for Anterior Shoulder Stabilization Surgery

Abstract ID: Poster 052

---

*Jacqueline E. Baron, B.A. / Marlboro, NJ
Kyle R. Duchman, M.D. / Iowa City, IA
Carolyn M. Hettrich, M.D., M.P.H. / Boston, MA
Natalie A. Glass, Ph.D. / Iowa City, IA
Shannon Ortiz, M.P.H. / Iowa City, IA
MOON Shoulder Group / Iowa City, IA
Brian R. Wolf, M.D., M.S. / Iowa City, IA

INTRODUCTION: The purpose of this study was to assess baseline operative variables utilized in primary arthroscopic repairs for anterior shoulder instability surgeries performed in the beach chair [BC] and lateral decubitus [LD] positions. It was hypothesized (1) that there would be more frequent anchor placement inferiorly on the glenoid when surgery was performed in the LD position and that (2) labral tear characteristics would be similar between LD and BC positioning groups.

METHODS: The present study is a cross-sectional analysis of a multicenter prospective cohort study. Participants ≥12 years that underwent primary arthroscopic anterior shoulder stabilization surgery were queried from November 2012-May 2019. Participants with workers' compensation, concomitant rotator cuff repair, isolated superior labrum anterior-posterior (SLAP) tears, or concomitant open and arthroscopic procedures were excluded. Baseline labral tear characteristics, anchor number and location of placement, and placement of an anchor at the lowest inferior position were collected. Continuous variables [mean ±standard deviation; median (min.-max)] and between group comparisons [Wilcoxon Rank Sum Tests] were assessed. Sub-stratification analyses were conducted (1) excluding patients with concomitant SLAP repairs and (2) excluding repairs extending into the posterior quadrant.

RESULTS: The BC position (357, 58.1%) was more common vs. the LD position (257, 41.9%). The length of labral tears was greater for positioning in LD [median: 126.0º (range: 36-270º) vs. BC [median: 108.0º (range: 18-270º)], $p<0.01$]. The number of anchors used for tears in the inferior quadrant differed across patient groups, with ≥ 2 anchors placed inferiorly more often in the LD position [BC; 80 (22.4%) vs. LD; 140 (54.5%), $p<0.01$]. The LD position was associated with more frequent placement of an anchor at the 6 o'clock position [(LD 137, 53.3%) vs. BC position (74, 20.7%) $p<0.01$]. Sub-stratification analyses excluding participants with (1) concomitant SLAP repairs and (2) repairs extending into the posterior quadrant supported the number, location of anchors placed, and anchor placement at the lowest inferior position (all $p<0.01$).

CONCLUSION: The median length of the labral tear documented in the LD position was longer than that documented in the BC position. This could represent more extensive tear patterns or possibly improved visualization in LD positioning. Patients undergoing anterior instability arthroscopic surgery in the LD position more frequently had ≥ 2 anchors in the inferior quadrant and a 6 o'clock anchor placed.

Soft Tissue and Transosseous Repair Techniques have Equivalent Failure Rates and Outcomes Following Total Shoulder Arthroplasty

Abstract ID: Poster 053

---

*Charles T. Fryberger, III, M.D.
Tyler J. Brolin, M.D.
Jim Wan, Ph.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

BACKGROUND: Subscapularis failure after anatomic total shoulder arthroplasty (TSA) is a well-recognized complication. Despite the existence of multiple repair techniques, no consensus for subscapularis management currently exists. We proposed to compare the clinical failure rates and outcomes of transosseous subscapularis repair (TOR) to primary tendon repair (PTR) in patients undergoing TSA.

METHODS: Institutional database query returned 306 primary anatomic total shoulder arthroplasties with a minimum of 2 years follow-up. Transosseous subscapularis repair was performed in 192 patients and PTR was performed on 114. Patient outcomes included clinical subscapularis failure, visual analog scale (VAS) pain scores, American Shoulder and Elbow Surgeons (ASES) scores, active range of motion (ROM), strength testing, complications, and re-operations. Independent two sample T-tests and chi-square tests were used to compare continuous and categorical data, respectively, between groups. Additionally, Wilcoxon rank sum tests were utilized for nonparametric continuous data. Differences with $p<0.05$ were considered statistically significant.

RESULTS: The number of clinical subscapularis failures at minimum 2-year follow-up was not significantly different between the groups (4.2% for TOR and 4.4% for PTR, p=0.747). Average VAS (TOR=1.3 and PTR=1.1, p=0.720) and ASES (TOR=84.7 and PTR=83.6, p=0.753) scores were also not significantly different at most recent follow-up. Additionally, there was no significant difference between groups regarding internal rotation function on ASES subscoring (TOR=2 and PTR=1.9, p=0.495). There were also no significant differences between groups regarding IR ROM (TOR=58 degrees and PTR= 54 degrees p=0.080), IR strength (TOR=91.4% 5/5 strength and PTR= 87.5% 5/5 strength, p=0.785), complications, (TOR=7.8% and PTR=11.4%, p=0.546), or re-operations (TOR=5.7% and PTR=6.1%, p=0.833).

CONCLUSIONS: Both transosseous and primary soft tissue repair techniques following subscapularis tenotomy result in good outcomes following primary anatomic TSA. No differences were found between groups regarding failure rate, range of motion, strength, pain, or ASES scores at minimum 2-year follow-up. Both techniques may be used successfully to manage the subscapularis in TSA.

Can Axillary Radiographs Predict Concentric Glenoid Wear on Axial CT Scans?

Abstract ID: Poster 054

---

*Teja S. Polisetty, B.S. / Fort Lauderdale, FL
Paul Devito, D.O. / Fort Lauderdale, FL
Kofi Agyeman, M.D. / Miami, FL
Leah Elson, MSc / Fort Lauderdale, FL
Andrew Malarkey, D.O. / Fort Lauderdale, FL
Michael Bercik, M.D. / Lancaster, PA
Emmanuel McNeely, M.S., M.H.A. / Fort Lauderdale, FL
Jonathan Levy, M.D. / Fort Lauderdale, FL

INTRODUCTION: Axillary radiographs have been considered sufficient to identify concentric glenoid wear in osteoarthritic shoulders. However, with variable glenoid wear patterns, CT assessment has become emphasized. The purpose of this study was to evaluate the ability to consistently identify concentric glenoid wear using axillary radiographs and mid-glenoid level axial CT scans.

METHODS: Preoperative axillary radiographs and mid-glenoid axial CT scans of 330 patients treated with anatomic total shoulder arthroplasty were reviewed. Five independent examiners with differing levels of experience characterized glenoid morphology as either concentric or eccentric. The correlation between axillary radiographs and CT determined morphologies was assessed, and both intra- and inter-observer consistency was calculated.

RESULTS: When concentric wear was identified on radiographs, CT confirmation was seen an average of 61% of cases (range 53-76%). Inter-observer consistency averaged 75% for radiographs and 73% for CT scans. There was significant inter-observer variability. Higher levels of training corresponded to greater consistency between imaging analyses ($p < 0.001$). The senior-most observer identified the highest proportion of concentric wear on radiographs ($p<0.001$), showed greatest consistency between attempts when using CT ($p<0.001$), and had greatest agreement of radiographs and CT evaluating glenoid morphology ($p<0.001$).

CONCLUSIONS: For the experienced shoulder surgeon, concentric glenoid wear identified on axillary radiographs will appear concentric on 2D CT in approximately 75% of cases. Obtaining a CT to confirm glenoid wear patterns has greatest benefit for less-experienced surgeons. Amongst all levels of experience, axillary radiographs and single slice mid-glenoid CT scans appear to be insufficient at consistently predicting wear patterns.

Beach Chair Positioning Increases Risk of Cerebral Deoxygenation Events for Upper Extremity Fracture Surgery

Abstract ID: Poster 055

---

*Christopher F. Deans, M.D. / Omaha, NE
Paul R. Johnson, M.D. / Pewaukee, WI
Elizabeth Lyden, M.S. / Omaha, NE
Matthew A. Mormino, M.D. / Omaha, NE
Matthew Teusink, M.D. / Omaha, NE

INTRODUCTION: Beach chair positioning can provide exposure benefits for the surgeon, but has been shown to be an independent risk factor for cerebral deoxygenation events (CDE). CDEs have been reported to lead to neurovascular complications ranging from deafness to death in rare case reports. The purpose of this prospective case-control study was to compare relative and absolute CDEs in upper extremity surgery for proximal humerus fracture in the beach chair and supine positions. We hypothesized there would be an increased risk of CDEs in patients undergoing surgery for proximal humerus fractures in the beach chair position compared to supine.

METHODS: Following IRB approval, patients undergoing surgical treatment (open reduction-internal fixation, hemiarthroplasty, reverse shoulder arthroplasty) of proximal humerus fractures between January 2014 to April 2019 at a single academic medical center were enrolled in the study. Patient position was based on surgeon preference. Cerebral oxygenation monitoring of bilateral frontal cortex was performed using near-infrared spectroscopy. Data was collected every two seconds during the case. Patient comorbidities, associated injuries, and demographics were recorded. Consistent with prior definitions in the literature, a CDE was defined as a decrease in cerebral tissue oxygenation greater than or equal to 20% from baseline values (relative), or below an absolute threshold of 55% (absolute).

RESULTS: Thirty-six patients (15 in supine group, all ORIF; 21 in beach chair group, 16 ORIF, 5 arthroplasty) were prospectively evaluated. The overall rate of CDEs was significantly higher in the beach chair group (76%, 16/21) compared to the supine group (27%, 4/15; p=0.006) There were 9 absolute / 7 relative CDEs in the beach chair group and 2 absolute / 2 relative in the supine group. No known neurologic complications occurred. Vasopressors were required in 86% of the beach chair group and 47% of the supine group. CDEs were associated with higher ASA class (p=0.044), and demonstrated a trend toward association with diabetes and obesity (p=0.06, 0.09).

DISCUSSION: CDE rates are significantly higher in beach chair positioning for upper extremity fracture surgery when compared to supine position. Patients with higher ASA class as well as potentially diabetes and obesity are at greater risk for CDEs in beach chair position. While the clinical effects CDEs have not yet been shown, this study provides surgeons with valuable insight into minimizing perioperative neurologic risk for upper extremity fracture surgery.

Incidence of and Risk Factors for Glenohumeral Osteoarthritis Following Anterior Shoulder Instability: A Population-Based Study of 154 Patients at an Average 15-Year Follow-Up

Abstract ID: Poster 056

---

*Bradley M. Kruckeberg, M.D.
Devin P. Leland, B.S.
Christopher D. Bernard, B.S.
Aaron J. Krych, M.D.
Christopher L. Camp, M.D.
Rochester, MN

INTRODUCTION: The rate of osteoarthritis (OA) in patients with anterior shoulder instability varies within the literature, with the majority of studies investigating rates after surgical stabilization. Anterior shoulder instability appears to lead to increased rates of OA, although risk factors for developing OA in non-operative and operative cohorts are not well defined. The purpose of this study was to determine the incidence of clinically symptomatic OA in a community-based population and identify risk factors for the development of OA following anterior shoulder instability.

METHODS: An established geographic database was used to identify patients less than 40 years old diagnosed with anterior shoulder instability between 1994 and 2016. Patient information, including demographics, imaging and surgical details, was collected and comparative analysis was performed between groups with and without OA, as well as patients who underwent surgical and non-surgical management.

RESULTS: The study consisted of 154 patients with a mean follow-up of 15.2 years (range 5.1-29.8). Overall, 22.7% of patients developed clinically symptomatic glenohumeral OA. Twenty-eight percent of patients who underwent at least 1 surgical intervention and 17% of patients who underwent non-operative management of anterior shoulder instability developed glenohumeral OA (p=0.176). Patients who developed arthritis were older at initial instability event (p=0.002) and had higher BMI (p=0.007). Risk factors for developing OA included seizure disorders (RR 2.61, 95 % CI 1.34-5.07), cartilage injury on initial MRI (RR 2.48, (1.00-6.13), current or former smoker (RR 2.46, 95% CI 1.37-4.42), laborer occupation (RR 2.14, 95% CI 1.14-4.01), and age at initial instability event (OR 1.09 per year, 95% 1.03-1.17). Athletes (RR 0.51, 95% CI 1.08-3.54), specifically contact athletes at the time of initial instability (RR 0.45, 95% CI 0.21-0.97), were less likely to develop OA.

CONCLUSIONS: In a US community-based population of patients less than 40 years old with anterior shoulder instability, approximately one-fourth of patients developed symptomatic OA at a mean follow-up of 15 years from their first instability event. When accounting for differences in patient demographics, there was no difference in the rates of OA in patients who underwent surgical and non-surgical management for shoulder instability. Overall, there was an increased risk in patients with seizure disorders, cartilage injury on initial MRI, current or former smokers, laborer occupation, and increased age at the initial instability event.

Preoperative Opioid Usage Predicts Markedly Inferior Outcomes Following Reverse Total Shoulder Arthroplasty

Abstract ID: Poster 057

Patrick J. Smith, M.D.
*Matthew Fournier, M.D.
Tyler J. Brolin, M.D.
Robert T. Neel, B.S.
Richard A. Smith, Ph.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

INTRODUCTION: Reverse total shoulder arthroplasty (RTSA) is an effective treatment for rotator cuff deficient conditions and other end stage shoulder pathologies. Due to its popularity, identifying factors that are predictive of outcomes after RTSA are of increasing interest. While preoperative opioid use has been shown to predict inferior outcomes following anatomic total shoulder arthroplasty, its effect on outcomes following RTSA is less clear. This study evaluates a series of RTSAs in order to determine the influence of preoperative opioid use on clinical and radiographic outcomes at a minimum of 2 years follow-up.

METHODS: Retrospective review of primary RTSA patient data revealed 263 patients with at least two years of clinical and radiographic follow-up. Patients were classified as preoperative opioid users (71 pts) if they had taken narcotic pain medication for a minimum of 3 months prior to surgery, or opioid naive (192 pts) at the time of surgery. Visual analog pain scores (VAS), American Shoulder and Elbow Surgeons (ASES) scores, strength, range of motion (ROM), complications, and revisions were assessed. Radiographs were analyzed for signs of loosening or mechanical failure.

RESULTS: The mean age for the cohort was 69.9 years old (range 22-89), and the mean follow-up time was 2.8 years (2.0-6.4 years). Opioid users were significantly younger (66.0 vs. 70.9 years, $p=0.01$) at time of surgery. Opioid users also had significantly higher preoperative rates of mood disorders, chronic pain disorders, disability status, and prior DVT (all $p<0.05$). Postoperatively, opioid users had inferior VAS (2.6 vs 1.2, $p<0.01$) and ASES scores (63.2 vs 75.2, $p<0.01$). Opioid users also had significantly higher rates of complications (28.2% vs 17.1%, $p=0.046$), periprosthetic radiolucency (8.5% vs 2.1%, $p=0.016$), and subsequent revision arthroplasty (14.1% vs 4.7%, $p=0.009$). There were no significant differences between groups regarding the amount of improvement from the preoperative to postoperative state for any of the studied objective examination variables.

CONCLUSIONS: Preoperative opioid use portended markedly inferior clinical outcomes in patients undergoing reverse total shoulder arthroplasty. Additionally, opioid users had significantly increased rates of complications, periprosthetic radiolucency, and revisions. Though there are confounding factors with the associated diagnoses of mood disorders, chronic pain disorders, and disability status, preoperative opioid use appears to be a significant marker for adverse outcomes and diminished value of RTSA.

Can The Opioid Risk Tool and Benzodiazepine Use Predict Opioid Consumption after Shoulder Arthroplasty?

Abstract ID: Poster 058

Kiran Chatha, M.D. / Miami, FL
*Nikolas Echeverry, B.S. / Boca Raton, FL
Marcella Zamis, B.S. / Boca Raton, FL
Vani J. Sabesan, M.D. / Boca Raton, FL

BACKGROUND: Currently, 130 people are dying daily from opioid-related overdoses in the US leading to increased pressure being put on physicians to help curtail prescriptions. Risk factors for increased opioid usage have been identified for shoulder arthroplasty, but no comprehensive risk tools are currently available. The purpose of this study was to assess the applicability of a previously validated Opioid Risk Tool (ORT) in predicting postoperative opioid use and dependence in SA patients.

METHODS: A retrospective review of 500 patients undergoing SA within a single hospital system from 2014-2016 was performed. Demographic variables were recorded and ORT score calculated. The ORT has three sections: family history of substance abuse, personal history of substance abuse or physical abuse, and psychological diseases as well as an age and gender stratification. Patients were categorized in groups based on ORT risk score - 3 or lower indicates low risk, 4-7 indicates moderate risk and score of 8 or higher indicates high risk. Patients were assessed for opioid and benzodiazepine use from prescription drug monitoring databases (PDMPs). Dependence was defined as continuous prescriptions for three months. Regression analyses were performed.

RESULTS: Average age of the cohort was 68.7 years, with 54% females and an average ASA class of 2.67. Preoperatively, 36.2% of the cohort was opioid-dependent and postoperatively this decreased to 30%. There were no significant differences in demographics between groups. In the preoperative opioid-dependent group, the average ORT score was 2.0. When looking at each category, 9% of the opioid-dependent group reported active tobacco use (ORT score of 3.14 [Low risk]) and only 2% of the opioid dependent cohort reported drug use (average ORT score of 8.25 [High risk]). There was no significant correlation between ORT risk categories and postoperative opioids consumption. (r=0.107). One third (33%) of patients were found to be dependent on benzodiazepines, 47% of which were opioid-dependent and reported consuming an average of 219 TMEs compared to 93 TMEs in the non-benzodiazepine using group. Of the patients that were using benzodiazepines, 77% had multiple opioid prescriptions.

CONCLUSIONS: The general ORT risk calculator does not seem to be effective in predicting opioid consumption and risk of dependence for orthopedic SA patients. Further efforts are needed to develop better orthopedic specific risk assessment tools to screen for opioid dependence and abuse. Benzodiazepine use may be a quick simple screening tool to identify patients at risk for higher quantities of postoperative opioids and postoperative opioid dependence. Future risk assessments for orthopedics should include prolonged preoperative benzodiazepine use as a factor.

TRAUMA

The Effect of Retained Syndesmotic Screws on Patient Functional Outcome

Abstract ID: Poster 059

---

*Lasun O. Oladeji, M.D. / Columbia, MO
Shaun F. Steeby, M.D. / Topeka, KS
John Worley, M.D. / Columbia, MO
Gregory J. Della Rocca, M.D. / Columbia, MO
Brett D. Crist, M.D. / Columbia, MO

INTRODUCTION: Syndesmosis injuries are commonly fixed with trans-articular position screws. While this treatment maintains stability across the syndesmotic joint, these screws may hamper mobility and be a source of pain. Routine screw removal remains controversial. This study sought to examine pre and postoperative outcomes, functional status, as measured by motion analysis, in patients scheduled for syndesmotic screw(s) removal.

METHODS: Eight patients scheduled for removal of syndesmotic screw(s) following fixation of unstable syndesmotic injuries were recruited for this study. The Dynamic Athletic Research Institute (DARI) motion capture system was used to evaluate functional outcomes while performing squats and lunges preoperatively, 6 weeks and 3 months postoperatively. The DARI markerless gait motion capture system uses multiple infrared cameras to capture motion related data points to provide a functional movement analysis.

RESULTS: Four males and four females with a mean age of 36.3 ± 17.1 years and BMI of 30.2 ± 7.1 completed this study. During a squat preoperatively, the knee flexion of the injured limb was 2.4° more (96.2° vs. 93.9°) than the non-injured limb; at final follow-up knee flexion of the injured limb was 4.5° more (96.8° vs. 92.2°) than the non-injured limb (p=0.489). There was no significant difference in knee displacement side-to-side between the injured and non-injured limb (p=0.970). Ankle flexion was 3.5° less (23.3° vs. 26.8°) on the injured limb preoperatively and 3.1° less (22.1° vs. 25.2°) on the injured limb postoperatively when compared to the non-injured limb (p=0.913). Mid-torso flexion was significantly greater postoperatively (47.2° vs. 36.2°, p=0.029). Lunge stride was 0.1 meters longer for the injured limb both preoperatively and postoperatively (0.84 vs. 0.74 preoperatively and 0.96 vs. 0.86 postoperatively, p=0.179). While performing a lunge, ankle flexion was 6.2° less (13.9° vs. 20.2°) on the injured limb preoperatively and 2.0° less (15.2° vs. 17.2°) on the injured limb postoperatively (p=0.662). Patient reported outcome data was available for three patients. AAOS F&A core standardized score increased from 86.3 ± 11.9 to 92.7 ± 11.0 (p=0.359); however, shoe comfort standardized score decreased from 100 ± 0 to 83.3 ± 28.9 (p=0.423).

CONCLUSION: Removal of syndesmotic screw(s) resulted in a significant increase in mid-torso flexion during squats. Removal of syndesmotic screw(s) does not significantly change body mechanics during squat or lunge maneuvers. While removal of syndesmotic screw(s) may not result in a significant functional improvement, patients report subjective improvements indicating that syndesmotic screw removal may be clinically significant.

Early and Late Below the Knee Amputation after Trauma Results in Similar Long-Term Outcomes

Abstract ID: Poster 060

Gabrielle Anne Bui, B.A.
Joseph A. Buckwalter, M.D., Ph.D.
Jason Wilken, Ph.D.
John Davison, M.P.H.
Ignacio Garcia Fleury, M.D.
*Michael C. Willey, M.D.
Iowa City, IA

INTRODUCTION: The indications for early below knee amputation (BKA) after high energy lower extremity trauma remains controversial. The purpose of this study was to (1) define an objective definition of early and late amputation and (2) use that definition to compare cost of and rates of unplanned revision for individuals who underwent early and late BKA after traumatic injury.

METHODS: A series of consecutive individuals that received lower extremity prosthetic care from a single prosthetics group following BKA for traumatic injury were identified between 4/1999 and 4/2016. Retrospective chart review was performed to document cause of amputation, demographic data, number of orthopedic procedures before and after amputation, number of unplanned revisions, and surgical complications. Total hospital costs and prosthetic costs were recorded from time of injury to three years following amputation. Between group comparisons were made using Wilcoxon Rank Sum test for continuous variables and Chi-square or Exact tests, as appropriate. Length of stay and number of surgeries were compared using Poisson regression. A p-value was considered statistically significant and all analyses were made using SAS V9.4.

RESULTS: 113 individuals met criteria. Nontraumatic cause of amputation was the most common reason for exclusion. The median time between injury and amputation was 41 days. We defined early amputation as within 6 weeks (42 days) of injury. There were 56 individuals with early amputations (median 4 days after injury) and 57 with late amputations (median 306 days after injury). There was no significant difference between total hospital cost three years after amputation between early and late amputation groups ($83,302 vs $ 80,003 p=0.82). Prosthetic costs from time of injury to 3-year post-amputation were similar between the two groups with median cost $36,621 in the early amputation group versus $ 39,308 in the late group (p=0.921). Early amputation were more likely require unplanned revision surgery than late amputation 0.89 ± 0.13 vs 0.39 ± 0.08, p=0.0013.

DISCUSSION: Individuals who underwent early below knee amputation had a significantly higher rate of unplanned revision surgery. While the early amputation had higher rates of unplanned revision and higher initial cost associated with hospital admission, total hospital costs and total prosthetic costs were comparable between the two groups at three year follow-up. Delay in amputation did not result in increased long-term hospital cost.

Cannulated Screws or Hemiarthroplasty for Femoral Neck Fractures: Is There a Difference in Mortality?

Abstract ID: Poster 061

---

*Marc Greenberg, B.S.
S. Andrew Sems, M.D.
Jonathan D. Barlow, M.D.
William W. Cross, III, M.D.
Brandon J. Yuan, M.D.
Juan S. Vargas-Hernandez, M.D.
Rochester, MN

BACKGROUND: The incidence of femoral neck fractures (FNFx) is increasing dramatically. Historically, relatively stable fracture patterns have been treated with in-situ cannulated screw fixation (CSF) while displaced fractures have been treated with hip arthroplasty. Several studies have focused on radiographic fracture characteristics attempting to predict which fractures, when treated with CSF, would result in failure and need for conversion arthroplasty. Additionally, it has been assumed that because of the increased surgical insult patients undergoing hemiarthroplasty (HA) would experience more perioperative complications and increased mortality. This study aimed to compare patients with FNFx treated with CSF or HA, and determine if HA is indeed associated with increased perioperative morbidity and mortality.

METHODS: Using an institutional registry, we identified patients with FNFx (AO-OTA code 31-B) treated with HA or CSF between 2001 and 2017. We excluded patients younger than 60 years, and those treated with internal fixation constructs other than CSF or HA. 2211 patients were included, 1721 were treated with HA and 490 with CSF. The mean age at surgery was 83 years, with 66% being female. Mean follow-up was 19 months. Multivariate analysis was performed when appropriate.

RESULTS: One-year mortality was 25% for the CSF group and 29% for the HA group (p-value =0.99). Rate of reoperation within the first year was 19% and 4%, respectively ($p<0.001$). Among patients treated with HA, the overall mortality risk ratio was 0.96 (95% CI, 0.73-1.27) and reoperation risk ratio was 0.19 (95% CI, 0.1-0.36). 30-day, 90-day and 1-year mortality odds ratios and their 95% CI were 1.48 (0.45-4.82), 1.02 (0.5-2.13) and 1.24 (0.7-2.21), respectively.

CONCLUSIONS: Patients with FNFx treated with HA were not associated with increased risks of short-, mid-, or long-term mortality when compared to those treated with CSF. Hemiarthroplasty treatment entailed a significantly lower reoperation risk when compared to CSF.

SUMMARY: Hemiarthroplasty for femoral neck fracture entails decreased risk of reoperation while maintaining an equivalent mortality risk when compared to cannulated screw fixation.

Patient Functional Outcomes Following Sacroiliac Screw Removal

Abstract ID: Poster 062

---

*Lasun O. Oladeji, M.D. / Columbia, MO
John David Adams, M.D. / Greenville, SC
John Worley, M.D. / Columbia, MO
Gregory J. Della Rocca, M.D. / Columbia, MO
Brett D. Crist, M.D., FACS / Columbia, MO

OBJECTIVES: Sacroiliac or iliosacral screw fixation is commonly used to address posterior pelvic ring injuries. Retention or removal of these screws after healing is controversial. To date, very little is known regarding changes in mobility and biomechanics following removal of sacroiliac screw fixation. This study sought to examine functional status, as measured by motion analysis, and outcome in a cohort scheduled for sacroiliac screw(s) removal.

METHODS: Seven patients scheduled for removal of sacroiliac screw(s) were recruited to participate in this study. The Dynamic Athletic Research Institute (DARI) motion capture system was used to evaluate patients' functional outcomes while performing squats and single leg squats preoperatively, 6 weeks, and 3 months postoperatively. The DARI uses multiple infrared cameras to capture motion related data points in order to provide a functional analysis of movements.

RESULTS: Five males and two females with a mean age of 40.3 ± 12.2 years and BMI of 25.1 ± 4.5 completed this study. During a squat preoperatively, the knee flexion of the injured side was 0.8° more (105.9° vs. 105.1°) than the non-injured side; at final follow-up knee flexion of the injured side was 2.0° less (107.1° vs. 109.2°) than the non-injured side (p=0.235). There was no significant difference in knee displacement side-to-side between the injured and non-injured side (p=0.420). There was no significant difference in hip displacement preoperatively and postoperatively for squats (p=0.875) and single leg squats (p=0.769). Mid-torso flexion decreased postoperatively (35.4° vs. 35.0°, p=0.870). During single leg squats, knee flexion on the side of injury was 4.4° greater (77.1° vs. 72.7°); at final follow-up knee flexion of the injured side was 2.6° greater (78.2° vs. 75.6°) than the non-injured side (p=0.780). Hip flexion on the side of injury was 7.9° greater (69.4° vs. 61.5°); at final follow-up knee flexion of the injured side was 3.8° less (53.3° vs. 57.1°) than the non-injured side (p=0.272). There was no significant difference in knee or hip displacement while performing single leg squats (p>0.459). Iowa pelvic scores were available for two patients. Preoperative Iowa pelvic scores averaged 70.5 and postoperative scores averaged 81.5 (p=0.222).

CONCLUSION: Removal of sacroiliac screws appears to alter hip kinematics, especially when considering single leg movements, however these changes do not appear to be significant. Removal of sacroiliac screw(s) may not result in a significant functional improvement; however, there may still be clinical value for patients with symptomatic or broken hardware.

Does Sagittal Plane Alignment and Surgical Approach Affect Pilon Fracture Outcomes?

Abstract ID: Poster 063

---

*Trevor R. Gulbrandsen, M.D. / Iowa City, IA
Brett D. Crist, M.D., F.A.C.S. / Columbia, MO
Andrew Polk, B.S. / Columbia, MO
Robert M. Hulik, M.D. / Jackson, MS
Clay A. Spitler, M.D. / Birmingham, AL

INTRODUCTION: Pilon fracture outcomes with radiographic sagittal plane alignment parameters beyond articular reduction have not been emphasized. Surgical approach is a factor that may affect the surgeon's ability to correct the sagittal plane alignment. The purpose of this study is to evaluate how surgical approach impacts anterior distal tibial angle (ADTA), lateral distal tibia angle (LDTA), and lateral talar station (LTS). Our hypothesis was that the anterolateral (AL) approach would improve the sagittal plane parameters due to the primary plate placement.

METHODS: A retrospective review was performed on patients who underwent operative management for pilon fractures at 2 ACS Level 1 Academic Trauma Centers. Clinical data points including demographics, comorbidities, AO/OTA classification, surgical approach, and complications were recorded. Quality of reduction was radiographically measured using the ADTA, LDTA, and LTS postoperatively.

RESULTS: 580 pilon fractures met inclusion criteria. When compared to the AL approach, the modified anteromedial (AM) approach had decreased rates of local wound care, and unplanned reoperations. The AM approach had increased rates of superficial infection, deep infection, and amputations. There was no difference in ADTA, LDTA, or LTS between the modified AM and AL approach ($p = 0.49$, $p = 0.41$, $p = 0.85$). There was a difference in LTS with tobacco users ($p = 0.02$).

DISCUSSION AND CONCLUSION: The sagittal plane alignment does not appear to be affected by the surgical approach. Therefore, the surgical approach to pilon fractures should be based on the fracture pattern and the patient's soft tissue envelope. This study shows that the modified AM is a safe and effective approach to complex fractures and the surgeon should consider the specific fracture pattern when choosing the specific approach.

TUMOR

Long-Term Outcomes and Complications of Free Fibula Reconstruction after Resection of a Tumor in the Upper Extremity

Abstract ID: Poster 064

---

*Matthew B. Shirley, M.D.
Matthew R. Claxton, B.S.
Matthew T. Houdek, M.D.
Steven L. Moran, M.D.
Karim Bakri, M.B.B.S.
Peter S. Rose, M.D.
Rochester, MN

INTRODUCTION: Limb salvage surgery is the desired treatment in many patients with neoplasms in the upper extremity. Post-resection reconstruction of segmental bone defects is challenging. Given the complications associated with structural allografts, free vascularized fibula grafts (FVFG) have become a mainstay of successful reconstruction in this patient population. The authors of this study sought to examine the long-term outcomes and complications in a group of patients undergoing resection of both malignant and benign tumors from the upper extremity who subsequently underwent reconstruction using FVFG.

METHODS: Twenty-nine patients with a benign or malignant tumor in the upper extremity reconstructed with a FVFG between 1995 – 2017 were reviewed. The group consisted of 14 females and 15 males with a mean age of 29±20, and a mean follow-up of 7±5 years. Seventeen (59%) cases included reconstruction of the humerus, 11 (38%) of the radius/ulna, and 1 (3%) clavicle.

RESULTS: The overall 2-, 5-, and 10-year survival rates were 96%, 87%, and 76% respectively. Local recurrence survival rates for the same time points were 96%, 91%, and 84%. Distant metastasis survival rates were 96%, 83%, and 55% for these time points. Rate of first time union was 72%, with 7 patients achieving union after additional bone grafting. Overall union rate was 97% at a mean time of 12±11 months. All patients with diabetes (n=2) failed to unite primarily (p=0.07). Local radiotherapy (HR 2.55, 95% CI 0.42-15.40, p=0.28) and adjuvant chemotherapy (HR 0.62, 95% CI 0.12-3.18, p=0.43) were not associated with primary union failure. Including cases with delayed union (n=8), complications occurred in 62% of cases, including FVFG fracture (n=4) and infection (n=4) being most common. Complications led to reoperation in 10 (34%) patients. Donor site complications occurred in 3 (10%) patients including claw toe (n=1), tibia fracture (n=1), and wound dehiscence (n=1). Mean postoperative MSTS rating was 82±21%, with a good to excellent Mankin functional outcome occurring in 21 (72%) patients. There were 5 failures, 2 amputations, and 3 deaths due to local tumor recurrence.

DISCUSSION AND CONCLUSION: The FVFG is the workhorse for upper extremity reconstruction after oncologic resection, providing patients with a reliably functional extremity. Overall survival, union, and limb salvage is high using this method; however, 1 in 4 patients will need an additional bone grafting procedure to achieve union.

Utility of All-Polyethylene Tibial Components in Oncologic Endoprosthetic Reconstruction of the Distal Femur

Abstract ID: Poster 065

Brandon R. Bukowski, M.D.
Paul L. Sousa, M.D., M.B.A.
Joshua D. Johnson, M.D.
*Adam J. Tagliero, M.D.
Kevin I. Perry, M.D.
Peter S. Rose, M.D.
Matthew T. Houdek, M.D.
Rochester, MN

INTRODUCTION: Endoprosthetic reconstruction has emerged as a reliable technique for limb salvage for tumors of the distal femur. Most systems utilize metal-backed tibial components based on perceived biomechanical benefit and modularity. Use of an all-polyethylene tibial component has been shown to improve survival and decrease cost in the primary arthroplasty setting, but use in oncologic reconstruction has been limited. The purpose of this study was to compare outcomes between patients reconstructed with an all-polyethylene (AP) versus metal-backed (MB) tibial component following oncologic endoprosthetic reconstruction.

MATERIALS AND METHODS: 129 patients undergoing primary endoprosthetic reconstruction for an oncological process of the distal femur between 1985-2018 were identified using our institutional total joint registry. Mean age and BMI were 42±23 years and 26.2±7.6 kg/m^2 respectively. The most common pathology was osteosarcoma (n=66, 51%). An all-polyethylene tibia was used in 91 (71%) patients. Mean clinical follow-up was 13±9 years.

RESULTS: There was no difference ($p>0.05$) in mean age, gender, body mass index (BMI) or reconstructions performed for a primary bone tumor between groups. Revision-free (HR 0.92, 95% CI 0.42-2.04, p=0.84) and infection-free survival (HR 1.09, 95% CI 0.40-2.96, p=0.86) were not significantly different when comparing all-polyethylene to metal-backed components. There was no difference in the incidence of tibial component revision for loosening between groups (1% AP vs. 3% MB, p=0.53). Aseptic polyethylene exchange was more common in patients with metal-backed components (4% AP vs. 16% MB, p=0.003). There was no difference in infection rates between groups (21% AP vs. 13% MB, p=0.33). Of the patients with all-polyethylene components undergoing debridement for infection, the tibial component was retained in 9 patients, and only 1 patient underwent subsequent resection 10 years following the initial debridement. There was no difference in mean range of motion (AP 93±22o vs. MB 92±22o, p=0.76) or Knee Society scores (AP 85±14 vs. MB 84±13, p=0.63).

DISCUSSION: Endoprosthetic distal femur reconstruction utilizing all-polyethylene tibial components is a reliable technique for limb salvage surgery for tumors of the distal femur. There was no difference in the incidence of tibial component loosening when compared to metal-backed components. However, the tibial polyethylene is more likely to be revised in the modular setting but can often be maintained in septic and aseptic cases of revision in the all-polyethylene setting with no difference in functional outcome.

PEDIATRICS

Continued Slip After Internal Fixation for Slipped Capital Femoral Epiphysis: Reasons for the Phenomenon

Abstract ID: Poster 066

---

*John V. Horberg, M.D.
Ryan J. O'Rourke, M.D.
Kathleen A. McHale, M.D.
Springfield, IL

INTRODUCTION: Progression of treated slipped capital femoral epiphysis (SCFE) has been reported albeit infrequently. The few clinical reports and one invitro laboratory study emphasize inadequate fixation across the physis. As early childhood obesity has increased, the average age for SCFE has lowered to 11 leading some authors to hypothesize that with more growth remaining, there may be a higher chance for continued slipping after fixation. With 7 hips in 6 patients, we present one of the largest cohorts of progressive SCFE after internal fixation in the English speaking literature and an analysis of potential causes of this phenomenon.

METHODS: We retrospectively assessed 7 hips in 6 patients with slip progression s/p surgical fixation for SCFE. Age, gender, slip type, medical comorbidities and laboratory findings were assessed. Postoperative imaging was used to assess quality of fixation. Finally, long-term clinical outcomes were reported.

RESULTS: All patients were 11 years old and younger (eleven x3; ten x2; and six x1). 5/6 were obese, all had had pain for months. There were 3 unstable slips. These patients had no known pre-injury metabolic disease. Of these, one was found to have hyperthyroidism and another hypovitaminosis D. Three patients had stable slips. Of these, one had had a surgically-treated UBC in the ipsilateral femoral neck; one had Down's with undertreated hypothyroidism; and one was 6 with short stature.

Six hips in 5 patients were treated with partially threaded single screw fixation, all with at least 5 screw threads across the physis. The 11-year-old girl with severe hypovitaminosis D underwent fixation of the affected right hip with threaded K wires and had implant removal at 8 months. The patient with a UBC and both patients with hypothyroidism developed AVN by 4 months following the second surgery.

DISCUSSION: Based on previous literature, all hips in our cohort were managed with technically adequate constructs yet still failed. This cohort suggests that previously undiagnosed and untreated endocrinopathy is not only a risk factor for SCFE but for slip progression following surgical fixation. These data suggest that endocrine screening in all cases of SCFE should be considered.

Nonoperative Management of Seromas in Pediatric Spinal Deformity Surgery

Abstract ID: Poster 067

---

*George H. Thompson, M.D.
James Yu, M.D.
Anne Dumaine, M.D.
Connie Poe-Kochert, C.N.P.
Justin Mistovich, M.D.
Cleveland, OH

INTRODUCTION: Seromas and their potential sequalae of wound drainage and surgical site infection (SSI) are common complications after pediatric spinal deformity surgery. Many surgeons perform an early debridement to prevent (SSI). Can a conservative approach to seroma still yield equivalent patient outcomes?

METHODS: We performed a retrospective review of our institution's Pediatric Orthopaedic Spine Database for patients who developed a postoperative seroma from 1996-2016. Inclusion criteria were pediatric patients <21 years who underwent primary spinal fusion with instrumentation and developed a postoperative wound seroma. Seromas were clinically defined an afebrile patient with a wound fluid collection that was soft and non-tender to palpation and without induration or erythema. Growing spine surgeries and revision procedures were excluded.

RESULTS: Twenty-five cases of postoperative seromas were identified. All were managed conservatively without an operative irrigation and debridement. Treatment consisted of monitoring the incision. If there was spontaneous drainage, a dry sterile dressing was applied to the wound and changed as needed until drainage ceased. One case had needle aspiration antibiotic prophylaxis. The 24 remaining cases were simply monitored. Five patients were started on a prophylactic antibiotic course for 10 days.

Seromas were identified at a mean of 14.7 days (range, 7-45 days) postoperatively and resolved at a mean of 29.6 days (range, 12-60 days) postoperatively. Seromas occurred in 12 idiopathic scoliosis patients, 12 neuromuscular scoliosis, and 1 patient with Scheuermann's kyphosis. Twenty-two patients had posterior spinal fusions while 3 patients had same day anterior and posterior spinal fusions. Galveston technique was performed in 8 patients, 12 patients had a hybrid construct (with screws and hooks/wires), 3 had pedicle screw constructs, 1 had sacral ala screws, and 1 had only hooks/wires.

All cases resolved spontaneously without development of an acute SSI. Interestingly, 3 cases (12%) subsequently developed a late surgical site infection (range, 18-38 months postoperatively). The 3 late infections developed before an institutional infection prevention bundle was implemented (nares screening, chlorohexidine/mupirocin decolonization, and targeted antibiotic prophylaxis). One late infection occurred with the Galveston technique and the other 2 occurred in hybrid constructs. Of the late infections, 2 were idiopathic scoliosis patients and 1 was a neuromuscular patient. None of these patients had seromas that drained spontaneously. One of the adolescent idiopathic scoliosis patients had tattoo after posterior spinal fusion. The neuromuscular patient was discharged home on TPN through PICC line. Both of the idiopathic scoliosis patients with late infection had no growth from their intraoperative cultures.

CONCLUSIONS: Conservative management of postoperative seromas after pediatric spinal deformity surgery is appropriate management. It is unclear if the seroma contributed to the development of the 3 late infections. Further studies are needed regarding the relationship of late infections in seroma patients.

HAND

Comparing Gender quick Disabilities of the Arm, Shoulder, and Hand (qDASH) Scores Following Elective Hand Surgeries

Abstract ID: Poster 068

Megan Mooney, M.D. / Toledo, OH
*Adam Mierzwa, M.S. / Toledo, OH
Kristin Toy, M.D. / Toledo, OH
Margaret Jain, M.D. / Silverdale, WA
Martin Skie, M.D. / Toledo, OH

INTRODUCTION: Studies conclude measurable differences in musculoskeletal disease incidence, prevalence, and natural course with respect to gender. There are no studies examining the differences in surgical outcomes of elective hand surgery between genders. As patient satisfaction becomes more closely associated with subjective outcomes in elective orthopedic surgeries, our goal is to determine if there are significant variations in qDASH scores in response to elective hand surgeries between genders.

METHODS: This is a retrospective chart analysis. Patients over the age of 18 who have undergone elective hand surgery were included. Patients' were excluded due to failure to follow-up or failure to complete qDASH forms. Data including gender, age, smoking status, NSAID usage, ASA score, diabetes status, procedure type, and qDASH scores (preoperative, 2 , 6 , and 12 weeks postoperatively) were recorded. Statistics (independent t-test) were performed using SPSS program.

RESULTS: The average age is 50.86 and 52.12 for females and males; respectively (p=0.682). The average ASA score had little variation between genders (2.14, females; 2.16, males; p=0.670). The most common procedure performed was cubital tunnel release (37.9% for females and 40.2% for males). The next most common procedure types were trigger release (16.4% and 14.3 for females and males; respectively), cyst/ganglion excision (15.0% and 11.6%; respectively), and ligament reconstruction tendon interposition (LRTI) surgery (8.4% and 5.4%; respectively). Pearson Chi-squared analysis did not demonstrate significant differences between the proportions of procedure type in association with our female and male populations (p=0.065). The mean preoperative qDASH scores for all procedure types are 46.62 and 37.66 for females and males (p =0.002), respectively. At two weeks postoperative, the mean qDASH scores are 41.88 for females and 29.61 for males (p=0.012) followed by a 6 week qDASH of 31.31 and 22.26 (p=0.082) and 12 week qDASH scores being 25.19 and 16.80 (p=0.116). Taking into account the higher score reported by our female population initially, the overall rates of functional improvement were similar between genders.

CONCLUSION: There are significant differences in preoperative and 2 week postoperative qDASH scores following elective hand surgeries with respect to gender. Six and 12 week qDASH scores differences did not reach statistical significance. Our findings suggest that although females and males demonstrate different qDASH scores throughout the preoperative and postoperative time course, the overall rates of improvement have similar trends. More

research is required in order to determine outcomes of specific procedures with respect to gender.

The Incidence of Anconeus Epitrochlearis in Ulnar Nerve Decompression: A Retrospective Chart Review

Abstract ID: Poster 069

---

*Shankar Narayanan, M.D. / Columbus, OH
Gregory Versteeg, M.D. / Chicago, IL
Nisha Crouser, M.D. / Columbus, OH
Kara Colvell / Columbus, OH
Hisham Awan, M.D. / Columbus, OH

BACKGROUND: The ulnar nerve can be compressed at multiple sites at the elbow, including an anatomical variant, the anconeus epitrochlearis (AE). Compression of the ulnar nerve due to the AE has been reported as early as 1979. The incidence of this muscle in the general population, as reported in cadaveric, ultrasound, or MRI studies is between 4% and 34%. However, the incidence of the AE in patients with a clinical diagnosis of ulnar nerve neuropathy undergoing ulnar nerve decompression at the elbow has not been elucidated.

HYPOTHESIS: The incidence of the AE in patients undergoing ulnar nerve decompression surgery will be between 5-10%. The presence of the AE will not correlate with worsening EMG results.

METHODS: 286 surgeries in 264 patients from a single surgeon underwent ulnar nerve decompression at the elbow (CPT 64718) between January 2014 and October 2016. A retrospective chart review was undertaken where demographic data, hand dominance, EMG results, and presence of the AE was recorded. Fifty-eight patients were excluded from the study due to missing EMG data or duplicate data query. Basic statistical analysis was undertaken.

RESULTS: The Anconeus Epitrochlearis was found 23 times in 206 patients (11.2%). The average age of patients with the AE was found to be similar to the average age of patients without the AE and who underwent ulnar nerve decompression at the elbow (51.2 and 51.1). EMG results did not demonstrate a difference amongst patients who had the AE versus those who did not and who underwent decompression (41.6 m/s vs 42.2 m/s). There was no difference in the percent of patients with diabetes (30%) versus without diabetes (25%) in patients with an AE in patients undergoing ulnar nerve decompression.

SUMMARY: This is the first study to our knowledge that demonstrates incidence of the AE in patients undergoing ulnar nerve decompression at the elbow which is 11%. There was no difference in the age of patients who have the AE versus those who do not undergoing decompression, which is different than prior literature. Nerve conduction velocity did not change based on presence of AE. Diabetics undergoing cubital tunnel release were not more likely to have an AE.

Novel Instrumentation-Free Intra-Articular Proximal Phalanx Base Fracture Fixation Using Polydioxanone Suture

Abstract ID: Poster 070

---

*John M. Capelle, M.D. / St. Louis, MO
Natalie Gaio, M.D. / Madison, WI
Heidi Israel, Ph.D., F.N.P, C.C.R.C. / St. Louis, MO
J. Gary Bledsoe, Ph.D. / St. Louis, MO
Bryce Stash, M.D. / St. Louis, MO
Joao Panattoni, M.D. / Vero Beach, FL

BACKGROUND: Intra-articular proximal phalanx base fractures are a challenging fracture to repair. This project utilizes polydioxanone suture (PDS) maintain the reduction of cadaveric intra-articular proximal phalanx base condyle fractures. It examines clinical and radiographic outcomes of a small sample population performed in vivo. The purpose of this study is to evaluate biomechanical strength of this instrumentation-free repair in cadaveric models and also to demonstrate its effectiveness in a retrospective review of cases using this technique.

METHODS:
Biomechanical Arm
A biomechanical study was performed on 15 cadaver hand/wrist specimens. A dorsal dissection was performed on digits two through five. A dial osteotomy of the proximal phalanx base was performed. Two oblique holes were drilled through the proximal phalanx diaphysis, then PDS was passed through the holes. The suture was tied after reducing the fracture, maintaining the reduction. The specimen was stressed through the MTS machine for 1000 cycles. Then, radiographic and anatomic step-off and gap of the intra-articular fracture were measured.

Clinical Arm
A retrospective review was performed of patients utilizing this instrumentation-free technique from 2013 to 2018. Radiographic step-off and gap were measured and patient's clinical outcome was collected.

RESULTS:
Biomechanical Arm
The mean radiographic fracture gap and step-off were significantly improved with this technique, which were 1.4 mm and 0.6 mm respectively. The anatomic mean gap and step-off also both improved respectively by 2.0 mm and 0.3 mm.

Clinical Arm
Five consecutive patients utilizing this technique were retrospectively reviewed. Four had no pain with full range of motion at final follow-up (80%) and all demonstrated radiographic union. The mean fracture pre-reduction and post-surgery gap was 4.3 mm and 0.8 mm, respectively. The fracture gap at the final post-operative appointment was 1.2 mm. The mean fracture pre-reduction and post-surgery step-off was 1.5 mm and 0.2 mm, respectively. The mean fracture step-off at the final follow-up was 0.5 mm. The difference between the presurgery gaps and step-offs and both post-surgery gaps and step-offs was significant.

CONCLUSION: This study utilizes biomechanical and clinical data to demonstrate the effectiveness of an instrumentation-free intra-articular proximal phalanx base fixation technique.

It facilitates a strong construct that promotes fracture union, maintains joint congruency, and avoids expensive hardware. There is also no hardware joint penetration, no need for secondary surgery, no need for a volar approach, and a lessened risk of fragment fracture.

Total Wrist Fusion with an Intramedullary Device: A Single Institution Series with Intermediate-Term Follow-Up

Abstract ID: Poster 071

Richard Samade, M.D., Ph.D.
Andrew B. Campbell, M.D.
Hisham Awan, M.D.
*Kanu S. Goyal, M.D.
Columbus, OH

INTRODUCTION: Total wrist fusion (TWF) is a commonly-used treatment for end-stage (radiocarpal and midcarpal) arthritis. The aims of this investigation were to describe pain level, functional status, and complications following total wrist fusion using a locked intramedullary nail (IMN).

METHODS: A single institution series of 35 patients (38 wrists) with IMN TWF from 2010–2017 was performed. Outcome questionnaires were collected from 23 patients (24 wrists), including the Visual Analog Scale (VAS), Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH), and Patient Rated Wrist Evaluation (PRWE) questionnaires. Eighteen of 23 patients returned to clinic for repeat radiographs of the operative wrist, physical examination, and Mayo Wrist Score assessments. Demographics, surgical indications, length of follow-up, and complications were recorded. Three fellowship-trained hand surgeons assessed radiographic fusion using a five-point Likert scale.

RESULTS: The patients undergoing total wrist fusion were 47.9 ± 12.4 years of age, with an equal number of cases in male and female patients. Median length of follow-up for all patients was 122.3 weeks (interquartile range: 49.6–212.9 weeks). Following 29% (11) of cases, a reoperation or office procedure in the ipsilateral hand and/or wrist was performed, with 16% (6) cases due to the implant itself. The median VAS pain score was 0 (interquartile range: 0–0.25) and the QuickDASH, PRWE, and Mayo wrist scores were 40.0 ± 27.0, 35.0 ± 26.0, and 54.7 ±14.8, respectively. The average-rated radiographic wrist fusion by the surgeons in 68% of cases was exceeded 3/5. Complications included a bent IMN due to a fall, several metacarpal stress reactions and fractures, metacarpal screw loosening, and reoperation for symptomatic nonunion.

DISCUSSION/CONCLUSION: Total wrist fusion with an IMN results in minimal wrist pain and has functional outcomes comparable to other reported techniques. Several hardware complications were noted, including a 32% asymptomatic and symptomatic nonunion rate (suggested by Likert scores less than 3/5 as rated by the 3 hand surgeons). Future studies could further add to knowledge from this study collecting longer-term and standardized data with additional patients.

Public Insurance is a Risk Factor for 30- and 90-Day Unplanned Readmission Following Posterior Lumbar Fusion

Abstract ID: Poster 072

---

*Andrew G. Golz, M.D.
Jonathan Yun, B.S.
Cara Joyce, Ph.D.
Bartosz Wojewnik, M.D.
Maywood, IL

INTRODUCTION: Readmission rates are considered a strong indicator of hospital performance. Low rates of readmission are associated with reduced expenditures and improved quality of care. The majority of hospitals in the United States are now being penalized for higher-than-expected readmission rates. Because these penalties will have a profound financial impact, it is imperative to identify risk factors for unplanned readmission. The purpose of this study was to identify risk factors, in particular insurance type, for 30- and 90-day readmission following posterior lumbar fusion (PLF).

METHODS: An analysis of 30- and 90-day readmissions was performed using the Healthcare Cost and Utilization Project's Nationwide Readmissions Database (NRD) 2014 with visits for PLF. Weighted estimates of patient characteristics were estimated overall and the 30- and 90-day readmission rates compared using Rao-Scott chi-square tests. Odds ratios for patient characteristics associated with readmission were calculated from multivariable logistic regression models.

RESULTS: Over nine months, 12,633 index admissions for PLF were identified, representing n=27040 weighted encounters. The 30- and 90-day readmission rates were 5.7% and 9.6%, respectively. Public insurance was an independent risk factor for readmission. Medicare patients had an increased risk of both 30-day (OR 1.53, 95% CI 1.14-2.05) and 90-day (OR 1.57, 95% CI 1.27-1.93) readmission. Medicaid patients similarly had an increased risk of 30-day (OR 1.94, 95% CI 1.36-2.76) and 90-day (OR 1.60, 95% CI 1.20-2.13) readmission. Other risk factors for readmission included increased age, greater number of comorbidities and higher Elixhauser score, history of drug abuse, diabetes mellitus, long-term steroid use, non-elective admissions, weekend admissions, longer length of stay, greater total charges, non-routine discharges, surgical complications, 3-7 levels of fusion, and acute kidney failure identified during the index admission.

CONCLUSION: In addition to multiple other risk factors, patients with Medicare and Medicaid insurance are at increased risk for both 30-day and 90-day readmission following posterior lumbar fusion. It is necessary to include these factors in risk-adjusted models of reimbursement and allocate additional resources to these patients in order to prevent unplanned readmission and further propagation of pre-existing healthcare disparities in hospitals that care for high-risk patients.

Lumbar Laminectomies are of Greater Risk of Perioperative Adverse Outcomes in Those 80 Years of Age and Older

Abstract ID: Poster 073

---

*Marissa A. Justen
Christopher A. Schnebel, M.D.
Patawut Bovonratwet, M.D.
Neil Pathak
Arya Varthi
Jonathan N. Grauer, M.D.
New Haven, CT

BACKGROUND: Lumbar stenosis is one of the most commonly diagnosed lumbar spine conditions and is frequently treated via laminectomy of one or multiple levels. With lumbar stenosis often presenting in later life, laminectomy is increasingly considered in older patients. Nonetheless, such older patients are often more fragile and more susceptible to complications, so the risks and benefits of surgical intervention in older populations warrants investigation. The purpose of this study is to compare perioperative adverse events following lumbar laminectomy in patients aged ≥80 years to those <80 years of age in the Academy of College Surgeons National Surgical Quality Improvement Program (NSQIP) database to better stratify the risk associated with laminectomies in older populations.

METHODS: Using the NSQIP database, all patients who underwent lumbar laminectomy from 2005 to 2017 were dichotomized into two groups, those ≥80 and those <80 years of age. Preoperative demographics and comorbidities were controlled for and comparison of perioperative adverse events between both cohorts was carried out using multivariate regression.

RESULTS: In total, 44,311 patients <80 years of age and 4,886 patients ≥80 years of age who underwent lumbar single, or multiple level laminectomies meeting the study inclusion criteria were identified. Those over 80 years old were more likely to have functional dependence, greater ASA status, diabetes mellitus, a lower body mass index (BMI), and decreased smoking status.

Even after controlling for preoperative comorbidities, those who were 80 years old or greater had a significantly higher 30-day rate of urinary tract infections (RR=1.77, p=<0.001, 95% CI=1.30-2.41), occurrences of pneumonia (RR=1.75, p=0.002, 95% CI=1.04-2.95), extended lengths of hospital stay (RR= 1.33, p=<0.001, 95% CI=1.22-1.45), readmission rates (RR=1.56, p=<0.001, 95% CI=1.31-1.85), and occurrences of death (RR=3.08, p=<0.001, 95% CI=1.64-5.78).

CONCLUSION: Patients 80 years of age or older experience more preoperative complications, even after adjusting for patient characteristics and comorbidities. This is not interpreted to suggest that such intervention should not be considered for this patient population, but rather highlights the increased risks associated with this older population and the importance of patient optimization, counseling, and perioperative attention when considering lumbar laminectomies in this group.

Cervical Spine Fractures in Parkinson Disease

Abstract ID: Poster 074

---

*Jordan M. Walters, M.D.
Kevin W. Sexton, M.D.
David B. Bumpass, M.D.
Little Rock, AR

INTRODUCTION: Falls and fractures in Parkinson disease (PD) patients occur more frequently than in the general population, due to osteoporosis and gait instability; PD patients are thus at a risk for low-energy cervical spine fractures. While the literature contains several PD hip fracture studies that show increased mortality and hospital length of stay (LOS), there is a paucity of research on outcomes of cervical spine fractures in PD patients. We hypothesized that PD patients who sustained cervical spine fractures would have more complications, longer hospital length of stay, and higher mortality than non-PD patients with cervical fractures.

METHODS: This study utilized the National Inpatient Sample (NIS) to retrospectively compare cervical spine fracture outcomes between Parkinson and non-Parkinson patients in the last quarter of 2015. Inclusion criteria included any patient above the age of 18 with a cervical spine fracture. ICD-9 and -10 codes were used to identify concomitant cervical fracture and PD diagnoses. The validated Elixhauser risk-adjustment method was used to calculate comorbidity scores to compare the cohorts.

RESULTS: The total patient population studied was 62,590 patients. The PD patients did have higher baseline Elixhauser comorbidity scores. PD patients did experience higher inpatient mortality and displayed a greater risk for 30-day readmission. Interestingly, mean hospital LOS was lower (0.95 day less) for the PD patients.

DISCUSSION: In a nationwide cohort study, PD patients with cervical fractures had more baseline medical comorbidities, higher post-fracture mortality, and a greater risk of hospital readmission than cervical fracture patients without PD. When treating Parkinson disease patients with cervical fractures, spine surgeons should be cognizant of the increased risk for medical and perioperative complications.

Development of the Spine Oncology Study Group Outcomes Questionnaire - 8 Domain (SOSGOQ-8D)

Abstract ID: Poster 075

---

*Felicity Fisk, M.D. / Detroit, MI
Markian A. Pahuta, M.D. / Detroit, MI
Ann Versteeg, M.D., MHSc, Ph.D. / Utrecht, The Netherlands
Charles Fisher, M.D., MHSc / Vancouver, Canada
Nicolas Dea, M.D., MSc / Vancouver, Canada

INTRODUCTION: The AOSpine Knowledge Forum Tumor developed the spine oncology-specific outcome CMS known as the SOSGOQ2.0 for measuring patient-reported, health-related quality-of-life (HRQOL). No mapping of SOSGOQ2.0 to utilities currently exists. The purpose of this study was to reduce the SOSGOQ2.0 from 4 domains with 4 items each to an 8 item SOSGOQ-8) that would be better suited for developing a utility mapping.

METHODS: Responses to SOSGOQ1.0 and SOSGOQ2.0 obtained from the Epidemiology, Process and Outcomes of Spine Oncology (EPOSO) and Metastatic Tumor Research and Outcomes Network (MTRON) studies. Data was organized into training, validation, and test sets. MTRON data was used to create the training test set (n=112), on which to perform confirmatory factor analysis (CFA) to calculate non-neurologic item loading on each domain. All combinations of the two items in each domain with the highest loading were used to create a pool of candidate domain questions for a training data set. EPOSO responses were divided into a validation set (n=80) and a test set (n=181). The validation set was used to fit a Poisson regression model for each set of candidate questions. Regression equations were applied to rank domain questions based on magnitude. The lowest rank total set of domain questions were selected. The test set was used to evaluate performance of the regression models.

RESULTS: All 4 neurologic function single questions (leg weakness, arm weakness, bladder dysfunction, bowel dysfunction) were retained to maintain content validity and clinical relevance. CFA demonstrated adequate model fit and confirmed the structure of non-neurologic SOSGOQ2.0 domains. All items were clinically relevant with factor loadings > 0.50. Poisson regression models for all combinations of candidate domain questions provided excellent fit of the validation set (pseudo-R^2 values > 0.75). The regression model with the lowest rank sum consisted of SOSGOQ2.0 items 3, 13, 16, and 19.

DISCUSSION: We have developed an 8-item questionnaire by formally shortening the SOSGOQ2.0 in accordance with published guidelines to facilitate mapping of utilities for QALY calculation. Our analysis indicates that in addition to the neurologic single items, the SOSGOQ-8D should include:

- Does your spine limit your ability to care for yourself?
- How much has your pain limited your mobility (sitting, standing, walking)?
- Have you felt depressed?
- Do you feel that your spine condition affects your personal relationships?

Reliability of the Neck Disability Index (NDI) and Japanese Orthopedic Association (JOA) Questionnaires in Adult Cervical Radiculopathy and Myelopathy Patients When Administered by Telephone or via Online Format

Abstract ID: Poster 076

---

*Gaurang Gupte, B.S.
Jacob M. Buchowski, M.D., M.S.
Colleen Peters, B.S., M.A.
Lukas P. Zebala, M.D.
St. Louis, MO

INTRODUCTION: Phone and email-based administration of patient-reported outcomes instruments can increase response rates in long-term studies. The study sought to validate phone and email administration of the Neck Disability Index (NDI) and the Japanese Orthopedic Association Cervical Myelopathy Evaluation Questionnaire (JOA) in cervical myelopathy and/or radiculopathy patients.

MATERIALS AND METHODS: 206 nonsurgical along with pre- and post-surgical cervical myelopathy and/or radiculopathy patients presenting to a tertiary spine center were included. Patients (mean age: 58.5 years) were randomized in a 1:4 ratio to either email completion of the NDI and JOA before or after in-office completion, or to phone completion before or after in-office completion. Questionnaires were administered within a 1 to 4 week interval (mean intervals: 13.6 days combined email group; 14.0 days phone-before-office group; 14.3 days phone-after-office group). 161 patients completed both assessments within the timeframe. A paired t-test assessed differences between written in-office and corresponding e-mail and phone versions. Intraclass correlation coefficients assessed homogeneity. Test-retest reliabilities were examined for postoperative patients (n=145) since the study included both surgical and nonsurgical patients. Recall bias was assessed in postoperative patients via intraclass correlation coefficients. McNemar's and Cochran-Mantel-Haenszel tests assessed response rate differences between phone and email versions.

RESULTS: There was no significant difference between e-mail and in-office versions (n=85) of the NDI (p=0.17, Mean Difference=1.34) and JOA (p=0.64, Mean Difference=0.11). No significant difference was seen between phone followed by in-office administration (n=32) of the NDI (p=0.88, Mean Difference=0.22) and JOA (p=0.38, Mean Difference=-0.22), nor between in-office administration followed by phone (n=44) for the NDI (p=0.10, Mean Difference=2.79) and JOA (p=0.37, Mean Difference=0.27).

Intraclass coefficients (ICCs) of the e-mail versions of the NDI and JOA were 0.88 and 0.78; of the phone-before-office versions of the NDI and JOA were 0.91 and 0.82; and of the office-before-phone versions were 0.86 and 0.78, respectively. Similarly, strong intraclass correlation coefficients indicating no recall bias were found for "In-Office" and external assessments completed by post-surgical patients with days between assessments lesser and greater than the mean (ICC range 0.63-0.92).

No significant difference was seen in completion rates between e-mail and in-office questionnaire completion (p=0.13) and phone-before-office and in-office questionnaire completion (p=0.31). However, a significant difference was found in completion rates for phone-after-office questionnaires (p<0.001).

CONCLUSION: NDI and JOA administration over phone and e-mail in patients with cervical myelopathy or radiculopathy is valid with strong test-retest reliability and internal consistency, and can reduce non-response rates.

FOOT AND ANKLE

Arthroscopic Assessment of Syndesmotic Instability in the Sagittal Plane

Abstract ID: Poster 077

---

*Rohan Bhimani, M.D. / Boston, MA
Bart Lubberts, M.D., Ph.D. / Boston, MA
Jafet Massri-Pugin, M.D. / Boston, MA
Daniel Guss, M.D., M.B.A. / Boston, MA
Jonathon C. Wolf, M.D. / Caldwell, ID
Gregory Waryasz, M.D. / Boston, MA
Christopher W. DiGiovanni, M.D. / Boston, MA

INTRODUCTION: Syndesmotic instability is multi-directional, occurring in the coronal, sagittal, and rotational planes. Despite the multitude of studies examining such instability in the coronal plane, other studies have highlighted that syndesmotic instability may instead be more evident in the sagittal plane. The primary aim of this study was to arthroscopically assess the degree of syndesmotic ligamentous injury necessary to precipitate syndesmotic instability in the sagittal plane. Secondarily, we aimed to determine the optimal cut-off measurement of fibular translation in the sagittal plane that arthroscopically distinguishes stable from unstable injuries.

METHODS: Twenty-one above-knee cadaveric specimens underwent arthroscopic evaluation of the syndesmosis, first with all syndesmotic and ankle ligaments intact and subsequently with sequential sectioning of the anterior inferior tibiofibular ligament (AITFL), the interosseous ligament (IOL), the posterior inferior tibiofibular ligament (PITFL), and deltoid ligaments (DL). In all scenarios, an anterior to posterior (AP) and a posterior to anterior (PA) fibular translation tests were performed under a 100N-applied force. AP and PA sagittal plane translation of the distal fibula relative to the fixed tibial incisura was arthroscopically measured.

RESULTS: Compared with the intact ligamentous state, there was no difference in sagittal fibular translation when only one or two ligaments were transected. After transection of all the syndesmotic ligaments (AITFL, IOL, and PITFL), or after partial transection of the syndesmotic ligaments (AITFL, IOL) alongside the DL, fibular translation in the sagittal plane significantly increased as compared with the intact state (p-values ranging from $p=0.041$ to $p<0.001$). The optimal cut-off point to distinguish stable from unstable injuries was equal to 2mm of fibular translation for the total sum of AP and PA translation (sensitivity 77.5%; specificity 88.9%)

CONCLUSION: Syndesmotic instability appears in the sagittal plane after an injury to all three syndesmotic ligaments or after partial syndesmotic injury with a concomitant deltoid ligament injury. The optimal cut-off point to arthroscopically distinguish stable from unstable injuries was 2 mm of total fibular translation. This data can help surgeons arthroscopically distinguish between stable syndesmotic injuries and unstable ones that require syndesmotic stabilization.

Diagnosing Medial Ankle Instability with Gravity Stress Ultrasound and Weight Bearing Ultrasound - Establishing Natural Variations in Healthy Population

Abstract ID: Poster 078

---

*Rohan Bhimani, M.D.
Jirawat Saengsin, M.D.
Noortje Hagemeijer, M.D.
Song Ho Chang, M.D.
Gregory Waryasz, M.D.
Daniel Guss, M.D., M.B.A.
Christopher W. DiGiovanni, M.D.
Boston, MA

BACKGROUND: Destabilizing injuries to the deltoid ligament have relied on radiographic stress examination for diagnosis, with a focus on medial clear space (MCS) widening. Increasingly, ultrasound has also been used in the clinical setting. The aim of this study is to assess the MCS with ultrasonography while weightbearing and with a gravity stress test (GST) in the uninjured ankle to establish normative values for future comparisons.

METHODS: Study participants with no reported ankle injury in their pre-medical history were included. MCS was examined using ultrasound while the patient lying in the lateral decubitus position to replicate a GST and while weightbearing. The MCS was assessed in mm at the anteromedial aspect (Anterior-MCS) and at the inferomedial aspect of the ankle joint (Inferior-MCS). All measurements were obtained with the ankle held in a neutral and plantarflexed position. A linear mixed model was built for analysis. An unpaired two-sample t-test was used to compare the MCS distances measured with GST and weightbearing.

RESULTS: A total of 50 ankles were included for analysis, including 15 males (64%) with a mean age of 36.4±12.96 years. Average MCS ranged from 3.38-3.60 mm with weightbearing and 4.25-4.29 mm with GST. MCS values were significantly higher with GST than with weightbearing measurements (Anterior and Inferior-MCS: $P < 0.01$). MCS values were significantly larger with the foot in a planterflexed position as compared to a neutral position when performing a GST (Anterior and Inferior-MCS: $P < 0.01$). No significant differences in MCS distance were found when comparing laterality or gender ($P > 0.05$).

CONCLUSION: Ultrasound can measure the MCS of the ankle while performing dynamic stress manoeuvres. Notably, with the deltoid ligament intact, a gravity stress test increases MCS widening more than weightbearing alone, and holding the ankle in plantarflexion while performing a gravity stress view heightens this difference. Additional clinical studies are necessary in the injured setting to better understand the implication of this test.

Maximum Articular Preparation for Ankle Arthrodesis Using Mini-Open vs. Transfibular Approach

Abstract ID: Poster 079

Karthikeyan Chinnakkannu, M.D.
Eildar Abya, M.D.
Haley M. McKissack, B.S.
Aaradhana J. Jha, M.D.
Ashish Brahmbhatt, M.D.
Leonardo Moraes, M.D.
Sameer Naranje, M.D.
Ashish Shah, M.D.
*Charles Reddoch Sutherland, Jr., B.S.
Birmingham, AL

OBJECTIVES: Both the mini-open and the transfibular approaches of tibiotalar arthrodesis have been proven to be effective techniques, but no studies have elucidated superiority of either one. The objective of this study was to assess and compare the maximum amount of articular surface that can be prepared in mini-open versus trans-fibular approach for tibiotalar arthrodesis.

METHODS: Four specimens underwent joint preparation with the mini-open approach and five with the trans-fibular approach. Articular surfaces of the tibio-talar joint were maximally-prepared by removing the cartilage using osteotomes and curettes. Surface area left unprepared was measured for each surface and student's t-test was used to assess the differences.

RESULTS: On the inferior aspect of the tibia, the average percent of unprepared articular surface area in the mini-open approach was 7.22%, 22.46%, and 24.84% for the inferior surface, the medial malleolus, and the lateral malleolus, respectively. The average percent of unprepared surface area was greater for all three articular surfaces in the transfibular approach, with 19.09%, 26.96%, and 35.98% left unprepared. The mini-open approach provided greater surface preparation of the talar dome and articular surface for the medial malleolus, leaving an average of 5.30% surface area unprepared on the dome as compared to 13.91% in the transfibular approach. All four medial malleolar articular surfaces on the talus were completely prepared using the mini-open approach, compared to an average of 48.47% left unprepared with the transfibular approach. In contrast, the mini-open approach left an average of 19.89% surface area unprepared on the lateral malleolar articular surface of the talus, compared to 10.20% in the transfibular approach.

CONCLUSIONS: When performing tibiotalar arthrodesis, the mini-open approach may allow for more complete preparation of the joint. If transfibular approach is warranted, supplemental instrumentation and approaches may be needed to ensure adequate preparation, particularly of the talar articular surface for the medial malleolus of the tibia.

SUMMARY: In this cadaveric study, the maximum amount of articular surface that could be prepared was compared between the mini-open and transfibular approaches. Results showed that the mini-open approach provided the greatest average prepared surface area on all articular surfaces except the talar articular surface for the lateral malleolus. Thus, the mini-open approach may allow for more complete preparation of the joint in tibiotalar arthrodesis, but if

transfibular approach is warranted, supplemental approaches may be beneficial to maximize preparation.

Postoperative Aspirin Use and Its Effect on Bone Healing in the Treatment of Ankle Fractures

Abstract ID: Poster 080

Allison Hunter, M.D.
Charles C. Pitts, M.D.
*Bradley K. Alexander, B.S.
Tyler Montgomery, B.S.
Matthew Anderson, B.S.
John T. Wilson, B.S.
Joshua L. Washington, B.S.
Gerald McGwin, M.D., Ph.D.
Michael D. Johnson, M.D.
Ashish B. Shah, M.D.
Birmingham, AL

INTRODUCTION AND PURPOSE: There is hesitancy to administer nonsteroidal anti-inflammatories (NSAIDs) within the postoperative period following fracture care due to concern for delayed union or nonunion. However, aspirin (ASA) is routinely used for chemoprophylaxis of deep vein thrombosis (DVT) and is gaining popularity for use after treatment of ankle fractures. We examine the incidence of nonunion of operative ankle fractures and risk of DVT in patients who did and did not receive postoperative ASA. We hypothesize that time to clinical and radiographic union and the risk of DVT are no different.

METHODS: A retrospective chart review was performed on all patients treated between 2008 and 2018 for ankle fractures requiring operative fixation by three Foot and Ankle fellowship-trained orthopedic surgeons at a single institution with a minimum of 3 months follow-up. Demographics, preoperative comorbidities, and postoperative medical and surgical complications were compared between patients who did and did not receive ASA postoperatively. For both groups, union was evaluated by clinical exam as well as by radiograph.

RESULTS: 506 patients met inclusion criteria: 152 received ASA and 354 did not. Radiographic healing at 6 weeks was demonstrated in 95.9% (94/98) and 98.6% (207/210), respectively (p-value .2134). There was no significant difference in time to radiographic union between groups. The risk of postoperative DVTs in those with and without ASA was not significantly different (0.7% (1/137) vs 1.2% (4/323), respectively; p-value .6305).

CONCLUSION: Postoperative use of ASA does not delay radiographic union of operative ankle fractures or affect the rate of postoperative DVT. This is the first and largest study to examine the effect of ASA on time to union of ankle fractures.

Sagittal and Axial Posterior Calcaneal Screw Prominence are Independent Risk Factors for Hardware Removal

Abstract ID: Poster 081

---

*Alan G. Shamrock, M.D. / Iowa City, IA
Karthikeyan Chinnakkannu, M.B.B.S. / Iowa City, IA
Cameron Foreman, M.D. / Iowa City, IA
Natalie Glass, Ph.D. / Iowa City, IA
Annunziato Amendola, M.D. / Durham, NC
Phinit Phisitkul, M.D. / Sioux City, IA
John E. Femino, M.D. / Iowa City, IA

INTRODUCTION: Painful hardware requiring removal is common after the use of posterior calcaneal screws. Screw prominence in the sagittal plane is readily determined with a lateral radiograph, however, screw location in the axial plane requires an intraoperative axial hindfoot view. The impact of screw prominence in the isolated axial plane on symptomatic hardware is unknown. The aim of this retrospective review is to determine, by analyzing postoperative radiographs, the association between posterior calcaneal screw type, sagittal and axial prominence, location, and trajectory with painful hardware requiring surgical removal.

METHODS: A consecutive series of 365 cases of posterior calcaneal screws in 333 patients (163 females; 48.9%) (mean age 47.4 years) was retrospectively reviewed from 2004-2018. Inclusion criteria included the use of at least one posterior calcaneal screw and postoperative radiographs consisting of weight-bearing lateral and axial hindfoot views. Weight-bearing radiographs were examined to determine screw head prominence in the lateral and axial planes, screw trajectory, and screw location in the calcaneus. Screw trajectory was calculated by subtracting the angle of the screw from the horizontal by the calcaneal pitch. Other variables collected included patient demographic information and screw number, diameter, and type. Statistical analysis was performed using Wilcoxon rank-sum and chi-square tests.

RESULTS: The HWR rate was 16.7% (n=61). The HWR group was significantly younger (44 vs 48; p=0.004) with more females (67.9% vs 45.4%; p=0.003). Body mass index (BMI) (p=0.417) and calcaneal pitch (p=0.765) were not different between groups. Of screws that were flush or buried in the sagittal plane, 9.1% (n=64) were prominent on the hindfoot view. Screws flush/buried on both the lateral and hindfoot views (p<0.0001) were not associated with pain; prominent screws on the lateral radiograph (p=0.0002) and both the lateral and hindfoot radiographs (p=0.0071) were significantly more likely to undergo HWR. Isolated axial plane prominence of the plantar screw was found to be an independent risk factor for HWR (p=0.0060). Screw diameter (p=0.2318), location (p=0.4691) and trajectory (p=0.1077) were not associated with pain.

DISCUSSION: Posterior calcaneal screws that were prominent on the lateral radiograph and both the lateral and hindfoot views were associated with HWR. Additionally, isolated prominence of the plantar screw on the hindfoot radiograph was a significant risk factor for HWR. These results emphasize the importance carefully analyzing the axial view in addition to a lateral view with intraoperative fluoroscopy.

Evaluation of Appropriate Screw Length and Diameter to Prevent Mal-Reduction in Zone II/III 5th Metatarsal Fractures: A Retrospective Analysis

Abstract ID: Poster 082

Ankit Khurana, M.D.
Karthikeyan Chinnakkannu, M.D.
Ashish Brhmbhatt, M.D.
Aaradhana J. Jha, M.D.
*Jessyca L. Ray, B.S.
Ashish B. Shah, M.D.
Birmingham, AL

INTRODUCTION: Percutaneous fixation of 5th metatarsal fracture is associated with good outcomes, but may lead to malreduction due to improper implant selection and placement. Our aim was to determine effects of screw entry, length and diameter on reduction parameters both previously defined and those introduced by the authors and to evaluate if this malreduction transpired to delayed union, nonunion or refracture.

MATERIALS AND METHODS: We retrospectively reviewed acute, delayed, and nonunion cases of isolated skeletally mature zone II/III 5th metatarsal fractures managed with intramedullary screw fixation with a single screw. Specific ratios were defined by the authors like entry point ratio in AP and Lateral, canal width ratio in AP and Lateral, and screw diameter/canal ratio. These were calculated apart from metatarsal length on both views pre- and postoperatively, distance on apex to base, apex height and canal width. Comparisons were made between plantar cortex distraction/lateral cortex distraction and ratios of screw length, diameter, and entry point were compared. Further analysis differentiated between time to union and distraction in lateral/plantar cortices.

RESULTS: 48 patients were included (30 females). Males had longer ($p<0.001$ in AP and lateral view), wider ($p=0.004$ in AP and 0.003 in lateral view) metatarsal than females and the apex to base distance on AP ($p=0.001$) as well as apex height on lateral view ($p=0.007$) was significantly more in males. The mean screw length was 46.21 mm (35-60 mm) and screw diameter was 5 mm (4-6.2 mm).

Multiple regression analysis revealed plantar and lateral gap was determined by entry point ratio on Lateral and AP view respectively ($p<0.001$, AP and Lateral). There was no statistically significant association of either screw diameter/canal ratio ($p=0.36$,AP; $p=0.89$,Lateral) or screw/apex length ratio ($p=0.36$,AP; $p=0.67$,Lateral) to plantar/lateral gap. There was no significant correlation between time to union and presence of plantar/lateral gap ($p=0.179$).

DISCUSSION/CONCLUSION: We found screw length or diameter did not lead to significant planter or lateral fracture site distraction. To prevent loss of metatarsal curvature and maintain metatarsal length entry should be both medial and superior. We conclude entry point should be given more significance than screw diameter and length in managing zone II/III fifth metatarsal base fractures.

DISCLOSURES

Each participant in the Mid–America Orthopaedic Association 2020 Annual Meeting has been asked to disclose if he or she has received anything of value, in any amount, from a commercial company, which relates directly or indirectly to the subject of their presentation. The options to disclose are as follows:

1. Royalties from a company or supplier
2. Speakers bureau/paid presentations for a company or supplier
3a. Paid employee for a company or supplier
3b. Paid consultant for a company or supplier
3c. Unpaid consultant for a company or supplier
4. Stock or stock options in a company or supplier
5. Research support from a company or supplier as a principle investigator has been received
6. Other financial or material support from a company or supplier as a primary investigator
7. Royalties, financial, or material support received from publishers
n. No conflicts to disclose

These codes reflect the numbers used in a series of questions answered by all persons participating in the AAOS online Disclosure Program or disclosed direct to MAOA.

NOTE: Per ACCME guidelines, we do not have to include medical/orthopedic publications, editorial/governing board positions, or board member/committee appointments for a society in the following disclosures.

Mid–America Orthopaedic Association does not view the existence of these disclosed interests or commitments as necessarily implying bias or decreasing the value of the author's participation in the Annual Meeting; however, these data are offered to the audience as additional information that may be helpful in evaluating the educational presentations.

The following disclosures have been made either direct to the MAOA or AAOS office:

BOARD OF DIRECTORS	DISCLOSURE
Mormino, Matthew A. President	n
Mahoney, Craig R. 1st Vice President	4 – Trak Surgical, Inc.; 5 – Johnson & Johnson, Smith & Nephew
Turner, Norman S. 2nd Vice President	n
McLain, Robert F. Immediate Past President	3b – SI Bone

Wolf, Brian R. Secretary	1, 2, 3b, 6 – CONMED Linvatec; 3c – SportsMed Innovate; 6 – Arthrex, Inc., Smith & Nephew
Otterberg, Erik T. Treasurer	n
Kurland, Robert L. Historian	n
Cabanela, Miguel E. Managing Director	n
Siebler, Justin C. 2020 Program Committee Chair	n
Agarwal, Animesh Membership Committee Chair	2 – AO North America; 2, 3b – KCI, Smith & Nephew; 5 – Bone Support; 7 – Springer
Cannada, Lisa K. Education Committee Chair	5 – Foundation for Orthopaedic Trauma
Karam, Matthew D. Exhibits Committee Chair	4 – Iowa Simulation Solutions LLC, Mortise Medical LLC
Sierra, Rafael J. Member at–large (one year)	1, 3b – Link Orthopaedics; 1, 3b, 4 – Orthalign; 1, 5 – Zimmer; 2, 3b, 5 – Biomet; 3b – Think Surgical, Inc.; 5 – Cytori, DePuy, a Johnson & Johnson Company, Stryker; 7 – Springer
Dahm, Diane L. Member at–large (two years)	1, 4 – TENEX Health (spouse), Sonex Health, LLC (spouse); 5 – Arthrex, Inc.
Keeney, James A. Member at–large (three years)	3b – DePuy, a Johnson & Johnson Company, Flexion Therapeutics, Heron Therapeutics
MAOA STAFF	**DISCLOSURE**
Cabanela, Miguel E. Managing Director	n
Kluck, Pam	n
McKinley, Sue	n
VanLaere, Cayen	n
PROGRAM COMMITTEE	**DISCLOSURE**
Siebler, Justin C. Chair	n
Cross, William W., III	n
Dilisio, Matthew F.	2 – Arthrex, Inc.
Higuera, Carlos A.	2, 3b, 5 – KCI; 4 – PSI; 5 – CD Diagnostics, Cymedica, Ferring Pharmaceuticals, OREF, Orthofix, Inc., Orthogenics, Stryker, Zimmer
Meneghini, R. Michael	1, 3b – Osteoremedies; 1, 3b, 5 – DJ Orthopaedics; 3b – KCI, Kinamed; 4 – Emovi, Olio Health
Noiseux, Nicolas O.	1 – Link Orthopaedics; 3b, 5 – MicroPort, Smith & Nephew; 5 – DePuy, a Johnson & Johnson Company
EXHIBITS COMMITTEE	**DISCLOSURE**
Karam, Matthew D. Chair	4 – Iowa Simulation Solutions, LLC, Mortise Medical LLC
Archdeacon, Michael T.	1, 3b – Stryker; 7 – SLACK Incorporated
Carlson, Jon B.	n

Guthrie, S. Trent	n
Huo, Michael H.	3b – AO Foundation, B–One Orthopedics, DePuy, a Johnson & Johnson Company, Implantcast
EDUCATION COMMITTEE	**DISCLOSURE**
Cannada, Lisa K. Chair	5 – Foundation for Orthopaedic Trauma
Bishop, Julie	n
Crist, Brent D.	2 – Kinetic Concepts, Inc.; 3b – Globus Medical, Pacira; 3c – Orthocentric; 4 – Orthopaedic Implant Company; 5 – Synthes
Ponce, Brent A.	1– Wright Medical Technology, Inc.; 2, 3b – Tornier; 4 – Help Lightning
Willey, Michael C.	5 – Biomet
PRESENTERS, CO–AUTHORS, and MODERATORS	**DISCLOSURE**
Abdel, Matthew P	1 – Stryker; 7 – Springer
Abraham, Megha M.	n
Abu–Amer, Wahid	n
Abya, Eildar	n
Acuña, Alexander J.	n
Adamczyk, Mark J.	n
Adams, John David	3b – Arthrex, Inc
Adams, William H.	n
Adhia, Akash	n
Adogwa, Owoicho	n
Agarwal, Animesh	2 – AO North America; 2, 3b – KCI, Smith & Nephew; 5 – Bone Support; 7 – Springer
Agel, Julie	n
Agyeman, Kofi	n
Ahmed, Farhan	n
Ahn, Junho Ahn	n
Aibinder, William	n
Akhtar, Zeeshan M.	n
Akram, Faisal	n
Albert, Michael C.	1 – OrthoPediatrics Bandloc Inc.; 3b – AMB Surgical; 3b, 4 – OrthoPediatrics
Albright, Patrick D.	n
Alexander, Bradley K	n
Alexander, John H	n
Allan, D Gordon	n
Almaguer, Adam	n
Al–Mansoori, Ahmed	n
Alvi, Mohammed A.	n
Aman, Zachary S.	n

Amendola, Annunziato	1 – Arthrosurface, Smith & Nephew; 1, 2 – Arthrex, Inc; 3c – Bonse Solutions, Inc, Extremity Development Corporation, First Ray Inc, Lima Corporation, Rubber City Bracing; 4 – First Ray; 7– Springer, Wolters Kluwer Health
Amirouche, Farid	n
Amundson, Adam W.	n
An, Qiang	n
Ananthasubramaniam, Karthikeyan	n
Anderson, Donald	4 – Iowa Simulation Solutions, LLC
Anderson, John G	1, 2, 3b – Stryker; 3b – bespa, Biomet; 5 – Wright Medical Technology
Anderson, Matthew	n
Andrew, Christopher M.	2, 3b, 3c – JRI Ltd
Anis, Hiba K.	n
Anthony, Christopher A.	3b – McKinsey & Company
Archdeacon, Michael T	1, 3b – Stryker; 7 – SLACK Incorporated
Arguello, Alexandra M	n
Atchison, Jared	n
Athens, Christian M	n
Athey, Alexander G	n
Athiviraham, Aravind	2 – Arthrex, Inc
Au, Brigham	2 – Smith & Nephew
Austin, Matt	3b – Corin USA, Link Orthopaedics; 5 – Zimmer
Awan, Hisham M.	2, 3b – Acumed, LLc
Azar, Frederick M.	3b – 98point6, Myoscience, Zimmer; 4 Pfizer; 7 – Elsevier, Wolters Kluwer Health
Bae, Donald S.	3b – Orthopediatrics; 7 – Lippincott Williams & Wilkins, Springer
Baer, Geoffrey S.	3b – CONMED Linvatec
Baker, Courtney E.	n
Bakri, Karim	n
Balderama, Earvin S	n
Baldwin, Margaret A.	n
Barlow, Jonathan D.	3b – Stryker
Barnes, C. Lowry	1 – DJO, Zimmer; 3b – HealthTrust, 3b, 4 – Responsive Risk Solutions; 5 – ConforMIS; 6 – Corin USA
Baron, Jacqueline E	n
Barrera, Bene D	n
Barry, Kenton M.	n
Barsoum, Wael K	1 – Exactech, Shukla Medical; 1, 2, 3b, 5 – Stryker; 1, 5 – Zimmer; 3b, 4 – Peerwell; 4 – Beyond Limits, Capsico Health, Custom Orthopaedic Solutions, Sight Medical; 5 – DJO, Inc, NIH, Orthosensor, Third Frontier; 7 – Thieme
Bartels, Douglas W.	n

Bartol, Stephen	3b – DePuy, a Johnson & Johnson Company
Barton, Cameron B	n
Bass, Robert L	n
Battaglia, Muriel R.	n
Beal, Matthew D.	3b – Zimmer; 5 – Corin USA, Link Orthopaedics
Beason, Austin	n
Bechtold, Daniel A.	n
Becker, Hillary A.	n
Bedard, Nicholas A.	n
Behrend, Lindsey A	n
Beletsky, Alexander	n
Bell, Anthony	n
Bercik, Michael	3b, Novus Surgical; 6 – LIMA
Berend, Keith R.	1, 3b, 5 – Zimmer Biomet; 4 – Elute, Inc, Joint Development, SPR Therapeutics, LLC; 5 – Kenetic Concepts, Inc, SPR Therapeutics, VuMedi
Berglund, Derek	n
Bernard, Christopher D	n
Bernatz, James T.	n
Bernhardt, Jeremy A	n
Bernholt, David L.	6 – Arthrex, Inc, Smith & Nephew
Berry, Daniel J	1, 3b, 5 – DePuy, A Johnson & Johnson Co; 3b, 4 – Bodycad; 7 – Elsevier, Wolters Kluwer Health – Lippencott Williams & Wilkins
Bess, Laura	n
Bettencourt, Jacob W	n
Bettin, Clayton C	n
Bhatti, Atiq R.	n
Bhimani, Rohan	n
Bigach, Stephen D.	n
Bin Dajim, Nayef	n
Binau, Ashley L.	3a – Synergy
Binkley, Neil C.	3b – Amgen; 5 – GE Healthcare, Radius
Bircher, James	n
Bishop, Julie Y.	n
Black, Natalie Renee	n
Blackwell, Ryan E.	n
Bledsoe, J. Gary	n
Bloomfield, Michael R.	n
Bober, Kamil	n
Boese, C. Kent	2 – Johnson & Johnson; 5 DePuy, a Johnson & Johnson Company
Bollier, Matthew J	n
Boothby, Benjamin	n

Borah, Bijan J.	3c – Exact Sciences
Borrelli, George J.	n
Borroto, Wilfredo J.	n
Bosco, Joseph A	4 – Genovel, Proventus Health, Relative Risk Solutions
Bou–Akl, Therese	n
Bovid, Karen M.	n
Bovonratwet, Patawut	n
Bowers, Katherine A.	n
Brabston, Eugene W.	3b – Orthopaedic
Brahmbhatt, Ashish	n
Bratescu, Rachel	n
Brenner, Madison	n
Briskin, Isaac	n
Brogan, David M.	n
Brolin, Tyler J.	3b – DePuy, A Johnson & Johnson Co; 5 – DJ Orthopaedics
Brooks, Andrew E.	n
Brown, Joseph T.	2 – Stryker; 3b – Alphatec Spine
Brown, Lindsey	n
Brown, Nicholas M	n
Brown, Timothy S.	n
Bruggers, Jennifer L.	2, 3b – Johnson & Johnson; 3b – Biocomposites
Buchler, Lucas T.	n
Buchowski, Jacob M.	1 – Globus Medical, K2M; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Buckwalter, Joseph A.	n
Bui, Gabrielle Anne	n
Bukowski, Brandon R	n
Bumpass, David B	2 – Medtronic Sofamor Danek; 3b – NuShores Biosciences LLC, OrthoPediatrics
Buraimoh, Morenikeji	n
Burnham, Robert R.	n
Burr, Rebecca G.	n
Burrow, Zac P	n
Bush, Ashleigh N	n
Butler, Bennet A.	n
Bydon, Mohamad	n
Cabot, John H	n
Calder, Mark M.	n
Caldwell, Lindsey S	n
Calkins, Tyler E.	n

Callaghan, John J.	1, 3b – DePuy, A Johnson & Johnson Co; 4 – Cresco Labs, Flexion Therapeutices, Joint Vue; 7 – Journal of Arthroplasty (deputy editor), Wolters Kluwer Health
Camp, Christopher L.	n
Campbell, Andrew B.	n
Cancienne, Jourdan	n
Cannada, Lisa	5 – Foundation for Orthopaedic Trauma
Cannon, Dylan J.	n
Cantrell, Austin J	n
Capelle, John M.	n
Carender, Christopher N	n
Carlson, Bayard C	n
Carlson, Jon B	n
Carlson, Samuel W.	n
Carofino, Bradley C.	3b – DJ Orthopaedics, 3b, 5 – Exatech, Inc; 5 – Orthofix, Inc
Carter, Erika	n
Casnovsky, Lauren	n
Cassidy, Carter	n
Castle, Joshua P	n
Cates, Robert A	n
Cates, William T	n
Cavendish, Parker A.	n
Caycedo, Francisco J	n
Chaharbakhshi, Edwin	n
Chahla, Jorge	3c – Arthrex, Inc, CONMED Linvatec, Smith & Nephew
Chalmers, Brian P.	n
Chalmers, Peter N.	1, 2 – DePuy, A Johnson & Johnson CO; 3b – Arthrex, Ince, Mitek; 7 – Journal of Shoulder & Elbow Surgery
Chambers, James S.	n
Chang, Song Ho	n
Chan–Hee, Jo	n
Charters, Michael A.	n
Chatha, Kiran	n
Checketts, Jake X.	n
Cheema, Sana G	n
Chen, Antonia F	3b – 3M, ACI, American Medical Foundation, bOne, Convatec, DePuy, A Johnson & Johnson CO, Heraeus, Recro, Stryker; 3b, 4 – Irrimax; 3b, 5 – Avanos; 4 – Graftworx, Hyalex, Joint Purification Systems, Sonoran; 7 – SLACK Incorporated
Chen, Jason Y.	n
Chen, Jeffrey W.	n
Chen, Jie	n

Chen, Sarah L.	n
Chinnakkannu, Karthikeyan	n
Chong, David Y.	4 – Wheaton Brace Co
Christian, Robert A.	n
Christmas, Kaitlyn N.	3a – Wright Medical Technology; 3b DJ Orthopaedics
Chrumka, Alexandria I.	n
Church, Dane J	n
Churchill, Jessica L.	n
Ciesielski, Alex	n
Cipparrone, Nancy E.	n
Clare, Michael P	n
Claxton, Matthew R.	n
Clohisy, John C.	1 – Microport; 3b – Microport Orthopedics; 3b, 5 – Zimmer; 5 – Department of Defense; 7 – Wolters Kluwer Health
Coda, Reed G	n
Cofield, Robert H.	1 – DJ Orthopaedics; 7 – Wolters Kluwer Health
Cohen, Joseph B.	n
Cohn, Matthew R	n
Cole, Brian J	1 – Elsevier Publishing; 1, 3b, 5 – Arthrex, Inc; 3b, 4, 5 – Regentis; 4 – Bandgrip Inc, Ossio; 5 – Aesculap/B.Braun, National Institutes of Heals (NIAMS & NICHD); 6 – Athletico, JRF Ortho, Smith & Nephew; 7 – Operative Techniques in Sports Medicine
Colosimo, Angelo J	n
Colvell, Kara	n
Compton, Jocelyn	n
Conant, Scott H	n
Conrad, David	n
Contreras, Erik	n
Cooper, Benjamin J	n
Corlette, Jill	4 – Procter & Gamble
Cornett, Chris A.	n
Corrigan, Chad M	2 – AO North America
Cotton, Colin	n
Cotton, Michael O	n
Couch, Cory G	n
Courtney, P. Maxwell	2 – ConvaTexc; 3b – DePuy, A Johnson & Johnson Co, Hip Innovation Technology; 4 – Parvizi Surgical Innovation; 7 – Journal of Bone & Joint Surgery
Crawford, Matthew D.	6 – Smith & Nephew
Crist, Brett D	2 – Kenetic Concepts; 3b – Globus Medical, Pacira; 3c – Orthocentric; 4 – Orthopaedic Implant Co; 5 Synthes
Cross, William W	n
Crouser, Nisha	n

Culvern, Chris	n
Cummings, Nancy	4 – Cardiosolutions
Cunningham, Brian P	3a – (spouse) CODE Technology; 5 – Integra
Currier, Bradford L.	1 – DePuy, A Johnson & Johnson Company, Zimmer; 4 – SpinologyTenex; 7 – Wolters Kluwer Health
Curtis, Daniel	n
Cvetanovich, Gregory L.	n
Dadgar, Azad	4 – Johnson & Johnson
Dahlgren, Nicholas	n
Dahm, Diane L	1, 4 – (spouse) Tenex Health, Inc, Sonex Health; 5 – Arthrex, Inc
Dalton, Conner	n
Darrith, Brian	n
Dart, Bradley R	n
Daum, Joshua	n
Dávila Castrodad, Iciar M.	n
Davis, Benjamin J.	n
Davis, William	n
Davison, John	n
Dawson, Sarah	n
Dayton, Steven	n
Dea, Nicolas	2 – Baxter; 2,4 – Medtronic; 3b – Stryker
Deans, Christopher F.	n
Deckard, Evan R	n
Deirmengian, Gregory K.	2, 3b, 5 – Zimmer; 3b – Biomet, Synthes, 4 – CD Diagnostics, Biostar Ventures, Domain, Trice; 5 – CD Diagnostics; 7 – Journal of Bone & Joint Surgery
Del Core, Michael A	n
Delanois, Ronald E.	5 – Flexion Therapeutics, Orthofix, Inc, Stryker, Tissue Gene, United Orthopedics
Delgado, Domenica A	n
Della Rocca, Gregory J.	3b – Bioventus, Wright Medical Technology, Inc; 4 – Mergenet, The Orthopaedic Implant Company
Della Valle, Craig J.	1, 3b, 5 – Smith & Nephew, Zimmer; 3b – DePuy, A Johnson & Johnson Co; 4 – Orthophor & Surgiphor, Parvizi Surgical Innovations; 5 – Stryker; 7 – SLACK Incorporated, Wolters Kluwer Health
DeMik, David E.	n
DePhillipo, Nicholas N.	n
Devito, Paul	n
D'Heurle, Albert	n
Diaz de Leon, Alejandro	n
DiBartola, Alex C.	n
Dick, Nicholas R.	n

Dietz, Paula	n
DiGiovanni, Christopher W.	1, 3b, 4, 6 – Extremity Medical, Inc; 2, 3b, 4, 6 – Wright Medical Technology, Inc; 4 – CreOsso, Osso VR; 4, 6 – Paragon 28; 5 – Arthrex, Butterfly Network, Orfiks, OrthoScan, Inc; 6 – Omega Grant; 7 – Elsevier, S4Carlisle Plublishing, Saunders/Mosby–Elsevier, Springer, Wolters, Kluwer Health
Dilisio, Matthew F.	2 – Arthrex, Inc
Dilley, Julian	n
DiNicola, Nicholas J.	n
DiStasi, Stephanie	n
Dixon, Tonya L.	n
Dolan, Lori A.	6 – Green Sun Medical
Domb, Benjamin G.	1 – DJO Global, Orthomerica; 1, 3b, 5 – Arthrex, Inc; 3b – Adventist Hinsdale Hospital, Amplitude; 3b, 5 – Medacta, Stryker
Dombrowsky, Alexander	n
Dong, David	n
Doro, Christopher J.	n
Drummond, Mauricio Jr.	n
Duchman, Kyle R.	6 – Arthrex, Inc., Zimmer
Duethman, Nicholas C	n
Dumaine, Anne M.	n
Duminie, Sean P.	n
Duncan, Christoper M.	n
Duncan, Nathan	n
Eads, Ryan	n
Echeverry, Nikolas	n
Edwards, Paul K.	1, 3b –DJ Orthopaedics
Ehiorobo, Joseph O.	n
Eikenberry, Alexander	n
Elias, John J	n
Elkins, Jacob	n
Elliott, Marilyn	n
Ellis, Henry B	n
Ellis, Robert T.	n
Elson, Leah	3b – OrthoSensor
Emery, Charles F	4 – GlaxoSmithKline, Pfizer
Englert, Graham	n
Erlichman, Robert B.	n
Eswaran, Sanju P	n
Etcheson, Jennifer I.	n
Evans, Douglas A.	n
Evans, Tyler D.	n

Everhart, Joshua S.	n
Feinglass, Joseph	n
Femino, John E.	3b – Arthrex, Inc, Integra
Fene, Evan S	n
Fernandez, Claire	n
Ferras, Zeni	n
Fidai, Mohsin	n
Fillingham, Yale A.	3b – Johnson & Johnson, Medacta; 4 – Muvr Labs, Inc
Finnoff, Jonathan	3b – Sanofi–Aventis; 7 – Springer, Wolters Kluwer Health
Fisher, Charles	1, 3b – Medtronic; 3b – Nuvasive; 5 – OREF
Fisk, Felicity	3b – DePuy, A Johnson & Johnson Co
Fitts, Jamal	n
Fitzpatrick, Sean	n
Flanigan, David C.	3b – CONMED Linvatec, DePuy, a Johnson & Johnson Company; 3b, 5 – Moximed, Musculoskeletal Transplant Foundation, Smith & Nephew, Vericel, Zimmer; 5 – Aesculap/B.Braun, Anika Therapeutics, Arthrex, Inc., Cartiheal, Ceterix, Histogenics, Stryker
Fleissner, Paul R.	2, 3b, – Exactech, Inc.
Flurin, Pierre	1, 3b – Exactech
Foreman, Cameron	n
Forsythe, Brian	3b, 5 – Stryker; 4 – Jace Medical; 5 – Arthrex, Smith & Nephew; 7 – Elsevier
Fournier, Matthew N.	n
Fowler, Timothy P	n
Fox, Jake	n
Fralinger, David	n
Francois, Audrice	n
Frankle, Mark A.	1, 2, 3b, 5 – DJO Surgical; 3b – Cayenne Medical, Synchrony; 5 – Zimmer
Franovic, Sreten	n
Frantz, Travis	n
Frazzetta, Joseph J.	n
Freedman, Brett A	n
Freychet, Benjamin	n
Frisch, Nicholas B.	2 – 3m; 3b, 5 – Zimmer; 4 – Advanced Orthopaedic Specialties, PeerWell; 5 – Don Joy
Fryberger, Charles T.	n
Fu, Sunyang	n
Fuller, Brian	n
Funk, Rebecca D.	n
Gabra, Joseph N.	n
Gaio, Natalie	n

Gannon, Emmett J.	n
Garbis, Nickolas G.	2 – DJ Orthopaedics, Wright Medical Technology
Garcia Fleury, Ignacio	n
Gardner, Matthew P.	1, 2, 3b – Nuvasive; 3b – DePuy, A Johnson & Johnson Co; 5 – Research Support
Garvin, Kevin L.	n
Gaudiani, Michael A.	n
Gee, Shawn	n
Gekas, Caroline P	n
George, L. Watson	n
George, Nicole E.	n
Gerlinger, Tad L.	2, 3b, 4 – Smith & Nephew; 4 – Theracell
Gilot, Gregory	1 – Zimmer; 3b – DJ Orthopaedics; 4 – MyMedicalImages
Glass, Natalie A.	n
Glogovac, Georgina	n
Go, Cammille C.	n
Goble, Haley M	n
Golden, Ann S	n
Golz, Andrew G.	n
Gonzalez, Mark H.	1 – Biomet, Johnson & Johnson, Zimmer; 3b – Smith & Nephew; 4 – Ortho Sensing Technology
Goodspeed, David C.	3b – Synthes
Gorman, R Allen.	5 – DJ Orthopaedics
Gossett, Leland E	n
Goyal, Kanu S	5 – Acumen, LLC, Skeletal Dynamics
Grabau, Jonathan D.	n
Graf, Ryan M.	n
Graham, R. David	n
Grantham, W. Jeffrey	4 – Pfizer; 6 – Smith & Nephew
Grauer, Jonathan N.	3b – TIDI Products
Grauer, Jordan	n
Grawe, Brian M.	n
Graziano, Gregory	3c – Medtronic Sofamor Danek
Grear, Benjamin J	7 – Saunders/Mosby–Elsevier
Greenberg, Marc	n
Grindel, Steven I.	3b, 5 – Wright Medical Technology, Inc.
Grits, Daniel	n
Grogan, Brian F.	n
Gross, Bruno	n
Gryzlo, Stephen M	n
Guanciale, Anthony F.	n
Gulbrandsen, Trevor R	n

Gulledge, Caleb M	n
Gungor, Busra	n
Gupte, Gaurang	n
Guss, Daniel	5 – Arthrex, Inc, Butterfly Network, Orthoscan; 6 – Wright Medical Tech, Inc
Guthrie, S Trent.	n
Hagemeijer, Noortje	n
Haghshenas, Varan	n
Hajewski, Christina J.	5 – OREF
Hale, Rena F.	n
Haleem, Amgad	n
Hall, Jacob T	n
Halstrom, Jared R	n
Hannon, Charles P.	3b – ExplORer
Hansen, Benjamin J.	3a – Forest Pharmaceuticals, Myraid Genetics; 3b – Biomet, Zimmer
Hanssen, Arlen D	1 – Stryker; 7 – Elsevier
Hanssen, Arlen D.	1 – Stryker; 7 – Elsevier
Hardesty, Christina K.	3b – Medtronic, Orthopediatrics
Hardt, Kevin D.	3b – Moximed; 3b, 5 – Medacta
Harms, Kelly A.	n
Harold, Ryan E.	n
Harper, Katharine	n
Harris, Joshua D	2 – Xodus Medical; 2, 3b, 5 – Smith & Nephew; 5 – DePuy, A Johnson & Johnson Co; 7 – SLACK Incorporated
Harris, Kristie	n
Hart, Adam	n
Hart, Thomas	n
Hartley, Brandi R	n
Hartline, Jacob T	n
Hartman, Curtis W.	2, 3b, 5 – Smith & Nephew; 5 – Pfizer
Hartwell, Matthew J	n
Hasan, Laith	n
He, Jun Kit	n
Hedt, Corbin A	n
Heidenreich, Mark J.	n
Heise, Griffin M.	n
Helms, Jonathan R	n
Helvie, Peter F.	n
Hendrickson, Nathan R	n
Henning, Jordan	n
Henning, Grant D	n

Hermanns, Christina A	n
Hessburg, Luke.	n
Hettrich, Carolyn	n
Hevesi, Mario	3b – Moximed
Hewlett, Angela	5 – LeafBio Inc; 7 – Springer
Hidden, Krystin	n
Higuera, Carlos A	2, 3b, 5 – KCI; 4 – PSI; 5 – CD Diagnostics, Cymedica, Ferring Pharmaceuticals, OREF, Orthofix, Inc., Orthogenics, Stryker, Zimmer
Hilibrand, Ari S.	1 – Amedica, Biomet; 4 – Lifespine, Paradigm Spine
Hines, Jeremy T.	n
Hirase, Takashi	n
Ho, Christine A.	7 – Wolters Kluwer Health
Hogue, Matthew H	n
Holt, Joshua B.	n
Holte, Andrew J.	n
Holzmeister, Adam M.	n
Hong, Thomas	4 – Intuitive; Sanofi–Aventis
Hoopes, Robert R	n
Hopkinson, William J.	4 – Johnson & Johnson, Pfizer, Zimmer
Horberg, John V	n
Houdek, Matthew T	n
Howe, Benjamin M.	4 – Imagen
Hsu, Alan	n
Hsu, Wellington K.	1, 3b – Stryker; 3b – Allosource, Asahi, Bioventis, Medtronic Sofamor Danek, Mirus,. Nuvasive, Wright Medical Technology, Inc; 5 – Medtronic
Hu, Alex	n
Huang, Sharon G	n
Hulik, Robert M.	n
Hunter, Allison	n
Huo, Michael H.	3b – AO Foundation, B–One Orthopedics, DePuy, Johnson & Johnson Co, Implantcast
Huyke, Fernando A.	n
Incavo, Stephen J	1 – Innomed, Kyocera, Osteoremedies, Smith & Nephew, Wright Medical Technology, INC, Zimmer; 4 – Nimbic Systems
Isbell, Jonathan	n
Israel, Heidi	n
Ivanov, David V	n
Jabara, Justin	n
Jack, Robert A.	n
Jacobs, Cale	3b – Flexion Therapeutics; 5 – Medtronic, Smith & Nephew

Jacobs, Joshua J.	4 – Hyalex, 5 – Medtronic Sofamor Danek, Nuvasive, Zimmer; 7– Journal of Bone & Joint Surgery
Jaeblon, Todd	5 – Synthes
Jain, Margaret	4 – AthenaHealth
Jain, Mohit	n
Jean–Pierre, Mirlande	n
Jean–Pierre, Nancy	n
Jeray, Kyle J.	2 – Radius; 3b – Zimmer
Jha, Aaradhana J	n
Jildeh, Toufic R	n
Jimenez–Almonte, Jose H.	n
Johnson, Adam	n
Johnson, Anna	n
Johnson, Brian	n
Johnson, Daniel J	n
Johnson, Eric B	n
Johnson, Joshua D.	n
Johnson, Michael D.	3b – In2bones, ODI; 5 – SBI
Johnson, Paul R.	n
Jones, Grant L	5 – OrthoSpace; 6 – Musculoskeletal
Jones, Jaclyn	n
Jones, James R	n
Jones, Kerwyn C	n
Jones, Kristen E.	n
Jones, Travis J	n
Josifi, Erlena	n
Joyce, Cara	n
Judd, Hyrum	n
Justen, Marissa A.	n
Kadado, Allen A.	n
Kadri, Omar	n
Kaeding, Christopher C	3b, 5 – Smith & Nephew; 5 – Active Implants, Ceterex, Vericel, Zimmer
Kamaci, Saygin	n
Kamath, Atul F.	1 – Innomed; 2, 3b, 4, 5 – Zimmer; 2, 3b, 5 – DePuy, A Johnson & Johnson Co; 4 – Johnson & Johnson, Procter & Gamble
Karam, Matthew D	4 – Iowa Simulation Solutions, LLC, Mortise Medical LLC
Karns, Michael R	3b – DePuy, A Johnson & Johnson Co
Kaszuba, Stephanie	n
Kay, Andrew B	n
Kayupov, Erdan	n
Keating, Timothy C.	n

Keeney, James A.	3b – DePuy, a Johnson & Johnson Company, Flexion Therapeutics, Heron Therapeutics
Kelemen, Margaret N.	n
Keller, Nicole B.	n
Kelly, Derek M.	7 – Elsevier Health
Kelly, Samantha P	n
Kennedy, Mark	n
Kennedy, Nicholas I.	n
Kennon, Justin C.	3a, 4 – Eli Lilly
Kenter, Keith	3c – BioPoly, LLC
Keyt, Lucas K	n
Khalil, Lafi S.	n
Khan, Safdar N.	n
Khazi, Zain M.	n
Kheir, Michael M	4 – Kleu LLC
Khurana, Ankit	n
Killen, Cameron J.	n
Kim, Andrew	n
Kink, Rudy J.	n
Kirchner, Graham	n
Kishawi, Deena	n
Kissenberth, Michael J.	6 – Arthrex, Inc, Arthrocare, Arthrosurface, Breg, DJ Orthopaedics, Greenville Hospital System, Neurotech, Pacira, Smith & Nephew
Kit He, Jun	n
Klag, Elizabeth A.	n
Klavas, Derek M	n
Kleweno, Conor	1, 3b – Globus Medical; 3b – Stryker, Synthes
Kliethermes, Stephanie A.	n
Klika, Alison K	n
Knapik, Derrick M	n
Koehler, Daniel M	n
Koen, Sandra	n
Kolodychuk, Nicholas N.	n
Kolowich, Patricia A.	n
Kolz, Joshua M	n
Kopechek, Kyle J.	n
Koroukian, Siran	6 – American Renal Associates, Celgene
Kothari, Parin	n
Krebs, Olivia B	1, 3b, 4 – Stryker; 7 – Journal of Anthroplasty
Krebs, Viktor E.	1,2 – Stryker; 3b – Stryker Orthopaedics
Krenek, Katherine M.	n
Kruckeberg, Bradley M	n

Krueger, Chad A	n
Krych, Aaron J.	1, 3b, 5 – Arthrex, Inc; 3b – JRF Ortho, Vericel; 5 – Aesculap/B.Braun, Arthritis Foundation, Ceterix, Histogenics
Kuhlmann, Noah A.	n
Kumar, Padam	n
Kunze, Kyle N.	n
Kurland, Robert L.	n
Kushelev, Michael	n
Kuzma, Scott A	n
Lack, William	n
Lack, Williams D.	n
Lall, Ajay C.	6 – Arthrex, Inc, Medwest Associates, Smith & Nephew, Stryker
Lambert, Bradley S	6 – Major League Baseball
Lang, Gerald J.	n
Lange, Jeffrey K.	n
LaPrade, Matthew D.	1, 2, 3b, 5 – Smith & Nephew; 1, 3b – Arthrex, Inc, Ossur; 3b – Linvatex; 7 – Thieme
LaPrade, Robert F.	1, 3b, 5 – Arthrex, Inc, Ossur, Smith & Nephew; 5 – Linvatec
Larson, Christopher M.	3b – Smith & Nephew
Larson, Dirk R.	n
Larson, Evan P.	n
Laughlin, Richard T.	n
Lawler, Ericka A	n
Lawton, Cort D	n
LeDuc, Ryan	n
Lee, Cody S.	n
Lee, Gwo–Chin	2, 3b – DuPuy, A Johnson & Johnson Co; 3b – Corin USA, Heron Therapeutics, Stryker; 5 – Ferring Pharmaceuticals, KCI, Smith & Nephew, United Orthopedics
Lehner, James T	n
Leland, Devin P	n
Levine, Brett R.	3b – Exactech, Inc., Link Orthopaedics, Merete; 5 – Artelon, Zimmer
Levy, Bruce A.	1, 3b – Arthrex, Inc; 3b, 5 – Smith & Nephew; 5 – Biomet, Stryker
Levy, Jonathan C.	1 – Innomed; 1, 3b – DJ Orthopedics; 3b – Globus Medical; 5 – Biomet, Orthofix, Inc, OrthoSpace, Rotation Medical, Tornier
Levy, Nate	n
Lewallen, David G.	1 – Mako/Stryker; 1, 3b – Zimmer Biomet; 4 – Acuitive Technologies, Ketai Medical Devices; 5 – Corin USA
Lewallen, Laura W.	1 – Zimmer; 5 – (family member) Zimmer
Li, Daniel	n
Li, Jefferson	n
Li, Mengnai	n
Liberman, Shari R	n

Light, Terry R.	n
Lima, Diego J.	n
Lima, Diego J.L.	n
Limberg, Afton K.	n
Lin, James S.	n
Liou, William	6 – Exactech
Liu, Boshen	n
Locker, Joshua C.	n
Logli, Anthony L	n
Long, Jake S.	n
Love, Bridgette M	n
Lu, Yining	n
Lubberts, Bart	n
Ly, Thuan V.	n
Lyden, Elizabeth R.	n
Lynch, Daniel J	n
Lyons, Madeline M	n
Madden, Tyler S.	n
Magnussen, Robert A	5 – Zimmer; 6 – Arthrex, Inc
Mahoney, Craig R.	4 – Trak Surgical, Inc.; 5 – Johnson & Johnson, Smith & Nephew
Makhani, Ahmed A	n
Makhni, Eric C	2 – Xodus Medical; 3b – Smith & Nephew; 7 – Springer
Malarkey, Andrew	n
Maldonado, David R.	n
Malhotra, Gautam	n
Malik, Azeem T	n
Malkani, Arthur L.	1, 2, 3b, 5 – Stryker
Malpani, Rohil	n
Mannen, Erin M.	5 – Boba, Inc, Medtronic
Manning, David W.	1 – Biomet; 2 – Medacta; 3b – Medacta USA
Mansor, Yosif	n
Maradit–Kremers, Hilal	n
Marigi, Erick M.	n
Markel, David C.	1, 2, 3b, 5 – Stryker; 2 – Halyard; 4 – Arboretum, The CORE Institute; 5 – Ascension Providence Hospital, OREF, US Veteran Administration
Marra, Guido M.	1 – Zimmer
Marsh, J. Lawrence	1 – Biomet, Tornier; 4 – FxRedux; 7 – Oxford Press
Martin, Case W	n
Mascoli, Anthony M	n
Massri–Pugin, Jafet	n
Matar, Robert N	n

Maupin, Jeremiah J	n
Maxheimer, Brook	n
Mayes, Wesley H.	n
McCartney, Christian C.	n
McClatchy, S. Gray	n
McCulloch, Patrick C.	2 – Vericel; 5 – Arthrex, Inc., DePuy, a Johnson & Johnson Company
McGinty, Jasmin L.	n
McGwin Jr, Gerald	n
McHale, Kathleen A	n
McIntosh, Amy L.	2 – Nuvasive
McKissack, Haley M	n
McLain, Robert F.	3b – SI Bone
McLaughlin, Richard J.	n
McMurtie, James T	n
McNeely, Emmanuel	n
Mears, Simon C.	4 – Delta Ortho LLC
Mehdi, Syed K.	n
Mehran, Nima	n
Mehta, Mitesh P.	4 – Amgen Co, Procter & Gamble
Meiyappan, Arjun	n
Mejia, Alfonso	5 – Acumed, LLC, Arthrex, LLC, Smith & Nephew, Synthes
Melugin, Heath P.	n
Meneghini, R. Michael	1, 3b – Osteoremedies; 1, 3b, 5 – DJ Orthopaedics; 3b – KCI, Kinamed; 4 – Emovi, Olio Health
Mercado, Arthur	n
Merriam, John	n
Meta, Fabien	n
Metz, Rachelle M.	n
Mickley, John P	n
Mierzwa, Adam	n
Mighell, Mark A.	1 – NewClip; 2– DePuy, A Johnson & Johnson Co, Wright Medical Technology; 2, 3b – Stryker; 3, 3b, 5 – DJ Orthopaedics
Mihalko, William M.	1, 2, 3b, 5 – Aesculap/B.Braun; 2 – Pacira Biosciences, Inc; 3b – Pacira Inc, Zimmer; 5 – Department of Defense, Myoscience, National Institutes of Health (NIAMS & NICHD), Stryker; 7 – Saunders/Mosby–Elsevier
Milbrandt, Todd A.	3b – Medtronic, Orthopediatrics, Zimmer; 4 – Viking Scientific; 6 – Broadwater
Miller, Benjamin J.	n
Miller, Timothy L.	n
Miniaci–Coxhead, Sarah Lyn	3b – Integra LifeSciences; 7 – Journal of Bone & Joint Surgery
Mistovich, Justin	3b – Orthopediatrics; 4 – Right Mechanics, Inc

Moeller, Amy T.	n
Mohamed, Nequesha S.	n
Mohiuddin, Amer	n
Molloy, Robert M.	2,3b,5 – Stryker; 5 – Zimmer
Momaya, Amit	3b – Fidia Pharma USA, Miach Orthopaedics
Mont, Michael A.	1 – Microport; 1, 3b, 5 – Stryker; 3b – Cymedica, Flexion Therapeutics, Pacira, Perforamnce Dynamics, pfizer, Skye Biologics; 3b, 4 – Peerwell; 3b, 5 – DJ Orthopaedics, Johnson & Johnson, Ongoing Care Solutions, Orthosensor, TissueGene; 4 – USMI; 5 – National Institures of Health (NIAMS & NICHD); 7 – Medicus Works, LLC, Up–to Date, Wolter Kluwer Health
Montgomery, Tyler	n
Moon, Andrew	n
Mooney, Megan	n
Moor, Molly	n
Moraes, Leonardo	n
Moran, Steven L	1, 3b – Integra; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Morcuende, Jose A.	3b – Clubfoot Solutions
Morehouse, Hannah	n
Morgan, Allison M.	n
Morgan, Joseph A.	n
Moric, Mario	3b – Zimmer
Mormino, Matthew A.	n
Morrey, Mark E	4 – Tenex
Morris, Michael J.	1, 3b – Total Joint Orthopedics; 2, 3b, 5 – Zimmer Biomet; 4 – Joint Development Corporation, SPR Therapeutics, LLC; 5 – KCI, SPR Therapeutics
Morris, Randal	n
Morrisett, Ryan W	n
Mott, Michael P.	3b – Musculoskeletal Transplant Foundation
Moutzouros, Vasilios	n
Mu, Brian H.	n
Muh, Stephanie J.	3b – DePuy, A Johnson & Johnson Co, Exactech, FX Shoulder
Mullen, Scott M	3b – Stryker
Mumford, Joseph E.	n
Munaretto, Nicholas F	n
Mundy, Andrews	n
Munoz, James D	n
Murphy, Garnett A	1, 2, 3b, 5 – Wright Medical Technology, INC; 5 – Allsotem, Arthrex, Inc, Biometric, Ferring Pharmaceuticals, Smith & Nephew; 7 – Saunders/Mosby–Elsevier
Murphy, Michael P.	n

Murray, Trevor G	3b – Biomet, Zimmer
Myeroff, Chad	n
Nabers, Matthew	n
Nace, James	5 – Stryker
Nahhas, Cindy R.	n
Nam, Denis	3b, 5– KCI; 3b – Stryker; 5 – Zimmer
Naranje, Sameer M	n
Narayanan, Shankar	n
Nascone, Jason W	1 – CoorsTek; 1, 2 – Synthes; 2 – Zimmer; 2, 3b – Smith & Nephew; 3b – DePuy, A Johnson & Johnson Co; 4 – Imagen
Neel, Robert T.	3b – Diamond Orthopedics, Wright Medical Technology
Nelson, Benjamin	n
Nelson, Lauren M	n
Nelson, Patrick A	n
Nemsick, Michael	n
Nettrour, John F.	5 – DePuy, A Johnson & Johnson Co
Neviaser, Andrew S	n
Nguyen, Benjamin P.	n
Nguyen, Duy K.	n
Nguyen, Ngoc Tram V.	n
Nicolay, Richard W.	n
Nielson, Mark	2, 3b – DJ Orthopaedics; 4 – Pacira
Noiseux, Nicolas O.	1 – Link Orthopaedics; 3b, 5 – MicroPort, Smith & Nephew; 5 – DePuy, a Johnson & Johnson Company
Noonan, Thomas J.	3b – Stryker
Norris, Brent L.	3b – Acumed, LLC, DePuy, A Johnson & Johnson Co, Wishbone Medical; 4 – Norris Surgical, ORI, LLC; 5 – AONA, COTA
North, Wayne Trevor	4 – PeerWell
Norton, John	n
Nystrom, Lukas M.	3b – KCI, Onkos Surgical, Inc.
Nzegwu, Ifeanyi N.	n
Odadeji, Lasun O	n
Odor, Nathan	n
Oh, SaeRam	n
Ohanisian, Levonti	n
Ohliger, Erin E	n
Ohliger, James E	n
Ojo, Oluwatosin	n
Okoroha, Kelechi R	n
Oladeji, Lasun O.	n
Ollivier, Matthieu	n
Oppizzi, Giovanni	n

Ornell, Samuel S	n
O'Rourke, Ryan J	n
Ortiz, Shannon	n
Osmon, Douglas R	n
Osmon, Douglas R.	n
Otero, Jesse E	3b, 5 – DePay, A Johnson & Johnson Co
O'Toole, Robert V	1, 3b – CoorsTek; 2 – Zimmer; 3b – Smith & Nephew; 3b, 4 – Imagen
Owen, Aaron R	n
Owen, Robert	n
Owens, Jessell M	n
Oyekan, Anthony A	n
Padgett, Douglas E.	1, 2, 3b – DJ Orthopaedics; 4 – Orthophor, Parvizi Surgical Innovations, Tangen
Padley, Michelle A	n
Pagnano, Mark W.	1 – DePuy, A Johnson & Johnson Company, Stryker; 3b – KCI; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Pahuta, Markian A.	n
Paliobeis, Andrews S	n
Pallante, Graham D.	n
Pamplin, Jordan L	n
Panattoni, Joao	n
Panchbhavi, Vinod Kumar	2 – Stryker; 7 – Wolter Kluwer Health
Pannu, Tejbir S	n
Pareek, Ayoosh	n
Parikh, Harsh R	n
Parker, Emily A.	n
Parker, John	n
Parkes, Chad W.	n
Parman, Michael D.	n
Parvizi, Javad	1, 3b, 4 – Corentec; 3b – 3M, Ethicon, Heraeus, NCI, Stryker, Tenor, TissueGene, Zimmer; 4 – Alphaeon, Ceribell, Hip Innovation Technology, Intellijoint, Joint Purification Systems, MDValuate, MicroGenDx, Parvizi Surgical Innovations, Physician Recommended Nutriceuticals, PRN–Veterinary; 7 – Datatrace, Elsevier, Jaypee Publishers, SLACK Incorporated, Wolters Kluwer Health – Lippincott Williams & Wilkins
Pasque, Charles B	n
Pate, Matthew J	n
Patel, Bhavik H	n
Patel, Harshadkumar	n
Patel, Kushal R.	n
Patel, Pratik B.	n
Patel, Preetesh D	3b – Stryker

Patel, Romil Kanu	n
Patel, Shaan	n
Pathak, Neil	n
Pattamapaspong, Nuttaya	n
Paul, Aaron W	n
Pawloski, Jacob	n
Peabody, Michael T.	n
Peabody, Terrance D.	n
Pearson, Jeffrey	4 – Stryker
Pearson, Jentry M	n
Peck, Sarah C	n
Perets, Itay	n
Perry, Kevin I.	n
Perry, Michael W	n
Peters, Colleen	n
Peters, Christopher L.	2, 3b, 5 – Biomet; 4 – CoNextionas Medical, Muve Health
Peters, Colleen	n
Peterson, Joshua G.	n
Peterson, Leif E	n
Petit, Logan S.	n
Pettit, Robert J.	3a – Stryker
Pharr, Zachary K.	n
Phieffer, Laura S.	3b – Johnson & Johnson
Phisitkul, Phinit	1 – Arthrex, Inc; 4 – First Ray, Mortise Medical
Pitts, Charles C	n
Piuzzi, Nicolas S	5 – Zimmer
Platts, Brooks	n
Plumarom, Yanin	n
Podeszwa, David A.	3c – Orthopediatrics; 7 – Elsevier
Poe–Kochert, Connie	n
Polansky, Scott	n
Polisetty, Teja S.	n
Polk, Andrew	n
Polly, David W.	3b – SI Bone; 7 – Springer
Ponce, Brent A.	1 – Wright Medical Technology; 2, 3b – Tornier; 4 – Help Lightning
Prather II, John C	n
Puffinbarger, William R.	n
Putman, Jesse	n
Putnam, Sara	n
Quatman, Carmen E.	3b – Johnson & Johnson
Rahman, Tahsin	n

Rainer, William G.	n
Ray, Jessyca L	n
Razi, Afshin E.	n
Reddy, Manoj	n
Rees, Harold W.	n
Remily, Ethan A.	n
Ren, Weiping	n
Rhee, Peter C	3b – Trimed
Rhode, David	n
Ricciardi, Benjamin F.	n
Riccio, Anthony	5 – Arthrex, Inc, Smart Medical Devices; 7 – Saunders/Mosby–Elsevier
Rice, Justin	n
Richard, Heather M.	n
Richardson, David R	7 – Saunders/Mosby–Elsevier
Riesgo, Aldo M	3b – Stryker, Zimmer
Riew, K. Daniel	1, 2, 3b – Biomet; 2 – DePuy, A Johnson & Johnson Co; 2, 3b – Medtronic, Nuvasive; 4 – Amedica, AxioMed, Benvenue, Expanding Orthopedics, Osprey, Paradigm Spine, Spinal Kinetics, Spineology, Vertiflex; 5 – AO Spine; 6 – Advance Medical, Zeiss
Riley, Matthew	n
Rinehart, Dustin	n
Rinehart, Kent	n
Rivera, John–Luke	n
Rizzo, Marco	3b – Zimmer; 3c – Synthes
Rizzone, Katherine H.	n
Roberts, Craig J.	7 – Elsevier
Robinson, Matthew G.	n
Roche, Christopher P.	3a, 4 – Exatech, Inc
Roche, Michael W.	n
Roebke, Austin J.	n
Rojas, Edward O.	n
Rondon, Alexander J	n
Rose, Peter S.	3b – K2M, Inc.; 6 – DePuy, a Johnson & Johnson Company
Rosinsky, Philip J.	n
Rowe, Dale E.	n
Rubeiz, Michael	n
Rubin, Lee E.	3b – DePuy, A Johnson & Johnson Co, Thompson Surgical Instruments; 4 – 3D Surgical Inc; 7 – Johns Hopkins University Press, SLACK Incorporated
Rudraraju, Ravi T	n
Russell, Michael D.	n
Ryan, J Conner	n

Ryan, John M.	n
Ryssman, Daniel B	n
Sabastian, Arjun S	n
Sabatino, Meagan J	n
Sabbag, Orlando D.	n
Sabesan, Vani J.	5 – Arthrex, Inc, Orthofix, Inc, Wright Medical Technology, Inc
Saengsin, Jirawat	n
Salata, Michael J	3b – Stryker
Salazar, Dane H.	n
Saltzman, Matthew D.	1 – Wright Medical Technologies; 1, 3b – Becton Dickinson
Samade, Richard	5 – Skeletal Dynamics
Samagh, Sanjum P.	n
Samuel, Linsen T.	n
Sanchez–Sotelo, Joaquin	1, 2, 5 – Stryker; 2 – Acumed; 2, 3b – Wright Medical Technology; 3b – Exactech, Inc., Inc.; 7 – Elsevier, Journal of Shoulder and Elbow Surgery, Oxford University Press
Sanders, Thomas	n
Sandhu, Kevin P	n
Sangeorzan, Bruce J	n
Saris, Daniel B. F.	3b – Smith & Nephew; 5 – JRF
Sarvari, Fahad	n
Sawatzke, Alexander B	n
Sawyer, Jeffrey R.	2 – Nuvasive, Republic Spine; 7 – Mosby, Wolters Kluwer Health – Lippincott Williams & Wilkins
Schaffer, Jonathan L.	1 – Flex Life Healthcare (FKA Zin Medical, Inc); 3b – MyDoc PTE LTD, Orthogenics; 4 – iBalance Medical, SnappSkin; 7 – Elsevier, Springer, Taylor & Francis
Scharschmidt, Thomas J	3b – Daiichi Sankyo, Stryker; 5 – Millenium Pharmaceuticals
Schiele, Steven	n
Schiffman, Corey J.	n
Schippers, Sarah M	n
Schleck, Cathy D.	n
Schloss, Michael A	n
Schmidt, Grant O	n
Schmitt, Daniel	n
Schnebel, Christopher A.	n
Schneider, Andrew D.	n
Schneider, Andrew M.	n
Schneider, Anna	n
Schoch, Bradley S.	1, 3b – Exactech
Schoenfeldt, Theodore L	n
Scholz, Natalie	n

Schroeppel, J. Paul	3b – Vericel
Schwartz, Kaylin	n
Schwarzman, Garrett	4 – Abbott
Sciadini, Marcus F	3b – Globus Medical; 3b, 4 – Stryker
Scott, Bryan	n
Scott, Elizabeth J.	n
Scott, Jared	n
Searls, William C	n
Seetharam, Abhi	n
Seitz, Amee L	n
Selley, Ryan S	n
Selley, Ryan S.	n
Sembrano, Jonathan N.	5 – Nuvasive, Orthofix, Inc.
Sems, S. Andrew	1, 3b – Zimmer
Sershon, Robert A.	3b – 2ndMD
Severin, Anna	n
Sexton, Kevin W.	1 – Baxter Healthcare
Shah, Apurva	n
Shah, Ashish B	n
Shah, Ritesh R.	2 – Flexion; 2, 3b – Smith & Nephew; 2, 3b, 5 – Microport; 2, 5 – Pacira; 5 – Biomet, IntelliJoint, Zimmer; 7 – Wolters Kluwer Health–Lippincott Williams & Wilkins
Shamrock, Alan G	n
Shannon, Steven F	n
Shapira, Jacob	n
Sharma, Sumender	n
Shaw, Jonathan H.	n
Sheth, Bhavya	n
Sheth, Ujash	n
Shi, Tong	n
Shimberg, Jilan	n
Shin, Edward D.	n
Shirley, Matthew B.	n
Siebler, Justin C.	n
Siegel, Matthew	n
Sierra, Rafael	1, 3b – Link Orthopaedics; 1, 3b, 4 – Orthalign; 1, 5 – Zimmer; 2, 3b, 5 – Biomet; 3b – Think Surgical, Inc.; 5 – Cytori, DePuy, a Johnson & Johnson Company, Stryker; 7 – Springer
Siesel, Craig	n
Siff, Todd E	n
Sikoski, Christian	n
Siljander, Breana J.	n

Silva, Matthew	2 – Amgen Co, Merck
Silverton, Craig D.	1 – Biomet
Simon, Peter	n
Simske, Natasha M	n
Sinclair, Mark R.	n
Singh, Gurmit	n
Siqueira, Marcelo B.	n
Sivasundaram, Lakshmanan	n
Siy, Alexander B.	n
Skie, Martin	3c – Integra Life Sciences
Sliepka, Joseph M.	n
Smith, Grace	n
Smith, Hugh M.	n
Smith, Patrick J.	n
Smith, Richard A.	n
Smith, Scott A.	n
Sodhi, Nipun	n
Sohn, Sunghwan	n
Songy, Chad E.	n
Son–Hing, Jochen P.	3b – Orthopediatrics
Sorensen, Amelia A	n
Sosnoski, David A.	n
Sousa, Paul L.	n
South, Shannon M.	n
Speeckaert, Amy L	n
Sperling, John W.	1 – Biomet, DJ Orthopaedics, Innomed; 3b – Exatech, Zimmer; 3b, 4 – RA
Spiegel, David A.	7 – Springer
Spiker, Andrea M.	3b – Stryker
Spindler, Kurt P.	1 – Nphase; 3b – Cytori–Scientific Advisory Board, Flexion, Mitek, NFL, Samumed; 5 – DJ Orthopaedics, National Institutes of Health (NIAMS & NICHD)
Spitler, Clay A.	2 – AO Trauma; 3b – DePuy, A johnson & Johnson Co, KCI; 4 – ROM 3 Rehab LLC
Sporer, Scott M.	1, 3b – DJO Surgical, Osteoremedies; 1, 5 – Zimmer; 5 – Styrker; 7 – SLACK Incorporated
Sridharan, Mathangi	n
Sridharan, Mathangi J.	n
Stakenas, Steven	n
Stambough, Jeffrey B.	n
Stanfill, John G.	n
Stankard, Matthew	n

Stanley, Ellen	n
Stash, Bryce	n
Statz, Joseph M.	n
Steeby, Shaun F	n
Stefl, Michael	n
Steinmann, Scott P.	3b – Acumend, LLC, Arthrex, Inc, Biomet
Steinmetz, R. Garrett	n
Stevens, Trenton T	n
Stewart, Robert J.	n
Stockwell, Erin L.	n
Streubel, Philipp	2 – Zimmer
Strickland, Carson D.	n
Strnad, Gregory J.	1 – nPhase
Strotman, Patrick K.	n
Stuart, Michael J.	1, 2, 5 – Arthrex, Inc; 5 – Stryker
Stubbs, Trevor	n
Stumpf, Monica	n
Sucato, Daniel J.	n
Suleiman, Linda I.	n
Sultan, Assem	n
Sun, Joshua J.	n
Surace, Peter	n
Sutherland, Charles R	4 – Johnson & Johnson, Merck
Sweeney, Patrick	n
Swointkowski, Marc F	n
Tagliero, Adam J.	n
Tammachote, Nattapol	2 – Smith & Nephew, Stryker
Tan, Timothy L	n
Tanner, Stephanie	6 – BoneSupport
Tarakemeh, Armin	n
Taunton, Michael	n
Taylor, Kevin A	n
Teague, David C	n
Terry, Michael A	2, 5, 6 – Smith & Nephew: 7 – Saunders/Mosby–Elsevier
Tetreault, Matthew W.	n
Teusink, Matthew	3b – DJ Orthopaedics
Thigpen, Charles A.	3b – Breg; 4 – Players Health, Trex
Thomas, J. Alex	1, 3b – Nuvasive
Thompson, George H.	1, 3b, 4, 6 – OrthoPediatrics; 3a – (son owner) JPT Medical Technologies; 6 – Nuvasive, Shriners Hospital for Children; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins

Thompson, Samuel F	n
Throckmorton, Thomas W.	1 – Exatech, Inc, Zimmer; 4 – Gilead; 7 – Saunders/Mosby–Elsevier
Thrush, Justin L	n
Tibbo, Meagan E.	n
Tigabu, Kirubel	n
Tjong, Vehniah K	n
Tobey, Jonathan L	n
Tokish, John M.	1, 2, 3b – Arthrex, Inc; 2, 3b – Mitek; 3b, DePuy, A Johnson & Johnson Co; 7 – Journal of Shoulder & Elbow Surgery
Tompkins, Marc	6 – Allosource—ROCK group, Vericel–ROCK group
Tonino, Pietro M.	3b – CONMED Linvatec; NCS; 4 – Regeneration Technologies, Inc
Torchia, Michael E	n
Toy, Kristin	n
Tramer, Joseph S	n
Trousdale, Robert	1, 3b – DePuy, a Johnson & Johnson Company
Turner, Norman S.	n
Turner, Travis W	n
Tuttle, John R	n
Tyagi, Vineet	n
Ulery, David J	n
Ussef, Najib R	n
Vail, Thomas P.	1, 3b – DePuy, A Johnson & Johnson Co; 4 – Hyalex
Vajapey, Sravya P.	n
Vakharia, Rushabh M.	n
Vara, Christopher S.	n
Vargas–Hernandez, Juan S.	n
Varner, Kevin E	1, 3b, 4 – In2Bone; 1, 4 – Wright Medical Technology, INC
Varthi, Arya G.	n
Vaseenon, Tanawat	n
Vasileff, W. Kelton	3b, 5 – Zimmer
Veale, Kodi A	n
Vera, Angelina M	n
Verma, Nikhil N	1, 5 – Smith & Nephew; 3b – Orthospace; 3b, 4 – Minivasive; 4 – Cymedica, Omeros; 5 – Arthrex, Breg, Ossur, Wright Medical Technology; 7 – Arthroscopy, Vindico Medical–Orthopedics Hyperguide
Versteeg, Ann	n
Versteeg, Gregory	n
Villa, Jesus M	n
Viner, Gean C	n

Visscher, Sue L.	n
Volchenko, Elan	n
Voos, James E	3b – Arthrex
Vopat, Bryan G	n
Vopat, Matthew L	n
Waddell, Bradford S.	3b – KCI; 5 – Stryker
Wagner, Eric R	n
Wagner, K. John	n
Wahlig, Brian D.	n
Walker–Santiago, Rafael	n
Wallace, Stephen J.	n
Waller, Garrett	n
Wallington, David G.	n
Walsh, John P.	n
Walsh, Ryan N.	n
Walters, Jordan D.	n
Walters, Jordan M.	n
Wan, Jim	n
Wanderman, Nathan R	n
Wang, David L	n
Wang, Yanshan	n
Warren, Jared A	n
Warth, Lucian C.	3b – Link Orthopaedics, OsteoRemedies, Stryker
Waryasz, Gregory	5 – Arthrex, Inc, VKTRY
Washington, Joshua L	n
Washington, Joshua L.	n
Weber, Timothy	n
Weiner, Joseph A.	n
Weinstein, Stuart L.	7 – Wolters Kluwer Health
Weistroffer, Joseph K.	n
Welby, John	n
Wendling, Alexander C	n
Wera, Glenn D.	n
Westerman, Robert W.	3b – CONMED Linvatec; 3c, 5 – Smith & Nephew
Westermann, Robert W.	3b – CONMED Linvatec; 3c, 5 – Smith & Nephew
White, Joel D	n
Whitener, Jake	n
Whiting, Paul S	n
Wilken, Jason	n
Wilkie, Wayne A.	n
Wilkinson, Brandon G	n

Willey, Michael C.	5 – Biomet
Williams, Benjamin R	n
Williams, Brady T.	n
Wilneff, Matthew	n
Wilson, Erin	n
Wilson, John T.	n
Wilson, Nathaniel M	n
Wilson, Philip L	5 – AlloSource, Ossur; 7 – Elseviar
Winkel, Luke	n
Wise, Kelsey	n
Wojewnik, Bartosz	1, 3b – HD Lifesciences
Wolf, Allison	6 – SI Bone
Wolf, Brian R	1, 2, 3B, 6 – CONMED Linvatec; 3c – SportsMed Innovate; 6 – Arthrex, INC, Smith & Nephew
Wolf, Jonathon C.	n
Worley, John	n
Wozniak, Amy	n
Wright, Joshua	n
Wright, Thomas W.	1, 3b, 5 – Exatech, Inc; 7 – Wolters Kluwer Health – Lippencott Williams & Wilkins
Wu, Karen	2 – Genentech; 3b – Medtronic, Penumbra; 3b, 5 – Stryker; 5 – Microvention
Wurtz, Jeffrey	n
Wurtz, L Daniel.	n
Wyatt, Charles W	n
Wyles, Cody	n
Wynn, Malynda S	3a – Johnson & Johnson
Xiao, Honglin	n
Xiong, Ashley E	n
Yahuaca, B. Israel	n
Yang, Yang	n
Yanke, Adam B	3b – JRF Ortho, Olympus, Organogenesis, Patient IQ, Smith & Nephew; Sparta Biomedical; 5 – Arthrex, Inc, Vericel
Yee, Heather	n
Yetter, Thomas R	n
Young, Porter	n
Yu, Charles	n
Yu, James	n
Yu, Jonathan	n
Yuan, Brandon J.	n
Yuan, Frank F. N.	n

Yun, Jonathan	n
Zajichek, Alexander	n
Zebala, Lukas P.	6 – Health Help
Zelle, Boris A	5 – DuPuy, A Johnson & Johnson CO, KCI
Zhang, Li–Qun	n
Zhang, Xiaochun	5 – Lyfstone
Zheng, Evan	n
Zhou, Guangjin	n
Zhou, Jun	n
Zhou, Liang	n
Ziemba–Davis, Mary	n
Zuckerman, Joseph D.	1 – Exatech, Inc; 3b – Musculoskeletal Transplant Foundation; 3c – Gold Humanism Foundation, J3Personica/Residency Select; 4 – AposTherapy, Inc, Hip Innovation Technology; 7 – SLACK Incorporated, Thieme, Inc, Wolters Kluwer Health – Lippencott Williams & Wilkins
Zura, Robert D.	2 – Smith & Nephew; 2, 3b – Bioventus; 3b – Osteocentric
Zurek, Lauren C	n
Zynda, Aaron J	n