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37th Annual Meeting
April 10 – 14, 2019
Hilton Sandestin Beach Golf Resort | Miramar Beach, FL

2019 PODIUM & POSTER ABSTRACTS

*Denotes presenter

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- Breakout Session #2 | Sports Medicine
- Breakout Session #3 | Trauma
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- Breakout Session #5 | Tumor/Education/Practice Management

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Disclosure Information

MAOA FIRST PLENARY SESSION
Thursday, April 11, 2019

Long-Term 17-Year Follow-Up After Meniscus Repair with Concomitant Anterior Cruciate Ligament Reconstruction in a Pediatric and Adolescent Population

Paper 001

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BACKGROUND: Studies have shown good and excellent clinical and radiographic results following meniscus repair. Limited published information exists on the long-term outcomes, however, especially in a pediatric and adolescent population. The purpose of this study was to determine long-term results of meniscus repair and concomitant ACL reconstruction in a pediatric and adolescent population. More specifically, our aims were to determine the clinical success rate of meniscus repair with concomitant ACL reconstruction, compare results to mid-term outcomes, and analyze risk factors for failure.

METHODS: Patients 18 years of age and younger who underwent meniscus repair with concomitant ACL reconstruction between 1990 and 2005 were reviewed. Patient demographics, injury history, and surgical details were recorded and risk factors for failure were analyzed. Physical examination findings and clinical outcomes at latest available follow-up were collected. Subjective knee outcomes were compared to mid-term results. Descriptive statistics and univariate analysis were used to evaluate the available data.

RESULTS: 47 patients (30 females, 17 males) with a mean age of 16 (SD: 1.37) and mean follow-up of 16.6 years (SD: 3.57) were included in this study. Overall, 13 of 47 patients (28%) failed meniscus repair and required repeat surgery at the time of final follow-up. Of the 13 failures, 9 patients underwent a subsequent meniscectomy, 2 underwent both meniscectomy and revision ACLR, 1 underwent both meniscus repair and revision ACLR, and 1 underwent meniscus repair followed by subsequent meniscectomy. IKDC Scores improved from a mean of 47.9 preoperatively to 87.7 postoperatively ($p<0.01$). IKDC score at long-term follow-up (87.7) did not significantly differ from mid-term (88.5) at mean follow-up of 7.4 years ($p=0.97$). Tegner Activity Scores improved from a mean of 1.9 preoperatively to 6.3 postoperatively ($p<0.01$). When considering pre-injury Tegner Activity levels, scores decreased from a mean of 8.3 pre-injury to 6.3 at the time of final long-term follow-up ($p<0.01$).

CONCLUSIONS: In conclusion, the long-term overall clinical success rate (failure-free survival) was 72% for repair of pediatric and adolescent meniscal tears in the setting of concomitant ACL reconstruction. Patients reported excellent knee subjective outcome scores that remained favorable when compared to mid-term follow-up.

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MAOA FIRST PLENARY SESSION
Thursday, April 11, 2019

Do Geriatric Hip Fractures Need Follow-Up Past Three Months? A 10-Year Retrospective Review

Paper 002

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BACKGROUND: The average cost per patient for hip fracture care has been estimated to be $13,000-$16,000 for one year. Excess costs occur after hospitalization, with a third spent during the first three months following discharge. This time-frame is historically when the majority of complications and mortality occurs. The goal of this study was to examine the radiographic and clinical significance of elderly patients with surgically treated hip fractures follow-up beyond three months.

METHODS: From January 2006 through December 2016, all consecutive patients over age 50 years with an intertrochanteric hip fracture and treated with a cephallomedullary nail or sliding hip screw were analyzed. Following surgery, all subsequent postoperative visits and x-rays were examined and radiographic measurements of femoral neck-shaft angle, tip-apex distance, and femoral neck screw telescoping/backing out were determined. All postoperative complications were recorded and healing was assessed at each visit as defined by bridging on three out of four cortices at the fracture site on AP and lateral x-ray.

RESULTS: 296 patients met inclusion criteria (43.6% male, 56.4% female, average age 74.8 years). 229 patients returned for follow-up (77.3%) and 188 patients achieved radiographic healing (82.1%). The average time to union was 64.5 days with a wide standard deviation of 31.1 days. The average time interval for significant complications to occur all fell within three months. The average time to death was 54.9 days, the average time to infection requiring reoperation was 18.8 days, and average time to hardware failure was 32.3 days. On POD 0 immediately after surgery, the average neck-shaft angle was 137°, the average tip-apex distance was 22.5 mm, and the average telescoping/backing out of the femoral neck screw was 11.6 mm. The neck-shaft angle and tip-apex distance had no significant change across all time-points. The screw telescoping averaged 16.9 mm at 6-week follow-up and 18.6 mm at 3-month follow-up, after which there was no significant change.

SUMMARY: Intertrochanteric femur fractures in the elderly treated with a cephallomedullary nail or sliding hip screw did not demonstrate any significant radiographic changes or complications beyond the first 90 days. Further research his warranted into the potential cost-benefit ramifications of limiting hip fracture follow-up to three months. This would presumably cut costs by eliminating the need for additional transportation, unnecessary appointments, and radiographic studies beyond the critical time-period of 90 days.

MAOA FIRST PLENARY SESSION
Thursday, April 11, 2019

Comparison of Total Knee Arthroplasty Outcomes in Patients with and without Chronic Preoperative Opioid Usage

Paper 003

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Shikha Sachdeva, M.D.
Langan Smith, B.S.
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INTRODUCTION: Chronic opioid use prior to total knee arthroplasty (TKA) has been shown to lead to poorer outcomes. However, it is unknown whether these results are dose dependent. We compared outcomes in patients with varying doses of preoperative opioid use to patients who were opioid naïve prior to TKA.

METHODS: A retrospective review was conducted of 556 consecutive primary TKA cases performed by a single surgeon from 2015-2016. 157 patients (28%) were taking opioids preoperatively, 98 of which had minimum 1 year follow-up and were included in the study group (averages: age 65 years, BMI 34 kg/m^2, follow-up 20 months). This study group was matched by age, sex, and BMI to patients from the original 556 cases without preoperative opioid use, comprising the control group (averages: age 65 years, BMI 34 kg/m^2, follow-up 21 months). The study group was subdivided into 4 groups based on daily preoperative morphine equivalent units (MEU): <6, 6-<12, 12-<18, and >18 MEU.

RESULTS: Postoperative opioid use >3 months was more common in the study group (RR 3.33, CI 2.24 to 4.97, p<0.0001), as was the likelihood of being discharged to a skilled nursing facility (RR 2.43, CI 1.05 to 5.59, p=0.0372). Incidence of postoperative knee pain >3 months (RR 1.38, CI 0.91 to 2.11, p=0.1285) and medical complications leading to readmission (RR 1.4, CI 0.45 to 4.21, p=0.5656) were higher in the study group. Prolonged opioid use was significantly higher in all MEU groups, and there was a dose-related trend of continued postoperative knee pain >3 months.

DISCUSSION: This study suggests a preoperative opioid dose relationship with TKA patients having prolonged postoperative pain. The study group had a statistically significant increase in skilled nursing requirements at discharge and use of narcotics beyond 3 months. Efforts need to be undertaken to decrease narcotic dosage prior TKA.

MAOA FIRST PLENARY SESSION
Thursday, April 11, 2019

Patient Opioid Requirements Are Often Far Less Than Their Discharge Prescription Following Orthopedic Surgery: Results of a Prospective Multicenter Survey

Paper 004

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INTRODUCTION: Evidence-based, procedure-specific guidelines for opioids are urgently needed to optimize pain relief and minimize excess opioid prescribing and the potential for opioid diversion in our communities. Our institution developed orthopedic procedure-specific prescribing guidelines based on historical prescribing patterns in mid-2017. We subsequently implemented a prospective, multicenter survey initiative to evaluate opioid consumption after discharge following 7 common elective orthopedic surgical procedures to further inform opioid management prescribing strategies.

METHODS: This prospective initiative was conducted from March 2017-January 2018 at a single academic institution. Patients undergoing total hip arthroplasty, total knee arthroplasty, carpal tunnel release, knee meniscectomy, rotator cuff repair, lumbar laminectomy, and lumbar fusion were randomly surveyed by telephone call between 21-35 days following discharge. Surveys were initiated in 1,269 patients and completed by 951, resulting in a response rate of 75%.

RESULTS: Among the 951 patients who completed the survey, 94% received opioids at discharge. A median of 388 OME (IQR 225,675) were prescribed, but only a median of 120 (IQR 20,356) OME were consumed after discharge. At the time of survey, 77% of patients had leftover opioids and 60% of all opioids prescribed to the cohort went unused, representing 29,787 5mg tablets of oxycodone. Patients used no opioids in 18% of cases and 35% required <50 OME. Only 10% of patients reported properly disposing of their remaining opioids. By days three, five and seven following surgery, 39%, 55%, and 66%, respectively, of all surveyed patients reported discontinuation of opioids; this varied by procedure.

CONCLUSIONS: Most orthopedic patients use far fewer opioids following orthopedic surgery than they are prescribed, even following implementation of conservative prescribing guidelines. Further improvement of our opioid prescription guidelines so they more precisely align with anticipated procedure- and patient-specific requirements will reduce the amount of excess opioids available for diversion in our communities.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Long-Term Follow-Up of the Universal Total Wrist Arthroplasty in Patients with Rheumatoid Arthritis

Paper 005

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INTRODUCTION: Total wrist arthroplasty can offer pain relief with preservation of motion to patients with rheumatoid arthritis, although few studies have investigated the long-term results of this procedure. The purpose of the present study is to report the retrospective results of total wrist arthroplasty with use of the Universal wrist prosthesis in a consecutive series of patients with rheumatoid arthritis.

METHODS: Twenty-two patients (28 wrists) were identified for retrospective review. All patients underwent Universal total wrist arthroplasty by a single surgeon between the years of 1997-2004. Of the 22 patients identified, 6 patients had died. Of the remaining 16 patients, 13 (17 wrists) were available for clinical follow-up, providing an 81% follow-up rate. All 13 patients returned for clinical and radiographic evaluation with a mean follow-up of 16.8 years (range, 13 to 20 years) after the index procedure. Outcome measures included the Disabilities of the Arm, Shoulder and Hand (DASH) score, wrist range of motion (ROM), grip strength and pinch strength testing and standard radiographic findings.

RESULTS: All patients evaluated in the cohort were female. The average age of the cohort was 60.8 years. When evaluating average DASH scores, there was no statistical difference between preoperative and long-term follow-up DASH scores (42.3 vs. 38.9 respectively, $p=0.7$). When comparing average wrist ROM preoperatively and at latest clinical follow-up, there was a significant decrease in average wrist flexion and ulnar deviation (40° vs. 22° $p=0.02$; 17.6 vs. 15°, $p=0.02$) and a significant increase radial deviation (13° vs. 8.4°, $p< 0.05$). There was no statistical difference when comparing preoperative and follow-up grip and pinch strength ($p=0.22$, $p=0.38$, respectively). Of the 17 wrists with long-term follow-up, 12 underwent revision surgery. Two additional patients had undergone revision arthroplasty prior to their passing making an overall revision rate of 82% (14 of 17 wrists). Kaplan Meyer survivorship rates at 5, 10, and 15 years for the original prosthetic components were 75%, 40%, and 33%, respectively.

CONCLUSIONS: The results for the Universal wrist prosthesis at an average of 16.8 years minimum follow-up include a high rate of failure, most often because of carpal component loosening, resulting in revision of 14 (82%) of 17 wrists at the time of the latest follow-up. Of the 13 patients that were evaluated in our series, only 1 patient had maintained a stable implant with minimal signs of loosening with a follow up of 20 years.

Keywords: Total wrist arthroplasty, Rheumatoid arthritis, long-term follow-up
Level of Evidence: IV

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

The Impact of Social Deprivation on Pediatric PROMIS Health Scores After Upper Extremity Fracture

Paper 006

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PURPOSE: While social deprivation is acknowledged to influence physical and mental health in adults, it is unclear if and how social deprivation impacts perceived health in children. This study was conducted to evaluate the impact of social deprivation on Patient-Reported Outcomes Measurement Information System (PROMIS) scores in children presenting for treatment of upper extremity fractures.

METHODS: This cross-sectional evaluation analyzed data from 975 new pediatric patients (8-17 years old) with upper extremity fractures presenting to a tertiary orthopedic center between June 1, 2016 and June 1, 2017. They completed self-administered PROMIS Computer Adaptive Tests (CATs). The Area Deprivation Index (ADI) was used to quantify social deprivation. Bivariate statistical analysis determined the effect of disparate area deprivation (based on most and least deprived national quartiles) for the entire population.

RESULTS: 327 (34%) children lived in areas categorized as the most socially deprived quartile of the United States while 202 (21%) lived in the least socially deprived quartile. Children in the most deprived quartile had significantly worse mean PROMIS Upper Extremity Function, Mobility, Pain Interference, and Peer Relations scores compared to those in the least deprived quartile. Significantly more children from the most socially deprived areas were African American. Patient age, sex, and fracture type were not significantly different between patients from the least and most socially deprived quartiles.

CONCLUSIONS: Children living in areas of greatest social deprivation report worse Upper Extremity Function, Mobility, Pain Interference, and Peer Relations scores on self-administered PROMIS CATs compared to children from areas of least social deprivation at presentation for care of upper extremity fractures. The impact of social deprivation on perceived health and function is evident before adulthood and therefore, interventions to mitigate this effect should be offered to children as well as adults.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Outcomes of Staged Treatment for Complex Distal Radius Fractures

Paper 007

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BACKGROUND: Distal radius fractures are common, but outcomes of treatment with early external fixation and staged open reduction internal fixation (ORIF) have not been reported. In polytraumatic patients with these fractures, other injuries may require prioritization, leading to a staged treatment for temporary damage control. External fixation is used in these situations when immediate ORIF is unavailable. There exists a paucity of literature describing the indications or complications of the staging. The objective was to retrospectively analyze complications and their associations when performing a staged protocol of external fixation followed by ORIF.

METHODS: 47 patients and 50 wrists met inclusion criteria of having received staged external fixation followed by ORIF over seven years. Medical and social histories, injury characteristics, treatment characteristics, and complication data were collected. Fisher's exact test was used to compare deep infections with patient characteristics (diabetes, smoking, and drug use), surgical approach, and pin site location. Wilcoxon two-sample test was used to evaluate infection and length of time spent in the external fixator.

RESULTS: Indications for the protocol included open fractures, traumatized soft tissues, acute carpal tunnel syndrome, radial artery repair, and inadequate splint reduction. Mean follow-up time of patients was 9.3 months. Patients spent a mean of 9.2 days in the external fixator. For definitive treatment, 41 received a volar approach and 9 a dorsal approach. 20 wrists experienced complications, including 2 nonunions. Five patients developed infections. The rate of deep infection with volar approach was 2.4%, compared to 22.2% with dorsal approach. Ex-fix pin sites overlapped radiographically with the plate in 20 fractures, with 3 deep infections in this group (15%) and no deep infections in the group without overlap.

CONCLUSION: Staged external fixation followed by ORIF results in reliable healing of complex fractures with a 96% union rate but is also associated with a high complication rate of 40%. This is a viable option for temporizing complex distal radius fractures, but caution should be exercised. Since low-grade open distal radius fractures do not require emergent debridement and immediate internal fixation is safe, complications might be avoided by restricting this protocol to complex or physiologically unstable patients.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Incidence and Risk Factors of Scaphoid Fracture Associated with Radial Head and Neck Fracture

Paper 008

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BACKGROUND: There have been no large-scale studies that have investigated the relationship between proximal radius fracture and scaphoid fracture. Given similar mechanism of injury and devastating consequences with missed scaphoid fracture, it is important to better understand the risk factors for concomitant injury of these upper extremity injuries.

PURPOSE: The aim of this study was to understand the risk factors for having concomitant proximal radius and scaphoid fractures to identify at-risk patient populations to drive improvement in diagnosis and clinical management of these injuries.

METHODS: By completing a retrospective review of the National Trauma Data Bank (NTDB) from 2007 through 2012, 11,309 patients were identified as having proximal radius fracture with injury severity score (ISS) of less than 15 as a proxy for low energy. These patients were then categorized by presence of concomitant scaphoid injury. Presence of scaphoid fracture with proximal radius fracture was then analyzed based on age, gender, race, trauma type, mechanism, and ISS.

RESULTS: We identified 378 scaphoid fractures among the 11,309 patients with proximal radius fractures. The most common mechanism of injury for concomitant fracture was a fall. While race and open fracture did not reach significance for concomitant injury, both age and gender were significant. Males were more likely to have scaphoid fracture with associated proximal radius injury. Additionally, there was a stepwise increase in risk for scaphoid fracture with each younger age group noted in the study. Subset analysis of falling as the injury mechanism demonstrated an even higher risk of concomitant fractures in males and young patients when compared to the analysis of all-cause injury.

CONCLUSIONS: There is a significantly higher risk for concomitant injuries in males and young patients, especially those whose mechanism is a fall. Close examination of the wrist should be performed with any proximal radius fracture, and any pain should be cause for further investigation of scaphoid injury.

LEVEL OF EVIDENCE: Level IV Prognostic

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MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Safety and Efficacy of Forearm Tourniquet Compared to Upper Arm Tourniquet for Local Intravenous Regional Anesthesia in Hand Surgery

Paper 009

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BACKGROUND: Local anesthetic toxicity remains one of the most feared complications of intravenous regional anesthesia (Bier block) in upper extremity surgery. The forearm tourniquet may offer advantages over the conventional upper arm tourniquet, with a decreased dose of local anesthetic, shorter procedure times, and less tourniquet pain. Research to date is limited regarding the clinical efficacy and complications of the forearm Bier block as compared to conventional upper arm Bier block. The purpose of this study was to assess the effectiveness, complications, duration, cost, and patient satisfaction between forearm and upper arm Bier block during hand surgery.

METHODS: Twenty-three patients undergoing carpal tunnel release, ganglion excision, or trigger finger release under intravenous regional anesthesia (Bier block) were randomized to upper arm or forearm tourniquet. Protocols were standardized for upper arm (0.5% lidocaine 3 mg/kg, max 50 mL) and forearm (0.5% lidocaine, 2 mg/kg, max 25 mL) Bier block techniques. The quality of surgical anesthesia, adverse events (measured by abnormalities noted in the electrocardiogram, systolic blood pressure fluctuations, and symptoms of local anesthetic toxicity), tourniquet discomfort, and need for supplementary local anesthetic or anxiolytic were recorded and assessed. Pain was assessed intraoperatively and 30 minutes postoperatively using a visual analog scale (VAS). Patient satisfaction with surgery was assessed for 21/23 patients using the Iowa Satisfaction with Anesthesia Scale (ISAS) on the first postoperative day by phone survey.

RESULTS: There were no intraoperative or postoperative complications in either the upper arm or forearm group. No difference was observed between groups with respect to intraoperative ($p=0.618$) or postoperative VAS pain scores ($p=0.626$), patient satisfaction ($p=0.807$), or administration of supplemental local anesthetic ($p=0.266$). The average procedure time was 16.7 minutes for the forearm group and 18.9 minutes for the upper arm group ($p=0.478$), with average tourniquet times of 21.6 minutes and 26.2 minutes, respectively ($p=0.007$). Total hospital charges associated with the procedure were 4.93% lower for the forearm group compared to the upper arm group ($p=0.045$).

CONCLUSIONS: Forearm Bier block regional anesthesia is a safe, efficient, and cost-effective technique for intravenous regional anesthesia during hand surgery. Forearm Bier block technique reduces the dose of local anesthetic and therefore risk for systemic toxicity, and it allows for a shorter tourniquet time.

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MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Operating Room Supply Waste in Elective Hand Surgery

Paper 010

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BACKGROUND: Hospital waste and its disposal is a significant component of healthcare expenditures, with 70% of that waste coming from operative suites. Recent trends towards single-use items and prepackaged sets of common surgical goods have increased the amount of waste that is completely unused before being removed from the sterile field, and studies have shown that changes made to decrease waste of such unnecessary items do result in significant cost savings.

PURPOSE: The purpose of this study was to quantify the waste generated in three separate OR settings in elective hand surgery- a university hospital, a private hospital, and a private practice ambulatory surgery center (ASC). By cataloging supplies that are commonly opened but unused and examining literature surrounding surgical waste, we aim to produce recommendations that will be useful in assisting surgeons and hospital administrators in reducing unnecessary surgical supply waste.

METHODS: We observed 10 random elective hand surgery cases performed by each of 4 different attending hand surgeons in 3 different venues. Data recorded included Procedure, Case Length, Tourniquet Time, and a list of unused disposable supplies that were opened for the procedure. Unused supply costs were calculated and totaled for comparison.

RESULTS: The total costs of wasted supplies over 40 cases was $1,574.19, with a median and mean of $39.87 and $39.35, respectively. The two most expensive supplies wasted were a mini-C arm drape ($29.05), and bovie electrocautery ($27.15). The three most often wasted supplies were blue towels, raytec sponges, and 4x4" gauze dressing.

Both private and university hospitals showed comparable average levels of waste ($48.15, $52.05, $53.38) over a random sampling of 10 cases by 3 surgeons. The operations performed in the private ASC had significantly lower average supply waste costs ($3.84) while simultaneously having similar case and tourniquet times and case variety. The case with the highest waste in the ASC was less than the lowest level of waste in any of the main operating room theaters ($15.72 vs. $18.16).

CONCLUSION: Unused sterile waste is a multifactorial issue that can result in significant healthcare expense. The volume and cost of this waste varies widely across different surgical settings, despite similar procedure types and durations. Therefore, surgeon and staff efforts to reduce the opening of unnecessary items, represents a worthwhile cost-cutting measure in hand surgery, and other surgical fields.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Early Postoperative Improvement in Sleep and Pain After Carpal Tunnel Release in Patients with Carpal Tunnel Syndrome

Paper 011

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BACKGROUND: Carpal tunnel syndrome (CTS) is the most common compressive neuropathy of the upper extremity. We sought to assess the subjective and objective improvement in preoperative symptoms related to CTS, particularly those affecting sleep; and describe opioid consumption postoperatively.

METHODS: All patients undergoing primary CTR for electromyographically (EMG) proven CTS were studied prospectively. All procedures were performed by hand surgery fellowship-trained adult orthopedic and plastic surgeons in the outpatient setting. Patients underwent either endoscopic or open carpal tunnel release (CTR) from June 2017 – December 2017. Outcomes assessed were pre- and postoperative quickDASH, VAS, and Pittsburgh Sleep Quality Index scores as well as postoperative pain control.

RESULTS: Sixty-one patients were enrolled. At two weeks, all showed significant ($p<0.05$) improvement in quickDASH scores. At six weeks, 40 patients were available for follow-up. When compared to preoperative scores, quickDASH (51 vs. 24.5; $p < 0.05$), VAS (6.7 vs. 2.9; $p < 0.05$), and PSQI (10.4 vs. 6.4; $p < 0.05$) scores continued to improve when compared to preoperative scores. At two-week follow-up, 39 patients responded to the question, "How soon after your carpal tunnel surgery did you notice an improvement in your sleep?" Seventeen patients (43.6%) reported they had improvement in sleep within 24 hours, 12 patients (30.8%) reported improvement between 2 and 3 days postoperatively, 8 patients (20.5%) reported improvement between 4 and 5 days postoperatively, and 2 patients (5.1%) reported improvement between 6 and 7 days postoperatively.

CONCLUSIONS: Sleep disturbance is a well-documented symptom of CTS. The present study demonstrates rapid and sustained improvement in sleep quality and function following CTR.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Cost Savings of Carpel Tunnel Release Performed In-Clinic Compared to an Ambulatory Surgery Center: Time-Driven Activity-Based-Costing

Paper 012

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INTRODUCTION: Over 500,000 patients undergo carpal tunnel release (CTR) in the United States each year, making CTR one of the most common surgical procedures. CTR has historically been performed in the operating room, although an increasing number of CTR procedures are being performed under local anesthesia in the clinic setting due to the simple nature of the procedure. The purpose of our study is to evaluate TDABC for CTR performed in the clinic compared to CTR performed in the ambulatory surgery center (ASC).

METHODS: Beginning January 2014, we offered patients CTR in clinic under a local anesthetic vs. CTR in an ASC with sedation and local anesthetic. Patients were prospectively surveyed using a 10-question quality of care survey from 2015 to 2017. The survey assessed for overall perceptions of the experience with a 10-point VAS pain scale for procedural and post-procedure pain. Time-Driven Activity-Based Costing (TDABC) was utilized to quantify cost. This would involve recording each clinicians (RN, OA, PA, MD, etc.) time with direct patient contact and associating it with the individuals' hourly salary to derive a sum cost. We then performed a retrospective review of all patients, aged 18 and over, who underwent isolated CTR and paired with their TDABC-cost. Statistical analysis involved parametric comparative tests between patient cohorts for both the TDABC-cost and patient pain.

RESULTS: A total of 59 participants completed the post-procedure CTR survey during the study period, 23 (38.9%) in the ASC group and 36 (61.1%) in the clinic group. Overall time for the procedure from patient arrival to discharge was significantly longer in the ASC cases, averaging 215.7 [201.3, 230.1] minutes compared to 78.6 [59.3, 97.9] minutes ($p < 0.01$). Both procedural and postoperative VAS pain scores were comparable between clinic and ASC cohorts, procedural pain: 1.8 vs. 1.9 ($p = 0.91$) and postoperative pain: 4.8 vs. 4.9 ($p = 0.88$). A TDABC analysis identified ASC CTR procedures to average $557.07 [$522.06, $592.08] and clinic procedures to average $151.92 [$142.59, $161.25] ($p < 0.01$).

CONCLUSION: Our study showed that clinic based CTR provided similar outcomes with regard to patient-reported pain, reduced procedural time by 70.2 minutes, while decreasing TDABC-estimated costs by an average of $405.15 per procedure.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Biomechanical Study of Extensor Tendon Lacerations Over the Finger Metacarpophalangeal Joints

Paper 013

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PURPOSE: The purpose of this study was to assess the percentages of extensor tendon lacerations over the finger metacarpophalangeal (MCP) joints that may lead to an MCP joint extensor lag.

METHODS: Eight fresh-frozen cadaveric hand specimens without recognized injury or motion-limiting finger arthritis were obtained. The extensor and flexor tendons were isolated proximal to the carpal bones for active loading of the extensor tendons and passive loading of the flexor tendons. The forearm bones and finger metacarpals were rigidly secured to a testing jig. The extensor tendon slips were exposed over the finger MCP joints. Sequential, full-thickness, transverse cuts were made through the extensor tendons over each finger MCP joint. The fingers were cycled before tendon cutting and after each incremental tendon cut. Extensor tendon gaps were measured and inclinometer measurements of MCP joint rotation were obtained. The rotational change in MCP joint motion after tendon cutting was compared to MCP joint motion before tendon cutting to determine the MCP joint extensor lag.

RESULTS: Incremental cuts of the extensor tendons caused sequential increases in subjacent MCP joint extensor lags, in addition to interactive effects on other finger MCP joints. Extensor lags of the index and small finger MCP joints were significant with lacerations extending across 75% or more of the combined widths of the extensor tendon slips, whereas extensor lags of the long and ring finger MCP joints were significant with lacerations involving 90% or more of the widths of the extensor tendons. A significant MCP joint extensor lag in the index and small fingers was also observed when 1 of 2 extensor tendon slips in either finger was completely transected.

CONCLUSION: In this biomechanical study of partial extensor tendon lacerations over the finger MCP joints, we found that MCP joint extensor lags varied by both the finger involved and the percentage of tendon laceration.

CLINICAL RELEVANCE: Lacerations of extensor tendons overlying the finger MCP joints in clenched-fist-to-mouth injuries are usually repaired in a delayed fashion. An improved understanding of the relationships between extensor tendon slip lacerations at this level and MCP joint extensor lags may provide a basis for treatment algorithms.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Distribution of Costs in a 90-Day Episode of Care for Patients Undergoing ORIF for Distal Radius Fractures – Moving Towards Bundled Payment Models in Hand Surgery

Paper 014

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INTRODUCTION: Due to a recent shift from fee-for-service to value-based healthcare models, there has been a growing interest in implementation of bundled payments. While current literature has explored distributions of 90-day costs for total joint arthroplasty and elective spinal fusions, data remains limited on distribution of costs for patients undergoing open reduction internal fixation (ORIF) for isolated distal radius fractures.

MATERIALS AND METHODS: The Medicare 5% Standard Analytical Files (SAF5) dataset was queried for patients undergoing ORIF for distal radius fractures using Current Procedural Terminology codes (CPT; 25607, 25608, and 25609) for outpatient procedure and International Classification of Diseases (ICD) 9th edition procedure code (ICD-9-P-7932) for inpatient procedures. Costs/Reimbursements of healthcare resource utilization up to 90 days following the index procedure was retrieved and manually filtered into the following pre-defined categories – (1) Facility costs, (2) Surgeon costs, (3) Hospital Care, (4) Investigations and other facility services, (4) Anesthesia, (5) Imaging, (6) Office visits, (7) Physical therapy, and (8) Skilled Nursing Care or Inpatient rehabilitation costs. The dataset was divided into 4 sub-sets based on regions (Midwest, West, South, and Northeast) to better understand regional variation in total 90-day costs.

RESULTS: A total of 5,973 patients undergoing ORIF for distal radius fractures were included in the final cohort out of which 1,093 were inpatient (IP) and 4,880 were outpatient (OP) procedures. The total 90-day reimbursement was estimated to be $11,309 for IP and $6,488 for OP. Facility costs comprised the major portion of the total 90-day payments (IP=75.5%; OP=71.0%), followed by surgeon costs (IP=6.3%; OP=11.1%). Post-acute care (office visits, physical therapy, skilled-nursing care/inpatient rehabilitation) was not a major cost-driver of 90-day bundle, making up only 11-12% of total 90-day costs for both inpatient and outpatient procedures. Additionally, we separately analyzed re-admissions and associated costs due to medical/surgical complications following the procedure for comparison purposes. IP procedure had higher readmission rates as compared to OP (4.3% vs. 0.6%), longer average length of stay (3.0 days vs. 1.3 days) and higher average reimbursement per readmission ($22,074 vs. $5,283).

CONCLUSION: Facility-based charges were the major cost-driver of 90-day payments in patients undergoing ORIF for distal radius fractures. Undergoing surgery in an outpatient setting decreased the overall cost by nearly $5,000. With inpatient surgery for distal radius fractures shown to have poor outcomes, health-care providers and administrators should promote the need for outpatient procedure, where appropriate, in order to lower the financial and economic burden associated with this fracture.

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MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Characterization of the Dorsal Ulnar Corner in Distal Radius Fractures: Implications for Surgical Decision Making

Paper 015

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HYPOTHESIS: The dorsal ulnar corner (DUC) of intra-articular distal radius fractures constitutes a small, but important, component of the sigmoid notch and radiocarpal articular surface that may not be adequately captured with volar only surgical techniques.

METHODS: A multicenter retrospective review identified post-menopausal female patients with surgically treated low-energy intra-articular distal radius fractures. Patients with low-energy injuries (defined as a fall from standing height or < five feet) with preoperative CT scans were included. High-energy trauma or extra-articular fractures were excluded. DICOM data from each CT scan was analyzed using Amira 5.0 3D reconstruction software to visualize intra-articular fracture patterns and isolate the DUC fragment. The fragment was measured (dorsal surface radio-ulnar and proximal-distal dimensions; articular surface radio-ulnar and anterior-posterior dimensions). Articular surface measurement (dorsal to volar) was divided by each specimen's lunate depth (dorsal-volar, measured horn to horn) to normalize and control for distal radius size variability and is reported as percentage of lunate depth.

RESULTS: 80 patients met inclusion criteria. Mean dimension measurements of the DUC: dorsal surface proximal-distal dimension: 9.82 ± 5.02 mm, 95% confidence interval [8.72, 10.92]; dorsal surface radio-ulnar dimension: 9.07 ± 3.72 mm, 95% CI [8.25, 9.88]; articular surface radio-ulnar dimension: 7.44 ± 3.92 mm, 95% CI [6.58, 8.30]; articular surface anterior-posterior dimension: 4.14 ± 2.39 mm, 95% CI [3.62, 4.67]. Individual lunate depth measurement was used to normalize articular surface depth. On average, the DUC comprises 23.6% of the articular surface ± 13.6% with a 95% CI [20.7, 26.6].

SUMMARY: Biomechanical studies of extra-articular fracture models suggest volar plate distal locking screws extending 75% of the articular surface depth are sufficient for fixation [1]; however, our modeling suggests that, on average, this will not capture the DUC in intra-articular fractures. Mean DUC fragment articular surface depth in this study is < 5 mm and articular surface width is < 8 mm wide. This accounts for approximately 24% of the volar-dorsal width of the distal radius at the lunate facet indicating that use of screws extending across the distal radius 75% would most likely not capture this fragment. These findings expand current understanding of the morphology and size of the DUC fracture fragment and provide serious implications critical to understanding optimal operative fixation methods, which may include utilizing longer screws or performing fragment specific fixation. This information can also be used to develop more accurate distal radius intra-articular fracture models for biomechanical studies.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
Thursday, April 11, 2019

Perilunar Injury with Concomitant Radiocarpal Dislocation: Incidence and Proposal for Treatment

Paper 016

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PURPOSE: Perilunar injuries with concomitant radiocarpal dislocations represents an injury that have not been described and may often go undetected leading to poor patient outcomes. Therefore, the aim of our study was to report a single center incidence of concomitant radiocarpal dislocation in the setting of a perilunar injury and to discuss the implications of managing these combined injuries.

METHODS: A retrospective review was conducted of patients who sustained a perilunar injury and a concomitant radiocarpal dislocation at a single level 1 trauma center between January 2013 and January 2017. Patients with the combined injury pattern were compared to those with perilunar injury alone during the same study period. Outcome measures included pain scores (visual analogue score), wrist and forearm range of motion, patient's return to their former occupation, and multiple radiographic parameters.

RESULTS: Over the four-year study period, 27 patients were treated for a perilunar injury. Eight of these patients (30%) were found to have disruption of the short radiolunate ligament intraoperatively. When compared to patients with perilunar injury alone, these patients had a lower rate of return to work (57.1% [4 of 7] vs. 92% [12 of 13], p=0.01), a significantly longer length of time to return to work in those patients who were able to return (5.9 months vs. 3.8 months, p=0.04), and a higher rate of associated upper extremity injury (75% [6 of 8] vs. 15.8% [3 of 19], p=0.04). There was no difference in complication rate, range of motion, or pain scores between the two groups. Patients with a combined injury did have significantly lower mean Midcarpal Height Ratio (MCHR) postoperatively than patients with perilunate injury alone (1.52 vs. 1.64, p=0.02) and had a significantly higher mean scapholunate angle postoperatively. There was no difference in the degree of ulnar translocation of the carpus or lateral carpal anterior to posterior distance between the groups postoperatively.

CONCLUSIONS: Combined radiocarpal dislocation and perilunate dislocation or fracture-dislocation represents a high-energy variant from the classic description of a perilunar injury that may result in lower rates of return to work and marked delays in return to work when compared to perilunar injury alone. Identification of this injury is only possible with adequate exposure of the volar wrist ligaments. Therefore, a heightened awareness for this combined injury pattern should be maintained when treating patients with perilunar injuries.

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MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

The Impact of a Standardized Multimodal Analgesia Protocol on Opioid Prescriptions After Common Arthroscopic Procedures

Paper 017

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OBJECTIVES: The excessive prescription of opioid pain medication has become a problem on an individual and societal level. In an effort to decrease the amount of opioid pain medication dispensed after outpatient arthroscopic surgery, our institution developed a standardized multimodal analgesic regimen. We hypothesized that by implementing this protocol we would decrease the amount of opioids prescribed at the time of surgery as well as the total amount of opioids dispensed postoperatively.

METHODS: Patients who had undergone meniscectomy, rotator cuff repair, and ACL reconstruction were identified by CPT code in a window 12 months prior to and 6 months after the initiation of this standardized multimodal analgesic protocol. Charts were retrospectively reviewed to extract demographic data, the amount of opioids prescribed at the time of surgery, amount and frequency of opioid refills, and call-ins regarding pain medication or its side effects.

RESULTS: The average amount of opioids prescribed at the time of surgery decreased from 63.45 to 22.3 pills (64.9%, $p < 0.01$) for meniscectomy, from 73.1 to 39.7 (45.8%, $p < 0.01$) for ACL reconstruction, and from 75.6 to 39.8 (47.4%, $p < 0,01$) for rotator cuff repair. The percentage of patients receiving a refill of narcotics in the postoperative period also decreased for all groups: 13% to 4% ($p < 0.01$) in the meniscectomy group, 29.2% to 11.4% ($p < 0.01$) in ACL reconstruction, and 47.3% to 24.4% ($p < 0.01$) in the rotator cuff repair group. There was no significant difference in the percentage of patients calling in regarding their pain medication or its side effects.

CONCLUSION: Institution of a standardized multimodal analgesia protocol significantly decreased the amount of opioids dispensed after common arthroscopic procedures and did not result in an increased demand for refills. Our study also demonstrated that 20 opioid pills was adequate for patients undergoing meniscectomy, and 40 pills was adequate for ACL reconstruction and rotator cuff repair in the majority of cases. This protocol serves as an example of a way for providers to decrease the amount of opioids dispensed after surgery while still providing patients with adequate pain relief.

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

Reduction of Opioid Over-Prescribing and Consumption After Upper Extremity Surgery Through a Predictive Pain Calculator and Comprehensive Pain Plan

Paper 018

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INTRODUCTION: Opioid abuse and dependence is a worsening epidemic in the United States. Oftentimes, a person's first exposure to opioids is with prescription medication. For outpatient hand and upper extremity surgeries, opioid prescriptions may exceed the actual need for adequate pain control. The purpose of this study was two-fold: (1) to determine rates of opioid wasting and consumption after these procedures and (2) to create and implement a patient specific calculator for narcotic requirements with a detailed multimodal analgesic plan to guide postoperative prescriptions.

METHODS: Patients undergoing hand and upper extremity surgery at a single ambulatory surgery center were recruited before (n = 305) and after (n = 221) implementation of a postoperative pain control program. On the first postoperative visit, patients were given a questionnaire regarding opioid usage and pain control satisfaction. Demographic and procedural data were collected via chart review. With these data, we developed a patient specific opioid calculator and pain plan that was implemented on the second cohort of patients. Multivariate regression analysis was used determine the independent effect of the intervention.

RESULTS: Pre-intervention data suggested younger age, baseline opioid use, use of regional block, unemployment, bony, tendinous, or ligamentous procedures, and longer procedure time were predictive of higher opioid consumption. Both pre- and post-intervention cohorts had similar age, sex distributions, and procedure length. Following intervention, opioids prescribed decreased 63% from mean 32.0 ± 15.0 pills/surgery to 11.7 ± 8.9 ($p < 0.001$). Opioid consumption decreased 58% from mean 21.7 ± 25.0 pills/surgery to 9.3 ± 16.7 ($p < 0.001$). Opioid wastage decreased 62% from 13.8 ± 13.5 pills/surgery to 5.2 ± 10.3 ($p < 0.001$). The need to obtain more medications after the first prescription was 21.3% in the pre-implementation group and 16.0% in the post-implementation group ($p = 0.14$). Finally, patient satisfaction with pain control was similar between groups (on a scale of 1 to 10, 8.3 ± 2.3 in the pre-implementation group and 8.1 ± 2.4 in the post-implementation group, $p = 0.39$).

CONCLUSIONS: With implementation of a comprehensive pain plan for ambulatory upper extremity surgery, it is possible to reduce opioid prescription, consumption, and wastage rates without compromising patient satisfaction with pain control or increasing rates of unplanned pain medication refills.

Level of evidence: level II, therapeutic

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

The Effect of Preoperative Opioid Use on Outcome Scores and Postoperative Opioid Use After ACL Reconstruction

Paper 019

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OBJECTIVE: The excess prescription of opioid pain medication has become a recent focus in the literature and legislature. Orthopedic surgeons are among the top five prescribers of opioid pain medication among surgical subspecialties. Many studies have investigated opioid use in the postoperative period, and more attention is being given to the effects of preoperative opioid use. We aim to investigate whether preoperative opioid use has an adverse effect on outcomes after ACL reconstruction.

METHODS: Patients enrolled in our institutions prospective ACL registry between 4/2012 and 1/2016 completed KOOS and WOMAC outcome scores preoperatively as well as at 6 months and 2 years postoperatively. Patients who underwent subsequent procedures or revision surgery were excluded, n= 45. Charts were retrospectively reviewed to identify patients who had documented preoperative opioid use. Charts were also reviewed to determine whether patients were still using opioid pain medication at their 2 week and 6 week postoperative visit. Univariate analysis was carried out to identify statistically significant changes as well as minimal clinically important differences in outcome scores.

RESULTS: The incidence of preoperative opioid use in our cohort was 14.2% (N = 22). The percentage of patients using opioid pain medication was higher in patients who were using opioid preoperatively at both 2 weeks (50% vs. 32.3%, p = 0.14) and 6 weeks (18.1% vs. 5.26%, p = 0.06) postoperatively. Outcome scores were higher for all scales and at all time points for patients who were not using opioid preoperatively; however, these did not reach minimal clinically important differences. Both groups had a significant change in outcome scores between their preoperative scores and 6 month and 2 year postoperative scores. There was no significant difference in the amount of change in outcome scores at these time points between the preoperative users and non-users.

CONCLUSION: We found that approximately 14.2% of our patients undergoing ACL reconstruction were using opioids prior to surgery. Preoperative opioid use was found to predict increased postoperative use at 2 and 6 weeks following surgery. Patients who had preoperative opioid use had lower PROs at all time points compared those who did not use opioids before surgery, yet not all of these data points met MCID. Preoperative opioid use may not only predict prolonged postoperative use but may have deleterious effects on outcomes after surgery.

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MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

Preoperative Opioid Use and Degree of Arthritis Predicts Duration of Postoperative Opioid Use Following Arthroscopic Meniscus Surgery

Paper 020

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PURPOSE: The purpose of this study was to determine if preoperative opioid use predicted postoperative consumption after arthroscopic meniscal surgery. Additionally, we aimed to identify patient factors associated with increased opioid use following meniscus surgery.

LEVEL OF STUDY: Level III, Retrospective Cohort Analysis

METHODS: A retrospective review of all patients undergoing meniscus surgery at a single institution between August 2013 and February 2017 was performed. Patients were classified as opioid non-users if they had not received any opioid medications in the three months prior to meniscus surgery. Acute or chronic users were classified if patients had received at least one opioid prescription within one or three months preceding meniscus surgery, respectively. Clinical records were reviewed for postoperative opioid use within a year of surgery, as well as patient demographics and degree of knee osteoarthritis using the Outerbridge Classification at time of surgery. Risk factors for increased opioid use were then identified using Spearman's correlations.

RESULTS: A total of 735 patients were included in the analysis. The average age was 46.7 years old (Range: 12-79 years) and the average BMI was 30.2±6.2 (Range: 13.3-55.4). Patients who were acute or chronic opioid users preoperatively were more likely to continue to use opioids beyond one month postoperatively ($p<0.001$). A higher percentage of patients with advanced osteoarthritis (Outerbridge 3-4) were found to continue to use opioids at all time points beyond the first month postoperatively. Pairwise comparison showed total opioid prescriptions filled was significantly higher in Outerbridge 1-2 and 3-4 groups as compared to Outerbridge 0 ($p=0.023$, 0.014, respectively). There was no significant difference in postoperative opioid use when comparing meniscus repair vs. resection, primary procedure vs. revision, different tear types, or concomitant procedures.

CONCLUSION: Patient's chronicity of preoperative opioid intake and degree of knee osteoarthritis had a significant effect on postoperative consumption following arthroscopic meniscal surgery. Surgeons should recognize these risk factors for increased opioid use postoperatively and counsel their patients accordingly.

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MAOA BREAKOUT SESSION #2
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Fatigue Increases Anterior Cruciate Ligament Injury Risk in Youth Athletes: Results from a Field-Based Drop-Jump Test

Paper 021

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BACKGROUND: Anterior cruciate ligament (ACL) injury is common among adolescent athletes. The role of athlete fatigue on ACL injury remains unknown.

PURPOSE: The purpose of this study was to determine if fatigue increases ACL injury risk in adolescent athletes, as measured through a standardized fatigue protocol and video-based drop-jump test. A secondary aim was to determine if individual risk factors could be identified that place certain athletes at high risk for injury. Our hypothesis was athlete fatigue would lead to an increase in the risk of ACL injury as determined by a field-based drop-jump test.

STUDY DESIGN: Case Series

METHODS: Youth and adolescent athletes were recruited for this video analysis study. Athletes were recorded performing a standard drop-jump test assessing dynamic valgus upon landing. Participants then completed a standardized fatigue protocol consisting of a timed period of high-intensity aerobic tasks. Fatigue was quantified using a maximum vertical jump, which was compared to pre-fatigue values. The 3 drop-jump tests were repeated post-fatigue. All drop-jump recordings were randomized and scored for injury risk by 11 independent reviewers, and athletes who demonstrated increased injury risk after the fatigue protocol were identified. Uni-variate analysis was performed to identify characteristics that predisposed athletes to increased risk.

RESULTS: Eighty-five (47 females and 38 males) athletes with an average age of 15.4 years were included in this study. Forty-nine percent of athletes demonstrated an increase in injury risk graded by drop-jump assessment after a high-intensity fatigue protocol. A significantly higher percentage of athletes were graded “medium or high-risk” in jumps recorded after the fatigue protocol (68%) as compared to prior to the fatigue protocol (44%; $P < 0.01$). Female athletes ($P < 0.01$) and those older than 15 years of age ($P < 0.01$) were the most affected by fatigue.

CONCLUSION: In adolescent athletes, fatigue appears to increase the risk of ACL injury as assessed by field drop-jump testing. Female athletes and those over the age of 15 years were the most vulnerable to the effects of fatigue on ACL injury risk. These results may guide risk-stratified selection for ACL injury screening when utilizing drop-jump testing.

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

Do Tibial Eminence Fractures and Anterior Cruciate Ligament Tears Have Similar Outcomes?

Paper 022

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INTRODUCTION: Avulsion fractures involving the tibial eminence are considered equivalent in etiology to anterior cruciate ligament tears; however, there is limited data comparing outcomes of adolescent patients undergoing surgical fixation of tibial eminence fractures to those undergoing anterior cruciate ligament (ACL) reconstruction. The purpose of this study was to compare clinical outcomes, subsequent ACL injury rates, and activity levels between adolescent patients who underwent tibial eminence fracture fixation to patients with mid-substance ACL tears who required acute ligament reconstruction.

METHODS: This study included a group of patients with tibial eminence fractures treated with surgical fixation matched to a group of similar patients with ACL tears treated with reconstruction between the years of 2001 and 2015. Data regarding initial injury, surgical intervention, ACL/ACL graft injury rates, and physical examination findings were recorded. Clinical and functional outcomes were obtained using physical examination, IKDC subjective scores, Lysholm scores, and Tegner Activity levels.

RESULTS: Sixty patients with a mean follow-up of 57.7 (24-206) months were included. 20 patients (11 M:9 F) who underwent surgical fixation for tibial eminence fractures (TEF) with a mean age of 11.9 (7-15) years were matched to a group of 40 patients (23 M:17 F) who underwent ACL reconstruction for ACL tears with a mean age of 12.5 (8-15) years. The TEF group demonstrated significantly lower postoperative IKDC (TEF group: 94.0, ACL group: 97.2 [p=0.04]) and Lysholm scores (TEF group: 92.4, ACL group: 96.9 [p=0.02]). The TEF group returned to sport 121 days sooner ($p<0.01$), but there was no difference in postoperative Tegner scores (TEF group: 7.3, ACL group: 7.6 [p=0.16]). The TEF group demonstrated increased postoperative anterior laxity (p=0.02) and a higher rate of postoperative arthrofibrosis (p=0.04). There was no difference in subsequent ACL injury (p=0.41).

CONCLUSION: Patients with tibial eminence fractures demonstrated lower mean clinical outcome scores compared to patients with ACL tears at minimum 2-year follow-up. Additionally, they experienced more postoperative anterior laxity and had a higher rate of postoperative arthrofibrosis. There was no difference in subsequent ACL injury rate. The TEF group returned to sport sooner than the ACL group, but the postoperative activity level was similar.

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

Radiographic Description of Soft-Tissue Attachments Around the Elbow

Paper 023

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BACKGROUND: Little data exists on the radiographic correlation of soft-tissue attachments about the elbow.

PURPOSE: The purpose was to define the radiographic landmarks of the clinically significant soft tissue attachments about the elbow.

STUDY DESIGN: Descriptive laboratory study.

METHODS: In 10 fresh-frozen cadaveric elbows, the attachments of the MUCL, LUCL, annular ligament, triceps, and biceps were marked. Measurements were made on AP and lateral fluoroscopic images by independent observers.

RESULTS: On AP radiographs, the aMUCL measured an average 28.6 mm (95% CI, 27. 5-29.8 mm) from the humeral attachment to the midpoint of the MUCL ridge on the ulna and 14.3 mm, (95% CI 13.0-15.5) to the olecranon. The attachment of the aMUCL on the medial coronoid to the tip of the coronoid process was a mean of 13.6 mm (95% CI, 12.5-14.6 mm). The LUCL had a mean distance of 39.9 mm (95% CI, 38.6 – 41.1 mm) from the humeral attachment to the attachment on the supinator crest and 8.9 mm (95% CI, 8.1-9.8 mm) to the superior tip of lateral epicondyle. On the lateral radiographs; the humeral attachment of the aMUCL to the medial margin of the coronoid mean was 27.1 mm (95% CI, 25.9-28.2 mm) and 9.3 mm (95%CI, 17.5 -21.2 mm) to the tip of the coronoid process. The LUCL humeral attachment to the supinator crest was a mean 45.4 mm (95%CI, 44.1-46.8 mm). The supinator crest attachment to the tip of the coronoid process was a mean of 29.8 mm (95%CI, 28.7-30.8 mm). The LUCL humeral attachment site was located 8.9 mm (95%CI, 8.0-9.7 mm) posterior from the anterior humeral line.

CONCLUSION: The ligamentous attachments about the elbow were reproducibly demonstrated on radiographs in relation to osseous landmarks and radiographic lines.

CLINICAL RELEVANCE: The radiographic relationships will allow for improved identification of the ligament and tendon attachment sites of the elbow for intraoperative assessment and postoperative evaluation.

KEY TERMS: elbow, ligaments, trauma, radiograph, UCL, biceps, triceps, LUCL

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

Early Surgical Results of One-Stage Autologous Chondrocyte Implantation

Paper 024

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BACKGROUND: Articular cartilage injury is a devastating problem in patients of all ages but particularly in the younger population. One traditional method of treatment is the Autologous Chondrocyte Implantation (ACI), which has been recently upgraded to Matrix Autologous Chondrocyte Implantation (MACI). Both ACI and MACI require two surgeries. This could be costly and inconvenient to the patients, as well as adding more risk that is inherent in an additional surgery procedure. Emerging research in cartilage and new product development have proposed a one-stage ACI. This pilot study was conducted to evaluate the one stage ACI concept.

METHODS: All patients suffering an articular cartilage injury large enough to require cartilage replacement and a candidate for traditional ACI were considered for the one-stage procedure. Minimum one-year follow-up was required. Study outcomes included the collection of patient reported outcomes and MRI at one year postoperatively. Data on previous surgery, concurrent surgery, and subsequent surgery cases were also reported.

RESULTS: There were 21 patients who underwent one-stage ACI; 11 were female and 10 male. The average patient age was 16 (Range: 4-23). Follow-up averaged 19 months (Range: 12-26). The average lesion size was 2.5 cm^2 (Range: 0.9 – 7cm^2). There were 10 patellar lesions, 4 trochlear groove and medial femoral condyle lesions, and 3 lateral femoral condyle lesions. There were 12 patients who had surgery prior to the ACI procedure. At the time of the ACI procedure, 13 patients had a simultaneous procedure. Ten patients had an MPFL reconstruction, one patient had an OATS procedure, and 2 patients had an MPFL reconstruction with tibial tubercle osteotomy and trochleoplasty. Three patients underwent subsequent surgery. One patient had an MPFL reconstruction, one a chondroplasty for cartilage overgrowth, and one a plica resection.

KOOS pain, symptoms, ADL, Sport/Rec and QOL all improved from preoperative to 1 year follow-up. The averaged scores improved 30, 34, 23, 46, and 33, respectively. The IKDC improved 43 points, Lysholm 30, and SANE 43 points. Follow-up MRI demonstrated excellent cartilage incorporation on all patients. Two patients developed some cartilage overgrowth.

DISCUSSION/CONCLUSIONS: In this series, we report the results of a one-stage ACI procedure. Early results show marked improvement in patient-reported outcomes from preoperative to one year postoperative. MRIs showed excellent cartilage incorporation. Based on this series, the one-stage ACI seems promising and warrants further studies with larger sample size.

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MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

The Recurrent Instability of the Patella (RIP) Score: A Statistically-Based Model for Prediction of Long-Term Recurrence Risk After First-Time Dislocation

Paper 025

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PURPOSE: To describe the clinical history of a series of primary, lateral patellar dislocations and determine long-term predictors of recurrent instability while accounting for patients undergoing early operative management.

METHODS: A large geographic database of over 500,000 patients was used to identify patients who sustained a first-time lateral patellar dislocation between 1990 and 2010. Charts were individually reviewed to document demographics, radiographic measures including tibial tubercle to trochlear groove distance (TT-TG) and patellar length (PL), recurrent episodes of instability, and patellar stabilization surgery. A risk score that accounted for early surgical management was calculated using Fine and Gray competing risk regression and its ability to stratify patients was examined using cumulative incidence curves.

RESULTS: Eighty-one patients (mean age 19.9 ± 9.4 years, 38 M, 43 F) were identified and followed for a mean of 10.1 years (range 4.1–20.2). Thirty-eight patients (46.9%) experienced an episode of recurrent instability and 30 (37.0%) underwent patellar stabilization surgery, including seven who did so prior to recurrent dislocation. A multivariate, statistically-derived scoring system, the Recurrent Instability of the Patella Score (RIP Score), that employed age, skeletal maturity, trochlear dysplasia, and TT-TG/PL ratio to predict recurrent instability while accounting for patients managed surgically, was generated. The resulting RIP score stratified patients into low- , intermediate-, and high-risk categories, with 0.0%, 30.6%, and 79.2% 10-year recurrent instability rates, respectively ($p = 0.000004$) and an area under the curve (AUC) of 0.875 ($p = 0.00002$).

CONCLUSIONS: Patients who sustain a first-time, lateral patellar dislocation can be readily classified into low-, intermediate-, and high-risk categories employing the RIP Score based on age, skeletal maturity, trochlear dysplasia, and TT-TG/PL ratio. This long-term risk stratification holds significant potential clinical utility for determination of early operative candidates following primary patellar dislocation and may help prevent progressive articular damage due to recurrent patellar instability.

MAOA BREAKOUT SESSION #2
SPORTS MEDICINE
Thursday, April 11, 2019

How Long Does it Take for Patients to Complete PROMIS Scores? An Assessment of PROMIS CAT Questionnaires Administered in the Ambulatory Sports Medicine Clinic

Paper 026

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BACKGROUND: Challenges exist in routinely collecting patient reported outcomes (PROs) from patients in a busy ambulatory clinic. A number of validated Patient-Reported Outcomes Measurement Information System (PROMIS) subdomains allow for efficient PROs administration.

HYPOTHESIS/PURPOSE: The purpose of this study was to determine the time-to-completion (TTC) of three PROMIS computer adaptive test (CAT) scores. PROMIS Pain Interference (PROMIS-PI), Depression (PROMIS-Depression), and Physical Function (PROMIS-PF for lower extremity patients; PROMIS-UE for upper extremity patients) CAT questionnaires were administered in the ambulatory clinic. The secondary purpose was to determine the influence of patient demographic factors on TTC.

STUDY DESIGN: Cross-sectional study; Level IV evidence

METHODS: Patients were recruited from three fellowship-trained upper extremity and sports medicine orthopedic surgery clinics. PROMIS CAT questionnaires were administered to consecutive clinic patients during the study period (July 2017-September 2017). The start and completion times of each CAT were recorded. The primary outcome of interest was TTC of the questionnaires. Patients were stratified into age quartiles to determine the impact of age on TTC. Patient demographic information such as sex, race, and ethnicity were determined retroactively.

RESULTS: A total of 1,178 questionnaire-sets consisting of 3,658 individual PROMIS forms were analyzed. The average TTC was 3.29 minutes for all four forms in aggregate, with PROMIS-PI, PF, UE, and Depression taking on average 1.05, 0.74, 0.96, and 0.57 minutes to complete, respectively. Patients from the oldest quartile (70.3 ± 7.5 years old) had a statistically significant longer TTC as compared to the second quartile (41.2± 4.7 years old) of patients (3.70 vs. 2.87 minutes, $p < 0.05$). Asian patients had the longest PROMIS-PF TTC, while Caucasian patients completed PROMIS-PF with the shortest TTC (1.28 vs. 0.62 minutes; $p < 0.05$). Patients of unstated ethnicity had a longer TTC for PROMIS-PF compared to their Hispanic/Latino and non-Hispanic/Latino counterparts (0.91 vs. 0.30 and 0.70 minutes, $p < 0.05$).

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CONCLUSION: PROMIS CAT forms are efficient tools for collecting PROs in the ambulatory orthopedic surgery clinic. Older patients, Asian patients, and patients of unstated ethnicity took longer to complete the forms.

KEY TERMS: patient reported outcomes; PROMIS; time to completion; computer adaptive testing

WHAT IS KNOWN ABOUT THE SUBJECT: PROMIS subdomains are clinically relevant to the field of orthopedic surgery; however, implementation of PROMIS is not without challenges as patient time and energy appear to be limiting factors to compliance.

WHAT THIS STUDY ADDS TO EXISTING KNOWLEDGE: The average TTC for all four forms we tested was 3.29 minutes, with each segment taking approximately one minute or less. Older patients, Asian patients, and patients of unstated ethnicity had a higher average TTC. PROMIS is an efficient and easy to use tool for collecting PROs in the ambulatory orthopedic surgery clinic.

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A Decade of NSQIP: Trends and Reimbursement in Arthroscopic Surgery

Paper 027

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INTRODUCTION: Since 2005, the America College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) has been collecting preoperative patient characteristics, surgical data, and outcomes for various specialties including orthopedics. Although skewed towards tertiary academic centers, NSQIP provides important information on trends of arthroscopic procedures and reimbursement.

METHODS: Patients undergoing orthopedic surgery between 2006-2016 were queried to identify the top 100 most frequently used primary CPT codes. The arthroscopic cases were included in the analysis. The frequency of cases was identified including percent change in case volume comparing 2006-2014 to 2015-2016 weighted for the number of cases reported for those time periods. In addition, the median operative time was used to identify the highest and lowest reimbursement value cases as defined by median relative value units (RVU) per hour.

RESULTS: A total of 143,436 patients met inclusion criteria. The most frequent surgical cases were medial or lateral meniscectomy (n=54,675), shoulder decompression of subacromial space (n=33,393), and rotator cuff repair (n=28,491). The surgical procedure with least amount of cases included was arthroscopic hip debridement (n=1,586). In 2015-2016, the cases with the greatest percent increase compared to 2006-2014 were biceps tenodesis (65.2%), shoulder capsululorraphy (16.6%), and major knee synovectomy (10.4%). The cases with the greatest percent decrease over the same time period included: minor knee synovectomy (-39.7%), knee abrasion arthroplasty (-35.3%), and hip debridement (-29.3%).

Throughout the entire time period (2006-2016), procedures with greatest RVU per hour were knee chondroplasty (19.2 RVU/hr), knee major synovectomy (16.9 RVU/hr), and knee meniscus repair (16.9 RVU/hr). The procedures with the least RVU/hr were hip debridement (9.3 RVU/hr), distal claviculectomy (9.6 RVU/hr), and shoulder decompression of subacromial space (10.2 RVU/hr). There was no correlation between percent increase in case volume and RVU/hr ($r=-0.19$; $p=0.44$).

DISCUSSION AND CONCLUSION: Although, confounded by changes in CPT coding and concomitant procedures, the ACS NSQIP provides valuable information regarding procedures being performed at an increased frequency and reimbursement rates can differ by greater than 10 RVU/hr.

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Arthroscopy vs. Arthrotomy for Septic Knee Arthritis: Equivalent or Underpowered?

Paper 028

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INTRODUCTION: A recent study published in Arthroscopy by Grauer et al. examined 30-day complications following knee septic arthritis irrigation and debridement comparing arthroscopic versus arthrotomy as operation of choice. The study demonstrated some trends towards increased minor complications after knee arthrotomy when compared to arthroscopy. However, the study was only powered to detect a difference of ~15%. The purpose of this study was to increase the sample size and re-evaluate the question of if there was any difference in 30-day complications following arthrotomy versus arthroscopy for the treatment of septic knee arthritis.

METHODS: Patients undergoing knee arthroscopy and knee arthrotomy between 2006-2016 were identified in the American College of Surgeons National Surgical Quality Improvement Program. Patients without a primary diagnosis of septic knee arthritis were excluded from the study. The use of open arthrotomy compared to an arthroscopic surgical treatment was analyzed for its effect on the following outcomes: operative time, reoperation, hospital length of stay, readmission, and morbid events. Morbid events were classified as minor (transfusion, pneumonia, wound dehiscence, urinary tract infection, and renal insufficiency) and serious (wound infection, thromboembolic event, renal failure, myocardial infarction, prolonged ventilation, unplanned intubation, sepsis/septic shock, and death). Multivariate analysis adjusted for demographics and patient comorbidities.

RESULTS: A total of 1,270 patients met inclusion criteria with 454 patients undergoing knee arthrotomy and 816 patients undergoing knee arthroscopy. Patients undergoing knee arthrotomy had significantly higher ASA scores (2.8 ± 0.7 versus 2.6 ± 0.75; $p=0.0003$) compared to patients undergoing arthroscopy. After adjusting for potential confounders from demographics and ASA scores, knee arthrotomy was associated with an increased risk for increased operative time (Parameter estimate 4.555 [95% CI:3.023, 6.085]; $p<0.0001$), risk of a minor morbid event (OR 2.064 [95% CI: 1.447, 2.943]; $p<0.0001$), and risk of any morbidity (OR 2.285 [95% CI:1.527, 3.419]; $p<0.0001$).

DISCUSSION AND CONCLUSION: It is possible that previous published studies may have been underpowered to detect difference in 30-day complications following treatment of septic knee arthritis arthroscopically compared to open surgery. Arthrotomy was independently associated with increased risk for longer operating time, minor morbid events, and any morbid events.

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MAOA BREAKOUT SESSION #3
TRAUMA
Thursday, April 11, 2019

Short Cephalomedullary Nails Superior to Long Cephalomedullary Nails for Pertrochanteric Hip Fractures: A Randomized Prospective Study

Paper 029

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BACKGROUND: The purpose of this study was to compare functional and clinical outcomes between patients with pertrochanteric hip fractures treated with either a short (SN) or long (LN) cephalomedullary nail.

METHODS: 220 patients with intertrochanteric fractures were prospectively randomized to a SN (n=110) or LN (n=110). A total of 168 patients were followed for a minimum of 3 months (n=80) and LN (n=88) with a mean follow-up 8.5 months. Fifty-two patients did not meet minimum follow up with the majority of these lost to death. Demographics were similar between cohorts with respect to age, gender, diabetes, tobacco use, chronic kidney disease (CKD), body mass index (BMI), and AO/OTA fracture classification. The primary outcome measurement was functional outcome as evaluated by Short Form (SF-36) and Harris Hip scores (HHS) at 3 months. Secondary outcomes included implant failure, peri-implant fracture, mortality, operative time, estimated blood loss (EBL), and reoperation.

RESULTS: SN and LN cohorts were comparable in all aspects of the SF-36 and HHS subsections. There was a small, clinically insignificant difference in the HHS between the SN and LN cohorts (76 vs. 71, $p=0.02$). Patients treated in the SN cohort experienced shorter operative times (51 min vs. 80, $p<0.0001$), less EBL (70 cc vs. 207 cc, $p<0.001$) and shorter hospital LOS (5 vs. 7 days, $p=0.01$), but did not differ in tip-to-apex distance (TAD) (18.3 vs. 18.8, $p=0.51$) or subtrochanteric fracture extension (1.89 cm vs 2.15 cm, $p=0.24$). There was no difference in lag-screw cutout (SN 3.75% vs. LN 2.27%, $p=0.67$), deep surgical site infection (SN 1.25% vs. LN 2.27%, $p=1.00$), and peri-implant fractures (SN 2.49% vs. LN 2.27%, $p=1.00$) with the SN patients successfully treated nonoperatively and both LN patients requiring open reduction and internal fixation.

CONCLUSIONS: Patients treated with a SN or a LN for pertrochanteric femur fractures experienced comparable functional outcomes in regards to SF-36 and HSS. Despite no difference in functional outcomes, patients treated with a SN had shorter operative times, less EBL, and shorter hospital LOS with no difference in peri-implant fracture or lag-screw cut out when compared to the long nail cohort.

LEVEL OF EVIDENCE: Therapeutic Level I

MAOA BREAKOUT SESSION #3
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Thursday, April 11, 2019

Accurate Prediction of Antegrade or Retrograde Femoral Intramedullary Implant Length from Patient Height: A Review of 608 Cases

Paper 030

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METHODS: IRB approved retrospective chart review of 608 operatively treated femoral shaft fractures at a level 1 trauma center from 2011-2017. Patient Height (PH) was recorded in cm as well as femoral intramedullary implant length. Implant length, patient height, and technique (antegrade or retrograde) were recorded. Spearman and Pearson Correlation Coefficients were utilized for statistical analysis of implant length and patient height. A p value of <0.05 was considered significant.

RESULTS: 608 operatively treated fractures were reviewed, 350 antegrade, 258 retrograde. Pearson Correlation Coefficients for antegrade implants 0.676 with $p<0.01$, retrograde implants 0.628 with $p<0.01$. Two separate equations were determined to accurately predict $p<0.01$ femur nail implant length based on patient height. Antegrade Equation: =97.14033 +(1.76*[PHcm]). Retrograde Equation: =58.74479+(1.89317*[PHcm]).

CONCLUSION: Femur nail implant length can be accurately predicted based on patient height and technique utilizing the above equations. This is the first study utilizing a large number of femora to establish simple equations to aide with several issues. These equations serve as a simple templating tool. There is nothing in the literature that describes an accurate prediction model. Templating allows a check for the intraoperative measuring which would prevent an implant of incorrect length being implanted and discarded. This also allows for immediate implant availability as the implant representative can have a small selection of nails in the operating room, decreasing time spent waiting on implant retrieval. Another application is in the case of bilateral comminuted femur fractures to accurately estimate limb length. A fourth application is in remote environments where surgical planning is critical for determining implant needs.

MAOA BREAKOUT SESSION #3
TRAUMA
Thursday, April 11, 2019

Hybrid Screw Fixation for Femoral Neck Fractures: Does it Prevent Mechanical Failure?

Paper 032

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Conventional femoral neck fracture fixation uses partially threaded cancellous screws to maintain fracture reduction and compression. Fracture collapse and varus deformation can still occur due to posteriomedial comminution and lack of calcar support. We hypothesize fully threaded screw placed in the inferior posterior calcar region will provide improved biomechanical stability, providing fixed angle support with less fracture collapse, thus minimizing varus deformation and potential screw cutout.

Ten matched cadaveric pairs (20 femurs) were randomly assigned to two groups of screw fixation. Screws placed in an inverted triangular configuration. Group 1 (Hybrid) utilized one fully threaded inferior posterior calcar screw and two partially threaded superior screws. Group 2 (PTG) utilized all partially threaded screws. Screws placed using fluoroscopy with a template guide.

Specimens underwent standardized femoral neck osteotomy with cutting guides. Initial neck cut was perpendicular to the neck. 5 mm posteromedial wedge was then removed to simulate posteromedial comminution, producing an unstable fracture.

Specimens mounted in an MTS at 20° from the horizontal to simulate one-leg stance. Two loading sequences were utilized: (1) Axial load applied at rate of 1N/s up to 700N, followed by cyclic loading at 2Hz in force feedback control with loads of 700 to 1,400N for 10,000 cycles. (2) All surviving constructs were cyclically loaded to failure in a stepwise manner with a max load of 4,000N.

Statistical analysis using paired t-tests. Failure defined as 15 mm actuator displacement.

Construct stiffness was 2848 ± 344 N/mm in PTG vs. 2767 ± 665 for Hybrid ($P = 0.628$). 3 femurs failed during sequence 1 testing, all in PTG group. Load to failure demonstrated, Hybrid superiority with max cycles to failure (3797 ± 400 cycles) vs. (2981 ± 856 cycles in PTG) ($p = 0.010$). Hybrid superiority was demonstrated with Max load prior to failure (3290 ±196 N) vs. (2891 ±421 N in PTG) ($p = 0.010$). No significant difference in bone mineral density noted in the failure group ($P > 0.05$) or in any of the specimens.

Our study is first to assess the biomechanical effects of Hybrid fixation for femoral neck fracture. Hybrid screw configuration resulted in significantly stronger constructs, with higher axial load and increased cycles to failure. The advantageous mechanical properties demonstrated using a fully threaded inferior calcar screw appears to function as a mini fixed angle device and may prevent the common complication of excessive shortening and varus collapse. Further clinical correlation is needed.

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Tibia Fractures and NSAIDs. Does it Make a Difference? A Multicenter Retrospective Study

Paper 033

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PURPOSE: The purpose of this study was to compare healing time for diaphyseal tibia fractures (OTA/AO 42 A, B, C) treated with intramedullary nailing (IMN) in one geographic cohort using nonsteroidal anti-inflammatory drugs (NSAIDs) for postoperative pain control to that of another geographic cohort using narcotic medications. The groups represent differing cultural approaches to postoperative pain control, and we hypothesized there would be no difference in healing time.

METHODS: Tibia fractures presenting at two level 1 trauma centers located in two different countries between January 1, 2010, and December 31, 2017, were retrospectively screened for enrollment. Fractures classified as OTA/AO 42A, B, or C that were treated with IMN and had radiographic follow-up to union were included. Postoperatively, one geographic cohort (n=190) was prescribed NSAIDs and the other (n=182) was prescribed narcotics for pain control. Each analgesic method represented the standard of care for that location. Fracture union was defined as cortical bridging in at least 3 out of 4 cortices on AP and lateral radiographs. The primary outcome was healing time on radiographic evaluation.

RESULTS: There was no statistically significant difference in healing time between the two groups (p=0.64; 95% CI, -14.87 – 24.04). Average healing time was 185 days in the narcotic cohort and 180.5 days in the NSAID cohort. Both groups had similar mean age. The narcotic cohort included more polytrauma patients (18.9% vs. 13.4%). In the NSAID group, there was one open fracture resulting in infection and nonunion, which was treated with a bone transplant. Nine NSAID patients required additional surgeries to add plate fixation or bone graft, and three underwent revision nailing. The narcotic group had six open and two closed fractures resulting in nonunion. These required revision nails or additional plating. Three patients in the narcotic cohort required antibiotic nails for infection.

CONCLUSION: In our study, the difference in healing time between the NSAID and narcotic groups was not statistically significant. The deleterious effect of NSAID use on fracture healing has been debated for decades. Numerous animal studies have supported this theory; however, high quality clinical studies in humans have not provided convincing evidence to substantiate this negative effect. Our study suggests that NSAIDs may be used safely and effectively in the acute phase of fracture healing without significantly increasing the risk of delayed union or nonunion. Prospective randomized studies are necessary to rule out the negative effect of NSAIDS on bone healing.

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Effect of Postoperative Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) on Nonunion Rates in Long Bone Fractures

Paper 034

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INTRODUCTION: Long bone nonunion results in great burden to the treating surgeon, healthcare system, and patient. Risk factors for nonunion include fracture type, method of fixation, and patient comorbidities. Exposure to NSAIDs has been controversial in its association with subsequent nonunion. The purpose of this study was to evaluate whether NSAID exposure results in increased risk of nonunion in operatively treated long bone fractures and to evaluate the difference in reimbursement for fractures that healed and those that developed nonunion.

METHODS: Using the database, patients under a single payer private insurance with operatively treated humeral shaft (HS), tibial shaft (TS), and subtrochanteric femur (SF) fractures were identified using ICD-9 and ICD-10, and CPT codes. Patients were divided in cohorts based on NSAID use in the immediate postoperative period. Nonunion rates were evaluated. A cost analysis was also performed comparing nonunion and union, using a t-test to determine statistical significance. Data was analyzed with a metric of overall patient health status, the Charlson Comorbidity Index (CCI). Multivariate analysis was performed to determine whether NSAID use represents an independent risk factor.

RESULTS: Between 2007-2016, 5310 TS, 3947 HS, and 8432 SF fractures underwent operative fixation. Patients used NSAIDs in the first 90 days postoperatively in 900 TS, 694 HS, and 967 SF fractures. In these patients, nonunion rates were 18.9 % in TS fractures, 17.4% in HS fracture and 10.4% in SF fractures. When no NSAIDs were used, the rates were 11.4%, 10.1%, and 4.6% for each respective fracture type. SF fractures in patients taking NSAIDs had a 2.4 times higher risk of nonunion when calculating relative risk ($P<0.05$). NSAID use has a relative risk of nonunion of 1.7 in both HS and TS fractures. No difference was found in the CCI between those that used NSAIDs and those that did not. Multivariate analysis showed NSAID use to be an independent risk factor in all three fracture types. Lastly, cost analysis shows SF fracture nonunion results in $35,968.19 one-year reimbursement versus $22,435.05 in those that healed. Similar results were found in HS ($21,240.30 vs. $31,746.91) and TS ($28,077.04 vs. $49,995.25) ($P<0.05$).

CONCLUSION: This review has demonstrated that NSAID exposure is associated with fracture nonunion. It reviews epidemiology of long bone nonunion. Finally, it shows economic burden of fracture nonunion.

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Clinical Outcomes Following Intramedullary Nailing of Select Tibial Plateau Fractures

Paper 035

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PURPOSE: Although proximal third tibia fractures have traditionally been treated with plate and screws, recent investigations have shown equivalent outcomes with intramedullary nails (IMN). Reports have suggested that IMN may offer a more biologically friendly fixation method for select injuries. The purpose of this study was to report the outcomes of treatment of tibial plateau fractures with IMN.

METHODS: This was a retrospective review of patients > age 17 that underwent IMN for tibial plateau fractures (OTA/AO 41-A, 41-B with an ipsilateral shaft component, and 41-C1/2) at a Level 1 trauma center from 2013-2017. All patients had a minimum follow-up of 12 months. Radiographic analysis included union (evaluated by the radiographic union scale in tibial [RUST] score) and alignment. Normal coronal alignment, measured by the medial proximal tibia angle, was 87°. Normal sagittal alignment, measured by the posterior proximal tibia angle, was 81°. The visual analog scale (VAS) was administered to quantify pain (0-10). The Physical Function (PF) and Pain Interference (PI) domains of the PROMIS score assessed functional outcomes.

RESULTS: 85 patients were screened, 54 patients met inclusion criteria. The mean clinical follow-up was 27.8 months (range: 12-56 months). Average age was 43.9 years, mean BMI was 29.0, and 48% were smokers. 32 (59%) fractures were OTA/AO Type 41-A, 5 (9%) 41-B, and 17 (31%) 41-C. The median time to definitive fixation was 2 days, 28% of patients had compartment syndrome, 50% had an open fracture, and 47% had initial treatment with an external fixator. There were 7 (13%) deep infections and 6 (11%) nonunions requiring reoperation. The rate of malreduction >5° in the coronal plane and sagittal plane postoperatively was 6% and 11%, respectively; malunion >5° at final follow-up was 10% for each plane. The mean PROMIS PI was 55.0, PF 45.2, and VAS 3.7. The mean RUST score on final radiographs was 9.3. Analysis of patients with closed fractures (n=27) revealed a 4% rate of deep infection and 7% rate of nonunion.

CONCLUSION: This study demonstrated that IMN of select tibial plateau fractures was associated with a low rate of malalignment, nonunion, and infection in a series of patients with relatively severe injuries. Functional outcomes approached those of a normal population. This study suggests that good outcomes with a low risk of complications can be expected following IMN of select plateau fractures, although prospective trials comparing IMN to plates are needed.

MAOA BREAKOUT SESSION #3
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Thursday, April 11, 2019

Subsequent Femoral Fragility Fractures: Underreported and Construct-Related

Paper 036

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PURPOSE: In treating index femoral fragility fractures, construct selection may modulate subsequent fracture risk. However, research has not confirmed this. We hypothesized that subsequent fractures are underreported due to fractures being treated across multiple health systems.

METHODS: We retrospectively identified 273 patients treated surgically for index femoral fragility fractures, 172 receiving baseline care at our institution. We reviewed the record for patient, injury, and treatment factors as well as subsequent femur fracture. We assessed for associations of subsequent fracture with index fracture type, Charlson Cormorbidity Index (CCI), age, baseline care status and construct design, using chi-square, t-test and ROC analyses.

RESULT: Mean age was 79 years (minimum 50) and mean follow-up was 3.5 and 2.7 years with and without baseline care, respectively. We identified 25 subsequent femoral fragility fractures (10 ipsilateral and 15 contralateral). Neither subsequent fracture nor baseline care were associated with patient index fracture type, age, or CCI ($p > 0.05$ for all). However, baseline care was associated with a greater likelihood of identifying subsequent fractures (13.4% vs. 2.0%, $p<0.01$). Regardless of baseline care status, the ipsilateral peri-implant fracture risk for constructs spanning from femoral head to distal metaphysis (0%, 0 of 81) was lower than that for non-spanning constructs (5.2%, 10 of 192), $p = 0.04$. For patients receiving baseline care with non-spanning constructs the rate of subsequent per-implant fracture was even higher (9 of 125, 7.2%).

CONCLUSION: Despite similar risk factors, baseline care was highly associated with identifying subsequent fractures. Further, non-spanning index constructs were associated with a significantly higher rate of subsequent peri-implant fracture than spanning constructs. These findings suggest previous research underestimates the risk of subsequent peri-implant fracture and the association with index construct.

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Radiographic and Clinical Outcomes in Patients Who Develop Deep Infections After Undergoing Placement of Anterior Subcutaneous Pelvic Fixator

Paper 037

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BACKGROUND: The use of an anterior subcutaneous internal fixator (INFIX) has been reported in the literature for the reduction and fixation of unstable pelvic ring injuries with the appropriate posterior fixation. The incidence of infection after use of INFIX has been previously reported as 1-3%. Due to the limited numbers of infected cases in INFIX series there is no current recommendation on treatment. The purpose of this study is to report on infections after the use of INFIX for pelvic ring injuries, come to a consensus on treatment with retention or explanation of the device and report on clinical/radiographic outcomes.

METHODS: We retrospectively reviewed 143 patients from July 2012 to August 2017 who underwent INFIX and appropriate posterior fixation for treatment of unstable pelvic fractures. We assessed (1) rate of infection; (2) time to diagnosis of infection; (3) healing with callus formation and maintenance of reduction on radiographs; (4) ability to sit, stand, and lie on their side; and (5) evidence of persistent osteomyelitis at time of final follow-up. The minimum follow-up was 3 months.

RESULTS: The rate of INFIX infection in this series was 5.6% (N=8), slightly larger than reported in previous series of cases but much lower than the rates reported with external fixation of the pelvis. All of the infections occurred within 3 months of index surgery, with 5/8 occurring in the first month. Explantation of the device in addition to thorough irrigation and debridement was performed within 2 weeks of diagnosis of infection in all 8 cases. Each of the patients went onto radiographic union without loss of reduction. There was no clinical evidence of persistent osteomyelitis at final follow-up. All 8 patients were eventually able to sit, stand, and lie on their sides.

CONCLUSIONS: Although the placement of an INFIX device can lead to development of deep surgical site infections (5.6% in this study), there does not appear to be a significant negative effect on the overall clinical and radiographic outcomes in these patients. We believe that expedient treatment once diagnosis of infection is obtained in the form of explantation and thorough irrigation and debridement are critical to achieving these results.

MAOA BREAKOUT SESSION #3
TRAUMA
Thursday, April 11, 2019

Initiating A Diabetes Control Protocol In Orthopedic Trauma Patients Can Predict Surgical Site Infections and Improve Long-Term Diabetes Management

Paper 038

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INTRODUCTION: Diabetes mellitus (DM) is a risk factor for surgical site infections (SSIs) in elective orthopedic procedures. This finding has led many surgeons to implement medical optimization protocols and adopt hemoglobin A1c (Hgb A1c) cutoffs to serve as a contraindication to elective surgery. However, for trauma patients, for whom surgery cannot be delayed, it is unclear if perioperative DM intervention can affect the rate of SSIs. The objectives of this study were (1) to determine the incidence of SSIs in diabetic patients who underwent orthopedic intervention in the setting of trauma and (2) to establish a protocol for managing diabetic trauma patients.

METHODS: A retrospective chart review was performed at our Level 1 trauma center from January 2015 to December 2017. Patients with a known pre-injury diagnosis of DM were reviewed. All patients with at least one-month follow-up were included. Hgb A1c and blood glucose (BG) at admission, discharge, and at last available follow-up were recorded. Patients were divided into two groups: uncontrolled DM (Hgb A1c>7.5% or BG >300 mg/dL on admission) and controlled DM (Hgb A1c≤7.5% and BG ≤300 mg/dL). The primary outcome was SSI requiring an unplanned intervention including oral or intravenous antibiotics, local wound care, or unplanned reoperation. All patients were treated perioperatively with a standardized protocol including internal medicine co-management, sliding scale insulin, and if appropriate, were discharged with oral hypoglycemic agents and/or insulin.

RESULTS: There were 263 DM patients undergoing orthopedic interventions during the study period. 214 had adequate follow-up (81.3%) and were included in the final analysis. 74 (34.6%) patients met the criteria for uncontrolled DM. The overall rate of SSI was 24.3%; 39.2% of uncontrolled diabetic patients and 16.4% of controlled diabetic patients had SSIs (p=0.0004). Admission BG was significantly lower in patients who did not develop infections compared to those who did (173.2±74.6 mg/dL vs. 231.8±149.6 mg/dL, respectively, p=0.009); there was no difference in discharge BG (p=0.75). At last follow-up, 85.4% of uncontrolled diabetics (41/48) demonstrated an improvement in their Hgb A1c (median: 1.40%).

DISCUSSION: Trauma patients presenting with uncontrolled DM have a higher rate of SSI than patients with controlled DM. Admission BG was predictive of SSI risk. Orthopedic trauma creates a valuable opportunity for diabetes intervention that can positively impact patient outcomes beyond the acute surgical period.

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MAOA BREAKOUT SESSION #3
TRAUMA
Thursday, April 11, 2019

Does Standardization of Surgical Preparation Decrease Infection Rate in Closed Fracture ORIF?

Paper 039

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PURPOSE: To evaluate the effect of standardization of surgical prep on the deep infection rate for ORIF of closed fractures.

METHODS: As part of a quality improvement project, a total of 795 patients were identified with 893 discrete, new onset, closed fractures that were treated with surgery following standardization of practice for surgical prep from September of 2016 through November of 2017 at an ACS level 1 trauma center. A retrospective chart review included prep type, compliance with dry times of surgical prep, and the surgical procedure. Patients with multiple fractures were given separate entries for fractures that occurred at different anatomical sites. Adequate follow-up for patients to be included in the study group was 6 weeks minimum at our facility. The endpoint was return to the OR for deep infection prior to fracture healing. Return to the OR (operating room) for nonunion/malunion only was not included in the study group, unless, and infection was also present. Periprosthetic fractures and re-fractures were given separate entries as new fractures. Results were recorded and stratified by rate of infections per month. Data from 2 years prior to instituting the protocol served as the control group. Z-test was performed for statistical analysis.

RESULTS: 31 out of the 795 patients (3.36%) returned to the OR for deep infection. The historical control infection rate for the previous 2 years was 5.7% (105/1827). Therefore, the standardization project led to a decrease of 2.34%. A Z-test showed a statistically significant decrease in infection risk with a z-score of 2.788 (P=0.003 95% CI .01-1.0).

CONCLUSION: Standardization of surgical prep in the setting of ORIF of closed fractures significantly decreased the risk of postoperative infection requiring operative debridement. Standardizing the surgical prep minimizes confusion by staff who perform the prepping, and increases consistency. These effects were seen in the setting of using an alcohol pre-prep followed by use of an alcohol-based chlorhexidine final prep.

MAOA BREAKOUT SESSION #3
TRAUMA
Thursday, April 11, 2019

Bacterial DNA Screening to Determine Infection Risk in Patients with Closed Fractures Undergoing ORIF

Paper 040

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PURPOSE: The purpose of this prospective study was to screen patients for type and amount of bacteria present during the key stages of closed fracture ORIF in order to characterize potential predisposing factors for infection.

METHODS: After IRB approval, patients scheduled for ORIF of closed fractures of the distal radius or ankle were enrolled with informed consent. All components of perioperative management and surgical treatment, including patient preparation and use of antibiotics, were according to standard of care. Sterile swabs were used to obtain samples for standard aerobic and anaerobic microbial cultures and bacterial DNA PCR testing immediately upon surgical exposure of the fracture and immediately following final fixation prior to wound closure. Patients were managed and followed postoperatively according to standard of care. Clinical and radiographic healing and all complications were documented. If operative debridement for infection occurred, samples were obtained for standard aerobic and anaerobic microbial cultures. Microbial culture results were recorded based on bacterial species producing growth at each sampling point. PCR was used to identify (species) and quantify (#rRNA sequences) bacterial DNA retrieved at each sampling point.

RESULTS: A total of 20 patients with closed fractures (n=10 distal radius; n= 10 ankle) met inclusion criteria and completed the study protocol. Microbial culture from intraoperative swabs produced growth of coagulase negative Staphylococcus in two cases (1 ankle, 1 radius), both of which healed without complications. All intraoperative samples contained quantifiable amounts of bacterial DNA of multiple species with PCR. Staphylococcus, Proprionibacteriacea, Streptococcus, and Corynebacterium species were the most abundantly found organisms. One ankle fracture experienced wound dehiscence prior to fracture healing and operative debridement cultures grew Enterobacter cloacae. This patient had no microbial growth from ORIF intraoperative swabs and did not have a predominant species of bacterial DNA present.

DISCUSSION AND CONCLUSION: Quantifiable amounts of bacterial DNA of multiple species are present in closed radial and ankle fractures undergoing ORIF with Staphylococcus, Proprionibacteriacea, Streptococcus, and Corynebacterium species predominating. However, neither intraoperative screening of patients for bacterial DNA nor microbial culture from the fracture site was effective for determining risk of infection or other fracture-associated complications in this study. These data suggest that factors other than bacterial load present at the time of ORIF are responsible for common complications associated with surgical treatment of closed fracture

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MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Protocol-Based Dual-Antibiotic Protocol Effectively Reduces Prosthetic Joint Infection Rates

Paper 042

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INTRODUCTION: The use of vancomycin in dual-antibiotic prophylaxis is controversial, with conflicting reports on effectiveness and acute kidney injury risk. We have previously reported safety and effectiveness of a dual-antibiotic protocol with pre-incision administration of single dose vancomycin. We incorporated single-dose vancomycin, dual antibiotic prophylaxis into a service wide protocol protocol for dual-antibiotic prophylaxis beginning in January 2015, and performed this study to determine the effectiveness of this approach. Our hypothesis was that increased pre-incision vancomycin administration would be associated with clinically significant PJI reduction following total knee arthroplasty (TKA) and total hip arthroplasty (THA).

METHODS: After obtaining institutional review board approval, we retrospectively assessed 585 TKA (635 knees) and 492 THA (495 hips) procedures performed between January 1, 2015, and May 31, 2017. Study patients were compared with a historical control group of 872 TKA (957 knees) and 644 THA (664 hips) procedures performed between January 1, 2012, and December 31, 2014. A detailed medical chart was accomplished to determine antibiotic selection, vancomycin administration timing, and perioperative infection rates. Patient demographic features including age, gender, BMI, and ASA class were also assessed to determine medical complexity of patients treated with each approach. Statistical assessment was accomplished using a student's t-test or a Fisher's Exact test, with a p-value of <0.05 required for consideration of significance.

RESULTS: Study group patients were more likely than patients in the control group to receive vancomycin prophylaxis with their TKA (87.8% vs. 37.3%, $p<0.001$) or THA (91.1% vs. 48.1%, $p<0.001$). Among patients receiving vancomycin, study group patients were more likely to have at least 80% of the vancomycin infused prior to the incision for TKA (85.0% vs. 42.9%, $p<0.001$) and THA (81.6% vs. 50.6%, $p<0.001$). Patients receiving vancomycin ahead of their surgical incision had lower PJI rate (0.7%) than patients receiving cefazolin alone (2.1%, $p<0.01$) or vancomycin during their procedure (3.6%, $p<0.001$). There was no difference in PJI rate for on-time vancomycin administration between study and pre-protocol time periods (0.75% vs. 0.67%, $p=1.0$). The facility PJI rate significantly improved after protocol introduction (2.2% vs. 1.2%, $p=0.03$). Using available data, adoption of a dual antibiotic protocol with intentional pre-incision administration of single dose vancomycin would have reduced treatment costs by over $900K during the years of study.

CONCLUSION: The adoption of a dual-antibiotic prophylaxis approach can successfully reduce THA and TKA PJI rates. Success of the approach appears to be dependent on adequate preoperative vancomycin infusion.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Efficacy of Intraoperative Prophylactic Techniques for Prevention of Periprosthetic Joint Infection: Superiority of Betadine Against Multiple Bacteria

Paper 043

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INTRODUCTION: Multiple methods of intraoperative prophylaxis against periprosthetic joint infection (PJI) during primary total joint arthroplasty (TJA) have emerged, including betadine, chlorhexidine gluconate (CHG), and vancomycin powder. There is little evidence comparing these treatments. The purpose of this study was to examine the efficacy of current prophylactic techniques used in TJA against multiple pathogens commonly causing PJI.

METHODS: Clinically isolated strains of methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, E. coli, Haemophilus influenza, Burkholderia cepacia, and Staphylococcus epidermidis were exposed to sterile povidone-iodine (5%), CHG (0.05%), or vancomycin (5 mcg/mL) for various time points (immediate or 0 minutes, 3 minutes, 30 minutes, and 1 hour). Concentrations and time points were chosen based on current clinical practice and to establish a bactericidal range of exposure. Minimal inhibitory concentrations (MIC) were established prior to time-to-death analysis for each of the treatment groups using standard quantitative suspension methods with an incubation/exposure period of 24 hours. Bactericidal efficacy was determined by colony forming unit (CFU) counts after incubation.

RESULTS: Each of the treatments was inhibitory at standard clinical concentrations, and at lesser concentrations. Povidone-iodine demonstrated inhibitory activity against MRSA to an MIC of 0.08%, while the MIC of CHG was 0.00078%, and the MIC of vancomycin was 1.563 mcg/ML. The results were similar for the 5 other bacteria studied. By time to death, povidone-iodine resulted in complete bacterial inhibition (0 CFUs) at each time point tested, including immediate exposure time point, for each of the 6 pathogens tested. CHG was incompletely bactericidal against MRSA and Burkholderia to 3 minutes, but showed complete bactericidal activity at 30 minutes and 1-hour exposures for those bacteria and showed complete inhibition at all time points for the remaining bacteria tested. Vancomycin was not bactericidal up to 1-hour exposure time for any bacteria, but was at 24 hours for each.

CONCLUSION: All of the treatment methods studied were effective at killing and preventing growth of multiple bacteria in vitro. Betadine was superior to chlorhexidine and vancomycin powder via time-independence. Clinically, this study suggests that betadine is effective immediately against each of the 6 tested bacteria intra-wound, requiring only direct bacterial contact, and is not dependent on exposure time. Efficacy of chlorhexidine and vancomycin are time-dependent against spcific bacteria, while chlorhexidine is time-independent against most bacteria in this study.

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MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Povidone-Iodine Irrigation Prior to Wound Closure Did Not Decrease Infection in Primary Total Knee and Hip Arthroplasties: An Analysis of 11,738 Cases

Paper 044

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INTRODUCTION: Dilute povidone-iodine (PI) irrigation has become popular prior to wound closure in total hip arthroplasty (THA) and total knee arthroplasty (TKA), but there are limited reports evaluating its efficacy in decreasing periprosthetic joint infection (PJI). The goals of this study were to compare the rates of PJI requiring reoperation in primary THA and TKA patients who received and did not receive dilute PI irrigation.

METHODS: Between 2013 and 2017, we identified 5534 primary THAs and 6204 primary TKAs through our institution's total joint registry. In THAs, 1322 (24%) received dilute PI irrigation, and in TKAs 2410 (39%) received dilute PI irrigation. We evaluated PJIs requiring reoperation and non-operative wound complications at 3 months and 1 year. The same comparison was then performed using propensity scores to account for differences in baseline characteristics (age, gender, BMI, underlying diagnosis, smoking status, Charlson comorbidity index, date of surgery, and prior infection). Median follow-up was 2 years.

RESULTS: After accounting for baseline differences between groups using the propensity score weighted models, there was no significant difference in PJI reoperations at 3 months (p=0.2 THA, p=0.9 TKA) and 1 year (p=0.6 THA, p=0.9 TKA). Non-operative wound complications were similar between both groups at 3 months (p=0.3 THA, p=1.0 TKA) and 1 year (p=0.5 THA, p=0.4 TKA).

CONCLUSIONS: In this large single center retrospective series of over 11,000 THAs and TKAs, diluted PI did not decrease the rate of PJI, but we also did not note any wound complications related to its use. There are several reasons for these findings including the fact that during our adoption, there was a slight selection bias for the dilute PI to be used in patients deemed the highest risk. This is an area that would greatly benefit from a multi-center randomized clinical trial.

SUMMARY: In over 11,000 THAs and TKAs, dilute povidone-iodine prior to wound closure did not decrease reoperation for PJI, and was not associated with wound complications.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Dilute Betadine Lavage Reduces the Risk of Acute Postoperative Infection in Aseptic Revision Total Knee or Hip Arthroplasty: Interim Analysis of a Randomized Controlled Trial

Paper 045

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INTRODUCTION: Deep periprosthetic joint infection (PJI) after total knee (TKA) and hip (THA) arthroplasty is a rare but devastating complication with higher incidence after aseptic revision than primary procedures. The purpose of this randomized controlled trial is to evaluate the efficacy of using dilute betadine versus sterile saline lavage in aseptic revision THA and TKA to prevent acute postoperative deep PJI.

METHODS: Of the 450 patients that were randomized, 5 did not have 90-day follow-up, 9 did not receive the correct treatment, and 4 were excluded for intraoperative findings consistent with PJI. 221 Patients (144 knees and 77 hips) received saline lavage only and 211 patients (136 knees and 75 hips) received a three-minute dilute betadine lavage (0.35%) prior to arthrotomy closure. The cohort consisted of 260 females (60.2%) and 172 males (39.8%) with a mean age of 64.4 years old (range, 39 to 89 years) at the time of surgery. Patients were observed for 90 days postoperatively for the incidence of acute postoperative deep PJI. Statistical analysis was performed using t-tests or Fisher's exact test where appropriate. Power analysis determined that 285 patients per group are needed to detect a reduction in the rate of PJI from 5% to 1% with 80% power (alpha=0.05).

RESULTS: There were seven PJIs in the saline group and one in the betadine lavage group (3.2% vs. 0.5%, respectively; p=0.068). Age (p = 0.50), gender (p = 0.17), body mass index (p = 0.31) and Charlson comorbidity index (p = 0.69) were similar between groups suggesting appropriate randomization.

CONCLUSION: Although we did not reach statistical significance with the number of patients enrolled thus far, dilute betadine lavage appears to be associated with a clinically relevant reduction in the incidence of acute postoperative PJI following an aseptic revision procedure.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

The Ideal Diagnostic Thresholds for Diagnosing Periprosthetic Joint Infections in Patients with Diabetes Mellitus: A Multicenter Study

Paper 046

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INTRODUCTION: While patient with diabetes mellitus (DM) are known to be at an increased risk of PJI, it is unknown if the optimal threshold for the MSIS minor criteria differs in patients with DM compared to non DM patients. The purpose of this study was to determine the optimal threshold for the MSIS minor criteria in patients with DM.

METHODS: A multicenter retrospective study of 1026 patients from 2004 to 2016 was conducted in DM (159) and non-DM patients (867). 255 patients meet MSIS criteria for the diagnosis of a chronic PJI. Receiver operating characteristic (ROC) curves were used to evaluate ESR, CRP, synovial fluid WBC cell count and differential for diagnosing PJI with Youden J statistics to determine optimal thresholds.

RESULTS: The best test for diagnosing PJI based on the area under the curve (AUC) for the DM group was the synovial neutrophil percentage (AUC: 96.4%) with an optimal neutrophil percentage cut off of 72%. The synovial neutrophil AUC for the non DM group was 94.6% with an optimal cut off of 74%. The next best test, the synovial cell count AUC for the DM group was 95.9% with and optimal cut off of 3100. The least accurate test for diagnosing PJI for both groups was ESR with an AUC of 81.9% in the non DM group and 77.8% in the DM group.

CONCLUSION: While the MSIS minor criteria have standard thresholds for the diagnosis of PJI, not all minor criteria are equivalent and the ideal thresholds for some minor criteria may vary based on underlying patient medical comorbidities. In this cohort, synovial neutrophil percentage with an optimal cutoff of 72% was the best test for the diagnosis of PJI in patients with DM which was similar to non DM patients, while the least accurate test was ESR.

SUMMARY: In patients with diabetes mellitus, synovial neutrophil percentage was the best diagnostic test of periprosthetic joint infection with an optimal cutoff of 72%. The least accurate test was ESR. The MSIS minor criteria thresholds for diabetic patients were similar to non-diabetic patients.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Next-Generation Sequencing DNA Analysis in a Cohort of '2018 Definition' MSIS Hip and Knee Infections

Paper 047

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INTRODUCTION: The 2018 update to traditional MSIS criteria for defining periprosthetic joint infection (PJI) is a step forward in the diagnosis of hip and knee infections. While identifying the presence of infection is essential, isolating the offending bacteria is crucial to eradication. Next-Generation Sequencing (NGS) is a PCR/DNA-based technology which holds potential in culture negative and polymicrobial infection. We compared NGS and culture results in hip and knee infections meeting '2018 MSIS criteria'.

METHODS: Forty-one cases treated for infection from 6/2017-5/2018 at a single tertiary academic institution were reviewed. In all cases, deep tissue samples and swabs were obtained and sent for institutional laboratory culture and external NGS analysis. Culture results, 2018 MSIS criteria, and NGS results were recorded.

RESULTS: Thirty-three of 41 cases were culture positive (80.5%) with a single positive culture in 10 and two positive cultures for the same organism in 23. NGS was positive in 30/41 (73.2%). For infections with two positive cultures for the same organism, NGS identified the appropriate bacteria in 65.2% of cases (true positives, 15/23). NGS was negative for the cultured organism, but positive for a different organism in 21.7% of cases (false positives, 5/23). In eight culture negative infections, NGS analysis identified an organism in 4 cases (50%) with multiple organisms identified.

CONCLUSIONS: NGS is an advanced diagnostic modality in PJI infection which has potential in culture negative infection or the complex setting of failed treatment where polymicrobial etiology is potentially causative. However, in nearly 35% of cases with multiple cultures positive for the same organism, NGS was negative for the isolated pathogen. In its current iteration, NGS is of limited value and further study is required to evaluate optimal collection technique, define false positive and false negative rates, and understand clinical significance of a positive result prior to widespread adoption.

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MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
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Diagnostic Accuracy of the Alpha-Defensin Test at Reimplantation of a Two-Stage Revision for Periprosthetic Joint Infection; Good Correlation with MSIS Criteria, Poor Validity for Prediction of Failure at 1 Year

Paper 048

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INTRODUCTION: Periprosthetic joint infection (PJI) remains a diagnostic challenge that relies on multiple clinical and laboratory criteria that may not be consistently present. The alpha-defensin-1 (AD-1) test has been shown to correlate accurately with the Musculoskeletal Infection Society (MSIS) criteria for the diagnosis of PJI. Previous studies analyzing AD-1 excluded patients who had antibiotic spacers at the 2nd stage reimplantation. This study was conducted to compare the predictive ability of AD-1 and MSIS criteria for failure after reimplantation (1 year) using the "Delphi" failure criteria.

METHODS: This was a multi-center study of patients who underwent a second stage revision arthroplasty between May 2014 to July 2016. Patients who: (1) had a confirmed PJI and received a cement spacer, (2) underwent the second stage, (3) had MSIS criteria data and synovial fluid AD-1, and (4) had a minimum follow-up of 1 year were included, yielding a total of 69 patients (43 knees, 26 hips). Sensitivity, specificity, positive and negative predictive values, accuracy, area under the curve (AUC), and their exact 95% confidence intervals (CI) were determined to assess the validity of AD-1 against failure criteria at 1 year. Concordance index (c-index) and its Wald 95% CI were calculated to predict failure criteria using AD-1 then MSIS criteria. The two c-indices were compared using the non-parametric approach of DeLong.

RESULTS: AD-1 test validity for failure criteria at 1 year showed poor sensitivity (7.1%) and poor overall accuracy (72.5%; AUC=0.481). The c-index for AD-1 vs. failure criteria was 0.519 (95%CI=0.44-0.60), and the c-index for MSIS criteria vs failure criteria was 0.518 (95% CI=0.49-0.54), suggesting weak predictive abilities of these models. The contrast estimate between MSIS criteria and AD-1 was not significantly different from each other at -0.001 (95% CI%=-0.09-0.09), p-value of 0.99.

CONCLUSION: AD-1 and the MSIS criteria demonstrated weak predictive ability for failure criteria at 1 year. The use of AD-1 on cement spacers has not been validated, therefore its utility in second stage revisions in addition to the MSIS criteria remains unclear.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

A Retrospective Comparison of a Modified Single-Stage vs. a Traditional Two-Stage Revision Arthroplasty for Management of Periprosthetic Joint Infection

Paper 049

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INTRODUCTION: Prosthetic Joint Infection (PJI) is a devastating complication of total joint arthroplasty (TJA) that imparts heavy cost and life-threatening risk, particularly after multiple surgeries constituting the gold standard two-stage revision arthroplasty. The 5-year mortality following such an infection is even demonstrated to rival that of many common cancers, further emphasizing the need to devise an efficient means of resolution. The problem remains that there exists a paucity of data and lack of consensus regarding which approach is optimal in eradicating infection. Therefore, the aim of this study is to compare the one-stage revision arthroplasty to the gold standard two-stage revision as it pertains to infection cure rate. It is hypothesized that the one-stage revision will be comparable to its counterpart in eradicating infection.

METHODS: Retrospective cohort of 84 PJIs as confirmed by positive culture between 01/2010-03/2017. Forty-two consecutive two-stage exchanges followed by 42 consecutive modified 1-stage exchanges were performed by a single surgeon at a single site. Patients were not excluded based upon comorbidity nor virulence of organism. The primary evaluation criterion was the infection cure rate. Patients were followed until one year after definitive revision surgery or until revision failure. A revision failure involved a recurrent infection that was confirmed by repeat positive cultures. Return to surgery for aseptic reasons and wound complications, with negative cultures, were not considered revision failures.

RESULTS: The study population consisted of 42 males and females (1:1), mean age of 63.2 years (60.6, 65.9), and mean BMI of 35.0 (33.2, 36.8). Characteristics of age ($p=0.14$), BMI ($p=0.53$), and gender ($p=0.38$) were comparable between the two study groups. Comorbidities of coronary artery disease ($p=0.09$), chronic kidney disease ($p=0.24$), peripheral vascular disease ($p=0.24$), and type II diabetes ($p=0.59$) were comparable between the two study cohorts. There were 17 (40.5%) revision failures within the traditional two-stage study cohort, significantly larger than the 5 (11.9%) revision failures observed in the modified one-stage study cohort ($p<0.01$). Days until revision failure for two-stage procedures occurred at an average of 50.4 days versus the 77.2 days in the modified one-stage procedures ($p=0.18$).

CONCLUSIONS: One-stage revision arthroplasty is an effective means of eradicating infection when compared to the gold-standard two-stage revision, and thus proves to be an efficient approach toward resolution, while simultaneously subjecting the patient to a lesser surgical and economic insult.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Contemporary Two Stage Treatment of Periprosthetic Hip Infection Yields Excellent Results with an Evidence-Based Standardized Protocol

Paper 050

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INTRODUCTION: Single-stage resection and reimplantation for periprosthetic joint infection (PJI) in total hip arthroplasty (THA) is of recent interest, yet outcomes may be skewed by selected populations with healthier patients and less virulent organisms. This study quantified the effectiveness of a contemporary, evidence-based and standardized two-stage treatment protocol in patients with THA PJI including chronically infected, poor hosts.

METHODS: Sixty-one consecutive two-stage resection and reimplantation THAs for PJI between 2011 and 2017 were retrospectively reviewed in a prospectively collected registry database. Patients were categorized with McPherson's Staging System and infection was defined by MSIS criteria. Contemporary standardized protocols were adhered to including implant resection and meticulous surgical debridement, six-week intravenous antibiotics with a high-dose antibiotic spacer, a two-week drug holiday, and laboratory assessment of infection eradication prior to reimplantation. Extended antibiotics after reimplantation were not routinely used. Successful treatment was defined as reimplantation with component retention at minimum two-year follow-up.

RESULTS: After exclusions for confounds, 43 of 47 patients had obtained minimum two-year follow-up (mean 50.9 months). 54% were male with an average BMI of 31 kg/m^2. 56% were chronically infected poor hosts (Stage III-B/C). Three patients required repeat debridement and/or spacer exchange prior to final reimplantation. Treatment success rate was 95% at two-year follow-up. Success did not vary based on patient sex, age, BMI, or multi-organism PJI ($p \geq 0.117$). There were no failures in the early postoperative PJI group (stage I), and both failures occurred in the late chronic PJI group (stage III).

CONCLUSION: Our success rate with the two-stage procedure equals or exceeds that of single-stage treatment, even in an unselected cohort of chronically infected poor hosts. More rigorous scientific comparative studies are warranted prior to indiscriminate adoption of the single-stage treatment approach for PJI in THA.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Intraoperative Prophylactic Techniques for the Prevention of Periprosthetic Joint Infection in Primary Total Joint Arthroplasty: A Systematic Review and Meta-Analysis

Paper 051

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INTRODUCTION: The use of local intraoperative prophylactic techniques for the prevention of periprosthetic joint infection (PJI) in primary total joint arthroplasty (TJA) remains a topic of considerable controversy. The primary objective of this study is to provide a systematic review of the literature on infection rates after use of these prophylactic techniques in the setting of TJA.

METHODS: A comprehensive literature search was performed, following PRISMA guidelines, using MEDLINE/Pubmed, Embase, and the Cochrane Library. The Mantel-Haenszel method was used to estimate a common relative risk (RR) for the association between PJI and intraoperative prophylactic measures.

RESULTS: Nine eligible studies were included for qualitative synthesis. Of these, seven studies were eligible for quantitative synthesis with a total of 5331 patients. Prophylactic techniques included normal saline (NS) irrigation, dilute Betadine (povidone-iodine) irrigation, chlorhexidine irrigation, antibiotic irrigation, and topical vancomycin powder. The common RR for the association between PJI and treatment with chlorhexidine, dilute Betadine, and/or vancomycin powder compared to a combined NS control group was 2.79, 95% CI [1.62 – 4.81]. When NS irrigation was compared to dilute Betadine irrigation, the RR was 7.02, 95% CI [1.63 – 30.33]. Comparing NS irrigation with vancomycin powder, the RR was 2.83, 95% CI [1.08 – 7.38].

CONCLUSION: Although each of the 24 studied interventions appears to be safe and well tolerated, the efficacy of these techniques remains unclear. Further high-quality research is needed to support a scientifically validated and cost-effective protocol for the optimal prevention of PJI to reduce patient morbidity and mortality following primary total joint arthroplasty.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Antibiotic Elution and Mechanical Strength of PMMA Bone Cement Loaded With Borate Bioactive Glass

Paper 052

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INTRODUCTION: Local delivery of antibiotics using bone cement as the delivery vehicle is an established method of managing peri-prosthetic joint infections. Various fillers have been added to cement to increase antibiotic elution, but they often do so at the expense of strength. This study evaluated the effect of adding a borate bioactive glass, previously shown to promote bone formation, on vancomycin elution from PMMA bone cement.

METHODS: Five cement composites were made: three loaded with borate bioactive glass along with 0, 1, and 5 grams of vancomycin and two without any glass, but with 1 and 5 grams vancomycin to serve as controls. The specimens were soaked in PBS. Eluate of vancomycin was collected every 24 hours and analyzed by HPLC. Orthopedic-relevant mechanical properties of each composite were tested over time.

RESULTS: The addition of borate bioactive glass provided an increase in vancomycin release at Day 1 and an increase in sustained vancomycin release throughout the treatment period. An 87.6% and 21.1% increase in cumulative vancomycin release was seen for both 1g and 5g loading groups, respectively. Compressive strength of all composites remained above the weight-bearing threshold of 70 MPa throughout the duration of the study with the glass-containing composites showing comparable strength to their respective controls.

CONCLUSION: The incorporation of borate bioactive glass into commercial PMMA bone cement can significantly increase the elution of vancomycin. The mechanical strength of the cement-glass composites remained above 70 MPa even after soaking for 8 weeks, suggesting their suitability for orthopedic weight-bearing applications. Furthermore, the glass has been shown to have osteoconductive capabilities, increasing its application at the bone-cement-implant interface.

MAOA BREAKOUT SESSION #4
HIP AND KNEE ARTHROPLASTY INFECTION
Thursday, April 11, 2019

Combined D-Amino Acids with a Nanosolution with Magnetic Hyperthermia Successfully Disrupts Bacterial Biofilm – A Potential Treatment for Periprosthetic Joint Infection

Paper 053

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INTRODUCTION: Periprosthetic joint infection (PJI) is a devastating complication following total joint arthroplasty and accounts for up to 12% of revision hip arthroplasty and 22% of revision knee arthroplasty. Current PJI treatment protocols have proven difficult partially due to the protective impenetrable bacterial biofilm formation which may potentially lead to chronic infections. Treatment with D-amino acids (D-AA) and magnetic hyperthermia have previously been shown to disrupt existing biofilm. Is there an innovative method to disrupt an established biofilm for the treatment of PJI using a combination of such treatments?

METHODS: A novel combination of antibacterial D-AA and a thermoresponsive magnetic glycol-based nanocomposite with iron oxide nanoparticles (MagDAA gel) was formulated to work synergistically to eradicate Staphylococcus aureus biofilm. In vitro biofilm disruption was analyzed by crystal violet biofilm assay and cell viability was assessed using HeLa cell toxicity assay. This 5% glycol-based chitin solution (hydrogel) containing c-MNPs (cubic magnetic nanoparticles) was optimized to be in a liquid state when cool and gel state at body temperature for maximal targeting to infected tissue. D-AA composition and concentration were optimized against conventional antibiotics including vancomycin.

RESULTS: A combination of aromatic D-AAs was able to drastically disrupt biofilm, in contrast to vancomycin treatment which showed minimal S. aureus biofilm disruption at therapeutic doses. While the optimal concentration of D-AAs for biofilm disruption was toxic to mammalian cells with long-term exposure, 85% biofilm disruption was apparent early during treatment (2 hour incubation), prior to toxic levels of exposure. Treatment with the combined MagDAA gel solution alone did not disrupt biofilm, however treatment with a magnetic field to incubated MagDAA gel lead to complete biofilm eradication.

DISCUSSION AND CONCLUSION: This two-step process of pre-treatment with MagDAA gel followed by magnetic hyperthermia has shown complete disruption bacterial biofilm. Antibacterial MagDAA gel solution with magnetic hyperthermia demonstrates complete bacterial biofilm disruption and may potentially prove beneficial in the treatment challenges of PJI.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Sarcopenia is Associated with Increased Mortality and Complications Following Limb-Sparing Reconstruction for Sarcoma of the Extremities

Paper 054

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INTRODUCTION: Sarcopenia is a condition of decreased skeletal muscle mass and is associated with increased complications and mortality in carcinoma patients. Currently, there is a paucity of literature evaluating the impact of sarcopenia on operative outcomes in sarcoma patients. Sarcopenia may be a useful and objective screening tool to identify sarcoma patients at increased risk of postoperative complications and mortality.

METHODS: A retrospective, single-center review of 148 patients treated with surgical excision and limb reconstruction for sarcoma of the extremities from October 2010 to January 2017 was completed. Sarcopenia was defined as a Psoas Index (PI) <5.45 cm^2/m^2 for men and <3.85 cm^2/m^2 for women as measured from preoperative axial computed tomography scans. Logistic regression was used to assess the association between postoperative complications or mortality with patient demographics, PI, tumor grade, stage, and adjuvant therapy.

RESULTS: Primary sarcoma was diagnosed in 133 patients, recurrent sarcoma in 7, and metastatic sarcoma in 8. There were 101 cases of soft tissue tumors and 47 cases of primary bone tumors. Sarcopenia was present in 41 patients (27.7%) prior to treatment. Neoadjuvant therapies were given in 93 patients (62.8%) and adjuvant therapies were given in 74 patients (50%). Seventy-eight patients experienced complications (52.7%) and 20 patients died. Five major complications occurred including 1 myocardial infarction, 1 ruptured aortic aneurysm, 1 septic arthritis, 1 patient with hematoma evacuation postoperative day 1 and subsequent soft tissue coverage procedure, and 1 patient requiring multiple coverage procedures with plastic surgery. Presence of sarcopenia (OR 6.6, ref=no sarcopenia, p=0.0002) and metastatic disease (OR 18.9, ref=primary tumor, p=0.0004) were associated with a significantly greater odds of mortality. Patients with sarcopenia compared to patients without had 2.5 times greater odds of postoperative complications (p=0.0205). Age was the strongest predictor of wound complications, with a 3% increase in odds for wound complication for each 1 year increase in age (OR 1.03).

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
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Skin Fiducial Markers Enable Accurate Computerized Navigation Resection of Simulated Soft Tissue Tumors: A Static Cadaveric Model Pilot Study

Paper 055

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INTRODUCTION: It is estimated that in 2018 there will be 13,040 newly diagnosed soft tissue sarcomas and 5,150 deaths. Accurate localization and correlation of surrounding anatomy is essential for soft tissue tumor surgery success. Computerized navigation has demonstrated to be helpful in multiple areas of orthopedics such as spinal pedicle screw placement, joint replacements, and bone tumor resections. The purpose of this in vitro pilot study using cadaveric specimens was to evaluate the agreement between planned and resected margins of simulated soft tissue tumors (SSTT) using skin fiducial markers for navigation registration. A skin fiducial is an adhesive and noninvasive marker that is placed on the skin surface and easy to identify on MRI and CT scans. Navigation registration is the process by which preoperative imaging is linked to the anatomy of the operative site. We propose that skin fiducials can be used for navigation registration to safely localize a SSTT and aid in achieving accurate surgical resection margins.

MATERIALS AND METHODS: Multiplanar skin fiducial markers were applied prior to magnetic resonance imaging of cadaveric lower extremity specimens with implanted SSTT. A navigation pointer was used for registration and to guide resection of SSTT with approximately 10 mm planned margins. Digital calipers were used to measure resection margins. Kolmogorov-Smirnov tests were performed to confirm normality of group differences. A one sample t-test was used to determine measurement group differences ($P \leq 0.05$). Bland-Altman analysis and histogram plots compared planned and resected margins.

RESULTS: A total of 98 resection margins were measured from 26 SSTT. The planned margin mean was 10.0 mm (95% CI = 9.8 – 10.2 mm) and the resected margin mean was 11.5 mm (95% CI = 11.0 – 12.1 mm). One sample t-test results identified a 0.75 mm, 95% CI = 0.5 – 0.99 mm difference ($P < 0.001$). 94.9% (93/98) of resections fell within two standard deviations of the mean measurement difference suggesting good agreement.

CONCLUSIONS: Skin fiducial marker use for computerized navigation registration shows promising results when comparing planned and resected margins of SSTT in cadaveric specimens. With further research, skin fiducial marker use may become an effective, non-invasive method for localizing and aiding in soft tissue tumor resection.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Dual Mobility Components Cemented into an Acetabular Reconstructive Cage for Large Osseous Defects in the Setting of Periacetabular Metastatic Disease

Paper 056

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OBJECTIVE: Large osseous acetabular defects secondary to periacetabular metastatic disease frequently require advanced methods of acetabular reinforcement and reconstruction. Various techniques of acetabular reconstruction along with numerous constructs to increase stability have been described, but no consensus for the optimal management of these osseous defects has been reached so far. We present our technique and patient outcomes for acetabular reconstruction by cementing a dual mobility bearing into an acetabular cage construct.

METHODS: We reviewed 152 total hip arthroplasties (THA) and identified 18 patients with periacetabular metastatic disease and large osseous defects who required complex acetabular reconstruction utilizing a modular dual mobility cup cemented into an acetabular reconstructive cage. The following outcomes were evaluated: pain relief, functional improvement, and postoperative complications.

RESULTS: Mean follow-up was 3 years (range, 2-5.5 years), with 11 (61%) of the 18 patients identified being alive for two-year postoperative follow-up. Patients reported a significant improvement in both pain and functional outcomes. There were no dislocations reported or signs of loosening detected on radiographs. Two patients developed postoperative infections requiring irrigation and debridement with retention of components. One patient went on to require a hemipelvectomy 16 months following acetabular cage reconstruction due to recurrence of metastatic renal cell carcinoma.

CONCLUSIONS: Cementing a dual mobility bearing into an acetabular cage construct provides a highly stable and durable reconstruction option for patients with periacetabular metastatic disease and large osseous defects. Patients are able to return to immediate full weight-bearing with significant improvement in both function and pain.

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Thirty-Day Morbidity and Mortality in Surgical Management of Primary Bone and Soft Tissue Sarcomas – An ACS-NSQIP Analysis

Paper 057

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BACKGROUND: Primary bone and soft tissue sarcomas are rare, and identifying a large cohort of patients for analysis is challenging. The American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) prospectively collects perioperative data from more than 600 hospitals, making it ideal for studying rare procedures. To our knowledge, the ACS-NSQIP has not been used to evaluate outcomes after primary sarcoma surgery.

PURPOSE: This study uses a large national registry to characterize postoperative complications, readmissions, reoperations, and mortality after surgical management of primary bone and soft tissue sarcomas of the upper and lower extremities.

PATIENTS AND METHODS: We performed a retrospective review of patients in ACS-NSQIP who underwent surgery for primary bone or soft tissue sarcoma between 2006 and 2016. Patients were identified using diagnosis codes related to primary bone or soft tissue sarcomas of the upper limb, shoulder girdle, lower limb, and pelvis. CPT codes, OR time, and anesthesia technique were screened to exclude biopsies and superficial, uncomplicated tumor resections. Emergency surgeries and patients with metastatic disease or preoperative sepsis were excluded.

RESULTS: 1126 patients were identified. 207 (18.4%) patients had disease of the upper extremity or shoulder girdle, and 919 (81.6%) had disease of the lower extremity or pelvis. Intraoperative or postoperative bleeding requiring transfusion was the most frequent complication, with an incidence of 19.4%. Surgical site infections (SSIs) were the second most frequent complication, occurring in 9.9% of patients. 44.6% of SSIs were classified as superficial, 39.3% were deep, and 16.1% were organ space SSIs. The 30-day unplanned readmission and reoperation rates were 9.9% and 9.0%, respectively. SSIs accounted for 40.5% of readmissions and 32.6% of reoperations. Wound disruption with delayed healing was the second most frequently cited diagnosis for unplanned readmission (21.4%) and reoperation (27.9%). Residual tumor accounted for 14.0% of unplanned reoperations. The 30-day mortality rate was relatively low at 0.4%.

CONCLUSION: Surgical management of primary bone and soft tissue sarcoma carries substantial risks, with bleeding, SSI, and wound disruption contributing to unplanned readmission and reoperation. Although this study is limited by lack of granularity in oncology-specific variables, the sample size is an asset in our analysis. Further analysis is needed to identify modifiable risk factors associated with higher complication rates.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

The Resident's Transition into Orthopedics: Using a New Milestone Strategy to Determine Competency Deficits that can be Used to Target Proficiency Training

Paper 058

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BACKGROUND: The ACGME launched the Outcome Project in 2001, implementing competency-based medical education in the U.S. Specialty-specific Milestones were also introduced by the ACGME, with each Milestone indicating the performance level at which the residents are expected to perform. The goal of this study is to improve on the Standard Milestones by designing a self-study program to identify proficiency and competency deficiencies within the Orthopedic Residency. We hypothesized that our PGY1 Class (Test Group) would demonstrate adequate proficiency and competency when tested using 40 simulation-based exercises during their transition into orthopedics through the completion of PGY2. Data was collected to see if the Test Group performed comparably to a similar resident program (Control Group).

METHODS: A prospective, longitudinal, double-blind study was conducted on a Test Group (n=4) and a Control Group (n=4) from a comparable program. Residents were evaluated during four time periods (blocks) throughout PGY1 and PGY2. Multiple validated scoring systems were used to evaluate the residents during each simulation-based exercise, including the Global Rating Scale, OCAT, and O-Score. A non-validated evaluation customized to the exercise ("Flashpoint Milestone Evaluation") was also used. An evaluation score of 80% is considered proficient, and 60% is considered competent. Any score < 60% is considered a competence deficiency and is defined with potential patient safety issues in mind.

RESULTS: Across both groups, 39.05% of the residents' scores reached proficiency on the validated measures, 40.51% reached competency, and 20.44% of the scores were below competent. An independent samples t-test was conducted for the total number of scores (N=552) and indicated that there was not a significant difference between the Test Group and Control Group. Significant differences were found between the Test and Control Groups at individual stations within each block ($p<0.05$).

CONCLUSION: The residents in both the Test and Control Groups did not reach competency at every simulation-based exercise, indicating a potential patient safety issue. This implies that there may be discrepancies between what the faculty expects the residents to be able to do and what the residents can actually do at certain points in their residency. The results suggest that additional proficiency and simulation training may be recommended in addition to traditional apprenticeship experience. By looking more closely at the stations in which there was a significant difference between the Test and Control Groups, we were able to gain insight into the strengths and weaknesses of the current curriculum.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Implementation of a One Way, Online Video Interview as a Part of the Orthopedic Surgery Residency Application Process: Logistics, Results, and Benefits

Paper 059

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INTRODUCTION: Orthopedic residency matching is becoming ever more competitive leading to more applications submitted and greater demand on residency programs for efficient review. This institution investigated the use of one way video interviewing (OWVI) to efficiently review applicants. The primary goal of this investigation was to examine how one-way video interviews can be utilized as a screening tool to and to determine if OWVI scores correlate with traditional application metrics.

METHODS: This was a retrospective review of the 2017-2018 residency application process at a single institution. A subset of applicants was invited to participate in one way video interviews based on an initial scoring of applications employing standardized criteria. OWVI involves the candidate recording their answers to pre-selected questions from the interviewer, which can then be reviewed at a later time. These videos were scored on a 1-5 scale by two reviewers, and the final group of in-person applicants was selected based these scores. To identify associations between one way interview and traditional interview metrics, students completing in-person interviews were dichotomized into groups based on their OWVI score (5 vs. ≤4) and traditional application metrics were compared using student t test or Mann-Whitney test, as applicable.

RESULTS: 170 of 741 total applications submitted were offered OWVI based on initial screening of their application. The one way video interview was completed by 163 (96%) applicants, and the top 70 performers were selected for in person interview. This group of 70 consisted of 28 (43%) applicants who were given a OWVI score of 5, 33 (51%) who scored a 4, and 4 (4%) who scored a 3 on the OWVI. There were no significant differences between those applicants who received a "5" versus "≤4" in the following traditional application metrics: Quantitative Composite Scoring Tool score, modified Quantitative Composite Scoring tool score, Age, USMLE Step 1, USMLE Step 2, transcript score average rank score, or position on rank list.

DISCUSSION AND CONCLUSIONS: The major findings of this study were that one way video interviews can be fit within an already time- and resource-intense residency review process and there were no associations of one way video interview scoring with traditional application metrics. This indicates one way video interviews may provide additional information not otherwise accessible from the applicants' portfolio, potentially allowing programs to narrow their pool of applicants to those most likely to be "good fits" for the program.

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
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The Measurement of Orthopedic Surgeon Sleep and Burnout Using a Validated Wearable Device

Paper 060

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INTRODUCTION: Orthopedic surgeons experience partial sleep deprivation due to long work hours or call schedules that can potentially lead to burnout. The purpose was to assess the quantity and quality of orthopedic surgeon sleep and determine which factors are associated and correlated with decreased sleep and increased burnout.

METHODS: Orthopedic surgery residents (n=14) and attending surgeons (n=12) were prospectively enrolled and provided with a validated wearable device. Data was measured continuously to determine sleep quantity (total hours of sleep) and quality (sleep disturbances, sleep latency, sleep efficiency, REM sleep, deep sleep, and light sleep). Sleep deprivation was defined as getting less than 7 hours of sleep per day. Participants completed the Maslach Burnout Inventory (MBI). Bivariate correlations were determined using Spearman's rank correlation. Multivariate linear regression models were constructed to determine the effect of independent variables (age, attending surgeon, resident surgeon, postgraduate year level, gender, number of overnight calls, and total hours worked) on orthopedic surgeon burnout and sleep quantity and quality.

RESULTS: Twenty-one (12 residents and 9 attending surgeons, 15 males and 6 females) of the 26 (80.8%) enrolled subjects completed the four-week duration of the study. Orthopedic surgeons obtained 6.5 ± 0.8 hours of sleep per night (17.7% REM sleep, 19.4% deep sleep, 62.6% light sleep, 4.5 ± 1.1 minutes of sleep latency, and 89.9% sleep efficiency). Fourteen (67.7%) of the 21 orthopedic surgeons were sleep deprived. The total hours worked had a strong association ($p=0.001$) and a moderate negative correlation ($r=-0.550$, $p=0.010$) with total hours of sleep. Thirteen (61.9%) orthopedic surgeons (58.3% of residents and 66.7% of attending surgeons) experienced or were at risk for burnout. The number of overnight calls was significantly correlated with increased burnout ($r=0.435$, $p=0.049$). Female gender was also significantly associated ($p=0.041$) and correlated ($r=0.558$, $p=0.009$) with burnout. There was no significant association or correlation between total hours worked or sleep quantity and quality with orthopedic surgeon burnout.

DISCUSSION AND CONCLUSION: Orthopedic surgeons demonstrate a high rate of sleep deprivation with poor sleep quantity and quality that is significantly worse than the general population. Increased work hours are significantly associated and correlated with decreased hours of sleep. There is a high rate of burnout or risk of burnout among orthopaedic surgeons. The number of overnight calls and female gender is significantly correlated and associated with increased orthopaedic surgeon burnout.

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Is Grit the New Fit? -- Assessing Non-Cognitive Variables in Orthopedic Surgery Trainees

Paper 061

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BACKGROUND: Surgical resident attrition and burnout are topics of concern which may negatively impact education, economics, and patient outcomes. The field of Orthopedic Surgery is continuously looking for ways to optimize resident selection based on non-cognitive factors. Additionally, there is an added interest in utilizing these variables to identify at-risk residents and guide appropriate support and/or mentoring when needed. The purpose of this study was to determine overall levels of grit, self-control, and conscientiousness among orthopedic surgery residents, to compare levels of grit across orthopedic resident training levels, and to identify common applicant variables which may correlate with these valuable non-cognitive attributes.

METHODS: Grit, ambition, consistency of interest, perseverance of effort, self-control, and conscientiousness were assessed in orthopedic surgery residents and fellows using previously validated assessment tools. Additionally, resident training level and respondent demographic information were collected and analyzed in an attempt to identify factors that correlate with these variables.

RESULTS: 431 (431 out of 621, 69.4%) respondents completed the assessment. Orthopedic residents demonstrated high baseline levels of grit (4.0 of 5.0), self-control (3.8 of 5.0), and conscientiousness (4.4 of 5.0). The grit score of 4.0 places them in the 65th percentile of the general adult population. There were no significant differences in scores between training levels of orthopedic residents and fellows. Significantly higher self-control scores were seen in female trainees ($p=0.042$), inductees of Alpha Omega Alpha (AOA) honor society ($p=0.008$), and those with higher numbers of publications ($p=0.037$). Orthopedic trainees with more publications scored higher in the ambition sub-score (0 publications: 4.0 ± 0.7); 1-3 publications: 4.2 ± 0.5, 3 or more publications: 4.3 ± 0.5; $p<0.001$).

CONCLUSION: Orthopedic surgery residents demonstrated high levels of grit compared to the general population. Key objective variables utilized in the residency application process including AOA status and volume of research publications were predictive of these qualities.

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

How Safe is "Safe"? Radiation Exposure from Intraoperative CT in Traditionally Safe Operating Room Zones

Paper 062

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INTRODUCTION: Radiation exposure is an occupational hazard for all operating room staff. The NCRP recommends a maximum occupational whole-body radiation exposure of 5,000 mrem/year, with lower limits of 100 mrem/year for the general public and a 100 mrem prenatal total for pregnant women. Intraoperative computed tomography (CT) has many applications within orthopedic surgery. During a scan, safety measures may be taken to decrease exposure, including wearing lead aprons and increasing the distance from the source by moving to the substerile room or to the outside of the operating room. The purpose of this study is to quantify the amount of radiation exposure that occurs in areas of the operating room that are generally believed to be safe.

METHODS: The experiment was conducted in a standard operating room at a Level 1 tertiary referral center. An O-arm surgical imaging system was used, and a phantom comprised of a Lucite block simulated a 70 kg body. Inovision 451P-RYR radiation survey instruments were used to measure exposure rate and integrated dose per scan. Six locations were measured, including the position of the anesthesiologist (80 cm), the position of the radiation technologist (180 cm), the substerile room (500 cm), the operating room door (600 cm), the next-room nursing station (960 cm), and the hallway (1000 cm).

RESULTS: Mean exposure rate was highest at the anesthesiologist (2200 mrem/hr), followed by the door (25.33 mrem/hr), the technologist (21.0 mrem/hr), the substerile room (8.2 mrem/hr), the hallway (2.633 mrem/hr), and then the next-room nursing station (1.557 mrem/hr). The mean integrated doses per scan were 15.03 mrem for the anesthesiologist, 0.170 mrem for the technologist, 0.136 mrem at the door, 0.033 mrem in the substerile room, 0.014 mrem in the hallway, and 0.005 mrem at the next-door nursing station.

DISCUSSION/CONCLUSION: Reaching the annual non-occupational maximum would take 6 scans at the anesthesiologist's position, 588 scans at the technologist's position, 735 scans at the door, 3030 scans in the substerile room, 7142 scans in the hallway, and 20000 scans in the adjacent operating room. Exposure at the operating room door is equivalent to 1.7% that of a chest radiograph. Though there is measurable radiation exposure outside of the operating room, the magnitude is low enough to be clinically insignificant for the one-time accidental exposure. This study provides data that reinforces the need to wear protective gear or leave the room during the use of intraoperative CT, but unsuspecting next-door operating room staff need not worry about uninformed exposure.

MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

Optimization of Orthopedic Surgical Instrument Trays: Lean Principles to Reduce Fixed Operating Room Expenses

Paper 063

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INTRODUCTION: Optimization of surgical instrument trays improves efficiency and reduces cost. The purpose of this study was to assess the impact of optimizing orthopedic instrument trays at a tertiary medical center.

METHODS: Twenty-three independent orthopedic surgical instrument trays at a single hospital were reviewed from June 2017 to May 2018. Using lean methodology, surgeons agreed upon the fewest number of instruments needed for each of the procedure trays during two rounds of tray optimization. Instrument usage counts and cleaning times, room turnover times, tray weight, holes in tray wrapping, wet trays, and time invested to optimize each tray was tracked. Cost savings were calculated. Univariate regression analysis using two-tailed t test was used to determine statistical significance of changes made, when possible, with $p<0.05$ considered significant.

RESULTS: The mean instrument usage before and after lean optimization was 23.4% and 54.2%. Through the process of lean, 433 of 792 instruments (55%) were removed from 11 unique instrument trays (102 total trays), resulting in a reduction of 3,520 instruments. The total weight reduction was 574.3 pounds (22%) with a range of 2.1-16.2 pounds per tray. The number of trays with wrapping holes decreased from 13 to 1. Room turnover time decreased from 39.3 minutes to 38.4 minutes. The process of examining and removing instruments from trays took an average of 7 minutes 35 seconds per tray. The calculated total annual savings was $270,976 with a one-time savings of $500,554 from the cost of removed instruments. There were no requests by surgeons for removed instruments to be returned after final optimization.

CONCLUSIONS: Optimization of surgical trays on a department-wide scale can be achieved in a rapid, efficient fashion. In addition to substantial cost savings, tray optimization decreases the tray weights and cleaning times and may reduce the number of trays with wrapping holes and turnover times. Using lean methods to remove non-valued instruments improves efficiency and reduces hospital cost while encouraging surgeon and staff participation through continuous process improvement.

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MAOA BREAKOUT SESSION #5
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Long-Term Sustainability of a Quality Initiative Program on Transfusion Rates in Total Joint Arthroplasty; A Quality Initiative Follow-Up Study

Paper 064

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PURPOSE: Total joint replacement registries are increasingly used to identify areas for cost and quality improvement. One area of heightened focus is postoperative transfusions in hip and knee arthroplasty. There are marked variations in transfusion rates among institutions. We previously demonstrated that implementation of an educational program aimed to increase awareness of the American Association of Blood Banks' (AABB) transfusion guidelines led to an immediate decrease in transfusion rates. However, little is known about how these efforts endure over time. We now report on the long-term success and sustainability of implementing an educational program to increase awareness of transfusion guidelines at a single institution over a 6-year period.

METHODS: As part of the Michigan Arthroplasty Collaborative Quality Initiative (MARQI), our institution started an education program using AABB transfusion guidelines to improve variances in postoperative transfusions. We reviewed MARQUI data from 2012 through 2017 for all patients undergoing primary hip and knee arthroplasty at our institution. Data included gender, age, preoperative hemoglobin level, lowest postoperative hemoglobin level during admission, transfusion status, and number of units transfused. We categorized the data into 6 distinct time periods; 2012 to the education event in October of 2013, the previously published immediate post-education period from November 2013 to May 2014, the remainder of 2014, all of 2015, all of 2016, and all of 2017.

RESULTS: We identified 6645 primary hip and knee arthroplasty patients, 1707 pre- and 4938 post-quality initiative patients, respectively. There was a significant decrease in transfusions in the immediate post-education group (6.01%; $p<0.001$), 2014 group (4.36%, $p<0.001$), 2015 group (2.22%, $p<0.001$), 2016 group (2.85%, $p<0.001$), and 2017 group (1.12%, $p<0.001$) when compared to the pre-education group (14.82%). Subgroup analysis of only TKA showed reduction of post-education transfusions in each group: immediate post-education (3.58%, $p<0.001$), 2014 (2.12%, $p<0.001$), 2015 (0.59%, $p<0.001$), 2016 (1.78%, $p<0.001$), and 2017 (0.47%, $p<0.001$). Subgroup analysis of THA revealed a significant reduction in transfusions of the 2014 group (9.75%, $p<0.001$), 2015 (5.5%, $p<0.001$), 2016 (4.90%, $p<0.001$), and 2017 (2.79%, $p<0.001$) when compared to the pre-education cohort (22.54%). Analysis of pre- and postoperative hemoglobin among all TKA and THA patients demonstrated a decreased drop in hemoglobin in the immediate post-education group (3.49, $p=0.851$), 2014 (3.31, $p<0.001$), 2015 (3.04, $p<0.001$), 2016 (2.96, $p<0.001$), and 2017 (2.77, $p<0.001$) when compared to pre-education changes (3.59), which may reflect the initiation of tranexamic acid.

CONCLUSION: Use of a quality initiative is an effective means of identifying opportunities for cost and quality improvement. There is an ability to sustain an effective transfusion protocol via education of multiple years with continued improvement.

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MAOA BREAKOUT SESSION #5
Tumor/Education/Practice Management
Thursday, April 11, 2019

MAOA SECOND PLENARY SESSION
April 12, 2019

Prior Hip or Knee PJI in Another Joint Increases Risk of PJI after Primary TKA by 3 Fold: A Matched Control Study

Paper 066

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

INTRODUCTION: There is no literature regarding the risk of a patient developing PJI after primary TKA if the patient has previously experienced PJI of a TKA or THA in another joint. The goal of this study was to compare the risk of PJI of primary TKA in this patient population compared to matched controls.

METHODS: We retrospectively reviewed 95 patients (102 primary TKAs) from 2000–2014 with a history of a TKA or THA PJI in another joint. Mean age was 69 years; mean BMI was 36 kg/m^2. 27% high-risk patients were on chronic antibiotic suppression. Mean follow-up was 6 years. We 1:3 matched (to age, sex, BMI, and surgical year) these to 306 primary TKAs performed in patients with a THA or TKA of another joint without a subsequent PJI. Competing risk with death was used for statistical analysis. Multivariate analysis was utilized to evaluate risk factors for PJI in the study cohort.

RESULTS: The cumulative incidence of PJI in the study cohort (6.1%) was significantly higher than the matched cohort (2.6%) at 10 years (HR=3.3, p=0.02). Host grade in the study group was not a significant risk factor for PJI. Patients on chronic suppression had a higher rate of PJI (HR=15, p=0.002), with 6 of 7 patients developing a PJI being on chronic suppression. The new infecting microorganism was the same as the previous in only 2 of 7 patients.

CONCLUSION: In this matched cohort study, patients undergoing a clean primary TKA with a history of a TKA or THA PJI in another joint had a 3-fold higher risk of PJI compared to matched controls with a 10-year cumulative incidence of 6.1%. The risk of PJI was 15-fold higher in patients on chronic suppression; further investigation into reasons for this and mitigation strategies is recommended.

SUMMARY: Patients with a history of a THA or TKA PJI in another joint undergoing a clean primary TKA have a 3.3-fold higher risk of PJI when compared to matched controls.

MAOA SECOND PLENARY SESSION
April 12, 2019

Increased PJI Risk Following Primary TKA and THA with Alternatives to Cefazolin: The Value of Allergy Testing for Antibiotic Prophylaxis

Paper 067

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

INTRODUCTION: First generation cephalosporins remain the gold standard perioperative antibiotic for total hip and knee arthroplasty (THA, TKA). However, some patients have reported allergies to antibiotics that result in changes to perioperative antibiotic coverage. The aims of this study were to characterize antibiotic choices for perioperative TKA and THA prophylaxis, assess antibiotic allergy testing efficacy, and determine rates of periprosthetic joint infection (PJI) based on perioperative antibiotic regimen.

METHODS: We evaluated all patients undergoing primary TKA or THA at a single academic institution from January 2004-May 2017, yielding 29,695 patients with 3,411 patients (11.5%) undergoing preoperative allergy testing. A series of institutional databases were combined to identify allergy consultation outcomes, perioperative antibiotic regimen, and infection-free survivorship until final follow-up.

RESULTS: Among allergy-tested patients, 3,310 patients (97.0%) were cleared to use cephalosporins. For the entire cohort, 28,174 patients (94.9%) received cefazolin and 1,521 patients (5.1%) received non-cefazolin antibiotics. Infection-free survivorship was significantly higher among patients receiving cefazolin compared to non-cefazolin antibiotics with 99.40% vs. 99.34% at 1 month, 99.11% vs. 98.55% at 2 months, 98.83% vs. 98.22% at 1 year, and 98.15% vs. 96.96% at 10 years ($p<0.001$). The number needed to treat with cefazolin to prevent 1 PJI was 164 patients at 1 year and 84 patients at 10 years. Therefore, potentially 6,098 PJIs could be prevented by 1 year and 11,905 by 10 years in a cohort of 1,000,000 primary TKA and THA patients.

CONCLUSIONS: PJI rates are significantly higher when non-cefazolin antibiotics are used for TKA and THA, underscoring the positive impact of preoperative antibiotic allergy testing to increase cefazolin usage. This work highlights the positive impact of a formal preoperative antibiotic allergy testing program to increase cefazolin usage. Also, surgeons may consider using cefazolin as a dual agent in the case of known MRSA colonization, whenever possible for PJI prophylaxis during TKA and THA.

MAOA SECOND PLENARY SESSION
April 12, 2019

Large Opioid Prescriptions are Unnecessary After Total Joint Arthroplasty: A Randomized Controlled Trial

Paper 068

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INTRODUCTION: Opioids are an important component of multimodal analgesia, but improper utilization places patients at risk for overdose and addiction. The purpose of this randomized controlled trial is to determine whether the quantity of opioid pills prescribed at discharge is associated with the amount of opioids consumed or unused by patients after total hip (THA) and knee (TKA) arthroplasty.

METHODS: 286 Opioid naïve patients undergoing THA or TKA were randomized to receive a prescription for either 30 or 90 5mg oxycodone immediate release (OxyIR) tablets at discharge. All patients received acetaminophen, meloxicam, tramadol, and gabapentin perioperatively. Daily opioid consumption (morphine equivalent dose, MED), number of unused OxyIR pills, and pain scores were calculated for 30 days after discharge with a patient-completed medication diary. Number of OxyIR refills and total MED received were recorded for 90 days postoperatively. Power analysis determined that 141 patients per group were necessary to detect a 25% reduction in means in opiate consumption between groups. Statistical analysis involved t-test, rank sum, and chi-squared tests with alpha=0.05.

RESULTS: 161 Patients were randomized to receive 30 tablets and 143 to receive 90. In the first 30 days after discharge, the median number of unused OxyIR tablets was 15 in the 30 group versus 73 in the 90 group ($p<0.0001$). Within 90 days of discharge, 26.7% of the 30 group and 10.5% of the 90 group requested a refill ($p<0.001$), leading to a mean of 777.1 MED versus 1089.7 prescribed ($p<0.0001$). There was no difference between groups in mean MED consumed and pain scores within the first 30 days. Baseline demographics and outcome scores were similar between groups suggesting appropriate randomization.

CONCLUSION: Prescribing a smaller number of opioids at the time of surgery is associated with equivalent pain scores and opioid consumption, yet a significant reduction in unused narcotics.

MAOA SECOND PLENARY SESSION
April 12, 2019

Walking Greater Than Five Feet After Hip Fracture Surgery Decreases the Risk of Complications, Including Death

Paper 069

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INTRODUCTION: Hip fractures in the elderly are associated with significant and early morbidity and mortality. Progression of ambulation in the immediate postoperative period has not been well documented in the literature, and its influence on postoperative outcomes has not been adequately described. We hypothesized that patients who mobilize more quickly after surgical intervention of hip fractures will demonstrate fewer perioperative complications.

METHODS: A retrospective review was performed on all patients with proximal femur or hip fractures from October 2015 through September 2017 at our Level 1 trauma center. Inclusion criteria were patients at least 65 years old (y/o); with a low energy mechanism of injury (MOI); who underwent operative treatment of femoral neck, intertrochanteric, or subtrochanteric fractures. Patients younger than 65 y/o, had a high energy MOI, or who underwent nonoperative treatment were excluded. Inpatient physical therapy notes were used to track how soon and how far patients were able to ambulate postoperatively. Patient medical records were reviewed for 90-day postoperative complications.

RESULTS: 166 patients were included (N=121 female). There were 65 femoral neck, 90 intertrochanteric, and 11 subtrochanteric fractures. Fixation included 102 cephalomedullary nails, 49 hemiarthroplasties, 7 closed reduction and percutaneous screw fixations, 5 total hip replacements, and 3 sliding hip screws. Approximately half (N=81 patients) of the population had at least one postoperative complication. Walking greater than five feet by 72 hours postoperative (N=100 patients) was predictive of decreased morbidity (30.0% complication rate, compared to 77.3% for patients with five or less feet of ambulation, p=0.0001). Furthermore, walking less than five feet by 72 hours postoperative increased the likelihood of myocardial infarction (p=0.003), pneumonia (p=0.009), intensive care unit admission (p=0.0001), and death or hospice transfer (p=0.0008).

DISCUSSION: Our results suggest that the ability to ambulate a distance of greater than 5 feet within 72 hours postoperatively is associated with a significantly lower short-term postoperative complication rate. To our knowledge, this study is the first to quantify the relationship between postoperative hip fracture mobilization and perioperative morbidity and mortality.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Effects of Aging on Walking Ankle Kinematics in the Sagittal Plane in an Asymptomatic Population

Paper 070

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INTRODUCTION: Total Ankle Replacement (TAR) and Ankle Arthrodesis (AA) are standard treatments for end-stage ankle osteoarthritis. One of the most noted outcomes of either procedure is the effect on ankle sagittal plane range of motion (ROM), which is central to activities such as walking. The overall treatment goal is restoration of painless motion in a functional arc to normalize gait. However, functional restoration may be age-dependent, in that the normal aging process affects gait and may shift the definition of "normal" ROM. There are no age-specific norms for ankle sagittal plane ROM in asymptomatic populations, such that functional targets are not well established with respect to age. This study attempts to ameliorate this deficiency and define the effects of aging on ankle ROM.

METHODS: A retrospective analysis of prospectively collected data from the Fels Longitudunal Study database was performed. Subjects age 30 or older with a recorded normal walking gait analysis were included. Exclusion criteria included significant medical comorbidities, mechanical gait abnormalities, diabetes, any previous lower extremity surgery and/or lower extremity pain. Gait kinetics and kinematics were measured and recorded for each subject using three-dimensional quantitative gait analysis. Stepwise multiple regression analysis was then performed using the data to analyze the effects of age, gender, BMI, and physical activity level on ankle ROM during normal walking.

RESULTS: The sample included 570 healthy subjects, ages 30-88 years. Older age was associated with significantly lower ROM (β=-2.58, $P<0.01$). Female sex (β=1.19, $P<0.01$) and higher BMI (β=1.57, $P=0.02$) were significantly associated with greater ankle ROM. Physical activity level had no significant effect ($P=0.14$). The overall effect size of aging on ankle ROM was relatively small (loss of 0.10° per year), but greater than the effect size of sex or BMI. Older age was also associated with reduced gait speed and relative stride length (for each, $P<0.01$).

CONCLUSION: While age is related to a decrease in ankle ROM over time, the effect size of this is small. Potential ankle ROM decreases with age are likely mitigated by a concomitant age-related decrease in gait speed and relative stride length. This study identifies the effect of aging on walking ankle ROM. These relationships can be used to calculate age-specific and patient-specific functional targets, aid in the evaluation and treatment of patients with end-stage ankle arthritis, and may be of importance when designing implants or medical devices that provide an appropriate restoration of normal sagittal plane motion.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Revisiting the Prevalence of Associated Co-Pathologies in Chronic Lateral Ankle Instability: Are There Any Predictors of Outcome?

Paper 071

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BACKGROUND: The outcomes of surgical management for chronic lateral ankle instability are mostly favorable; however, certain co-pathologies may be associated with unfavorable outcomes. Co-pathologies are very common in chronic lateral ankle instability. The effect of these co-pathologies on postoperative outcomes is understudied and controversial in the literature. In addition, the few studies in the literature have focused on intra-articular co-pathologies. This is the first study addressing the potential impact of associated extra-articular co-pathologies on postoperative outcomes. The purpose of this study is to examine the frequency and impact of selected co-pathologies on outcomes after chronic lateral ankle instability repair.

METHODS: After Institutional Review Board approval, we retrospectively reviewed 382 cases of lateral ankle ligament repair/reconstruction between June 2006 and November 2016. Inclusion criteria included anatomical (Brostrom or Brostrom-Gould) ligament repair and first time ligament repair. Exclusion criteria included: age less than 18, history of gross traumatic event, concurrent or prior subtalar or triple arthrodesis or total ankle replacements, less than 3 months follow-up, and cases without either radiology or intraoperative report. All selected patient charts and radiograph reports were examined for the presence of any associated foot and ankle pathologies as well as clinical course. The Foot Functionality Index survey was administered via email. The effect of co-pathologies on re-operation rate and Foot Functionality Index scores were examined using binary logistic regression and the Student's t test respectively.

RESULTS: We included a total of 99 cases (mean age = 39.89 ± 14.24 years, mean body mass index = 31.74 ± 7.13 kg/m^2). There were 27 males and 72 females. Mean follow-up was 12.5 (range, 3-65) months. Re-operation rate was 13/99, (13.1%). Co-pathologies included: peroneal pathology (75/99, 75.8%), ankle impingement (40/99, 40.4%), low-lying muscle belly of peroneus brevis (36/99, 36.4%), and osteochondral lesion of talus (17/99, 17.2%). There were 29 respondents to the Foot Functionality Index survey. Mean total postoperative Foot Functionality Index score (23.69 ± 20.54) was not affected by any associated co-pathology ($p > .05$).

CONCLUSION: The presence of peroneal pathology, ankle impingement, low muscle belly of the peroneus brevis, or talar osteochondral lesion did not influence re-operation rates or postoperative Foot Functionality Index scores in patients with chronic lateral ankle instability.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Early vs. Delayed Mobilization Postoperative Protocols for Primary Lateral Ankle Ligament Repair: A Systematic Review

Paper 072

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BACKGROUND: Lateral ankle instability represents a common orthopedic diagnosis. Nonoperative treatment through physical therapy provides satisfactory results in the majority of patients. Some patients, however, experience persistent chronic lateral ankle instability despite appropriate nonoperative treatment. These patients may require stabilization which can include primary lateral ligament repair to restore ankle stability. Optimal postoperative rehabilitation for surgeons varies in how they balance protection of surgical repair with immobilization with the need for ankle joint mobilization to restore range of motion. The aim of this review is to provide insight into early and delayed mobilization postoperative protocols in patients undergoing primary lateral ankle ligament repairs to determine if an optimal evidence-based postoperative rehabilitation protocol exists in the literature.

METHODS: Following the PRIMSA criteria, a systematic literature review using the PubMed/Ovid Medline database was performed (10/11/1947-10/16/2017). Manuscripts that were duplicates, non-lateral ligament repair, biomechanical and non-English language were excluded. Postoperative protocols were reviewed and divided into two categories; early mobilization (within 3 weeks of surgery) and delayed mobilization (after 4 weeks of surgery). Return to sport, functional outcome scores (AOFAS, Karlsson scores), and total complications of both populations were recorded and statistically analyzed.

RESULTS: 27 out of 1,580 studies met the criteria for the final analysis, representing 1,424 patients undergoing primary lateral ligament repair with at least a 1-year follow-up. Average patient age in this study was 27.9 years. 233 patients were categorized in the early mobilization group (EM) vs. 1,191 patients in the delayed mobilization (DM). EM group had a complication rate of 5.57% (13/233) vs. 4.11% (49/1191) in the DM group. Skin wound complication rate was 1.17% (4/233) vs. 1.30% (15/1191) for EM and DM, respectively. Re-operation rate was 0 vs. 0.42% (5/1191) for EM vs. DM, respectively. Six studies reported return to sport, with patients in the EM group returning to sport on average of 14.5 weeks (n=52) vs. 12.7 weeks (n=170) in DM group.

CONCLUSION: Excellent surgical outcomes for primary lateral ligament repair were seen in both the EM and DM postoperative protocols. Patients in the EM protocol experienced a slightly higher complication rate and slower return to sport vs. patients participating in the DM postoperative protocol. No statistical conclusions could be conferred due to data heterogeneity. More studies are needed to definitively evaluate early or delayed ankle mobilization after primary lateral ligament repair.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Postoperative Tourniquet Pain in Patients Undergoing Foot and Ankle Surgery

Paper 073

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BACKGROUND: Tourniquets are commonly used to reduce bleeding intraoperatively during orthopedic surgery. If tourniquets are used incorrectly, left on for too long, or if the pressure is too high, they can cause pain, paralysis, damage to local skin, vasculature or neuromuscular structures, thrombosis and pulmonary embolism, compartment syndrome, reperfusion syndrome, and Tourniquet Pain Syndrome. There are variable guidelines for ideal tourniquet pressure and duration; the practice of fixed, high tourniquet pressures remains common. The purpose of this study was to assess for correlation between excessive tourniquet pressure and duration and increased incidence of tourniquet pain in foot and ankle surgery patients.

METHODS: A retrospective cohort study of 128 patients who underwent foot and ankle surgery with tourniquet use. Baseline systolic blood pressure, tourniquet pressure and duration, intraoperative opioid consumption, Post Anesthesia Care Unit (PACU) pain scores, PACU opioid consumption, and PACU length of stay were collected. Linear regression analysis was used to test for statistical correlation between tourniquet pressure and duration and postoperative pain scores, narcotic use, and length of stay in PACU.

RESULTS: A tourniquet pressure of 280 mmHg was used in 90% of the cases (N=128). Only 2.5% of patients had tourniquet pressures 100-150 mmHg above their systolic blood pressure. Mean tourniquet time was 107.5 min ±39.8 mins. Linear regression showed a significant positive correlation between tourniquet time and morphine equivalents used in the perioperative period ($r=0.410$; $p<0.001$) and with length of PACU stay ($r=0.250$; $p=0.012$).

CONCLUSION: Prolonged tourniquet times at high pressures, not based on limb occlusion pressure, lead to increased pain and opioid use and prolonged PACU length of stay. Basing tourniquet pressures on limb occlusion pressures, and decreasing duration could likely improve the safety of tourniquet use, however randomized clinical trials are needed to further evaluate this.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Postoperative Pain and Opioid Use Following Surgical Treatment of Ankle Fractures

Paper 074

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BACKGROUND: Chronic opioid abuse is one of the greatest public health challenges in the United States. While primary care and chronic pain management physicians may prescribe the majority of the opioids in the U.S., the most common first exposure to opioids comes from acute care prescriptions, such as those written after surgery. Moreover, these opioids are often prescribed in excess, with current estimates suggesting ~75% of the pills prescribed are unused.

Ankle fractures are the most common operatively treated fracture in orthopedic surgery. However, management of acute pain following ankle fracture surgery is challenging and the optimal perioperative pain regimen is still a point of controversy. Only recently has opioid consumption following foot and ankle surgery been studied. There is currently limited data available regarding the appropriate amount of opioid to prescribe following ankle fracture surgery.

This study evaluates opioid prescribing techniques of multiple foot and ankle surgeons, and associated patient outcomes. We aim to help surgeons improve their pain management practices and to limit opioid overprescription.

METHODS: Chart review and phone survey were performed on 42 adult patients within three to six months of ankle fracture fixation at our institution. These patients were offered to voluntarily participate in a standardized questionnaire regarding pain scores, opioid use, non-opioid analgesic use, pain management satisfaction, and patient prescription education.

RESULTS: 57% of patients reported that they were given “more” or “much more” opioid medication than needed, 38% stated that they were given the “right amount”, and 5% reported that they were given “less” or “much less” than needed. 40.0% were on opioids prior to operation. 53.5% did not require refill of discharge opioid prescriptions; 30.2% of patients did not fill any posteroperative opioid prescription. 16.3% of patients filled their discharge prescription and at least one additionall refill (mean refill = 2.22). Mean number of reported opioid pills taken after surgery was 17.4. Mean satisfaction with overall pain management at phone follow up was 8.6/10.

CONCLUSIONS: While postoperative pain and management vary substantially, a majority of patients feel that they are given more opioid medication than necessary following ankle fracture repair, and a majority of opioid prescriptions are not completely used. Going forward, it is likely that a majority of patients could experience the same beneficial results with less prescription opioid pain medication, which would reduce overpresciption and potential misuse.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Preoperative Opioid Use is Associated with Prolonged Postoperative Opioid Use Following Total Ankle Arthroplasty

Paper 075

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INTRODUCTION: The United States is in the midst of an opioid epidemic and perioperative opioid has garnered significant attention. Opioid use in the total ankle arthroplasty (TAA) population has not been well studied. We sought to identify factors associated with prolonged postoperative opioid use following TAA.

METHODS: The PearlDiver Research Program was utilized to query the Humana, Inc claims database from 2007-2016 for patients undergoing TAA using CPT code 27702. Variables interest included age≤49, fibromyalgia, depression or anxiety, low back pain, preoperative tramadol use, smoking, sex, drug abuse, and alcohol abuse, identified by ICD-9 and 10 codes. Preoperative opioid use was defined as having filled an opioid prescription in the 3 months prior to TAA. Patients were tracked monthly for 12 months following TAA for prescription claims data of all common commercially available opioids. Only patients active in the dataset for 3 months prior to TAA and 12 months after were included. Risk ratios (RR) were calculated for each of the factors.

RESULTS: 511 patients who underwent TAA were identified. 246 (48.1%) were male and 176 (34.4%) were classified as preoperative opioid users. There was an insufficient number of patients in the age ≤49, drug abuse, and alcohol abuse groups for analysis. Preoperative opioid users had a significantly higher RR at all months compared to non-users. At 12 months postoperatively, preoperative opioid use had RR of 4.36 [2.80-6.80] for an opioid prescription. Anxiety/depression diagnosis had a RR of 2.27 [1.44-3.59] for filling at opioid prescription at 12 months after TAA. LBP and Fibromylagia were associated with RRs of 2.27 [1.50-3.42] and 2.15 [1.42-3.28], respectively, for opioid prescriptions at 12 months post-TAA. Smoking was associated with greater postoperative opioid use at months 2-11 post-TAA. There were no consistent differences based on sex or preoperative tramadol use.

DISCUSSION: Opioid use within the 3 months prior to TAA was most strongly associate with prolonged postoperative opioid use. Fibromyalgia, depression or anxiety, and LBP were also associated with significantly greater postoperative opioid use. There was no consistently increased risk found between preoperative tramadol use and postoperative opioid use.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Arthroscopy in Lateral Ankle Ligament Surgery: Costs, Complications, Intra-Articular Defect Diagnosis, and Reoperations

Paper 076

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BACKGROUND: Lateral ankle ligament repair/reconstruction may be performed with concomitant arthroscopy. Arthroscopy has been shown to aid in the diagnosis of intra-articular defects (IAD) that often accompany lateral ankle ligament injuries. This study compares the differences in cost, complications, novel IAD diagnoses, and reoperations among patients with ankle sprain/chronic instability who underwent lateral ankle ligament repair/reconstruction with or without concomitant arthroscopic procedures.

METHODS: Data was collected from the PearlDiver Technologies Humana dataset. Patients included in this study (n=2,188) had records of ankle sprain or ankle instability prior to or on the same day as one of two procedures: lateral ankle ligament repair (n=1,141) or lateral ankle ligament reconstruction (n=1,063). This population was subdivided by whether patients had records of arthroscopic procedure(s) on the same day as the ligament surgery. This yielded four groups: repair with arthroscopy (n=219), repair without arthroscopy (n=922), reconstruction with arthroscopy (n=325), reconstruction without arthroscopy (n=738). Cost, complications, novel IAD diagnoses, and reoperations were assessed.

RESULTS: Average cost per patient was higher for both arthroscopy groups: repair with arthroscopy ($6,207.78), repair without arthroscopy ($3,677.11; $p < 0.0001$); reconstruction with arthroscopy ($5,758.21), reconstruction without arthroscopy ($4,601.13; $p = 0.0039$). There was a significantly higher proportion of patients with complications in the reconstruction without arthroscopy group than in the reconstruction with arthroscopy group (7.59%, 4.31%; $p = 0.0431$), but the difference between repair groups was insignificant ($p = 0.0626$). The proportion of patients with novel IAD diagnoses was significantly higher in both arthroscopy groups: repair with arthroscopy (53.0%), repair without arthroscopy (35.6%; $p < 0.0001$); reconstruction with arthroscopy (56.0%), reconstruction without arthroscopy (39.8%; $p < 0.0001$). There was a significantly higher proportion of patients who underwent reoperation for IAD in the combined (repair plus reconstruction) arthroscopy group (7.18%) than in the combined non-arthroscopy groups (4.91%; $p = 0.049$). Most importantly, the average time until IAD reoperation was significantly shorter in the combined arthroscopy group (271.923 days) than in the combined non-arthroscopy group (411.473 days; $p = 0.024$).

CONCLUSION: Concomitant arthroscopy with lateral ankle ligament surgery is more expensive but does not appear to increase the overall complication rate and may allow surgeons to diagnose and treat more intra-articular pathology. Among patients requiring IAD reoperation, the average time to reoperation was nearly 5 months shorter for patients receiving arthroscopy than for patients who did not receive arthroscopy.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Nationwide Analysis of Total Ankle Replacement and Ankle Arthrodesis in Medicare Patients: Trends, Complications, and Cost

Paper 077

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INTRODUCTION: Though less common than arthritis of the knee or hip, ankle arthritis causes great disability in those affected. Surgical management consists of either ankle arthrodesis (AA) or total ankle replacement (TAR). Traditionally, AA was viewed as the surgical standard of care to address ankle arthritis. However, TAR has grown in popularity. The purpose of this study was to evaluate utilization trends in TAR and AA. A secondary aim was to compare cost and complications for Medicare patients who underwent either an AA or TAR.

METHODS: Using the PearlDiver Technologies, Inc. database, Medicare patients with the diagnosis of ankle arthritis based on the International Classification of Diseases, 9th Revision (ICD-9) codes from 2005 to 2014 were retrospectively reviewed. Patients who underwent either AA or TAR utilizing ICD-9 procedure and Current Procedural Terminology (CPT) codes were identified. Annual ankle arthritis incidence and surgical utilization rates were recorded. Patients undergoing surgical intervention were split into AA and TAR groups, which were evaluated for postoperative complications, revision rates, and procedure cost.

RESULTS: 673,789 patients were identified with the diagnosis of ankle arthritis. 19,120 patients underwent AA and 9,059 underwent TAR. While rates of AA remained relatively constant, even decreasing, with 2080 performed in 2005 and 1823 performed in 2014, TAR rates nearly quadrupled with 460 and 1679 performed in the first and last years respectively. Average cost associated with TAR was $12,559.12 compared with $6,962.99 for AA ($P<0.05$). Overall complication rates were 24.9% in the AA group with a 16.5% revision rate compared to 15.1% and 11.0% respectively in the TAR group ($P<0.05$). 13.1% of AA reported a complication relating to the implant versus 4.2% in the TAR group. Patients younger than 65 years old had both higher complication and revision rates than their older counterparts in each surgical group.

CONCLUSION: TAR has become an increasingly popular option in the Medicare population for the management of end-stage ankle arthritis and is on pace to surpass AA in popularity. In our study, TAR demonstrated both lower revision and complication rates than AA. However, total ankle replacement represents a more expensive treatment option than ankle arthrodesis.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

A Comparative Analysis of Cost and Early Complications in Outpatient vs. Inpatient Hindfoot Fusion

Paper 078

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BACKGROUND: Hindfoot fusion procedures are increasingly being performed in the outpatient setting. However, the cost-effectiveness of these procedures compared to the risks and benefits have not been clearly investigated. The objective of this study was to compare patient characteristics, costs and short-term complications between patients who underwent inpatient and outpatient hindfoot fusion procedures.

METHODS: This was a retrospective review of all patients who underwent inpatient and outpatient hindfoot fusion procedures by a single surgeon at one academic institution from 2013-2017. Data collected for each patient included demographic information, operative variables, comorbidities, complications, costs and any subsequent emergency department visits, outpatient visits and inpatient readmissions.

RESULTS: Of 124 total hindfoot procedures performed over the study period, 34 were inpatient and 90 were performed in the outpatient setting. Between procedural settings, there was no significant increase in complications rate or frequency of re-encounters within 90 days. There were 30 re-encounters within 90 days after outpatient surgery versus four after inpatient surgery ($p=0.05$). The average total cost for outpatient hindfoot fusion was $4,159 USD less than inpatient hindfoot fusion ($p<0.0001$).

CONCLUSION: Outpatient hindfoot fusion is a safe alternative to inpatient surgery with significant overall cost savings and similar rate of short-term complications.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Effect of Type 1 and Type 2 Diabetes Mellitus on Complication and Reoperation Rates of Ankle Arthrodesis and Total Ankle Arthroplasty

Paper 079

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INTRODUCTION: Diabetes mellitus (DM) poses a risk for increased rate of complications in many orthopedic procedures. End-stage ankle arthritis is most commonly post-traumatic in nature and is treated surgically with both total ankle replacement (TAR) and ankle arthrodesis (AA). Current literature provides little guidance regarding outcomes in diabetic patients. The purpose of this study is to compare rates of postoperative complications and reoperations of diabetic patients undergoing surgical management of ankle arthritis to non-diabetic patients.

METHODS: Using the PearlDiver Technologies, Inc. database, Medicare patients diagnosed with ankle arthritis using ICD-9 codes were identified from 2005 to 2014. Patients were then sorted as diabetic or non-diabetic and further stratified into Type 1 diabetes (T1DM) and Type 2 diabetes (T2DM). Type 2 diabetics requiring insulin (T2ID) and not requiring insulin (T2NID) were also identified. Patients were identified who underwent either AA or TAR utilizing ICD-9 and CPT codes. These groups were evaluated for postoperative complications and reoperation rates. Chi-Squared testing was used to determine significance. Multivariate analysis was performed to determine whether diabetes is an independent risk factor.

RESULTS: 1477 diabetic patients underwent TAR and 5399 underwent AA versus 3900 TAR and 7838 AA in nondiabetics. Diabetics undergoing AA experienced complications at 32.2%, reoperations at 30.8%, and revisions at 18.7% versus 13.3%, 22.3%, and 19.2% respectively in patients without diabetes($P<0.05$). In diabetics undergoing TAR, the complication rate was 21.6% and reoperation rates were 16.9% versus 12.5% and 13% respectively in their nondiabetic counterparts ($P<0.05$). Revision rates were similar. Patients with T1DM had more reoperations and complications in TAR and AA compared to those with T2DM ($P<0.05$). In both surgical groups, Patients with T2ID had more complications and reoperations than those with T2NID ($P<0.05$). Multivariate analysis revealed diabetes as an independent risk factor for complication and reoperation in AA but only complication in TAR ($P<0.05$).

DISCUSSION AND CONCLUSION: Patients with a diagnosis of diabetes mellitus experienced higher complication and total reoperation rates when undergoing either TAR or AA. T1DM imparts a greater risk of surgical complication and reoperation than does T2DM. However, when insulin is required in T2DM, complication and reoperation rates are similar to those of T1DM.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Incidence of Venous Thromboembolism in Orthopedic Foot and Ankle Surgeries: A Retrospective Database Analysis for Years 2006-2015

Paper 080

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NTRODUCTION: Venous thromboembolism (VTE) is a rare but potentially lethal complication following orthopedic foot and ankle surgeries. The incidence of VTE after orthopedic foot and ankle surgery stratified by specific procedure has yet to be examined. The purpose of this study is to report the incidence of and identify risk factors for VTE in a large sample of patients receiving orthopedic foot and ankle surgery.

METHODS: In this study, we retrospectively analyzed data from the National Surgical Quality Improvement Program (NSQIP) 2006 to 2015 data files. The incidence of VTE was calculated for 30 specific orthopedic foot and ankle surgeries and for four broad types of foot and ankle surgery. A total of 23,212 patients were identified and grouped by current procedures terminology (CPT) codes. Demographic, comorbidity, and complication variables were analyzed to determine associations with development of VTE.

RESULTS: The mean age at the time of surgery was 52.7 ± 17.8 years. VTE events were documented 142 times in our sample, yielding an overall sample VTE incidence of 0.6%. The types of procedures with the highest frequency of VTE were ankle fractures (105/15,302 cases, 0.7%), foot pathologies (28/5,466, 0.6%), and arthroscopy (2/398, 0.5%). Female sex, increasing age, obesity level, inpatient status, and non-elective surgery were all significantly associated with VTE events. Postoperative pneumonia was significantly associated with VTE development. Patients who developed a VTE stayed at the hospital after surgery significantly longer than patients without VTE (6.2 vs.3.1 days). Patients who developed VTE also had significantly higher estimated probability of morbidity (8.0% vs. 6.0%) and mortality (2.0% vs. 1.0%) when compared to patients without VTE.

DISCUSSION AND CONCLUSION: While VTE after orthopedic foot and ankle surgery is a rare occurrence, several high-risk groups and procedures may be especially indicated for chemical thromboprophylaxis.

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MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Surgical Infection Incidence Associated with Summer Months in Foot and Ankle Surgery

Paper 081

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INTRODUCTION: Surgical site infections (SSI) are infections of the incision site, organ, or space at or near the surgical incision within 30 days of the procedure or within 90 days for prosthetic implants. Being the most common nosocomial infection, SSIs are a burden to the healthcare system as they increase costs, duration of stay, antimicrobial resistance, morbidity, and mortality. While there is limited orthopedic evidence suggesting that there is an increased incidence of SSI after surgeries taking place during the summer months, this association has not been examined in the setting of foot and ankle surgery. The purpose of this study was to determine whether seasonal variation plays a role in developing SSIs after orthopedic foot and ankle surgery.

MATERIALS AND METHODS: Data from the National Surgical Quality Improvement Program (NSQIP) years 2011-2015 were used in this study. The pooled and individual incidences of superficial incisional SSI, deep SSI, and organ space SSI were calculated and stratified by quarter of admission. The quarters of admission represent the various seasons (1=winter, 2=spring, 3=summer, 4=fall). Differences in the incidence of SSI as well as various demographic, comorbidity, and complication variables were evaluated using ANOVA for continuous variables and Pearson's Chi-Square for categorical variables.

RESULTS: A total of 17,939 patients were identified. After pooling the superficial, deep, and organ space infections, the overall SSI rate was highest in the summer months (July-September, 3rd quarter) at 2.68% as compared to 2.20%, 2.33%, and 2.14% in the other respective quarters (p=0.338). There was a total of 218 cases of superficial incisional SSI. The summer months had the highest incidence of superficial SSI at 1.38% compared to 1.14%, 1.13%, and 1.21% for 1st, 2nd, and 4th quarters, respectively (p=0.677). There were 145 cases of deep incisional SSI. The third quarter again had the highest rate at 1.02% compared to 0.72%, 0.93%, and 0.60% for 1st, 2nd, and 4th quarter respectively (p=0.105).

CONCLUSIONS: Our results show that superficial incisional SSI, deep incisional SSI, and open wound infections have increased likelihood during the summer months in the setting of orthopaedic foot and ankle surgery. Some studies have associated the increased temperature and humidity during the summer months with increased rates of infections and our results show similar trends. Additional evidence with larger sample sizes is needed to determine which specific procedures are at highest risk of infection during the summer months.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 12, 2019

Outcomes of Inpatient vs. Outpatient Elective Foot and Ankle Surgery

Paper 082

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BACKGROUND: Medical and surgical complications following orthopedic surgeries are undesirable, costly, and often grounds for imposing financial penalties to hospitals. A potential method to reduce these costs is to perform as many procedures as possible in the outpatient setting. The purpose of this study is to compare clinical outcomes between the inpatient and outpatient settings for elective foot and ankle surgeries using the National Surgical Quality Improvement Program (NSQIP) database.

METHODS: We conducted a retrospective analysis of data from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2011-2015. We searched the NSQIP database for any patient who received at least one of 218 CPT codes specific to orthopedic foot and ankle surgery, yielding 27 CPT codes and 7,672 patients. Descriptive statistics of patient demographics, comorbidities, and complications were calculated and stratified by inpatient status. Multivariable logistic regression modelling was used to identify predictors of medical and surgical complications.

RESULTS: The overall rates of pooled and individual medical and surgical complications were significantly higher in the inpatient group as compared to the outpatient group. Patients receiving outpatient surgery were significantly older and more frequently male. Patients who received surgery as an inpatient were significantly more likely to have each of ten studied comorbidities as compared to an outpatient.

CONCLUSION: The results of this study suggest that the success of outpatient management in elective foot and ankle surgery can be predicted based on ASA status, race, and specific comorbidities. Due to benefits of outpatient surgery such as cost reduction and patient satisfaction, performing a higher proportion of these operations in the outpatient setting may be beneficial in select patients.

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MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Surgical Decompression for Thoracic Outlet Syndrome in Adolescent Patients

Paper 083

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The purpose of this study is to characterize surgical outcomes following nTOS decompression at a large referral center in adolescent patients and identify relationships between perioperative factors and these outcomes.

A retrospective chart review of adolescent patients aged 13-21 treated surgically by a single surgeon for nTOS from 2000 and 2015, was conducted. The preoperative characteristics and intraoperative findings are described for these patients. In addition, patients with at least 24 months follow-up were included in long-term follow up analysis. In these patients, clinical outcomes included the Quick Disabilities of the Arm, Shoulder and Hand Survey (quickDASH), the Cervical-Brachial Symptom Questionnaire (CBSQ), the 10-point visual analog scale (VAS) for pain, the Single Assessment Numeric Evaluation (SANE), and the neurogenic TOS index (nTOS index). Analysis of variance (ANOVA) was used to compare outcomes between patients with different mechanisms of injury including: idiopathic, trauma, and overuse from sports or occupation. In addition, patients with rib resection versus those without rib resection were compared.

The study population consisted of 54 adolescents (61 arms) with a median age of 16.8 years. Mechanisms of injury primarily involved overuse (31 patients; 50.8%) or trauma (13 patients; 21.3%). Surgical procedures included neurolysis of the brachial plexus (60 extremities; 98.4%), anterior scalenectomy (59 extremities; 96.7%), middle scalenectomy (54 extremities; 88.5%), first rib excision (28 extremities; 45.9%), cervical rib excision (5 extremities; 8.2%), excision of coracocostal ligaments (26 extremities, 42.6 %), pectoralis minor tenotomy (9 extremities, 14.8%), and subclavian artery manipulation (50 extremities, 81.9%). Long-term follow-up was collected for 24 patients. In this patient subset, the average follow-up was 69.50 months and ranged from 24 months to 180 months. There was improvement in the VAS of 6.18 points from a preoperative average score of 8.18 and postoperative average score of 2.00. The average postoperative quickDASH and CBSQ scores were 11.36 (0 – 54.55) and 27.38 (0-92), respectively. The average NTOS Index was 17.19. The average SANE score before surgery as 28.96 and after was 85.42, representing a patient reported improvement in functionality of 194.95%.

We present the largest series to date of adolescent patients undergoing thoracic outlet decompression. In addition, we show excellent results and improvement in clinical outcome scores of these patients after surgical decompression in the longest follow-up study of these patients to date in the literature.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Failure Mode Differences with Simple vs. Mattress Sutures in Arthroscopic Bankart Repairs: A Cadaveric Study

Paper 084

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BACKGROUND: Traumatic anterior shoulder dislocations disrupt the anteroinferior labrum (Bankart lesion), leading to high rates of instability and functional disability necessitating surgical stabilization. Limited data exists regarding optimum suture configuration during arthroscopic Bankart repair, particularly in regards to failure modes after re-dislocation. The purpose of this investigation was to compare modes and location of repair failure between simple versus horizontal mattress suture configurations during arthroscopic Bankart repair in a cadaveric model.

METHODS: Forty-eight fresh-frozen, human cadaveric shoulders, aged between 30 to 60 years at time of death, underwent creation of iatrogenic Bankart lesions from the 3 o'clock to the 6 o'clock position on the glenoid. Shoulder laterality was alternated and randomized to either simple (n=24 shoulders) or mattress (n=24 shoulders) suture repair configuration. In each shoulder, Bankart repair was achieved using 3.0 mm anchors placed on the glenoid at the 3:00, 4:30, and 6:00 positions and secured via standard arthroscopic knot-tying techniques. Specimens were then tested in supine apprehension position using a servo-hydraulic testing machine and loaded to failure simulating a traumatic anterior dislocation. Following failure, open inspection of specimens was performed to determine the mode (anchor pullout, suture breakage, labral tear or capsular tear) and location (3:00 o'clock versus 4:30 o'clock versus 6:00 o'clock) of failure. Differences in failure mode and location were compared using nominal multivariate generalized estimating equations.

RESULTS: Failure modes based on suture configurations included: anchor pullout (5% simple, 12% mattress), suture failure (15% simple, 16% mattress), labral tear (50% simple, 4% mattress), and capsular tear (30% simple, 68% mattress). Labral tears were significantly more likely to occur with simple suture repair compared to mattress sutures ($p < 0.005$). Anchor pullout and suture failure were significantly more likely with mattress suture configuration ($p=0.01$, $p=0.03$ respectively). Both suture constructs failed most commonly at the 3:00 position.

CONCLUSION: Simple suture constructs fail at the labrum while anchor pullout and suture failures occur with mattress repair configuration after repeat shoulder dislocation following arthroscopic Bankart repair. Repair configuration did not significantly affect suture failure location.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Baseline Characteristics and Two-Year Outcomes of Patients with and without Maladaptive Psychopathological Conditions Undergoing Shoulder Stabilization Surgery

Paper 085

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OBJECTIVES: Patients with maladaptive psychopathological traits may be particularly susceptible to the quality of life reduction associated with shoulder instability. The purpose of this study was to investigate the influence of maladaptive psychopathological traits on two-year clinical outcomes in patients undergoing shoulder stabilization surgery.

METHODS: The Multicenter Orthopaedic Outcomes Network (MOON) Shoulder Instability cohort was utilized to identify all patients undergoing shoulder stabilization procedures. Patients were categorized as having the presence or absence of maladaptive psychopathological traits using the Personality Assessment Screener, a validated personality assessment tool. Preoperative baseline patient characteristics were compared between these two cohorts using univariate analysis, and two-year outcomes were compared using unadjusted and adjusted methods, controlling for baseline confounding variables with regression analysis. Findings with p-values <0.05 were considered statistically significant.

RESULTS: The average age of the 518 included patients was 24.1 ± 8.8 years while 90/518 (17.4%) were female and 100/518 (19.3%) had maladaptive psychopathological traits. Preoperatively, patients with maladaptive psychopathological traits were more frequently smokers (14.0% vs. 4.3%; $p<0.001$) and described longer duration of symptoms prior to surgery ($p = 0.019$) compared to patients without maladaptive traits. Patients with maladaptive psychopathological traits had statistically decreased SF-36 MCS, WOSI, SANE, and shoulder activity scores at baseline. At two years postoperatively, the SF-36 MCS and WOSI scores remained statistically decreased for patients with maladaptive psychopathological traits even after adjusting for confounding variables. There was no difference in the adjusted rate of revision surgery (4.8% vs. 4.3%; $p = 0.701$) or recurrent dislocation (10.3% vs. 6.4% $p = 0.119$) in patients with and without maladaptive psychopathological traits.

CONCLUSION: Preoperatively, patients with maladaptive psychopathological traits differ with respect to several demographic characteristics and have consistently inferior patient-reported outcomes. Several of these patient reported outcome measures remain statistically decreased at two years postoperatively for patients with maladaptive psychopathological traits even after adjusting for baseline confounders. These findings are important to consider during pre- and postoperative counseling for shoulder stabilization surgery.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Greater Muscle Degeneration in Aged Mice After Rotator Cuff Injury

Paper 086

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INTRODUCTION: Massive tears of the rotator cuff (RC) are often associated with irreversible muscle degeneration due to fibrosis, fatty infiltration, and atrophy. We have recently demonstrated that PDGFRβ+PDGFRα+ progenitor cells contribute to tissue fibroadipogenesis after injury. The purpose of this study was to evaluate age-related RC muscle response to injury in young and aged mice to determine the effect of age on fibroadipogenic degeneration in murine models of rotator cuff injury.

METHODS: Young (3-4 months old) and aged mice (12-18 months old) underwent tendon transection and denervation (TTDN), and RC were harvested at: 5 days, 2 and 6 weeks post-operation. Tissue sections were stained with H&E for assessment of morphology, picrosirius red for quantification of collagen, and Oil Red O for lipids. Fold change in gene expression was determined by RT-qPCR. Flow cytometry was used to analyze cell frequency.

RESULTS: TTDN induced greater muscle degeneration in aged mice RC compared to young RC tissues. Accumulation of fibrous tissue was only detected in non-injured RC muscle of aged mice. Development of fibrosis was accelerated in aged tissue within 5 days post TTDN as was gene expression of collagen type III at 5 days and 2 weeks post TTDN compared to matched young RC. Expression of the adipogenic gene leptin was higher in aged RC at 6 weeks of injury, indicating an increased adipogenic response. Flow cytometry showed no difference in the frequency of the fibroadipogenic PDGFRβ+PDGFRα+ cells in young and aged non-injured RC.

DISCUSSION AND CONCLUSION: RC tissue remodeling following TTDN in both young and aged murine models includes scar formation, fatty infiltration, and muscle atrophy, all of which is observed clinically. However, our results demonstrate significant age-dependent differences in RC response to injury with increased muscle degeneration in aged mice. Future studies will seek to understand why this discrepancy exists.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

The Proximal and Distal Effects of Blood Flow Restriction Therapy on Upper and Lower Extremity Strengthening: A Randomized Controlled Trial

Paper 087

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INTRODUCTION: Blood flow restriction (BFR) therapy consists of low-intensity exercise performed while wearing an inflatable tourniquet, partially restricting venous return. This technique produces similar physiologic and clinical effects to high-intensity routines with the advantage of less exertion. Proximal and distal effects of BFR on muscle strength have been demonstrated, however, there is a paucity of literature on its use in orthopedic conditions. Postoperative benefits include earlier and more efficient rehabilitation while limiting stress on surgical repairs. The purpose of this study is to determine the effects of low-intensity BFR therapy both proximal and distal to cuff placement in the upper and lower extremities.

METHODS: This was a prospective, randomized control trial of healthy subjects completing a standardized 6-week course of BFR therapy. Subjects were randomized into three groups: upper-extremity with BFR, lower-extremity with BFR, and control group (upper and lower extremity low-intensity therapy without BFR). Subjects were excluded for cardiac, pulmonary, or hematologic disease, or previous surgery in the extremity. Data collected at baseline and completion included: limb circumferences, isokinetic, and manual strength testing.

RESULTS: The therapy protocol was completed by 43 subjects. Average subject age was 27.7 years and 54% were female. For both upper and lower extremity groups, a statistically significant increase in manual strength was seen proximal and distal to the BFR tourniquet when compared to both the non-tourniquet extremity and the control group ($p<0.05$). Isokinetic testing showed increases in peak torque, total work, and average power in all three groups ($p=0.04$). Limb circumference significantly increased in both the upper ($p<0.01$) and lower extremities ($p=0.02$) compared to the control group. A significant increase in manual strength was noted in shoulder abduction and scaption, as well as hip extension and abduction even in the non-tourniquet BFR extremity compared to the control group ($p<0.05$).

CONCLUSION: Low-intensity BFR therapy significantly improved manual strength testing and muscle hypertrophy in the upper and lower extremities. BFR therapy had similar strengthening effects on both proximal and distal muscle groups. Strength increases even in the non-tourniquet BFR extremity compared to the control group extremity may corroborate a systemic effect of BFR therapy. This study provides pilot data to further evaluate the effects of BFR therapy on both proximal and distal muscle groups in operative and non-operative orthopedic conditions.

Level of Evidence: Level I, Randomized Control Trial

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Do Outcomes and Complications Differ When Total Elbow Arthroplasty is Performed Acutely for a Distal Humerus Fracture vs. After Prior Attempted Internal Fixation?

Paper 088

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INTRODUCTION: Internal fixation and total elbow arthroplasty (TEA) are both oftentimes considered for select patients with complex distal humerus fractures. Little is known regarding the comparative outcomes of fractures replaced acutely versus elbow arthroplasty performed as a salvage after prior attempted distal humerus internal fixation.

METHODS: Between 2005 and 2018, 22 TEAs were performed at our institution for an acute distal humerus fracture. During the same time period, 66 salvage TEAs were performed after prior internal fixation; the mean time between internal fixation and TEA was 88 (SD 156) months, and the main indications were post-traumatic osteoarthritis (32%) and nonunion (30%). There was a female predominance (70%) and significant difference in age between the primary and salvage cohorts (74 vs. 60 years, $p<0.001$). Cohort demographics were comparable in regards to AO/OTA classification and diabetes, but there was a significantly greater number of salvage TEAs in tobacco users (n=0 acute, n=15 salvage; $p=0.02$).

RESULTS: TEA provided similar outcomes in both cohorts in terms of Mayo Elbow Performance Score (acute 85, salvage 81, $p=0.32$) and motion (acute 95/81/75°, salvage 103/80/68° in flexion-extension/pronation/supination, $p=0.50/p=0.57/p=0.35$). The reoperation rate was similar (36% vs. 38%, $p=1.00$). Aseptic loosening (2 acute, 8 salvage) and deep infection (1 acute, 8 salvage) were the most common complications. The infection rate was lower in the acute cohort (5% vs. 12%), but with the numbers available this difference was not statistically significant.

CONCLUSION: The clinical outcomes, reoperation rates, and complications of TEA for distal humerus fractures seem to be similar when performed as a primary procedure or as salvage after prior internal fixation. The benefit of avoiding elbow arthroplasty in the acute setting needs to be balanced with the potential for two surgical procedures if internal fixation were to fail.

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MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Impact of Caffeine on Early Rotator Cuff Healing in a Rat Model

Paper 089

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BACKGROUND: Rotator cuff repairs (RCR) are common orthopedic procedures. Unfortunately, there remains a high rate of failure in the early to mid-term postoperative period. Previous studies have demonstrated inhibition of rotator cuff tendon-to-bone healing with non-steroidal anti-inflammatory drugs, fluoroquinolones, and nicotine. Caffeine, a commonly consumed substance, inhibits angiogenesis, bone formation, and collagen production – all necessary for tendon-to-bone healing. Little is known regarding the effects of caffeine on tendon healing. The purpose of this study was to evaluate the effect of caffeine on tendon-to-bone healing after RCR.

METHODS: Sixty-five adult male Sprague-Dawley rats underwent bilateral supraspinatus RCR after being randomized to receive daily oral gavage with either caffeine or distilled water pre- and postoperatively. Biomechanical properties of the supraspinatus tendons were assessed at two (21 samples), four (22 samples), and eight (22 samples) weeks postoperatively. Maximum force to failure was determined for each tendon. Histological staining and examination of the bone-tendon junction was performed on 18 supraspinatus tendon samples (six samples total per timepoint). Healing was compared between groups.

RESULTS: There were no significant differences in failure loads when comparing the caffeine group with the control group at two weeks (13.4 vs. 15.0, $p=0.64$), four weeks (23.6 vs. 24.1, $p=0.85$), and eight weeks (24.1 vs. 27.6, $p=0.27$) postoperatively. Force to failure in both groups increased over time ($p<0.05$). More osteoclasts were seen in the control group, suggesting a less robust healing response in the caffeinated rats.

CONCLUSION: Biomechanically, with supraspinatus repair in a rat rotator cuff model, failure load means in the caffeine group were lower than in the control group at all time points, but the differences were not significant. Histologically, fewer osteoclasts were shown in the caffeinated rats, potentially correlating with delayed healing.

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MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Preoperative Narcotic Use and Resiliency Scores Do Not Predict Changes In Sleep Quality Following Arthroscopic Rotator Cuff Repair

Paper 090

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INTRODUCTION: Sleep disturbance is common in patients with rotator cuff tears. The relationships among narcotic use, psychosocial factors, and sleep quality in these individuals is not clear. The goal of this study was to determine if changes in sleep quality are predicted by preoperative narcotic use and the patient's ability to cope with physiologic stress (resilience). Our hypothesis was that preoperative narcotic use and low resiliency scores would negatively impact changes in sleep quality.

METHODS: This is a prospective study of 32 continuous adult patients who underwent arthroscopic repair of a full-thickness rotator cuff tear from December 2016 to September 2017. Patients completed the Connor-Davidson Resilience Scale (CD-RISC), a validated 25 item scale for quantifying an individual's adaptive capacity. The Pittsburgh Sleep Quality Index (PSQI) was administered at baseline, 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. Preoperative narcotic use was gathered using a legal prescriber database. Sleep scores were compared to baseline using paired t-tests and McNemar's test. Linear regression was used to determine if preoperative narcotic use and the CD-RISC predicted changes in sleep quality.

RESULTS: The mean age in this series was 60 years (range 34-81), including 14 males and 18 females. There were 8 patients (25%) taking narcotics preoperatively. At baseline, only 4 (13%) of the patients reported having good sleep quality (PSQI <5). The rate of normal sleep was significantly better ($p < 0.001$) at 3 months (48%) and 6 months (31%). The nocturnal pain frequency (graded from 0-3 on PSQI) gradually improved at 2 weeks (2.4), 6 weeks (1.7), 3 months (1.1), and 6 months (0.9). Surprisingly, preoperative narcotic use and the CD-RISC did not significantly predict changes in PSQI or nocturnal pain frequency at any time point ($p > 0.05$).

CONCLUSIONS: This study confirms that most patients with rotator cuff tears will experience improvement in sleep quality following arthroscopic repair with notable improvements in nocturnal pain frequency as soon as 2 weeks following surgery. Contrary to our hypothesis, the use of preoperative narcotics and patient resilience measured with the CD-RISC did not have any association with changes in sleep quality or nocturnal pain frequency at 2 weeks, 6 weeks, 3 months, or 6 months following arthroscopic rotator cuff repair.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Deltoid Compartment Pressures Do Not Significantly Affect Postoperative Narcotic Utilization Following Arthroscopic Rotator Cuff Repair

Paper 091

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BACKGROUND: The use of postoperative narcotic pain medication following arthroscopic fixation of rotator cuff tears has been reported to exceed that of other shoulder surgeries, including open rotator cuff repair. One explanation for increased pain following arthroscopic treatment has been secondary to fluid extravasation into the surrounding soft tissues secondary to the required fluid pump and pressure created within the joint to enable appropriate visualization.The purpose of this investigation was to prospectively examine patient narcotic utilization following arthroscopic rotator cuff repair in relation to changes in deltoid compartment pressures immediately prior to and following arthroscopic repair.

METHODS: A prospective study was performed at a single institution utilizing three fellowship-trained surgeons. Patients aged 18 to 80 undergoing primary arthroscopic double row rotator cuff repair were included in the study, excluding patients undergoing revision surgery, single row repairs and patients previously on narcotic pain medication. Deltoid pressures were obtained using a manometer within the anterior, lateral and posterior deltoid compartments prior to incision and immediately following portal closure. All patients were provided with the same postoperative pain medication and rehabilitation protocol. Patients were provided with a pain journal to record daily narcotic utilization during the first four weeks following surgery. Pain journals were collected at the first postoperative visit and opioid utilization was calculated and standardized using morphine equivalents. Statistical analysis was performed to determine the impact of patient age, gender, pump type, pressure, and length of surgery on changes in deltoid compartment pressures. Logistic regression was performed to assess for correlations between changes in deltoid compartment pressures on narcotic use in the postoperative period.

RESULTS: A total of 81 patients underwent arthroscopic repair, consisting of 56 males (mean age, 56.4 ± 9.2 years) and 23 females (mean age, 59.1 ± 7.4 years). Average length of surgery was 73.9 ± 18.1 minutes while a pump was utilized in 79% (n=64) of cases. No significant differences in deltoid pressure readings prior to and following surgery was appreciated based on patient age (p=0.35), gender (p=0.56), pump type (p=0.14), pump pressure (p=0.78), or length of surgery (p=0.48). A total of 57% of patient returned a complete pain journal. Regression analysis found no significant association between changes in deltoid compartment pressures and narcotic pain medication requirement (p=0.22).

CONCLUSION: No significant correlation between deltoid compartment pressures following arthroscopic rotator cuff repair on postoperative narcotic utilization was appreciated.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Do Anatomic Changes Found in Pitching Elbow After a Season of Pitching Resolve with Offseason Rest: A Dynamic Ultrasound Study

Paper 092

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INTRODUCTION: To use ultrasound imaging to determine if adaptive changes to the elbow seen after a season of competitive college pitching resolves after offseason rest.

METHODS: Eleven collegiate pitchers were prospectively followed and evaluated prior to their first season, within 1 week of their last game of the season, and prior to the start of their next season (after a 2-month offseason of relative arm rest). Evaluations consisted of range of motion measurements of the shoulder, dynamic ultrasound imaging of the throwing elbow, and Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaires. Ultrasound images were then blinded to testing time point and evaluated by 2 fellowship-trained musculoskeletal radiologists.

RESULTS: Average pitcher age was 20.1 years. An average of 606 pitches were thrown during the season. Preseason 1 glenohumeral internal rotation deficit (GIRD) of the dominant arm measured 5.64° +/- 11.71°. At all three time points, there was a significant decrease in internal rotation (IR) and a significantly greater ulnar collateral ligament (UCL) thickness and cross-sectional area (CSA) in pitchers' dominant vs. non-dominant arm ($p < 0.05$). After a season of competitive pitching, there was a significant increase in UCL thickness ($p = 0.03$) and a non-significant increase in both unloaded and loaded ulnohumeral joint (UHJ) space ($p > 0.05$). Dominant arm IR decreased during a season of pitching ($p = .004$). Following offseason rest, UCL thickness returned to baseline as compared to preseason values ($p = 0.4$), while there was a decrease in unloaded ($p = 0.004$) and loaded ($p = .04$) UHJ space. GIRD did not resolve after offseason rest and IR continued to decrease prior to season 2 ($p = .02$). Preseason 1 and 2 QuickDASH scores positively correlated with the changes in UCL CSA seen throughout the season ($r = 0.69$, $p = 0.02$) and offseason ($r = 0.65$, $p = 0.03$), respectively. No demographic characteristics correlated with changes seen in UCL and elbow anatomy throughout any time points.

CONCLUSION: Our study demonstrates that stresses placed on the throwing elbow during a pitching season produce significant changes about the elbow anatomy. While changes in UCL thickness and ulnohumeral joint space were found to resolve after offseason rest, internal rotation deficits were found to be progressive and do not resolve. Adequate rest and offseason rehabilitation should be emphasized to allow adaptive changes in the anatomy of the pitching elbow to resolve.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Progressive Elbow MRI Abnormalities in Little League Baseball Players Are Common: A Three-Year Longitudinal Evaluation

Paper 093

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INTRODUCTION: Significant effort has been made to minimize the rate of shoulder and elbow injury among youth baseball players. Despite this effort, MRI evidence of shoulder and elbow pathology has been demonstrated in single season evaluations. Result of a three-year longitudinal assessment of Little League players' elbows including repeated bilateral elbow magnetic resonance imaging (MRI), throwing history, playing status, and physical examination are described.

METHODS: A prospective study of Little League players who were 12 to 15 years of age was performed. All players had preseason and postseason elbow MRI performed three years prior to the current study. Players underwent repeat bilateral elbow MRI, physical examination of bilateral shoulders and elbows, a detailed assessment of throwing history, and completed a questionnaire addressing playing history and any arm pain. Identified MRI pathology was categorized as mild/intermittent, moderate/persistent, severe/progressive, or resolved.

RESULTS: All 26 players who participated in the previous single season study returned for a 3-year longitudinal assessment, representing a 100% follow-up rate. Fifteen players (58%) had dominant arm MRI pathology. 80% of MRI findings (12/15 players) were determined to be new or progressive lesions. Players with post-season MRI pathology were significantly more likely to have MRI pathology at 3-years follow-up ($p<0.05$). Six of the 14 players (43%) with previously normal MRI had new pathology. Year-round play was a significant predictor of tenderness to elbow palpation ($p=0.027$) and positive MRI findings at 3-years ($p=0.047$). Moderate/persistent and severe/progressive MRI findings were more often seen in players who continued to play baseball, play pitcher or catcher, and play year-round baseball. Dominant shoulder internal rotation was significantly less than non-dominant shoulder internal rotation amongst all players (60.3° compared with 71.2°, $p=0.002$). Dominant shoulder external rotation was significantly increased in players who continued to play baseball when compared with those not playing (109.1° versus 99.3°, $p=0.012$), in players playing pitcher or catcher when compared with non-pitchers/catchers (111.4° versus 100.3°, $p=0.005$), and in players who played year-round baseball when compared with those playing <8 months/year (109.0° versus 100.2°, $p=0.026$).

DISCUSSION AND CONCLUSION: Dominant elbow MRI abnormalities are common in asymptomatic Little League baseball players. Three-year longitudinal evaluation suggests that these MRI findings commonly progress, especially amongst players who continue to play baseball. Year-round play appears to impart the most notable risk for physical exam abnormalities and progressive MRI pathology in youth players. Further guidelines addressing year-round play in Little League Baseball should be established.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Revision Ulnar Collateral Ligament Reconstruction in Professional Baseball: Current Trends, Surgical Techniques, and Outcomes

Paper 094

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BACKGROUND: Ulnar collateral ligament (UCL) reconstruction of the elbow is a commonly performed surgery on professional baseball pitchers. Recent reports have suggested that revision rates are on the rise and may be higher than previously thought. The purpose of this study was to provide a comprehensive report on current trends, surgical techniques, and outcomes of revision UCL reconstructions performed on professional baseball pitchers between 2010 and 2016.

METHODS: The Major League Baseball (MLB) Health and Injury Tracking System (HITS) was used to compile records of all revision UCL reconstructions performed on professional baseball pitchers between 2010 and 2016. Player data and outcomes were obtained from HITS while surgical details were obtained from operative reports. Descriptive statistical analysis was performed on epidemiologic data. Outcomes (return to play rates, return to play times, subsequent injuries, and subsequent surgeries) were compared across the most common surgical techniques (Docking vs. Modified Jobe) and graft sources (palmaris longus autograft vs. hamstring autograft).

RESULTS: A total of 69 professional baseball pitchers underwent revision UCL reconstruction from 2010 to 2016 at an average of 1,424 days (47 months) after their primary surgery. There was a trend toward increasing numbers of revision surgeries over time ($R^2=0.441$; $p=0.104$). The most commonly used tunnel configuration was the Modified Jobe technique (n=41, 59.4%) and the most common graft utilized was hamstring autograft (n=34, 49.3%). 76.6% of pitchers were able to return to play (RTP), and 55.3% were able to return to the same level of play. Mean time to RTP in players with a palmaris longus autograft was 436 days versus 540 days for hamstring autograft ($p=0.108$), and the mean time to RTP in players was 423 days for the Docking technique versus 519 days for the Modified Jobe technique ($p=0.296$). Similar rates of subsequent injuries and surgeries were noted between the two revision techniques and two most commonly used graft constructs.

CONCLUSIONS: Revision UCL reconstruction showed relatively high return to play rates, but only 55% of players returned to their same level of play. Mean time to RTP was shorter than that of other, smaller investigations. Although there were general trends towards decreased time to RTP for the Docking Technique and palmaris longus autograft, these differences did not reach statistical significance.

MAOA BREAKOUT SESSION #7
SPORTS/SHOULDER/ELBOW
April 12, 2019

Reconstruction of the Medial Ulnar Collateral Ligament of the Elbow: Comparison of a Novel Anatomic Technique to the Docking Technique

Paper 095

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INTRODUCTION: Although return to play rates are high (80-95%) following UCL reconstruction (UCLR), the mean time to return to play (12 to 18 months) is longer than desired. One option for improving this may be to optimize the strength and healing potential of the graft at the time of surgery. The purposes of this study were to: (1) describe a novel Anatomic UCLR technique designed to better replicate native UCL anatomy and maximize bone to tendon contact, and (2) to biomechanically compare this to the Docking Technique.

METHODS: 16 cadaveric elbows (8 matched pairs) were randomized to receive UCLR using either the Docking Technique (DT) or the novel Anatomic Technique (AT). In brief, the graft is flipped, fixed into a socket on the humeral side, and the tails are fixed on the ulna using 2 small all-suture anchors near the joint line and an intracortical button at the distal footprint. Palmaris longus autograft was used for all procedures. After UCLR, all specimens underwent biomechanical testing using an Instron Machine to determine maximal torque (Nm) to failure and stiffness (Nm/°).

RESULTS: The mean load to failure was 23.8 ± 6.1 Nm for DT vs. 31.9 ± 8.4 Nm for AT (MD: 8.1 Nm; 95% CI 0.23 to 16.0; p=0.045). Mean rotational stiffness was 1.9 Nm/° vs. 2.3 Nm/° for the DT and AT, respectively (p=0.367). The same mode of failure occurred in all DT elbows: tails of graft pulled out of humeral socket. The most common failure mode for the AT was suture pulling through the graft on the ulnar side (7 of 8, 88%).

DISCUSSION/CONCLUSION: The Anatomic Technique demonstrated increased strength and resistance to valgus torque compared to the DT, and this was comparable to that of the native UCL. Additional potential benefits of the AT include: reduced suture burden in the humeral socket, increased tendon-to-bone contact on the humeral and ulnar sides, multi-point fixation on the ulna, better replication of normal ligament anatomy at the ulnar footprint, ability to sequentially tension the, ability to re-tensioning if needed, creation of closed loop fixation on both sides, and avoidance of tunnel drilling in the ulna (potentially reducing the risk of injury to the ulnar nerve at this location). While further study is certainly needed, this technique may hold potential for promoting healing following UCLR and decreasing return to play times.

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MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Minimally Invasive Sacroiliac Arthrodesis: 1- and 2-Year Results Highlighting Compression, Grafting, and Stabilization

Paper 096

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INTRODUCTION: Sacroiliac (SI) joint pain remains an underdiagnosed and under-recognized source of chronic low back pain, especially in degenerative/deformative spine disease. As advances in minimally invasive approaches have become popularized, new techniques and technology are evolving. Studies in MIS SI arthrodesis remain limited due to small cohort sizes and industry-sponsored bias.

OBJECTIVE: The purpose of this study was to report upon a single-surgeon series and outcomes of patients undergoing primary MIS sacroiliac arthrodesis utilizing a technique highlighted by SI joint preparation, compression, and autografting at a major academic institution.

METHODS: Between 2013 and 2016, 52 patients were available for review after undergoing primary, unilateral SI joint arthrodesis via percutaneous joint decortication, application of autograft/allograft, and placement of a modified lag screw by a single surgeon. Prospectively collected data, including a VAS, SF-12, ODI, and other standardized clinical questionnaires were collected at the preoperative visit and the regular interval postoperative visits. CT scans were evaluated for evidence of radiographic fusion with bone bridging from the sacrum to the ilium.

RESULTS: 46 of the 52 patients (88%) had complete follow-up including patient outcome questionnaires and CT scans at the one year postoperative mark. In this cohort, 92% of patients gained CT-proven evidence of bony fusion at an average of 9 months postoperatively. 94% of the operated sacroiliac joints remained revision-free at an average of 2.4 years. Postoperatively, patients exhibited significantly improved ODI and SF-12 functional scores at all time points (ODI: preop 73.3; 3-month 58.6; 24-month 50.2; $p < 0.01$. SF-12: preop 31.4; 3-month 35.9; 24-month 37.1; $p < 0.01$). Back and leg visual analog pain scores decreased postoperatively by 57% and 70%, respectively ($p < 0.01$). Median hospital stay was 1 day, median estimated blood loss was less than 50cc, and there were no recorded major complications.

DISCUSSION: We report a large case series with standardized outcomes questionnaires and CT scans that demonstrate significant clinical improvement, decreased pain scores, and true arthrodesis in the vast majority of patients. This is a safe and effective technique for the appropriately diagnosed patient. This series highlights that excellent clinical outcomes and documented arthrodesis can be achieved by adhering to the 3 standard principles of arthrodesis: joint preparation, joint compression, and joint stability. It is clear that long-term studies of > 1-2 years are needed to assess the durability of SI fusion surgery.

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MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Acute Outcomes of Early (within 48 hours) vs. Late Acetabulum Fixation

Paper 097

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BACKGROUND: There is no consensus regarding the ideal timing of acetabular fracture surgery. Early fixation has been traditionally thought to put patients at risk for increased blood loss, longer length of surgery, and other possible complications. On the other hand, early treatment may facilitate patient mobilization and lead to decreased length of stay. The purpose of this study was to determine whether definitive fixation of acetabular fractures within the first 48 hours results in significant differences in blood loss, length of surgery, and length of stay.

METHODS: A retrospective review of 100 consecutive acetabular fractures that were treated with open reduction internal fixation from a single Level 1 trauma center. Sixty-one patients were treated within the first 48 hours of admission, and 39 were treated after 48 hours. Outcome variables collected include estimated blood loss (EBL), length of surgery, total length of stay, length of stay post-surgery, surgical approach utilized (anterior vs. posterior), and ISS score assigned. Student's T-test was used in SPSS for analysis.

RESULTS: Estimated blood loss (EBL) (632 mL vs. 645 mL, P-value 0.73) and length of surgery (3:38 vs. 3:33, P-value 0.75) were not significantly different between those treated >48 hours and those treated <48 hours. LOS (15 vs. 7.2 days, P-value 0.015) was significantly less for those treated with fixation <48 hours but ISS (16 vs. 8.9, P-value 0.007) was significantly higher for those with fixation >48 hours. Acetabulum fractures addressed via anterior approaches lost more blood and had a trend towards longer length of surgery compared to fractures addressed posteriorly.

CONCLUSION: This study demonstrated that there is no difference in blood loss or length of surgery in those treated with surgery earlier. Performing surgery early does not put the patient at undue risk in this respect. Those treated with surgery in the first 48 hours had a significantly shorter length of stay. Injury severity score (ISS) was higher in those treated after the first 48 hours. Taking into account that an average day in a medical-surgical bed at our institution costs $1,019/day, a staggering potential cost aversion would be possible with acute fixation of acetabulum fractures.

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MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Does Posterior Fixation of Anteroposterior Compression Type-2 Pelvic Ring Injuries Decrease Symphyseal Plate Failure? A Biomechanical Study

Paper 098

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INTRODUCTION: Recent clinical study suggests an advantage to adding an iliosacral screw to the fixation construct for APC-2 pelvic ring injuries. Others have described using a stress exam to determine pelvic stability and any required supplemental fixation. However, there have been no biomechanical studies to investigate specific fixation requirements for what is essentially a wide injury spectrum. Our study purpose was to determine if adding an iliosacral screw to symphyseal plate fixation will decrease displacement and thereby increase stability of the hemipelvis in a partially unstable (open-book) pelvic ring injury model.

METHODS: A unilateral open-book pelvic ring injury was created in 10 human cadaveric pelves by unilaterally releasing the sacrospinous, sacrotuberous, and anterior sacroiliac ligaments plus transection of the pubic symphysis, approximating the described APC-2A injury. Specimens were divided into 2 groups: (1) fixation of the pubic symphysis alone with a plate and (2) symphyseal fixation supplemented with a single iliosacral screw. DXA scans were performed on each specimen to ensure uniformity between the two groups. Each pelvis was mounted on a materials testing machine using a standard bilateral stance model and loaded at 550N for 500,000 cycles. Displacement measurements were taken at the superior and inferior pubic symphysis at 210,000 and 500,000 cycles.

RESULTS: Three specimens failed prior to the first time-point (210,000 cycles) due to technical errors and were not included in the final analysis. None of the remaining seven specimens had evidence of any implant failure, and there was no significant difference in displacement between the two groups. The mean superior and inferior pubic symphysis displacement in group 1 at 210,000 cycles was 2.38 mm and 5.2 2mm respectively, as compared to 2.74 mm and 5.08 mm in group 2 ($p = 1.0$). The mean superior and inferior pubic symphysis displacement in group 2 at 500,000 cycles was 3.60 mm and 7.01 mm respectively, as compared to 3.77 mm and 6.92 mm in group 2 ($p = 1.0$ and 0.86, respectively). Post-hoc analysis showed that a large sample size (45/group) would be required to detect any difference with 80% power.

CONCLUSIONS: The addition of an iliosacral screw to anterior symphyseal plate fixation does not provide improved biomechanical outcome in APC-2A equivalent pelvic ring injuries. Clinically, stress examination may be useful to determine the need for supplemental posterior fixation in APC-2 injuries.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Outcomes Impact of Postoperative Cast Immobilization Following Diaphyseal Forearm Fracture Fixation

Paper 099

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INTRODUCTION: Protocols for postoperative immobilization of open reduction internal fixation (ORIF) of ulna, radius, or both-bone forearm fractures have yet to be firmly established. Three methods of treatment have surfaced in the literature for postoperative care of forearm fracture ORIF: casting, splinting, or no immobilization. Published studies regarding surgically repaired forearm fractures have focused on the preferred treatment regimens of the authors instead of evidence-based protocols, with widely variable use and duration of casting or splinting. Some publications mention no postoperative immobilization is required, however, criteria for doing so were variable. There is a lack of evidence on outcomes of patients who are not placed in a cast postoperatively. The primary objective of this study is to evaluate if diaphyseal forearm fractures treated with ORIF and no postoperative cast placement have equivocal outcomes compared to published literature of casted patients. The secondary objective is to determine if there is a subpopulation in which lack of cast immobilization leads to increased post-operative complications.

METHODS: A retrospective cohort study was performed on 103 patients from the Orthopedic Associates of Michigan system who had ORIF for radial shaft, ulnar shaft, or both bone forearm fracture without cast immobilization from 2003 to 2014. A total of 89 valid cases met criteria. Sub-cohorts of current smokers, former smokers, diabetics, and obese patients were identified for sub-analysis.

RESULTS: The initial union rate at six months was 95.5%, with 4.5% of patients requiring revision surgery for nonunion. There was an increase in nonunion in current smokers, previous smokers, diabetics, and obese patients. The patients requiring revisions for nonunion all went on to union after additional intervention.

CONCLUSION: Postoperative management after ORIF with no cast or splint yields similar results to previously published studies which included variable postoperative immobilization techniques. Although there was an increase in the nonunion rate among current smokers, previous smokers, diabetics, and obese patients, revision for non-union yielded a 100% union rate in this patient population. The results of this study support no postoperative splinting or casting. However, postoperative immobilization could be considered more appropriate for those who are at higher risk for nonunion. More research is needed to further define evidence-based protocols for postoperative management of ORIF of forearm fractures. Weaknesses of this study include moderate sample size, retrospective nature of the chart review, and no control group or randomization.

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MAOA BREAKOUT SESSION #8
TRAUMA
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Operative vs. Nonoperative Treatment of Isolated Humeral Shaft Fractures: A Prospective Cohort Study

Paper 100

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PURPOSE: Non-operative management of isolated humeral shaft fractures has been considered the standard of care. There is little comparative data regarding functional outcomes between operative and non-operative management. The purpose of this study was to prospectively compare plate and screw fixation (ORIF) and functional bracing (NO) of isolated humeral shaft fractures with treatment and patient based outcomes.

METHOD: We performed a prospective comparative trial of ORIF v. NO treatment of isolated humeral shaft fractures at 12 centers (Clinical Trials #16589). We excluded pathologic fractures, those who could not follow-up, complete forms, or give consent. Surgeons counseled patients on treatment options and a patient centered decision was made. Patients were followed at 2, 4, 8, 12, and 26 weeks clinically and with x-rays until united. The primary outcome was the Disability of Arm, Shoulder, and Hand (DASH) score. Complications included nonunion, infection, iatrogenic nerve palsy, and decreased ROM.

RESULTS: 179 patients were enrolled; 6 month data was available for 104 (40F; 64M) aged 18–69 (average: 41). Forty-five patients underwent ORIF and 57 patients were NO. No differences were seen between groups in OTA fracture class, BMI, smoking, or arm dominance. At 3 and 6 months, the DASH was 35 and 20 for the NO group and 28 and 18 for ORIF ($p=0.24$ and 0.67). Narcotic use was lower at 2 weeks in the NO group (56% vs. 69%, $p=0.01$), but not different at 3 months (23% vs. 25%) or 6 months (both 9%). There was no difference in elbow ROM between the groups (average 1°-133°) or in patient participation in PT (both 63%). In the ORIF group, 6 patients (13%) developed postop iatrogenic radial nerve dysfunction (RND) and 1 (2%) developed an infection. Nonunion was reported in 2% of the ORIF group and 10% of the NO group.

CONCLUSION: We evaluated a prospective cohort with isolated humeral shaft fractures treated with ORIF or NO. We found no difference in the DASH or elbow ROM at 6 months. However, 10% of the NO group developed nonunion. Complications in the ORIF group included a 2% infection and nonunion rate and 13% iatrogenic RND. ORIF can be expected to result in higher union rates with the inherent risks of infection and RND. Finally, at 6 months, both groups demonstrated higher DASH scores than population norms, indicating incomplete recovery.

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MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Use of an Algorithm Improves Acetabular Fracture Classification in Inexperienced Practitioners

Paper 101

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PURPOSE: Experienced surgeons are able to classify acetabular fractures based on the Letournel system with high intra- and inter-observer reliability. For less experienced attending surgeons and residents, however, properly classifying these fractures can be difficult. This study aims to assess the effectiveness of the algorithm previously developed by Saterbak and Ly for teaching inexperienced practitioners to accurately classify acetabular fractures using the Letournel system.

METHODS: 25 medical students on their 4th year orthopedic rotation were given a test composed of 20 separate acetabular fractures portrayed on three pelvic radiographs: AP, obturator oblique, and iliac oblique views. For each set of radiographs, they were instructed to classify the fracture based on the Letournel system. After a 3-week washout period, the students repeated the same test. This time, however, they were provided with the algorithm previously described by Ly et al. 12 of the students were randomly separated and given a short presentation explaining the algorithm and its proper use. Student's t-test were performed as appropriate to compare groups. $P < 0.05$ (two-tailed) was considered significant.

RESULTS: On their pre-test, without the help of the algorithm, medical students scored an average of 4.04, 95%CI [2.78-5.29] out of 20. On their post-test, with the help of the algorithm, medical students scored an average of 8.32, 95%CI [7.08-9.55]. This improvement was statistically significant ($p= 0.000008$). When subdivided into elementary and associated patterns, pre- vs. post-test scores were still significantly improved ($p= 0.00004$) and ($p= 0.00007$), respectively. Of the 12 students randomly assigned to receive an intervention, there was no difference in pre-test ($p=0.67$) or post-test scores ($p=0.50$) when compared to the algorithm alone group.

CONCLUSIONS: Use of the Ly et al algorithm improved the ability of inexperienced practitioners to classify both elementary and associated type acetabular fractures. A presentation explaining the use of the algorithm did not affect their ability to classify these fractures. We conclude that a basic understanding of pelvic anatomy in conjunction with the algorithm is sufficient for inexperienced practitioners to increase their understanding of acetabular fracture classification.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Retrospective Review: Mortality, Cortical Thickness Index, and the Dorr Classification in Geriatric Femoral Neck Fractures

Paper 102

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INTRODUCTION: Geriatric hip fractures account for over 300,000 hospital admissions in the U.S. annually. Studies have shown that these patients have a 1-year mortality rate as high as 30%. Other studies have established risk factors for this increased risk of mortality. Cortical thickness index (CTI), first described by Dorr et al (1993) has been shown to be a reliable measurement to characterize proximal femur morphology. CTI is associated with risk of sustaining hip fracture as well as associated perioperative complications. However, no studies have compared CTI or Dorr classification with perioperative mortality rates.

METHODS: An IRB approved retrospective chart review of patients (>65 years) who sustained a closed femoral neck fracture from 2013-2015 was performed. Demographic factors and death records were collected. AP x-ray of the affected hip was measured using standardized measurement techniques using the IMPAX system. The cortical thickness was measured 10 cm distal to the lesser trochanter and index calculated by using the equation CTI= (Outer cortex diameter- Inner cortex diameter)/outer cortex diameter. Univariate statistical testing was performed to associate age, gender, Dorr classification, and cortical thickness variables to mortality outcome. Because age and gender were significantly associated with mortality risk ($p<0.10$ via two-sided testing), they were included as factors in a multivariate logistic regression model along with Dorr classification to predict the mortality outcome. Adjusted odds ratios with 95% confidence intervals and p-values were determined with Dorr A classification used as a reference.

RESULTS: 104 patients with femoral neck fractures from 2013-2015 were reviewed. 38 deaths resulted in a mortality rate at 1-year of 33%. The CTI was classified into 3 groups with Dorr A greater than 0.57, Dorr B 0.56-0.43, Dorr C less than 0.43. Multivariate logistic regression was used to control for age and gender. Using Group A as reference, those in Group B have 1.428x increase odds of mortality. This was not significant ($p=0.629$). Dorr Group C increases the odds of mortality by 7.5 times that of level A and this was significant ($p=0.020$).

CONCLUSION: Cortical thickness index and Dorr classification can be used to help identify those patients at increased risk of mortality with femoral neck fractures. Patients with Dorr C femurs had 7.5 times increased risk of mortality within 1 year compared to those of Dorr A.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Variation of Inpatient Cost of Care in the Treatment of Isolated Geriatric Hip Fractures

Paper 103

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INTRODUCTION: Intertrochanteric hip fractures are common injuries in the elderly, estimated annual incidence of 150,000 costing $6 billion, generating a growing financial burden as the population continues to age. This study evaluates the magnitude of cost variation seen for the inpatient phase of care of isolated geriatric intertrochanteric hip fractures.

METHODS: A retrospective review of 287 isolated closed geriatric hip fractures, 2013-2017, was conducted at a level 1 trauma center. The total episode cost of care was derived utilizing a time-driven-activity-based-costing algorithm from the Charge-Master-Description. Statistical analysis consisted of goodness-of-fit analysis and multivariate linear regression analysis to evaluate variables' roles toward the total inpatient cost of care.

RESULTS: The patient sample was primarily female, 205 (71.4%), with a mean age of 83.3. The mean inpatient cost of care was $19,837.53 (range: $9,129.18 to $64,210.70). Goodness-of-fit suggests that all independent cost components were unreliable predictors for the total cost of care (all $r2 < 0.10$). Regression analysis identified variables of: age, time between admit and surgery, LOS, and CCI (all $p<0.01$) as linear associates for the total cost of care, independently and integrated. However, the goodness-of-fit analysis suggests a highly variable for age ($r2=0.01$), time between admit and surgery ($r2=0.12$), date of procedure ($r2=0.03$), and CCI ($r2=0.04$) to the overall inpatient cost of care. While LOS presents with a relatively strong linear fit ($r2=0.78$) to the total inpatient cost of care.

CONCLUSION: Overall, the total inpatient cost of care in geriatric intertrochanteric hip fracture patients is highly variable and difficult to predict reliably. While LOS has a strong correlation, a precise linear algorithm cannot be converged to consistently predict inpatient cost of care. With the transition to bundled payments in orthopedic surgery, this study presents challenges of applying alternative payment models to geriatric hip fractures.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Interprosthetic Femur Fractures: An Increasing Burden

Paper 104

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INTRODUCTION: The prevalence of ipsilateral total hip arthroplasty (THA) and total knee arthroplasty (TKA) in the U.S. is rising in concert with life expectancy. This has led to a higher incidence of interprosthetic femur fractures, which present unique treatment challenges due to implants at both ends of the femur. The aims of our study were to assess treatment methodology, survivorship, complications, and clinical outcomes of patients who sustained an interprosthetic femur fracture.

METHODS: All patients sustaining a femur fracture between an ipsilateral THA and TKA from 1972-2017 were reviewed (n=71). Patients with available injury and post-treatment hip, knee, and femur radiographs were included. Operative notes and radiographs were reviewed to determine the treatment modality selected. Mean age and BMI at the time of fracture treatment were 73 years and 30 kg/m^2, respectively. Mean follow-up was 3 years. Survivorship, ambulatory status, Harris hip scores (HHSs), and Knee Society scores (KSSs) were assessed.

RESULTS: Forty-eight patients (68%) were treated with open reduction internal fixation (ORIF), 9 of whom also received strut grafts (7 allografts, 2 autograft fibulae). Twenty patients (28%) were treated with revision arthroplasty including: 12 revision THAs, 4 distal femoral replacements (DFRs), 2 revision TKAs, and 2 total femur replacements. One patient was treated with a knee arthrodesis and 2 were treated non-operatively in casts. Survivorship free from reoperation following ORIF was 75% at 2 years; survivorship free from re-revision among those treated with revision arthroplasty was 65% at 2 years (p=0.16). In all, 18 patients (25%) underwent reoperation, most commonly for non-/delayed union (n=5), periprosthetic joint infection (n=3), and aseptic loosening (n=3). Ninety-three percent of patients were ambulatory (62% with gait aids), and HHS and KSS were excellent (80 and 89, respectively) at latest follow-up.

CONCLUSION: Interprosthetic femur fractures are a challenging problem, resulting in an elevated rate of reoperation after ORIF and re-revision following revision arthroplasty. Despite frequent complications, clinical outcomes in those without complications were favorable after operative treatment with 93% of patients being ambulatory.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Iliac Crest Bone Grafting (ICBG) vs. the Reamer-Irrigator-Aspirator (RIA): Is There a Difference in Blood Loss and Transfusion Rates?

Paper 105

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INTRODUCTION: Iliac crest bone grafting (ICBG) and the reamer-irrigator-aspirator (RIA) are two common methods for acquiring autograft. RIA is a relatively newer technique that morselizes and harvests bone from the intramedullary canal of the femur or tibia. The complications associated with RIA have not been clearly defined; recently, studies have suggested that there is a high risk for blood loss with transfusion rates approaching 50%. The purpose of this study is to compare the blood loss and transfusion risks of ICBG and RIA.

METHODS: A total of 161 patients who underwent an autologous bone graft procedure using either RIA (n=70) or ICBG (n=91) for nonunion or arthrodesis were retrospectively identified with billing codes. Operations were performed at a level 1 trauma center. Demographic and operative variables were collected, including the methods of autograft harvest and indications for bone grafting. Outcomes included change in pre- and postoperative hematocrit (ΔHct), estimated blood loss (EBL), and incidence of transfusion. Continuous and categorical data were compared with student's t-test and chi-square test, respectively.

RESULTS: Median patient age was 46 years (range 18-81). RIA was performed at the femur (n = 65) or tibia (n = 5). The indication for graft placement in the RIA group included tibial or femoral nonunion (52%, 44%), arthrodesis (3%), and other (1%). Indications in the ICBG group were tibial or femoral nonunion (51%, 20%), arthrodesis (14%), and other (15%) ($p<0.001$). The mean ΔHct was not significantly different between the two group (RIA: -8.1, ICBG: -9.0, $p=0.71$); however, estimated blood loss was significantly higher in the RIA cohort (RIA: 366mL, ICBG 231mL, $p=0.012$). Additionally, the transfusion rate was significantly higher in the RIA group (RIA: 13%, ICBG: 0%, $p<0.001$). Of the 9 RIA patients who required a blood transfusion, 8 underwent repair of a femoral nonunion.

CONCLUSIONS: Estimated blood loss and transfusion rates were significantly higher in patients undergoing RIA compared to ICBG; however, the incidence of transfusion following RIA (13%) was considerably lower than previous reports. Further, 8 out of 9 transfusions in the RIA cohort occurred in patients undergoing repair of a femoral nonunion, which was a more common indication for autograft harvest in the RIA group (44% versus 20%). These findings suggest that the risk of transfusion following RIA is present but relatively low, and there are likely other factors contributing to blood loss besides the method of autograft harvest.

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Improved Outcomes and Safety for Gustilo Type II or III Open Fractures Using Piperacillin-Tazobactam Compared to Cefazolin With or Without Aminoglycoside Antibiotic Regimens

Paper 106

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BACKGROUND/PURPOSE: To determine rates of nephrotoxicity, return to OR for deep infection, or superficial infection/wound healing complications following treatment Gustilo Type II or III open fracture of the pelvis or extremities with either piperacillin-tazobactam or cefazolin plus aminoglycoside in addition to operative debridement.

METHODS: 137 patients with Gustilo Type II or III open fracture of the pelvis or extremities were treated with either piperacillin-tazobactam (n=90), cefazolin (n=65), or cefazolin plus an aminoglycoside (n=47) in addition to irrigation and debridement and internal fixation. Multivariate logistic regression modeling was used to determine the independent association between antibiotic regimen and return to the operating room for deep infection, treatment of superficial infection with oral antibiotics or delayed wound healing, and acute nephrotoxicity (defined as increase in baseline creatinine >50% or elevation above 1.6). Adjustment was performed for age, diabetes, open fracture grade, fracture location, length of inpatient stay, duration of antibiotic treatment, delay of initial antibiotic dosing, and delay from hospital arrival to operative debridement.

RESULTS: Compared to piperacillin-tazobactam, use of cefazolin alone had higher independent odds of deep infection requiring return to the operating room (adjusted odds ratio [aOR] 3.65 and 95% confidence interval [CI] 1.38, 9.67; p=0.009), but use of cefazolin plus an aminoglycoside did not (aOR 1.02 CI 0.31, 3.37; p=0.97). Compared to piperacillin-tazobactam, both cefazolin-based regimens had higher risk of delayed wound healing or superficial infection requiring oral antibiotics (cefazolin plus aminoglycoside aOR 2.49 CI 1.01, 6.14; p=0.047) (cefazolin alone aOR 3.35 CI 1.43, 7.85; p=0.005). Compared to piperacillin-tazobactam, there was a trend toward higher odds of nephrotoxicity with use of cefazolin plus an aminoglycoside (aOR 3.29 CI 0.87, 12.4; p=0.08) but not cefazolin alone (aOR 1.15 CI 0.35, 3.77; p=0.82).

CONCLUSIONS: Compared to cefazolin-based antibiotic regimens, piperacillin-tazobactam monotherapy reduces rates of superficial infection or wound healing complications following operative fixation of type II-III open fractures and may decrease inpatient risk of nephrotoxicity.

Level of evidence: III, retrospective comparative study

MAOA BREAKOUT SESSION #8
TRAUMA
April 12, 2019

Does Gastric Bypass Surgery Increase the Risk of Complications for Fracture ORIF?

Paper 107

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PURPOSE (HYPOTHESIS): To determine the rate of complications in patients status post gastric bypass surgery that undergo fracture ORIF. We hypothesize that these patients will have a higher risk of complications due to their relative malnutrition.

METHODS: After IRB approval, 30 patients were identified who had previous gastric bypass surgery and subsequently had ORIF of a fracture. Retrospective chart review including date of gastric bypass, BMI at time of gastric bypass, type of fracture and mechanism of injury (high vs. low energy), date of fracture, BMI at time of fracture, and presence of comorbidities—medical diagnoses, nicotine and NSAID use, and immunotherapy. Endpoints included any unplanned surgery related to their fracture—infection, nonunion, etc.

RESULTS: Patients average age at the time of fracture was 49 years with an average BMI of 30.66 kg/m^2. At the time of fracture, the average BMI decrease after gastric bypass was 15.1 kg/m^2. The average time between gastric bypass and fracture was 1461 days. Type II diabetes was noted in 33.3% (10/30) patients. Fractures sustained included distal radius fractures 30% (9/30), and ulnar, tibia/fibula, and femur fractures at 13.33% (4/30) each. Fall from standing was the most common mechanism of injury-55.2% (16/30), followed by MVC at 27.6% (8/30). Seven (23%) patients experienced complications requiring operative management including nonunion 13.3% (4/30), secondary fractures 6.67% (2/30), and deep infection 3.3% (1/30).

CONCLUSION: Our anecdotal experience made it feel like these patients had a much higher complication rate after fracture ORIF than the average patient. This review revealed that although these patients were on average less than 50 years old, that their injuries were more consistent with osteoporotic patients—i.e., low energy mechanism of injury and distal radius fractures. Furthermore, all of the complication rates exceeded those expected for non-gastric bypass patients-infection, nonunion, and secondary fractures. This study adds to the available literature that can be discussed with patients preoperatively regarding their risks with fracture surgery as well as the importance of the patients continuing their recommended nutritional supplementation after gastric bypass surgery.

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MAOA BREAKOUT SESSION #8
TRAUMA
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Outcomes in Hip Fracture Patients with History of Solid Organ Transplant

Paper 108

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PURPOSE: The outcomes of hip fracture patients with a history of solid organ transplant (SOT) has not been well studied. The purpose of this study is to see if there is an increased risk of complications in this group of patients.

METHODS: A retrospective chart review was performed on 1,439 consecutive hip fractures that underwent operative fixation at our institution from January 2005 to October 2013. After excluding patients <18 years old, multiple injuries requiring surgical intervention, or an associated femoral shaft fracture, 1,426 hip fractures were included for analysis. Patient demographics, comorbidities, surgery-specific data, postoperative complications, and mortality were recorded. Patients with a history of SOT were compared to patients without a history of SOT, who served as controls. Statistical analysis for comparison of categorical variables was carried out with Chi-Squared Test of Independence or Fisher's Exact Test if conditions were not met. Comparisons of continuous variables was done using Wilcoxon Rank Sum Test.

RESULTS: Patients with a history of SOT represented 1.3% of the hip fractures treated at our institution. These patients were younger on average (60.1 vs. 78.2 years old, $p<0.0001$) and more likely to be male (63% vs. 35%, $p=0.012$). They were also more likely to have a history of diabetes mellitus (58% vs. 23%, $p=0.0011$) and chronic kidney disease (74% vs. 21, $p<0.0001$) but there was no difference in ASA. Patients with a history of SOT had a significantly higher rate of DVT (15.8% vs. 3.8%, $p=0.039$), non-surgical site infection (42% vs. 22%, $p=0.046$) and 30-day readmission (52.6% vs. 15.9%, $p=0.0003$). There was no significant difference in transfusions, MI, CVA, PE, deep SSI, admit to surgery time, length of stay, or mortality between the two groups.

CONCLUSION: Patients with a history of SOT who underwent operative fixation for a hip fracture at our institution were more likely to be younger and male and they had a significantly higher rate of DVT, non-surgical site infection, and 30-day readmission than patients who did not have a history of SOT. A limitation of this study is the small number of patients who had a history of solid organ transplant limiting the ability to perform a multivariate logistic regression analysis and further large database studies are warranted.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Total Knee Arthroplasty in Patients Less Than 50 Years of Age: Results at a Mean of 13 Years

Paper 109

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INTRODUCTION: Patients between 45 and 54 years-old will be the fastest growing cohort seeking total knee arthroplasty (TKA) over the next 15 years. There is a paucity of literature describing the outcomes of TKA in this age group. The purpose of this investigation was to determine the clinical outcomes of TKA in patients less than 50 years of age at a minimum of 10-years follow-up.

METHODS: We reviewed 298 consecutive TKA performed on 242 patients at a minimum of 10 years postoperatively. 20 patients were deceased and 30 were lost to follow-up leaving 248 TKAs in 202 patients (91 male, 111 female) with a mean age of 45.7 years (range, 26 to 49) at the time of surgery. 86% had a diagnosis of osteoarthritis. The patella was resurfaced in all cases and there were 30 hybrid constructs with a cementless femoral and cemented tibial component, while the balance were cemented. Knee Society Scores were compared using a paired t-test.

RESULTS: At a mean of 13.0 years (range, 10.0 to 21.9), there were 9 revisions for tibial loosening (3.6%), 8 for deep infection (3.2%), 7 for polyethylene wear (2.8%), and 3 for femoral loosening (1.2%; all cementless femoral components). Kaplan-Meier analysis demonstrated 92.0% survivorship (95% CI 87.5 to 95.0%) with failures defined as aseptic component revision and 83.9% survivorship (95% CI 78.0 to 88.3%) for all-cause reoperation at 13 years. Knee Society Score improved from 44.4 preoperatively to 85.7 postoperatively ($p<.001$).

CONCLUSIONS: While overall durability was good in this young patient population, tibial fixation and deep infection were relatively common causes of failure. Interestingly, cementless fixation fared worse than cemented fixation of the femoral component. Further, the nearly 3% risk of revision for wear suggests that the use of more wear resistant bearing surfaces may reduce the risk of failure in younger patients.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Total Joint Arthroplasty Outcomes in Patients with a Previous Failed Toxicology Screen: Giving Patients a Second Chance

Paper 110

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INTRODUCTION: Substance abuse has been reported as a risk factor for complications following total joint arthroplasty (TJA). The purpose of this study was to review a consecutive series of patients who failed his/her toxicology screen on the day of surgery and assess whether the outcomes of their subsequently surgery are inferior to typical arthroplasty patient benchmarks.

METHODOLOGY: Patients who underwent either primary or revision TJA who had to reschedule their surgery for having a positive day of surgery toxicology screen between 2006 and 2017 were reviewed (n=43). Standard of care was to perform a urine drug screen for cannabinoids, phencyclidine (PCP), amphetamines, cocaine, benzodiazepines, opiates, barbiturates, and ethanol. Early measured outcomes (within 90 days postoperative) included postoperative complications, hospital length-of-stay (LOS), discharge disposition, readmissions, and revision surgery.

RESULTS: Poly-substance abuse occurred in 22/43 (51%) of patients. The most common substances abused were stimulants (cocaine, amphetamine, and phencyclidine [PCP]). The 90-day postoperative outcomes included 9 (21%) non-surgical complications, 1 (2%) surgical complication. The mean LOS was 4 days (range, 1-8), and 12 (28%) of patients were discharge to a non-home facility. Readmissions occurred in 5 (12%) of patients, and revision surgery occurred in 1 (2%) patient for deep infection.

CONCLUSION: Patients who underwent TJA after having their original surgery canceled due to a positive toxicology screen had relatively high rates of postoperative complication and readmission, as well as a long LOS when compared to typical TJA benchmarks. These patients have historically been labeled as a group who are most likely to experience as adverse postoperative outcomes. This study highlights the importance of addressing this modifiable risk factor.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Implementing a Scientifically Valid, Cost-Effective, and Scalable Data Collection System at Point of Care

Paper 111

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INTRODUCTION: Improving outcomes after surgical procedures and determining the value of health care can benefit from a scientifically valid, cost-effective, and scalable data outcome collection system. We hypothesized that such a system could be constructed in orthopedic surgery to: (1) capture >95% baseline validated patient-reported outcome measures (PROMs) for patients undergoing elective surgeries, (2) capture >95% surgeon-entered data on disease severity and treatment, and (3) be implemented as a standard of clinical care in daily practice without additional personnel costs.

METHODS: A modified Research Electronic Data Capture (REDCap) system was developed and implemented as a prospective cohort at the time of surgery to collect: demographic data, general health PROMs, joint-specific PROMs, and disease severity and treatments from patients and surgeons. All elective knee, hip, and shoulder orthopedic surgeries performed in a health-care system were included.

RESULTS: From 2-18-2015, to 7-31-2017, 16,021 consecutive orthopedic surgical cases were performed. 2% (320/16,021) patients were excluded due to language or physical barriers; of the remaining eligible patients, 0.6% (91/15,701) refused to participate. Ultimately, 15,610 patients were included in the OME cohort and administered preoperative PROMs. Of those, 97.4% (15,202/15,610) completed the PROMs, while 2.6% (408/15,610) did not due to technical or workflow issues. The median time for patients to complete the PROMs was 11.5 minutes. Surgeon disease severity and treatment details were completed for 99.9% (15,592/15,610) of cases, with median completion time of 1.6 minutes. Overall, 97.3% (15,185/15,610) of patients had complete baseline enrollment into the cohort.

DISCUSSION AND CONCLUSION: This “Framingham-like” orthopedic cohort is critical to improving patient outcomes in clinical practice. Whereas the vast majority of musculoskeletal RCTs evaluate only group means/medians and are not sufficiently powered to determine on an individual basis who benefits from the intervention, a pragmatic large prospective cohort can be used to address questions on an individual basis for patient selection for surgery. Multivariable analysis of this cohort will then aid the development of shared decision-making models based on risk calculators to “translate” the best evidence for treatment of an individual patient into routine clinical practice. A scientifically valid, cost-effective, and scalable platform with over 97% baseline completion of PROMs and disease severity and

treatments across elective knee, hip, and shoulder orthopedic procedures was implemented successfully at seven facilities. The hereby presented system is scalable to the entire orthopedic community, and could serve as a model for all procedural-based specialties during routine patient care.

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MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Physical Therapy on Postoperative Day 0 Following Total Knee Arthroplasty: A Randomized Controlled Trial of 394 Patients

Paper 112

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INTRODUCTION: Early mobilization with physical therapy (PT) has been emphasized as a strategy to facilitate early discharge following total knee arthroplasty (TKA). The purpose of this study was to determine whether starting PT the afternoon of postoperative day (POD) 0, instead of starting PT the morning of POD1, could shorten hospital length of stay.

METHODS: Patients undergoing TKA were randomized intraoperatively to start PT the afternoon following surgery or the morning of POD1. Hospital length of stay in hours was compared between groups. A post-discharge telephone survey assessed satisfaction with inpatient PT, self-perceived readiness for discharge, and pain on POD0 using 10-point analog scales. An a priori sample size calculation suggested that 328 patients were required to show a 4-hour difference in hospital stay between groups; 20% was added for attrition, resulting in 394 patients to be enrolled. Comparisons were made using the non-parametric Wilcoxon rank-sum test; consequently, medians are reported.

RESULTS: Out of 394 patients enrolled and randomized, 378 (95.9%) completed the study. 183 were randomized to start PT on POD0 and 195 to start PT on POD1. Baseline characteristics did not differ between groups, suggesting appropriate randomization. Hospital length of stay did not differ between groups (intention-to-treat analysis: median of 32.0 hours for POD0 PT versus 31.0 hours for POD1 PT, $p=0.646$; as-treated analysis: median of 31.0 hours for POD0 PT versus 32.0 hours for POD1 PT, $p=0.119$). Finally, the two groups did not differ in survey responses regarding satisfaction, readiness for discharge, or pain during the inpatient stay ($p>0.05$ for each).

CONCLUSIONS: This randomized trial suggests no difference in length of stay, patient satisfaction, or patient-reported readiness for discharge when PT is initiated on the day of TKA versus the morning after.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Prospective Evaluation of Neuromuscular Electrical Stimulation for Improving Outcomes Following Total Knee Arthroplasty

Paper 113

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INTRODUCTION: Neuromuscular electrical stimulation (NMES) has been reported as an effective method for quadriceps strengthening following TKA, as well as attenuation of muscle loss in the early postoperative recovery period. This study was a randomized controlled trial designed to investigate the use of NMES on TKA patients and its effect on postoperative outcomes, including quadriceps strength and function (timed-up-and-go test [TUG]).

METHODOLOGY: A randomized controlled clinical trial enrolling 66 primary TKA patients was conducted at a large academic medical center. Patients were randomized 2:1 in the treatment (NMES use, n=44) or control arm (no NMES, n=22). Measured outcomes were recorded at baseline and at 3, 6, and 12 weeks postoperatively, and included quadriceps strength (measured by handheld dynamometer) and TUG. Patients were analyzed both by intent to treat (ITT) and by determining those who were compliant (defined as device use for minimum average of 140 min/week) and excluding those who were not.

RESULTS: At 6 weeks postoperative, the treatment group showed an average increase of 4.52 lb quadriceps strength while control patients had an average 5.16 lb decrease in strength (p=0.09). Patients in the treatment arm showed significantly better TUG at both 6 and 12 weeks postoperative, analyzed by ITT (p=0.017 and 0.026, respectively) and compliant usage only (p=0.019 and 0.020, respectively).

CONCLUSION: The use of NMES did not show a statistically significant improvement in quadriceps strength following TKA. However, the quadriceps strength improvement noted in the treatment arm may be clinically significant as evidenced by the improved TUG test results.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Microporous Polysaccharide Hemosphere Efficacy and Safety in Primary Total Knee Arthroplasty

Paper 114

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BACKGROUND: Efforts to improve total knee arthroplasty (TKA) include minimizing complications such as hematoma and infection. Preventative management may include an absorbable hemostat utilizing microporous polysaccharide hemosphere (MPH) technology. There is scarce orthopedic literature reviewing MPH, especially within the realm of adult reconstruction. This study aimed to determine whether use of MPH in total knee arthroplasty was effective and if there were associated wound complications.

METHODS: A single surgeon practice was used to identify patients from 2013 - 2017. Billing queries detected primary TKA and intraoperative use of MPH. Consecutive treatment and control groups were established by use of absorbable hemostat. Records were reviewed for hematoma rate, superficial/deep infections, blood loss, and further operative intervention within 90 days.

RESULTS: 206 cases were identified, 147 met inclusion/exclusion criteria. Treatment group n = 93 and control n = 54, demographics were similar. Mean age and BMI were 66.1 +/- 9.4 and 32.7 +/- 5.9. No intergroup difference existed regarding superficial infection (P = 0.933). No deep infections or further operation ensued in either group. Five hematomas occurred, four were in the treatment group; this lacked statistical significance (P = 0.393). Positive correlation existed between hematoma and superficial infection (P = 0.009). Postoperative blood loss was significantly greater in the treatment group (P = 0.014).

CONCLUSION: MPH demonstrated inferior bleeding control and had no significant effect on rates of hematoma or infection in primary TKA. Our results along with increasing pressure to minimize operative expenses suggest application of this agent may be unnecessary.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Total Knee Arthroplasty in Patients with Lymphedema: A Matched Cohort Study

Paper 115

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INTRODUCTION: In the lower extremity, lymphedema is characterized by fluid buildup and swelling which can lead to fibrosis of the skin and recurring soft-tissue infections. Risk factors include obesity, older age, lower extremity surgery, and radiotherapy. There is currently a paucity of data examining the impact of lymphedema in primary total knee arthroplasty (TKA). The purpose of this study was to review outcomes following primary TKA performed in patients with lymphedema compared to a matched cohort with primary osteoarthritis.

METHODS: Over a 19-year period (1998-2016), 144 patients underwent primary TKA with a preceding diagnosis of ipsilateral lymphedema. There were 114 (79%) females, a mean age of 69 years, and mean BMI of 37.1 kg/m^2. Mean follow-up was 7 years (range 2-17 years). A blinded analyst completed a 1:2 match of patients with lymphedema to a group of patients without lymphedema undergoing primary TKA for osteoarthritis during the same period. Matching criteria included sex, age, date of surgery, and BMI. Matched controls included 228 (79%) females along with a mean age and BMI of 69 and 36.4 kg/m^2. The mean follow-up for the comparison cohort was 8 years (range 2-18 years). There were no significant differences between groups on the evaluated baseline parameters.

RESULTS: Patients with a history of lymphedema were at a significantly increased risk of revision TKA (HR 7.60, P<0.001), reoperation for any cause (HR 2.87, P<0.001), and postoperative infection (HR 6.19, P<0.001). Patients with lymphedema were also at increased risk for periprosthetic fracture (P=0.04) and tibial component loosening (P=0.01). Morbid obesity increased the risk of reoperation (HR 2.11, P=0.02) and trended toward increased risk of revision TKA (HR 2.29, P=0.059) and infection (HR 2.37, P=0.06).

DISCUSSION: Patients with lymphedema are at significantly increased risk of revision, reoperation, and infection following primary TKA. This data highlights the need for appropriate patient counseling in this population and optimization of lymphedema management before and after TKA.

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MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Free Flap Coverage for Revision Total Knee Arthroplasty

Paper 116

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BACKGROUND: Insufficient soft tissue coverage following either reimplantation of an infected total knee arthroplasty (TKA) or trauma can significantly affect outcome. When primary wound closure and local rotational flaps (gastrocnemius) fail, surgeons are faced with offering a transfemoral amputation or recommending a free flap. The purpose of the current study was to evaluate the outcome of patients whom required free flaps to provide soft-tissue coverage in a revision TKA.

METHODS: We used an institutional total joint registry database and reviewed the medical records for patients undergoing a free tissue transfer in the setting of revision TKA. Among 6,433 patients from 1994-2017, 8 (0.1%) required a free flap for wound coverage. The cohort consisted of 4 females and 4 males with a mean age and BMI of 54 years and 29.7 kg/m^2. Prior to the free flap, patients underwent an average 6 (range 2-15) prior surgeries on the knee with a mean wound size of 85 cm^3. Two patients underwent free flap due to concern for previous multiple incisions. Four patients underwent revision for an infected TKA and four were performed due to multiple incisions on a post-traumatic knee. Two patients previously received a gastrocnemius flap. Mean follow-up was 7 years (range 2-25 years).

RESULTS: Free flaps included vertical rectus abdominus (n=4), anterior lateral thigh (n=2), and latissimus (n=2). The anastomosis was performed with either an end-to-side (n=6) or end-to-end (n=2) technique into the superficial femoral (n=4), anterior tibial (n=3), or posterior tibial (n=1) vessels. All flaps were taken with a skin paddle, however for the flaps which required a split-thickness skin graft, mean graft size was 212 cm^2.

Six patients required a reoperation for all cause. Of these 4 patients have required revision surgery at mean of 7 years (range 4 months-24 years) for repeat infection (n=2) and tibial component loosening (n=2). One of these patients required a transfemoral amputation due to infection. In addition, there was one partial flap loss requiring a lateral gastrocnemius flap.

Following revision TKA there was a significant improvement in the mean KSS (47 vs. 76, P=0.02). There was a trend toward improvement in the mean total range of motion between pre- and postoperative assessments (49o vs. 92o, P=0.056).

CONCLUSION: In cases where free flap coverage is needed to salvage a TKA, patients should expect a high rate of complications; however, a majority of patients are able to preserve their limb and function.

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MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Obesity and Tibial Coronal Plane Alignment in Primary Total Knee Arthroplasty

Paper 117

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INTRODUCTION: Coronal alignment of the tibial implant correlates with survivorship of TKAs, especially in obese patients. We hypothesized that external landmarks are more difficult to palpate in obese patients and extramedullary guides for tibial resection are less reliable in obese patients. The purpose of this study was to determine if obesity affects coronal plane alignment of the tibial component when utilizing standard extramedullary tibial guide instrumentation during primary TKA.

METHODS: A retrospective review from June 2017 through February 2018 identified 162 primary TKAs (142 patients). There were 88 patients (100 knees) with BMI < 35 kg/m^2 and 54 patients (62 knees) with BMI ≥ 35.0 kg/m^2. The cohorts did not differ in age (p=0.37), sex (p=0.61), or Charlson comorbidity index (p=0.54). Three independent reviewers (JC, JO, TB) measured the angle between the base of the tibial component and the mechanical axis of the tibia on the anteroposterior view of long-leg EOS film at first postoperative clinic visit (6 – 12 weeks). Patients without long-leg films, or with inadequate films for performing measurements were excluded. Groups were compared with student's t-test. Reoperations, and complications were recorded to 90 days.

RESULTS: There was no significant difference in mean tibial coronal alignment between the two groups (control 90.9° ± 1.1 vs. obese 90.7° ± 1.2°, p=0.2621). There was no difference in varus versus valgus alignment (p=0.19). There was no difference in number of outliers (2 in each group, p=0.73). There was no difference in rate of reoperation (p=1.0) or complication (p=0.51).

CONCLUSION: Obesity did not affect coronal plane alignment of the tibial component when using an extramedullary guide during primary TKA in our population.

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MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Effect of Antibiotic-Impregnated Bone Cement on Postoperative Infections in Primary Total Knee Arthroplasty

Paper 118

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INTRODUCTION: Antibiotic-impregnated bone cement (AIBC) has been used for decades to treat and prevent postoperative infections in joint arthroplasty. The literature suggests its prophylactic use in primary total knee arthroplasty (TKA) is controversial and seldom justified. The purpose of this study was to compare rates of surgical site infection (SSI) and prosthetic joint infection (PJI) within the first two years following primary TKA using AIBC or cement without antibiotics added (non-AIBC).

METHODS: A retrospective review of all cemented primary TKA procedures from a large institutional database between January 2015 and December 2016 was conducted. This identified 6,073 cases, n=2,613 in which AIBC was used and n=3,460 cases using bone cement without antibiotics. Patients were stratified into low risk and high risk groups based on age (>65 years), BMI (>40), and Charlson Comorbidity Index (CCI; >3). Medical records were reviewed for diagnoses of SSI (skin and superficial wound infections) and PJI (deep joint infections requiring surgery) over a two-year postoperative period. Univariate analysis and multivariate regression models were used to ascertain the effects of cement type, patient factors (age, gender, BMI, CCI), operative time, and length of stay on infection rates.

RESULTS: The SSI rate was 3.0% and the PJI rate was 0.8% in the study population. Univariate analysis showed no significant difference in SSI rates with AIBC compared to non-AIBC (3.3% vs. 2.8%, p=0.278) or in PJI rates (1.0% vs. 0.7%, p=0.203). Multivariate logistic regression analysis adjusted for patient factors, operative time, and length of stay showed no significant difference in SSI rates with a procedure using AIBC compared to non-AIBC (OR=0.90; p=0.515) and no significant difference in PJI rates (OR=1.01; p=0.984). Mixed models also showed no difference in PJI rates with AIBC use after adjusting for surgeon variability as well as patient factors.

CONCLUSION: Prophylactic use of AIBC in primary TKA is not without consequence when considering the significant increase in cost and its potential side effects. This study shows that even when adjusted for patient factors, procedure-related factors, and length of stay, there is no clinically significant decrease in infection rates with the use of AIBC in primary TKAs.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

The Stiff Knee: Revision for Limited Range of Motion Following Primary Total Knee Arthroplasty

Paper 119

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INTRODUCTION: Stiffness that precludes functional knee range of motion (ROM) following total knee arthroplasty (TKA) remains a challenging problem. It is unclear what gains in function and ROM are achieved following revision surgery and whether this is influenced by a preoperative deficiency in flexion or extension. The purpose of this study was to evaluate a large cohort of patients undergoing revision TKA for limited ROM with attention toward the ability of modern surgical techniques to restore flexion and/or extension.

METHODS: All patients undergoing index revision TKA for limited ROM from 1998-2015 at a single institution were identified through a total joint registry. Patients with a history of previous revision or concomitant infection were excluded. There were 106 patients in the cohort; 63% were female, median age was 61 years, and median BMI was 28.7. Preoperative and postoperative ROM standardized to 1-year follow-up was assessed. Overall knee function was assessed with Knee Society Scores (KSS) before index revision and at final follow-up. Insufficient extension was defined as a flexion contracture ≥15° and insufficient flexion was defined as flexion ≤75°. Secondary outcomes included survivorship and all-cause reoperation including manipulation under anesthesia (MUA).

RESULTS: At 1-year follow-up, median total arc of motion increased by 20° (IQR, 6-40°; $p<0.001$) with a median 10° improvement in flexion (IQR, 0-30°; $p<0.001$) and median 5° improvement in extension (IQR, 0-15°; $p<0.001$). Preoperatively, 46 patients (43.4%) had inadequate flexion and 54 patients (50.9%) had inadequate extension. At 1-year postoperatively, this improved to 28 patients (26.4%) with inadequate flexion and 17 patients (16.0%) with inadequate extension ($p=0.014$ and $p<0.001$). Eighteen patients underwent MUA after index revision TKA, 12 (66.7%) with inadequate flexion, and the remainder with flexion between 80-105°. At 1-year follow-up, 8 (44%) had inadequate flexion and 12 (66.7%) had flexion <90° ($p= 0.0778$). Cumulative incidence of all-cause re-revision against the competing risk of death was 0.9% at 1-year, 3.8% at 2-years, and 8.6% at 5-years. Median pre-revision KSS was 35 points, which improved to 76 points at final follow-up ($p<0.001$).

CONCLUSION: Although most patients experienced some measure of clinical and functional improvements, gains were modest and a subset was unable to regain a functional arc of motion. Pre-revision limited flexion and post-revision manipulation under anesthesia were poor prognostic indicators.

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MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Emergency Department Visit within One Year Prior to Elective Total Knee Arthroplasty is Predictive of Postoperative Return to Emergency Department within 90 Days

Paper 120

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INTRODUCTION: The Comprehensive Care for Joint Replacement (CJR) Model, developed by Centers for Medicare and Medicaid Services, aims to improve the quality of joint replacement. Metrics, including emergency room visit rates after Primary Total Knee Arthroplasty (TKA), are of particular interest. The purpose of this study was to determine if preoperative Emergency Department (ED) visits are predictive of postoperative ED visits among patients undergoing elective TKA.

METHODS: Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) database was utilized to identify all patients who underwent elective primary total knee arthroplasty at all hospitals within our healthcare system between January 1, 2014, and December 31, 2017. 4542 patients were identified and then cross-referenced with institutional data to determine which patients had an ED visit from up to one year prior to their surgical date to 90 days after. We assessed if preoperative visit frequency or temporality are predictive of a return ED visit within 90 days.

RESULTS: TKA patients with a single preoperative ED visit had an OR of 1.9 of returning to the ER postoperatively ($P<.001$). Increasing preoperative visit frequency correlated with expanding rate of return to ED at 3 visits (OR 5.7, $P<.001$) and 5 visits (OR 6.9, $P<.001$). The proximity of the most recent preoperative visit to surgery was a risk factor for postoperative return to ED at within 30 (OR 2.9, $P<.001$), 60 (OR 3.0, $P<.001$), and 90 days (OR 2.4, $P<.001$). Average ED charges for a postoperative ED visit were $9,669.96.

DISCUSSION/CONCLUSION: Initiatives within arthroplasty such as the CJR model continue to be a prototype for improving outcomes and efficiencies within orthopedics. Performance in these metrics, including ED visits and readmission rates after elective TKA, are utilized as an initial measure of hospital quality. These measures will dictate compensation to hospitals and providers alike. Knowledge of risk factors that predispose patients to readmission or emergency department (ED) visits postoperatively would allow opportunity for intervention that could ultimately improve performance on these metrics, and more importantly, patient care. The results of our study show that presentation to the ED is common prior to TKA and is predictive of a postoperative visit within 90 days. Increasing preoperative visit frequency and closer proximity to surgery further increase a patients' risk of a postoperative visit within 90 days.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 12, 2019

Single-Dose Perioperative Antibiotics Do Not Increase the Risk of Periprosthetic Joint Infection in Unicompartmental Knee Arthroplasty

Paper 121

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INTRODUCTION: Unicompartmental knee arthroplasty (UKA) is commonly performed as an outpatient procedure. To facilitate this process, single-dose intravenous perioperative antibiotic administration is required compared to 24-hour intravenous antibiotic dosing schedules that are typical of most inpatient arthroplasty procedures. There is a paucity of literature to guide surgeons on the safety of single-dose perioperative antibiotic administration for arthroplasty procedures, particularly those that will be performed in the outpatient setting. The purpose of this study was to evaluate a large series of UKA performed with single-dose versus 24-hour intravenous antibiotic coverage to determine the impact on risk for periprosthetic joint infection.

METHODS: All UKA cases were evaluated from 2007–2017 performed by a single surgeon at an academic institution. There were 370 UKAs in the cohort; 72 were outpatient procedures receiving single-dose antibiotics and 298 were inpatient procedures receiving 24-hour antibiotics. No patients were prescribed adjuvant oral antibiotics. Mean age was 63 years, 47% were female, mean body mass index was 32 kg/m^2, and mean follow-up was 3.7 years (range, 0.1-10.4 years). Perioperative antibiotic regimen was evaluated and postoperative infectious complications were abstracted through a prospective total joint registry and manual chart review.

RESULTS: Deep infection occurred in 1 patient (0.3%) in the entire cohort, whose UKA was performed as an inpatient. Therefore, deep infection occurred in 1/298 inpatient UKAs (0.3%) and 0/72 outpatient UKAs (0.0%; p=1.00, Fisher's exact test). The lone infection occurred 1 month after surgery with isolation of polymicrobial organisms in an immunocompromised patient status post liver transplantation. In addition, there were 2 superficial site infections, both following inpatient UKA.

CONCLUSIONS: This study demonstrates a low periprosthetic joint infection risk (0.3% or less) following UKA with both single-dose and 24-hour perioperative administration of intravenous antibiotics. Administering single-dose perioperative antibiotics is a safe practice for UKA, which should alleviate that potential concern with performance of outpatient surgery.

SUMMARY: Single-dose perioperative antibiotics are safe following UKA with 0 infections in 72 evaluated cases. The comparative rate of infection with 24-hour administration of antibiotics was 0.3%.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

A Prospective Pilot Study in Hip Arthroscopy: How Many Opiates Should We Prescribe for Pain?

Paper 122

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INTRODUCTION: Orthopedic surgeons frequently use opioids for perioperative pain management and there is considerable variability in the amount prescribed between surgeons. As such, the appropriate number of opioids to prescribe for specific procedures is often unknown. Leftover prescription opioids are at risk for diversion to family and friends for nonmedical use. The aim of this study was to determine the optimal amount of narcotics to prescribe postoperatively for patients.

METHODS: 23 consecutive patients ≥ 18 years old were enrolled in the study. A preoperative questionnaire with demographic information, prior narcotic usage, and risk factors for increased narcotic usage was obtained. All patients were prescribed 60 hydrocodone/acetaminophen 10/325 pills postoperatively as part of a multimodal pain management strategy. Patients were called at 14 and 21 days postoperatively to tabulate the number of pills used and knowledge of how to properly dispose of pills.

RESULTS: The median number of narcotic pain pills required was 6 (IQR: 3,17). 56.5% of patients required ≤10 narcotic pain pills postoperatively. 77.6% of narcotics prescribed were unused and only 34.8% of patients knew how to properly dispose of narcotics. Knowledge of how to properly dispose of unused narcotics was protective against a prolonged duration of narcotic use postoperatively (Parameter estimate -5.7; 95% CI: -11.3, -0.1; p=0.045).

CONCLUSION: Reducing the number of prescribed narcotic tablets to 25 would likely meet the postoperative pain demands of over 80% of hip arthroscopy patients. More judicious postoperative prescribing patterns would decrease the amount of unused narcotics of which only one-third of patients know how to dispose of properly. Appropriate narcotic prescribing practices and patient education regarding use and disposal may help minimize physician contribution to opioid misuse, overuse and diversion.

Level of Evidence: IV, Prospective Case Series

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Concurrent Open and Arthroscopic Surgical Management for Hip Dysplasia Does Not Reduce the Rate of Reoperation

Paper 123

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INTRODUCTION: Patients with DDH are increasingly being managed with concurrent hip arthroscopy (HA) at the time of PAO. It is thought that by addressing intra-articular pathology at the time of PAO, the need for additional surgery may be reduced. The purpose of this study was to evaluate the rate of reoperation between patients treated with either PAO, HA, or combined PAO+HA for DDH.

METHODS: We identified patients from 2014–2017 that underwent surgical management for DDH. 114 patients: 40 PAO+HA, 32 PAO, and 42 HA patients were included. Patient and radiographic variables assessed included age, gender, body mass index (BMI), Tönnis grade, lateral center edge angle (LCEA), and Tönnis angle. Operative time, follow-up time, and reoperation rates were also evaluated.

RESULTS: Mean age was 28 years, 77% were female, and mean BMI was 25 kg/m^2. The grade of DDH was more severe in the PAO group ($p<0.001$). Mean follow-up time was 41 months in the PAO+HA group, 43 months in the PAO group, and 21 months in the HA group ($p<0.0001$). Operative time was significantly longer in the PAO+HA (155 minutes) group compared to the other groups ($p<0.001$). There were 12 reoperations in the PAO+HA group, 10 in the PAO group, and 6 in the HA Group. There was no significant difference in the overall rate of reoperation between the groups, with and without consideration of hardware removal ($p=0.15$ and $p=0.51$).

CONCLUSION: Contrary to our hypothesis, performing a combined PAO+HA at the index procedure did not significantly decrease the rate of reoperation compared to PAO or HA alone. However, performing a combined PAO+HA did significantly increase the overall operative time compared to the other groups. While HA at the time of PAO does allow for management of intra-articular pathology, it does not necessarily decrease the need for additional surgical procedures.

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MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Arthroscopic Reconstruction of the Irreparable Acetabular Labrum: A Match-Controlled Study

Paper 124

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PURPOSE: To report clinical outcomes of arthroscopic labral reconstruction in the hip at minimum two-year follow-up in comparison to a pair-matched labral repair group.

METHODS: Patients were included in this study if underwent labral reconstruction during hip arthroscopy and had minimum two-year follow-up data available. Exclusion criteria were active workers' compensation claims or previous ipsilateral hip surgery or conditions. Reconstruction patients were matched 1:2 to patients that underwent arthroscopic labral repair but otherwise met all inclusion and exclusion criteria. Matching criteria were age within five years, sex, body mass index (BMI) within five, same capsular treatment, and whether there was chondral damage of Outerbridge grade II or greater. Three patient-reported outcome (PRO) measures and visual analog scale (VAS) for pain were recorded preoperatively and at a minimum of two years postoperatively. International Hip Outcome Tool (iHOT-12) and patient satisfaction were also collected at latest follow-up.

RESULTS: 34 reconstruction patients were matched to 68 repair patients. There were no significant differences in demographics between groups for age ($p = 0.941$), gender ($p > 0.999$), and body mass index ($p = 0.935$). Both the reconstruction and repair groups saw statistically significant increases in all PRO measures preoperatively to 2-year follow-up. The repair group had a slightly higher mHHS and NAHS value of 85.6 and 83.8 respectively along with a lower VAS score of 2.4, while the reconstruction group had a higher HOS-SS value of 74.2. There were no significant differences in rates of postoperative complications ($p > 0.999$), secondary arthroscopy ($p > 0.999$), or conversions to THA ($p = 0.728$) between groups.

CONCLUSION: Arthroscopic labral reconstruction is a safe and effective procedure for the treatment of irreparable segmental deficiencies of the labrum. It is associated with significant improvement in PROs and a low incidence of secondary surgery within two-year follow-up. Improvements in PROs, VAS, patient satisfaction, and incidence of secondary procedures were comparable to a match control treated with labral repair.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Hip Arthroscopy Volume in United States Residency Programs: Are New Trainees Prepared?

Paper 125

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INTRODUCTION: Hip arthroscopy is a technically demanding procedure with a steep learning curve. Recent data suggest that at least 70-80 arthroscopic procedures are necessary before becoming competent in diagnostic hip arthroscopy, while >250 arthroscopic procedures are required to obtain competency in complex tasks and >600 are required for mastery of hip arthroscopy techniques. The purpose of this study is to determine if current arthroscopic case volume over the course of an orthopedic surgery residency is sufficient to meet the number of cases required to achieve competence and/or mastery in hip arthroscopy.

METHODS: Publicly available Accreditation Council for Graduate Medical Education (ACGME) case log data for arthroscopic procedures from accredited orthopedic residencies were reviewed from 2012-2017. Linear and segmental regression analyses were used to identify temporal trends, with significance set to $p<0.05$.

RESULTS: From 2012-2017, the median number of hip arthroscopy procedures logged over the course of a five-year orthopedic residency increased significantly from 0 cases in 2012 (range; 0-48 cases) to 5 cases in 2017 (range; 0-76 cases) ($p=0.02$). Over the study period, the median number of total arthroscopic procedures logged decreased from 301 to 186 ($p=0.01$), while the median number of all logged surgical procedures did not change significantly from 2,211 in 2012 to 1,603 in 2017 ($p=0.76$).

DISCUSSION: In the United States, resident experience with hip arthroscopy has increased. However, the discrepancy in the number of logged hip arthroscopy procedures between residents in the 50th percentile and residents in the 100th percentile suggests that the majority of orthopedic surgery residents are graduating with little to no hip arthroscopy experience. Moreover, the median number of total arthroscopic procedures has declined to the point where the average graduate may not be able to perform complex hip arthroscopy tasks based on previously published data. These findings support the need for further investigation into the best methods for training residents interested in performing hip arthroscopy.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

The Education and Training of Future Hip Arthroscopists: Aggregate Recommendations of High-Volume Surgeons

Paper 126

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INTRODUCTION: Hip preservation and arthroscopic surgery has seen a significant rise in the number of procedures performed, technical demand of newer techniques, and individuals pursuing careers in this field. However, there is no consensus on how to best prepare orthopedic surgeons for a career in hip arthroscopy. Our aim was to survey high volume hip arthroscopy surgeons regarding their perspectives on the current and future training of hip surgeons.

METHODS: We conducted a cross-sectional survey of 16 high-volume orthopedic surgeons specializing in hip arthroscopy to report their perspectives and opinions on the most appropriate education of future hip preservation surgeons. All participants completed the survey in person in an anonymous fashion.

RESULTS: Of the participating surgeons, the mean career hip arthroscopy volume was 1031.25 cases (250 to >3000) with an average annual volume of 162.08 cases (75-400). The average number of cases believed to be necessary for competent joint access, labral repair, acetabuloplasty/femoroplasty, labral reconstruction, and capsular closure/plication were 19.38 (10-40), 34.33 (15-50), 53.75 (20-100), 100.71 (10-200), and 53.33 (10-200), respectively. Fifty-six percent of the surgeons believe mid-career surgeons who have never done hip arthroscopy should not adopt it as part of their practice. Most (75%) surgeons believe a single weekend instructional course is an unacceptable way of beginning a hip arthroscopy practice. All surgeons, however, believe a sports medicine fellowship with exposure to a minimum of 40.71 (10-60) hip arthroscopies is acceptable, but 66.92 (25-10) is ideal. The most ideal way to begin a practice is thought to be a dedicated hip preservation fellowship (87.5%). 62.5% of surgeons believe most hip arthroscopies in the future will be done by surgeons who focus on the hip. If a dedicated hip preservation fellowship is pursued, all surgeons believe 6 to 12 months with 128.57 (50-250) arthroscopies is optimal.

CONCLUSION: Surgeons in training, interested in careers focused on hip preservation should strongly consider one (sports medicine), if not two (hip preservation) post-residency fellowships as the number of suggested procedures for competency is unlikely to be encountered in most orthopedic surgery residency programs. Ideally, a 6-12 month long hip preservation fellowship with both open and arthroscopic surgical hip preservations techniques, hip arthroplasty, and research exposure would be completed. Surgeons mid-career, should be cautious about adopting hip arthroscopy into their practice if they have not had prior adequate training.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Validation of a Novel Hip Arthroscopy Simulator

Paper 127

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BACKGROUND: Arthroscopic surgery in the hip can be technically demanding and has been cited to have a learning curve associated with safe and proficient practice. Recently, arthroscopic simulators have been developed to anatomically model a number of different joints including the knee, shoulder, and most recently the hip. Simulation training is becoming increasingly common in skill development, offering trainees the opportunity to practice arthroscopic procedures in a safe and controlled environment with no risk of harm to patients. Many newer simulator models have yet to be validated. The purpose of this study is to validate a novel anatomic hip virtual reality arthroscopy simulator.

MATERIALS AND METHODS: Twenty-one trainees (medical students and orthopedic surgery residents) and one sports medicine fellowship trained sports orthopedic surgeon at a single academic institution were recruited to perform a diagnostic hip arthroscopy using the VirtaMed ArthroS hip module anatomic virtual reality simulator. Trainee characteristics including level of training, general arthroscopy experience, and hip specific arthroscopy experience were gathered via questionnaire. Performance metrics including composite score, time, camera path length, and cartilage damage were recorded by the simulator for each attempt. Participants were categorized as novice (<25), intermediate (25-75), or advanced (>75) arthroscopists based on the number of arthroscopy procedures performed.

RESULTS: Overall performance on the simulator was significantly higher in those with more arthroscopy experience. Composite performance score in the novice category was 114.5 compared to 146.4 in the intermediate group and 151.5 in the advanced group ($p = 0.0019$). Novice arthroscopists performed the diagnostic hip arthroscopy module in an average time of 321 seconds compared to 202 in the intermediate group and 181 in the advanced group ($P < 0.002$). Camera path length required also improved with experience, 202 cm in the novice group versus 172 in the intermediate group and 147 in the expert cohort, but this did not reach a level of statistical significance ($p = 0.3804$). Cartilage damage and safety score did not differ significantly between groups. Simulator composite score and time showed a high degree of correlation with year of training ($r = 0.65$ and -0.70), respectively.

CONCLUSION: The novel ArthroS hip simulator shows good construct validity overall and performance correlates highly with number of general arthroscopic cases reported during training. Certain metrics such as simulated cartilage cannot distinguish between different levels of surgical experience.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

The Rapidly Assessed Predictor of Intraoperatively-Visualized Damage (RAPID) Score: An In-Clinic Predictive Model for High Grade Acetabular Chondrolabral Disruption

Paper 128

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PURPOSE: Preoperative assessment of cartilage pathology is critical to surgical planning and decision-making. Accurate radiographic determination of acetabular cartilage damage has remained elusive for modern imaging modalities, including magnetic resonance imaging (MRI) and arthrography. While risk factors have been individually described, there exists no multivariable system for predicting high grade cartilage damage. The purpose of this study was to determine preoperative predictors of Grade 3-4 Acetabular Labrum Articular Disruption (ALAD).

METHODS: All primary hip arthroscopies performed between December 2007 and April 2017 with retrievable radiographs at two high-volume institutions were reviewed. The predictive value of demographic and radiographic factors for intraoperative documentation of ALAD grade 3-4 damage was analyzed, entered into a multivariable model, and a statistically-guided scoring system for damage risk was created using the Akaike Information Criterion (AIC). The scoring system was then prospectively validated on 167 patients collected between April 2017 and February 2018.

RESULTS: 652 primary hip arthroscopies in 614 patients (390 F, 224 M, age: 33.2±12.5 years, BMI: 26.9±5.5) were analyzed. Male gender (OR: 3.1, $p<0.01$), age ≥35 years (OR: 2.0, $p<0.01$), cam morphology (alpha angle >55°, OR: 3.0, $p<0.01$), and Tönnis grade 1-2 changes (grade 1 OR 4.1, $p<0.01$; grade 2 OR: 9.3, $p<0.01$) were univariate risk factors for intraoperatively-documented high grade damage. A multivariable scoring system, the Rapidly Assessed Predictor of Intraoperatively-visualized Damage (RAPID) Score (0 to 5 points), was generated based on sex, Tönnis grade, and cam morphology. Patients with increasing RAPID scores had increasing risk of damage, with 10.5% risk in the 0 point score group and 88.0% risk in the 5 point group ($p<0.01$). Area under the curve (AUC) was 0.75 for the study group and 0.76 in the validation group ($p=0.94$).

CONCLUSION: While preoperative MRI imaging has diagnostic value for hip arthroscopy, the RAPID score provides added benefit as a readily employable, in-clinic system for predicting high grade cartilage damage without the need for advanced imaging. The discriminatory value of the RAPID score compares favorably with previous MRI and arthrography studies. This information will help the clinician and patient plan for high grade damage, and identify potential targets for cartilage treatment.

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MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
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Prognosis Following Hip Arthroscopy Varies in Professional Athletes Based on Sport

Paper 129

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BACKGROUND: Return-to-play (RTP) outcomes have been reported for professional athletes undergoing hip arthroscopy; however, it is unknown how postoperative performance is affected by sport played.

PURPOSE: To evaluate performance-based outcomes in professional athletes across different sports following hip arthroscopy.

STUDY DESIGN: Cohort study; Level of evidence, 3.

METHODS: Professional athletes of the National Football League (NFL), Major League Baseball (MLB), National Basketball Association (NBA), and the National Hockey League (NHL) who underwent hip arthroscopy were identified using an established protocol of injury reports and public archives. Sport-specific statistics were collected before and after hip arthroscopy for each athlete leading to a performance score. RTP was defined as the first regular or postseason game played following surgery.

RESULTS: Of the 131 professional athletes who met inclusion criteria, 116 (88.7%) returned to play. The RTP rates were 90.9, 81.0, 83.3, and 95.9% for NFL, NBA, MLB, and NHL, respectively, with no significant differences found through Kaplan-Meier analysis. The average number of seasons played after hip arthroscopy were 3.2, 2.8, 1.5, and 1.9 for the NFL, NBA, MLB, and NHL cohorts, respectively, which were not significantly different between sports. MLB and NHL cohorts experienced a significant decrease in games played in the first season following hip arthroscopy ($P = .04$, $.01$), while NHL players also experienced a decrease in games played in seasons two and three postoperatively ($P = .001$). Performance scores also significantly decreased in the NHL cohort for all seasons postoperatively when compared to preoperative values ($P < .001$, $P = .003$). Within professional hockey players, goalies demonstrated the greatest recovery time required to RTP ($P = .02$). No other statistically significant differences were found when comparing players of different sports.

CONCLUSIONS: While professional athletes demonstrate a high rate of RTP following hip arthroscopy across the four major North American team sports, hockey players demonstrate the worst prognosis following hip arthroscopy with sustained decreases in games played and performance in the first three seasons postoperatively. The reasons for this finding may be multifactorial including sport-specific physical demands, age at surgery, and point in career when surgery is performed in this cohort.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

PROMIS Validation in Hip Arthroscopy for FAI

Paper 130

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OBJECTIVES: The value of health care delivery and assessment has recently undergone a paradigm shift in the United States with increasing focus on Patient-Reported Outcomes (PROs). PROs provide a quantitative analysis of a patient's perception of their health, function, or quality of life and responses to medical interventions. Within the field of orthopedics, providers and policy makers are interested in the value of surgical intervention. The Patient Reported Outcomes Measurement Information System - Computer Adaptive Testing (PROMIS CAT) was developed to provide measures of patient-reported symptoms and healthcare outcomes across a variety of conditions in an easily accessible manner. In order to validate PROMIS in hip arthroscopy it must be correlated with known legacy measures. The hip outcome score (HOS), Non-Arthritic Hip Score (NAHS), and modified Harris Hip Score (mHHS) have served as traditional legacy measures in this population. The purpose of this study was to validate PROMIS CAT against traditional legacy measures in patients undergoing hip arthroscopy for femoral acetabular impingement (FAI).

METHODS: Patients undergoing elective hip arthroscopy for FAI at a single academic institution from April 2017 to April 2018 by two fellowship-trained surgeons were enrolled in the study. Patients under the age of 18, revision cases, and those for diagnosis other than FAI were excluded. Eligible patients completed multiple outcomes questionnaires prior to surgery and at 2 and 6 weeks postoperatively. Outcome measures included PROMIS CAT pain and physical function, mHHS, HOS (Activities of Daily Living [ADL] and Sport Subscales), NAHS, and Visual Analog Pain Scale (VAS). Pearson's correlation coefficients were calculated between each outcome measure.

RESULTS: A total of 81 patients elected to be included in the study at an average age of 39.6±12.6 years, 54 (66.6%) were female and 27 (33.3%) were male. All 81 patients completed the pre-surgical outcome measures, 50 completed the 2 week postoperative measures, and 46 completed the 6 week postoperative questionnaires. Strong correlations were observed between the PROMIS CAT Physical Function T-Score and the mHHS (r=0.64-0.81), HOS- ADL (r=0.75-0.82), HOS-Sport (r=0.57-0.72), and NAHS (r=0.55-0.75) measurement tools. PROMIS CAT Pain T Score and VAS also demonstrated a strong correlation (r=0.66-0.77).

CONCLUSION: PROMIS Physical Function Scores correlate strongly with mHHS, HOS-ADL, HOS-Sport, and NAHS scores at all time points. Likewise, PROMIS Pain Scores correlate strongly with VAS pain scores. These results indicate that PROMIS scores can be utilized as a valid physical function and pain assessment tools for patients with FAI undergoing hip arthroscopy.

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MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
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Effect of Cigarette Smoking on Patient Reported Outcomes in Hip Arthroscopy: A Matched-Pair Controlled Study with Minimum Two-Year Follow-Up

Paper 131

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BACKGROUND: The rate of hip arthroscopy has increased; however, there is limited literature examining patient reported outcomes (PRO) in smokers.

PURPOSE: To report 2-year outcomes of arthroscopic treatment of hip abnormalities in patients who smoke cigarettes compared to a control group of patients who abstain.

METHODS: From February 2008 to July 2015, data were prospectively collected and retrospectively reviewed to identify patients that smoke at the time of primary hip arthroscopy. Patients were matched 1:2 (smoking:nonsmoking) based on patient sex, age within 5 years, labral treatment (repair vs. reconstruction vs. debridement), workers compensation status, and body mass index (BMI) within 5 kg/m^2. All patients were assessed pre- and postoperatively with 4 patient-reported outcome measures: modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score-Sport Specific Subscale (HOS-SSS), and International Hip Outcome Tool 12 (iHOT-12). Pain was estimated on the visual analog scale. Satisfaction was measured on a scale from 0-10. Significance was set at $p \geq 0.05$.

Level of Evidence: III, cohort study

RESULTS: 75 hips (72 patients) were included in the smoking group and 150 hips (140 patients) were included in the control group. At preoperative baseline, the smoking group had significantly lower PRO scores when compared with the control group for mHHS, NAHS, and HOS-SSS. Both groups demonstrated significant improvement from preoperative baseline. Minimum two-year follow-up was achieved with an average of 42.5 months for the smoking group and 47.6 months for the control group ($p=0.07$). At latest follow-up, the smoking group reported inferior results for all scores. The improvement in PROs, the rate of conversion to total hip arthroplasty, the rate of revision arthroscopy, and the rate of complications were not statistically different between groups.

CONCLUSION: Patients who smoke had lower PRO scores preoperatively and at latest follow-up. Both groups demonstrated similarly significant improvement in all PRO scores. These results show that while hip arthroscopy may still yield clinical benefit in smokers, patients who smoke may ultimately achieve an inferior functional status and should be counselled on smoking cessation in order to optimize results.

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MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
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Does Iliopsoas Lengthening Adversely Affect Clinical Outcomes? A Multi-Center Comparative Study of Hip Arthroscopy with and without Iliopsoas Fractional Lengthening

Paper 132

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BACKGROUND: Iliopsoas fractional lengthening (IFL) continues to be a controversial procedure in hip arthroscopy.

PURPOSE: Report the outcomes of patients who underwent arthroscopic IFL, with femoroacetabular impingement (FAI) and a labral tear, and to compare their outcomes to a control group that did not undergo IFL.

METHODS: Data were retrospectively reviewed between July 2009 and April 2015. Patients were eligible if they had both a hip arthroscopy for FAI and labral tear treatment with IFL (Group A) and without IFL (Group B). IFL was indicated for painful internal snapping. Minimum postoperative follow-up was set to two years and the modified Harris Hip Score, International Hip Outcome Tool, Hip Outcome Score – Activity of Daily Living Score, and Hip Outcome Score – Sports Specific Subscale, visual analogue scale for pain, patient satisfaction, minimal clinically important difference (MCID), and patient acceptable symptomatic state (PASS) were calculated.

RESULTS: 351 hips (307 patients) met the necessary inclusion criteria in the IFL cohort with a mean follow-up time of 42.5±18.1 months. For the control cohort, 392 hips (354 patients) were included with a mean follow-up time of 43.9±19.6 months. Both groups showed significant postoperative improvement in two year follow-up PROs. The group with iliopsoas lengthening showed comparable results to the control group with respect to PRO improvement, MCID, PASS, rates of revision, or THA conversion.

CONCLUSION: Previous literature has shown iliopsoas lengthening to be an effective treatment for painful internal snapping hip or iliopsoas impingement. This comparative cohort study confirmed that treatment with arthroscopic IFL, in the setting of FAI and a labral tear, is a safe procedure with good short to mid-term follow-up results and associated improvement in PROs. Patients who underwent IFL showed similar outcomes compared to a control group treated for FAI and a labral tear pathology without IFL. In appropriately selected patients, arthroscopic IFL did not adversely affect clinical outcomes.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Use of Continuous Passive Motion Device After Arthroscopic Hip Surgery Decreases Postoperative Pain—A Randomized Controlled Trial

Paper 133

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PURPOSE: To determine whether continuous passive motion (CPM) usage improves outcomes following arthroscopic hip surgery involving acetabular labral repair. Our hypothesis is that CPM usage reduces pain and pain medication use and improves quality of life in individuals who undergo hip arthroscopy.

METHODS: We created a randomized controlled trial consisting of 54 patients who underwent arthroscopic acetabular labral repair. Patients were randomized to two groups, one with CPM use postoperatively and one without. Primary outcomes measured were pain level, patient satisfaction, and quality of life. Parameters used to measure these outcomes were self-reported pain scores on Likert scale, frequency of analgesic medication use, and self-reported scores on Hip Outcome Score Activity of Daily Living (HOS ADL). These parameters were compared between the two randomized groups using t-test for statistical analysis.

RESULTS: There was no statistical difference between the treatment and control groups in terms of patient characteristics. There was no statistical difference between the two groups in terms of HOS ADL scores, although the patients in the control group demonstrated a trend toward higher HOS ADL scores. The patients in the CPM group had a statistically significant decrease in pain levels after surgery compared to patients in the control group. The total morphine equivalent dose consumed in the first two postoperative weeks was higher in the control group compared to the CPM group, although this difference was not statistically significant.

CONCLUSIONS: Use of CPM resulted in lower pain level scores in patients after hip arthroscopy. Although there is no statistical difference in quality of life or quantity of analgesics consumed postoperatively, patients who used CPM tended to have lower HOS ADL scores (which is desirable) and less consumption of pain medication. A study with a larger sample of patients might elucidate more differences between the two groups.

Level of Evidence: II, therapeutic

Keywords: continuous passive motion; pain; patient satisfaction; quality of life; hip arthroscopy

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MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 12, 2019

Effect of the Trendelenburg Position on Perineal Pressure During Hip Arthroscopy: A Prospective Single Institution Study of 50 Consecutive Patients

Paper 134

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BACKGROUND: The use of traction during hip arthroscopy has become standard of care to provide safe joint access and to improve visualization. Traction-related complications such as pudendal nerve neuralgia and compression related soft tissue necrosis have been described.

PURPOSE: To identify the amount of pressure exerted by the perineal post during randomized Trendelenburg positioning in the modified supine position.

METHODS: We prospectively analyzed a consecutive cohort of 50 patients treated with hip arthroscopy by a single, high-volume orthopedic surgeon. Demographic variables and hip pathology were recorded for each patient. In the operating room, patients were placed in the modified supine position on a traction extension table with well-padded perineal post. A standard blood pressure cuff was secured to the post in order to measure pressure exerted on the perineum as traction was applied to distract the hip joint. For each patient, pressure against the perineum was measured at four different positions: 0, 5, 10, and 15 degrees of Trendelenburg. These positions were tested in a randomized order. Pressure was measured at each position both off and on traction, resulting in eight measurements per patient. Mean pressure was compared within subjects under the four period crossover design using a repeated measure (mixed) analysis of variance model. Examination of the residual error quantile plot showed that the pressure data followed a normal distribution, making the use of a parametric model appropriate. Tests were made for period and order effects.

Level of Evidence: III, cohort study

RESULTS: The effect of time period (1,2,3,4) overall and the effect of order (time period within each position-degree condition) was not significant ($P > 0.05$), demonstrating that the crossover design was successful. There was a statistically significant difference between non-traction and traction pressures at all positions of Trendelenburg measured ($P < 0.0001$). There was a mean pressure drop of 8.6 mmHg (23%) pressure drop between 0 and 15 degrees of Trendelenburg when the patient was off traction, a result which was statistically significant ($P < 0.0001$). Similarly, there was a mean pressure drop of 13.1 mmHg (19.9%) pressure drop between 0 and 15 degrees of Trendelenburg when the patient was on traction, which was also statistically significant ($P = 0.0006$).

CONCLUSION: Use of the Trendelenburg position during hip arthroscopy allows for significant decrease in pressure exerted on the perineum with or without traction at all positions beyond 0 degrees. The mean pressure drop was proportional to the degree of Trendelenburg applied.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Payment Variation in Commercial Health Plans

Paper 135

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Presented by Kemi Okunade, M.D., M.P.H. / Boston, MA

INTRODUCTION: This study explores the variation in commercial health plan payments to identify the relationship between payment and quality to address the question of payment inequality amongst high performing physicians. Specifically, the study addresses this hypothesis for total joint replacement payments for commercial health plans in Massachusetts.

METHODS: We analyzed the Massachusetts All Payor Claims data from 2011-2015. We defined the unit of analysis as an episode of care following the original CMS Bundle Payment for Care Improvement definition for total joint replacement. The episode starts with an inpatient admission for MS-DRG 469, 470 and covers all services post-discharge for 90 days. Allowed amounts were used to calculate the payment for the episode period and compared across 9 large health plans in MA.

We benchmarked physicians using Achievable benchmarks of care (ABCTM) (Weissman et al, 1999). Improved Bayesian estimation algorithms were developed for small sample sizes in rankings. We use a multidimensional performance score that incorporates both quality and utilization-efficiency measures, including ER utilization, readmissions and post-acute care services. Physicians are ranked by quartiles within each health plan.

Data quality was highly variable across the 5-year time frame, so results are provided for 2015 only, where data quality was deemed high. Sample sizes were highly variable across health plans, ranging from 155 to 2700, so detailed analysis is limited to the 2 largest health plans with volumes over 1,000.

RESULTS: We first present the descriptive statistics of health plan payments and quality for all 9 plans. Next, we evaluate the benchmarking methodology, followed by a description of variation in physician and facility payments for physicians in the highest quartile.

Average episode payment for a 90-day total joint replacement was highly variable across the nine plans, with a 2.5-times difference in payment, ranging from a median of $25,460 to $63,654. Within plan variation was also highly variable with some plans having high variation (IQR=$25,578) and others tighter distributions (IQR= $6,239). No consistent relationship was observed between plan size and payment variation.

Variation in episode payment was driven by differences in physician payments, facility payments, and post-acute spend. Median physician payment during the index stay ranged from a median of $2,916 to $9,931. The interquartile range across plans was also variable ranging from $215 for the plan with the

tightest distribution to $3,922 for the plan with the highest within plan variation. There was a 2.5-fold difference in the median facility payment ranging from a low of $ 17,821 to a high of $46,652.

Performance outcomes by health plans was highly variable. There was a 5-fold difference in ER rates across plans (3.1% to 6.2%). As expected high ER rates also showed high ER to readmission conversion with a 10-fold difference across plans ~1% to 11.2%. Readmission rates ranged from 3.1% on the low end to 6.2% on the high end.

The benchmarking methodology across all plans showed high validity with the top-ranking physicians, having high quality, 3.5% readmission rate, 7.4% ER rate, 2.5% ER- readmission conversion, as well as more efficient utilization of skilled nursing facilities and inpatient rehab. While length of stay was higher for inpatient rehab, the percent of patients discharged was significantly lower 0.8% compared to 2.3%. We observed similar consistency with the two largest health plans, with differences between the lowest and highest quartiles ranging from 1.5 to 2.5 times.

Variation in physician payment amongst top 25% ranked physicians during the inpatient stay was $1,726 at the 25th percentile and $2,475 at the 75th percentile in Plan A compared to $2,201 and $3,073 in Plan B. Median payment was $2,026 for Plan A compared to $ 2,743 for Plan B.

Variation in facility payment used by top ranked physicians was $24,442 for plan A compared to $27,585 for plan B, with an interquartile range of $4,211 and $9,343 respectively. The 75th percentile was $25,436 for Plan A versus $32,421 for Plan B.

CONCLUSION: Variation in physician payments among high performing physicians can create serious disincentives for value driven healthcare. For equally high performing physicians, the difference in physician payment between the lowest and highest paid physicians was almost two-fold. There was also a two-fold difference in facility payments used by these physicians. Commercial health plans need to re-evaluate their fee for service contracting rates and appropriate reimbursement to align reimbursement with high performance.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Primary Total Hip Arthroplasty in Patients Less Than 50 Years of Age at a Mean of 16 Years

Paper 136

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INTRODUCTION: The purpose of this study was to evaluate clinical and radiographic outcomes of patients less than 50 years of age undergoing primary THA at a minimum of 10 years.

METHODS: 309 consecutive THAs performed on 273 patients were reviewed. At a minimum of 10 years, 13 were deceased, and 23 were lost to follow-up, leaving 273 THAs in 243 patients who were followed for a mean of 16 years (range 10 to 19.9 years). The cohort consisted of 115 females (47.3%) and 128 males (52.7%), with a mean age of 42.3 years at the time of surgery (range, 19 to 49 years old). The majority of preoperative diagnoses included osteoarthritis in 168 (61.7%) and avascular necrosis in 61 (22.3%). 216 had highly-cross linked polyethylene (XLPE) and 57 non-XLPE acetabular liners. Analysis involved Kaplan-Meier survivorship with a log-rank test for equivalence, Fischer's exact test for pairwise comparisons and a paired t-test for Harris Hip Score both with alpha = 0.05 being statistically significant.

RESULTS: There were six revisions for wear in the non-XLPE group (10.5%) compared to none in the XLPE group ($p<0.001$). Similarly, survivorship with revision for any reason as the endpoint at 15 years was significantly higher in the XLPE group 93.0% (95% CI 88.7 to 95.7%) compared to 85.7% (95% CI 73.5 to 92.6%) in the non-XLPE group ($p=0.023$). Additional revisions in the XLPE group included 6 for instability (2.8%), 5 secondary to infection (2.4%), and 3 stem failures (1.4%). Non-wear related revisions in the non-XLPE group included 5 due to instability (8.8%) and 3 stem failures (5.3%). The femoral stems were cementless in 98% (266/273) and the acetabular components were cementless in all cases. Femoral head composition was CoCr in all cases and the majority of sizes in the non-XLPE cohort were 28 mm (52/57; 91%) while the XLPE group primarily consisted of 28 mm (141/216; 65%) and 32 mm (74/216; 34%) heads. The Mean Harris Hip Scores for the entire cohort improved from a mean of 46.2 points preoperatively to 89.8 points postoperatively at most recent follow-up ($p<.001$).

CONCLUSION: The use of XLPE has lead to a significant reduction in the risk of failure in patients < 50 years old, with over 93% survivorship at 15 years. Instability and infection, however, remain substantial causes of failure.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Charnley Cemented vs. Contemporary Uncemented Total Hip Arthroplasty with Highly Crosslinked Polyethylene Inserts: Have We Improved in 50 Years?

Paper 137

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INTRODUCTION: There have been considerable advances in prosthesis design and surgical techniques since the cemented Charnley total hip arthroplasty (THA) in the 1960/70s. Despite these improvements, there is a paucity of data comparing the long-term durability of successful historical cemented designs with conventional polyethylene (PE) vs. contemporary uncemented designs with highly cross-linked PE (HXLPE).

METHODS: The results of cemented Charnley THAs performed from 1969–1971 (n=2311; historical) were compared to uncemented THAs with HXLPE performed from 2004-2015 (n=7894; contemporary) at a single institution. Mean patient age was 63 years in both groups. The primary diagnosis was osteoarthritis in 75% and 87% of patients in the historical and contemporary groups, respectively ($p<0.0001$). Mean follow-up was 15 years in the historical group and 5 years in the contemporary group.

RESULTS: Patients in the contemporary group were at decreased risk for revision due to aseptic loosening/osteolysis (HR=0.29, $p<0.01$), and increased risk for revision due to periprosthetic fracture (PPFFx, HR=10.9, $p<0.01$) at 10 years when compared to the historical group. Ten-year survivorship free from dislocation did not differ between groups ($p=0.24$). Multivariable analysis identified an increased risk of PJI (HR=1.6, $p=0.04$) and PPFFx (HR=12, $p<0.01$) in the contemporary group, but the risk of aseptic loosening/osteolysis remained lower (HR=0.24, $p<0.01$). All-cause reoperation and revision rates did not differ significantly at 10 years ($p=0.06$, $p=0.29$), though the reasons for reoperation/revision did differ.

CONCLUSIONS: Total hip arthroplasty with contemporary uncemented components and HXLPE acetabular inserts led to significant improvement in survivorship free from aseptic loosening/osteolysis when compared to historical Charnley cemented THAs. However, there was a 12-fold increased risk of PPFFx, and surprisingly, no difference in the risk of revision due to dislocation. Although significant strides have been made with respect to implant fixation, there remains room for improvement when it comes to preventing PJI, instability, and PPFFx.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Instituting a Restrictive Opioid Prescribing Protocol for Primary Total Hip and Knee Arthroplasty: One Institution's Experience

Paper 138

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INTRODUCTION: Orthopedic surgeons overprescribe opioids postoperatively. In 2018, our practice began following AAOS guidelines for prescribing opioids following primary total hip and knee arthroplasty (TJA). We sought to: (1) describe historical prescribing patterns after TJA, (2) describe our experiences instituting a restrictive opioid prescribing protocol, and (3) compare results and clinical outcomes before and after protocol implementation.

METHODS: We retrospectively reviewed primary TJA from 2017 to 2018. Two cohorts were created: a historical cohort (surgery prior to prescribing protocol implementation; 282 patients) and a restrictive cohort (surgery after prescribing protocol implementation; 117 patients). All patients received periarticular or regional block at the time of surgery, and opioid use in the perioperative and postoperative periods was recorded in morphine milligram equivalents (MMEs). Outcomes were assessed with KOOS Jr, HOOS Jr, and PROMIS scores.

RESULTS: The two cohorts were not significantly different in any preoperative measure, including prior opioid exposure ($p=0.64$). Perioperative opioid use (85% vs. 80%, $p=0.28$) and postoperative inpatient opioid use (4.7±3.0 MME/hr vs. 4.5±2.9 MME/hr; $p=0.47$) were not significantly different between cohorts.

Patients in the historical cohort were given significantly larger initial prescriptions than patients in the restrictive cohort (751.5±296.6 MMEs vs. 387.3±202.2 MMEs; $p<0.01$). Patients in the historical cohort received significantly more refills per patient (0.5±0.8 refills vs. 0.3±0.5 refills, $p=0.02$), and a greater overall quantity of medication through refills (253.0±447 MMEs vs 84.0±166 MMEs, $p<0.01$). The number of phone calls per patient regarding pain or pain medication was significantly less in the restrictive cohort (0.7±1.4 calls/patient vs. 0.4±0.7 calls/patient, $p=0.02$). Clinical outcome measures were not significantly different between cohorts.

CONCLUSIONS: Drastic reductions in opioid prescriptions following TJA are possible without an increase in refills, phone calls, or adverse clinical effects. Patient education regarding opioid medication and expectations set preoperatively are important for successful implementation.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Does it Matter: Total Hip Arthroplasty (THA) or Lumbar Spinal Fusion (LSF) First? Preoperative Sagittal Spinopelvic Measurements Guide Patient-Specific Surgical Strategies in Patients Requiring both THA and LSF

Paper 139

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INTRODUCTION: In patients requiring both THA and LSF, consideration of preoperative sagittal spinopelvic measurements can aid in the prediction of post-fusion compensatory changes in Pelvic Tilt (PT) and guide adjustments to acetabular anteversion during THA. This study aims to identify relationships between spinopelvic measurements and post-THA hip instability and to determine if procedure order reveals a difference in hip instability rate.

METHODS: Patients at a single practice site who received both THA and LSF between 2005-2015 (292; 158=LSF prior to THA, 134=THA prior to LSF) were retrospectively reviewed for incidents of THA instability. Those with complete radiograph series (89) had their sagittal (standing) spinopelvic profiles measured preoperatively, immediately postoperatively, and 3 months, 6 months, 1 year, and 2 years postoperatively. Measured parameters included Lumbar Lordosis (LL), Pelvic Incidence (PI), PT, and Sacral Slope (SS).

RESULTS: The rate of dislocation in this group was 12.4% (11/89). No significant difference in dislocation rate between operative order groups was elicited (7/52 LSF first, 4/37 THA first). Compared to non-dislocators, dislocators had lower LL (-10.9) and SS (-7.8), and higher PT (+4.3) and PI-LL (+7.3). Predictive power of the model generated through multiple regression to characterize individual profiles of post-LSF PT compensation based upon peri-operative measurements was most significant at 1-year- (Multiple R=0.752, R2=0.565, F=0.000456, P=0.028) and 2-years (Multiple R=0.861 R2=0.741, F=0.031, P=0.001) postoperatively.

CONCLUSION: In performing THA after LSF, this study shows its ideal to wait at least one year post lumbar fusion, beyond which further compensatory PT change is minimal. However, the order of surgical procedure revealed no statistical difference in hip instability rates. In cases characterized by large PI-LL mismatch or large SS or LL loss, a greater consideration of full functional anteversion range between sitting and standing positions is needed to account for abnormalities not appreciated with standing radiographs solely.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Degenerative Lumbar Spine Disease, Not Lumbar Fusion, is a Risk Factor for Instability After Posterior Approach Total Hip Arthroplasty

Paper 140

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INTRODUCTION: Fixed spinopelvic motion due to surgical fusion or lumbar spine degenerative joint disease (DJD) and its relationship to total hip arthroplasty (THA) dislocation recently has been described. Dislocation rates as high as 20% in patients with spinal fusion have been reported. The two primary study objectives were: (1) to report the incidence of lumbar spine DJD and previous lumbar spinal fusion and (2) evaluate their relationship to postoperative instability in posterior approach THA.

METHODS: We retrospectively reviewed 809 consecutive posterior approach THAs performed between 2011 and 2017 in a prospectively collected institutional database. Exhaustive medical chart and radiographic review of existing lumbar spine imaging in the institutional radiograph system were utilized to identify patients with lumbar DJD and those patients with a history of lumbar spine surgery. Univariate and binary logistic regression analyses were used with $p < 0.05$ significant.

RESULTS: After dual-mobility bearings were excluded, 787 THAs in 689 patients were analyzed. There were 9 dislocations (1.1%, 9/787). Lumbar spine DJD and previous spinal surgery occurred in 31.6% (218/689) and 13.8% (95/689) of patients, respectively. In the 95 spinal surgeries, 34 were spinal fusions. Six of the nine dislocations had lumbar spine DJD ($p=0.022$). Previous lumbar spinal surgery and fusion were not associated with THA dislocation in this cohort. A larger femoral head/acetabular cup diameter ratio minimized dislocation risk ($p<0.002$).

CONCLUSION: While most reports of the spinopelvic relationship report a higher risk of THA dislocation with lumbar arthrodesis, our data conversely documents that lumbar DJD is the predominant risk factor. Until further research elucidates weather spinopelvic pathology and orientation specifically directs optimal implant position and placement, it is advisable to optimize the femoral head/cup diameter ratio by selecting the largest head diameter available for a given cup size in these high-risk patients.

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MAOA BREAKOUT SESSION #11
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Effectiveness of the Quadratus Lumborum Block for Total Hip Arthroplasty

Paper 141

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BACKGROUND: Quadratus lumborum (QL) block is an anatomic block where local anesthetic is injected between the quadratus lumborum muscle and the medial layer of the thoracolumbar fascia. This method has been shown to provide anesthesia to the T7 - T12 dermatomes for roughly 24 hours. This block has utility in surgeries near the waistline and within these dermatomes. This study aims to evaluate the effect of QL blocks on postoperative pain scores and required pain medicine used in patients after primary total hip arthroplasty (THA).

METHODS: The medical records of 238 patients who underwent primary THA at a single institution between January 1, 2017, and March 31, 2018, were retrospectively reviewed. Quasi random sampling was performed, and patients from the first five months and last five months were selected. Opioid consumption in total morphine equivalents and postoperative pain scores were compared between patients who received QL block preoperatively and patients who did not receive a QL block.

RESULTS: Of 238 patients evaluated in this study, 79 received a QL block and 159 did not receive a block. At PACU entry and discharge, patients not receiving a QL block had statistically significantly higher pain scores (2.6 vs. 1.1 and 2.7 vs. 1.2, respectively); pain scores at 12 hours (2.7 vs. 3.0), 24 hours (4.2 vs. 4.6) , and 48 hours (4.0 vs. 4.1) postoperatively were not significantly different between the groups. Patients receiving QL block required significantly less total morphine equivalents intraoperatively (13.06 vs. 25.09), in the PACU (4.50 vs. 8.70), within 24 hours (53.82 vs. 77.59), and within 48 hours (83.07 vs. 131.51) of surgery.

CONCLUSION: This study showed that patients receiving QL blocks had decreased primary pain scores compared to patients not receiving QL blocks for the initial postoperative period. There was also a significant decrease in opioid requirement for patients receiving a QL block. This is significant as the utilization of this anesthetic strategy could decrease pain and the use of opioid drugs in these patients. Randomized-controlled trials are necessary to further evaluate this.

MAOA BREAKOUT SESSION #11
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Osteonecrosis Risk Imparted by PPARG Genetic Variance and Pharmacologic Modulation

Paper 142

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INTRODUCTION: Osteonecrosis of the femoral head (ONFH) is multifactorial with 40% of cases classified as idiopathic. Genetic and epigenetic etiologies have been postulated, yet no biologically-significant molecular markers have been elucidated. The purpose of this study was to determine whether putative single nucleotide polymorphisms (SNPs) exist that are associated with biologically-relevant genes modulating ONFH risk.

METHODS: This multicenter genome-wide association study (GWAS) evaluated participants enrolled in a central tissue biobank from August 2009 to March 2017. An initial discovery cohort consisted of 102 ONFH cases and 4125 controls; a subsequent validation cohort included 38 ONFH cases and 464 controls. The ONFH and control populations were matched based on age, sex, and steroid exposure status. Unbiased GWAS was performed in the discovery cohort followed by targeted analyses of significant SNPs in the validation cohort. SNP candidates were further analyzed to determine their impact on evolutionarily conserved regions, protein binding motifs, and three-dimensional chromatin organization. Real world impact was subsequently assessed by means of targeted pharmaco-surveillance.

RESULTS: Seven SNPs with individual sub-genome-wide significance (P-range=1.58x10-2-5.50x10-6) were tightly clustered adjacent to the 3′ end of PPARG. Gene-level significance was achieved (P=3.33x10-6) when all seven were considered. The SNP with the strongest association (rs980990; odds ratio [OR], 1.95; 95% CI, 1.46-2.59; P =5.05x10-6) was located in a highly conserved region consisting of several critical protein binding sites (i.e., CTCF and CEBPβ). Disruption of these sites compromises susceptible three-dimensional chromatin organization and alters PPARG 3′ end interactions with its 5′ promoter and transcription start site. Subsequently, clinical record evaluation of 9,638,296 individuals demonstrated that use of anti-diabetic thiazolidinediones, a class of PPARG agonists, increased the relative risk for ONFH by 5.6 (95% CI, 4.5-7.1).

CONCLUSIONS: Increased risk of ONFH development is associated with malignant SNPs that disrupt PPARG regulatory domains. Mechanistically, this compromises musculoskeletal differentiation (pro-adipogenic and anti-osteogenic), and alters steroid metabolism and vasculogenesis (pathognomonic of ONFH). Pharmacologically, predisposition to ONFH was further exposed with thiazolidinedione use, which upregulates PPARG expression and increases proclivity for fractures. Collectively, these findings provide a foundation to address ONFH of uncertain origin, and inform diagnostic and therapeutic development for a patient population with limited options.

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MAOA BREAKOUT SESSION #11
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Perfusion of the Femoral Head During Surgical Hip Dislocation Through a Modified Direct Lateral Approach: Real-Time Doppler Flowmetry Monitoring

Paper 143

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BACKGROUND: Surgical hip dislocation is the gold standard procedure for complex intra-articular pathologies not amenable to arthroscopy. We have previously reported that this procedure could be safely performed through a trochanter-sparing direct lateral approach in a cadaveric model. The primary objective of this study was to confirm our previous findings in-vivo using laser Doppler flowmetry.

METHODS: Perfusion of the femoral head was measured intraoperatively in 30 patients (30 hips, age range 35-70 years old) undergoing hip resurfacing arthroplasty through our previously described modified direct lateral approach. Custom high-power laser Doppler probes were inserted into the femoral head immediately preceding capsular incision and continued until the native femoral head was reduced after a period of dislocation, allowing real-time monitoring. Changes in the Doppler blood flow after each procedural step were compared to the baseline value using Wilcoxon Signed-Rank tests.

RESULTS: There was an initial reduction in femoral head blood flow with anterior capsulectomy (mean -10%, range -77 to +136, p=0.134) that was not significantly different from the baseline signal by the time of hip reduction after a period of dislocation (mean +27%, range -93 to +626, p=0.166). Pulsatile Doppler signals that were synchronous with the pulse oxymeter were found in 100% of the baseline, 100% of the capsular incision and 90% of the reduced femoral heads.

CONCLUSIONS: This study provides in-vivo evidence for our previous findings that surgical hip dislocation could be safely performed through a trochanter-sparing modified direct lateral approach. The primary advantages of the described approach are (1) the avoidance of the osteotomy-related morbidity (nonunion, malunion, and hardware complications) and (2) the increased familiarity to many orthopedic surgeons as a common hip exposure technique. Because the major blood supply to the femoral head enters along the posteromedial aspect of the neck, care should be exercised to avoid extended capsular release or retraction in this region.

Level of evidence: Therapeutic level II

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April 13, 2019

Cadaveric Study of Anterior Acetabular Retractors During Anterior Total Hip Arthroplasty in Relation to the Femoral Neurovascular Bundle

Paper 144

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INTRODUCTION: The incidence of nerve injury in primary total hip arthroplasty (THA) was recorded as 0.09% to 3.7% resulting in paresthesias, neuropathic pain, or motor weakness. Although the incidence of vascular injuries is lower at 0.2% to 0.3%, they are more life threatening. These neurovascular injuries are commonly due to compression or traction from retractors. Of the various approaches, the direct anterior approach is traditionally considered less invasive and is becoming more popular. This study analyzes the relationship of the femoral neurovascular bundle to the anterior acetabular retractor during THA via direct anterior approach.

METHODS: Eleven fresh-frozen cadaver hemi-pelvises were utilized. Each hemi-pelvis underwent a standard direct anterior approach THA, with placement of an anterior acetabular retractor between the iliopsoas and acetabulum for visualization during acetabular preparation. Once proper placement of the retractor was attained, careful dissection of the femoral triangle was performed to expose the femoral neurovascular structures. The distances from the anterior retractor tip to the femoral nerve, artery, and vein were recorded with a ruler and analyzed as mean distance ± standard deviation.

RESULTS: In all 11 cadavers, the retractor tip was medial to the femoral nerve. The femoral nerve was draped over the tip of the retractor with the iliopsoas muscle separating the two. The mean distance from retractor tip to femoral artery was 5.9 mm (S.D. = 5.5, range 0-20), while the mean distance to the femoral vein was 12.6 mm (S.D. = 10.7, range 0-35). In five specimens, the femoral artery and vein overlapped the tip of retractor. It was noted if the retractor pierced the iliopsoas muscle during insertion, the femoral nerve was compressed between the retractor and acetabulum.

CONCLUSION: The femoral neurovascular bundle is at risk for injury during anterior THA from the anterior acetabular retractor. It is possible that the supine position might alter the relative position or tension of the bundle as compared to the lateral position. This could be indicative that during direct anterior approach, the femoral neurovascular bundle is in closer proximity and therefore at greater risk of injury, but further investigation is necessary. Surgeons must be aware of the proximity of the neurovascular structures in relation to the anterior acetabular retractor, careful not to perforate the iliopsoas muscle during retractor insertion, and avoid excessive traction to prevent nerve injury.

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A Risk Assessment Model for Unplanned Hospital Readmission Following Total Joint Arthroplasty

Paper 145

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BACKGROUND: Identifying predictors of hospital readmission and strategies to avoid them can help improve quality of care and reduce costs. Unplanned readmission following total joint arthroplasty (TJA) is a major driver of increased costs in an episode of care. The appropriate time to assess risk for readmission can vary based on whether a patient has a complication-free surgical episode. The objective of this study was to build predictive models for unplanned 30-day readmission following TJA based on variables (1) available at admission and (2) reassessed at discharge.

METHODS: A consecutive series of 4,067 patients who underwent elective primary and aseptic revision TJA (hips and knees) in 2016 were identified. We excluded 67 patients due to missing follow-up data. Demographics, comorbidities, surgical data, postoperative complications, discharge disposition, and hospital unplanned readmission were collected. Logistic regression with backward selection was used to build models. Model discriminations were measured using concordance index (c-index) and calibrations were assessed. Odds ratios with 95% confidence intervals were calculated.

RESULTS: A total of 218 patients (5.5%) had unplanned readmission within 30 days following surgery. Pre-admission model c-index was 0.701. Race (black), COPD, substance use, preoperative anticoagulants, age, and BMI were significant predictors for 30-day readmission prior to admission (data not shown). Post-discharge model c-index was 0.797. Substance use, non-home discharge, operative time, and hospital LOS were significant predictors for 30-day readmission.

CONCLUSION: This study demonstrates that reliable risk assessment at admission can be made preoperatively (c=0.701). A second model can be applied at discharge, to reassess risk and incorporate any potential issues that may have occurred during the episode of care. This discharge model has one of the highest scores reported, at nearly 80% predictability for 30-day readmission following TJA.

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Emergency Department Visit within One Year Prior to Elective Total Hip Arthroplasty is Predictive of Postoperative Return to Emergency Department within 90 Days

Paper 146

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INTRODUCTION: The Comprehensive Care for Joint Replacement (CJR) Model, developed by Centers for Medicare and Medicaid Services, aims to improve the quality of joint replacement. Metrics, including emergency room visit rates after primary Total Hip Arthroplasty (THA), are of particular interest. The purpose of this study was to determine if preoperative Emergency Department (ED) visits are predictive of postoperative ED visits among patients undergoing elective THA.

METHODS: Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) database was utilized to identify all patients who underwent elective primary total hip arthroplasty at all hospitals within our healthcare system between January 1, 2014, and December 31, 2017. 2437 patients were identified and then cross-referenced with institutional data to determine which patients had an ED visit from up to one year prior to their surgical date to 90 days after. We assessed if preoperative visit frequency or temporality are predictive of a return ED visit within 90 days.

RESULTS: THA patients with a single preoperative ED visit had an OR of 2.0 of returning to the ER postoperatively ($P<.001$). Increasing preoperative visit frequency correlated with expanding rate of return to ED at 3 visits (OR 6.8, $P<.001$) and 5 visits (OR 16.7, $P<.001$). The proximity of the most recent preoperative visit to surgery was a risk factor for postoperative return to ED at within 30 (OR 4.6, $P<.001$), 60 (OR 4.1, $P<.001$), and 90 days (OR 3.7, $P<.001$). Average ED charges for a postoperative ED visit were $10,242.68.

DISCUSSION/CONCLUSION: Initiatives within arthroplasty such as the CJR model continue to be a prototype for improving outcomes and efficiencies within orthopedics. Performance in these metrics, including ED visits and readmission rates after elective THA, are utilized as an initial measure of hospital quality. These measures will dictate compensation to hospitals and providers alike. Knowledge of risk factors that predispose patients to readmission or emergency department (ED) visits postoperatively would allow opportunity for intervention that could ultimately improve performance on these metrics, and more importantly, patient care. The results of our study show that presentation to the ED is common prior to THA and is predictive of a postoperative visit within 90 days. Increasing preoperative visit frequency and closer proximity to surgery further increase a patient's risk of a postoperative visit within 90 days.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Uncemented Total Hip Arthroplasty with a Tapered Femoral Component: A Minimum 30-Year Follow-Up

Paper 147

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INTRODUCTION: Excellent intermediate-term results with use of tapered femoral components in primary total hip arthroplasty have been reported. The purpose of this study was to evaluate the outcome of total hip arthroplasty with use of a Type I tapered femoral component in patients who had been followed for a minimum of 30 years.

METHODS: 145 consecutive uncemented total hip arthroplasties in 138 patients were performed between 1983 and 1985 using the Taperloc femoral component. All surgeries were performed by a single surgeon. The outcome of every femoral component with regard to stem fixation, retention, or revision was determined for all 145 total hip replacements. At a minimum follow-up of 30 years (range, 30-36), 37 patients (40 hips) were living. Detailed follow-up was obtained on each of these patients.

RESULTS: Of the 101 patients, (105 hips) who had died, 11 hips had undergone revision of the femoral component. Only one stem had been revised for aseptic loosening. In the remaining 40 hips in 37 living patients, seven stems (17.5%) had been revised. Four well-fixed femoral components were revised during acetabular revision, three stems were revised for late sepsis. None were revised for aseptic loosening. Of those hips not requiring revision, one femoral component (2.5%) was loose by radiographic criteria.

CONCLUSION: In this entire series of 138 patients (145 hips) living and deceased, only one femoral component required revision for aseptic loosening and only one stem was loose by radiographic criteria. These results demonstrate that stable fixation using a Type I tapered femoral component can be achieved at a minimum follow-up of 30 years.

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MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Mepivacaine Spinal Anesthesia for Total Hip Arthroplasty Facilitates Shorter Length of Stay and Fewer Urinary Complications Compared to Bupivacaine

Paper 148

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INTRODUCTION: Mepivacaine as an intermediate duration spinal anesthetic for rapid recovery has not been studied in total hip replacement (THA). The purpose of this study is to compare spinal mepivacaine versus bupivacaine for postoperative measures and safety in patients undergoing THA in the lateral decubitus position.

METHODS: We retrospectively reviewed a single surgeon contemporary cohort of 312 consecutive patients undergoing primary THA between 2015-2018 at a tertiary medical center (115 mepivacaine,195 bupivacaine). Primary outcomes were urinary retention, length of stay (LOS), neuraxial complications, pain control, and opioid consumption. Statistical analysis with univariate logistic regression was performed followed by a multivariate analysis controlling for age, gender, race, smoking, body mass index (BMI), and preoperative American Society of Anesthesiologists' (ASA) score, to evaluate the effect of anesthetic with primary outcomes.

RESULTS: The univariate analysis demonstrated patients undergoing THA with mepivacaine had a shorter LOS (0.9 ± 0.7 vs. 1.3 ± 0.7 days, $p<0.001$) and fewer required a postoperative foley (0.0% vs. 5.7%, $p=0.009$) compared to bupivacaine. Patients administered mepivacaine exhibited slightly higher VAS pain scores and morphine consumption per hour (MEQ) in the postanesthesia care unit (2.2 ± 2.5 vs. 0.8 ± 1.6, $p<0.001$; 2.6 ± 3.3 vs. 0.9 ± 2.1 equivalents/h, $p<0.001$), along with slightly increased VAS pain scores on surgical postoperative day 0, but otherwise exhibited no difference in VAS scores or morphine consumption afterwards. Controlling for age, gender, race, smoker, BMI, and preoperative ASA score, the mepivacaine group had a higher average MEQ (0.64 ± 0.22 vs. 1.17 ± 0.23; $p<0.001$), a lower LOS (0.90 ± 0.15 vs. 1.19 ± 0.15, $p<0.001$), and an almost 10 times higher chance for a same-day discharge (OR 9.67, 3.72-25.15, $p<0.001$). There was no need to convert to general anesthesia or transient neurologic symptom complication in either group.

CONCLUSION: Mepivacaine for spinal anesthesia with THA produced a significant improvement in recovery time with less urinary complications, a shorter length of stay, and a higher chance of same-day discharge. Pain was well controlled in both groups with slightly increased pain and MEQ in the early postoperative period. It deserves further study as an ideal anesthetic given its shorter duration and safety in facilitating rapid recover after THA.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Cobalt Ion Release in Metal-on-Polyethylene Total Hip Arthroplasty: A Simulator Study with Cellular and Microbiological Correlations

Paper 149

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INTRODUCTION: Adverse local tissue reactions (ALTR) to cobalt (Co) and chromium (Cr) are an increasingly recognized complication of metal-on-polyethylene (MoP) total hip arthroplasty (THA). This failure mechanism has also been associated with periprosthetic joint infection (PJI). The purpose of this study was to evaluate CoCr levels generated in simulators from MoP and ceramic-on-polyethylene (CoP) constructs, and determine their impact on human bone marrow mesenchymal stem cells (BMSCs) and Staphylococcus epidermidis.

METHODS: Ten hip simulator constructs were assembled with 36-mm high-offset femoral heads, highly cross-linked polyethylene liners, and titanium stems. Five constructs used CoCr femoral heads and five used ceramic. Constructs were submerged in fetal bovine serum (FBS) and run for 1,000,000 cycles. Samples of FBS were serially collected and evaluated for CoCr concentration. Various concentrations of simulator-generated CoCr were used to assess cytotoxicity or growth impact on BMSCs and S. epidermidis.

RESULTS: After 1,000,000 cycles, mean MoP Co concentration was 1406 ng/mL compared to 0.8 ng/mL in CoP ($p<0.001$). Mean MoP Cr concentration was 142 ng/mL compared to 3.5 ng/mL in CoP ($p<0.001$). The mean CoCr ratio observed was 18, reinforcing clinical observations of differentially elevated Co relative to Cr in MoP constructs with concerns for trunnionosis. Co ions were significantly more toxic to human BMSCs than control SiO_2 in a dose-response manner ($p<0.001$). S. epidermidis growth curves were not significantly impacted across various Co ion concentrations derived from the simulators.

CONCLUSIONS: This study provides an ex vivo proof-of-concept that ceramic femoral heads can significantly decrease metal ion generation, and therefore, complications associated with ALTR. MoP constructs built in ideal conditions generated substantial CoCr debris, highlighting a baseline risk with these implants that may be exacerbated by host factors or imperfect surgical technique. Evaluation of impact on BMSCs confirms that levels produced under ideal conditions can be cytotoxic. However, these concentrations didn't potentiate or inhibit S. epidermidis growth, suggesting elevated PJI rates with ALTR are related to other factors.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

In Vivo Corrosion of Sleeved Ceramic Femoral Head Implants: A Retrieval Study

Paper 150

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INTRODUCTION: Ceramic femoral heads are increasingly used in total hip arthroplasty (THA). To mitigate the potential for ceramic head fracture and improve fit on different trunnion geometries or used trunnions, many of these implants are designed with a titanium sleeve. There is limited data to suggest whether the sleeves of ceramic femoral heads are susceptible to corrosion. The purpose of this study was to evaluate a series of retrieved sleeved ceramic femoral heads and determine qualitative and quantitative damage and corrosion patterns.

METHODS: An IRB-approved implant retrieval database was utilized to identify all sleeved ceramic femoral heads collected from 1995 to 2004. There were 16 implants with an average duration in situ of 70 months (range, 13-241 months). None were revised for metal-related complications. Mean BMI was 29 kg/m^2 and 7 patients (44%) were female. Ten implants (63%) were from primary THAs and 6 (38%) were from revision THAs. Damage and corrosion were qualitatively graded using a modified Goldberg method. Quantitative assessment was performed with a validated coordinate measurement machine (CMM) that evaluated the inner aspect of the sleeve. Results are presented as maximum linear material loss.

RESULTS: Among the 16 retrieved implants, 1 (6%) demonstrated severe Grade 4 corrosion, 2 (13%) had moderate Grade 3 corrosion, 8 (50%) had mild Grade 2 corrosion, and 5 (31%) had no visible corrosion. The implant demonstrating severe corrosion was the only one of 16 with a modular (rather than factory pre-assembled) titanium sleeve. Mean maximum linear corrosion depth at the taper interface was 7.7 microns (range, 0.9-32.9 microns); there was a non-significant difference between the mean for primary (5.6 microns) and revision (11.2 microns) implants ($p= 0.31$). There were 5 implants (31%) that had a maximum linear corrosion depth >10 microns, a threshold suggestive of potentially clinically significant material loss. There was no association between implant duration in situ and mean maximum linear corrosion depth ($R2=0.008$, $p=0.7403$).

CONCLUSION: This study is the first to quantify corrosion at the titanium interface of sleeved ceramic femoral heads. Potentially clinically significant damage and corrosion patterns were observed in a few failed retrievals; however, the majority of cases demonstrated minimal or no damage. Furthermore, there was no association between corrosion scores and primary versus revision status or duration in situ, suggesting these implants currently are performing well for the majority of patients.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Femoral Head Penetration Rates of Second Generation Sequentially Annealed Highly Cross-Linked Polyethylene at Minimum Five Years

Paper 151

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INTRODUCTION: Second generation highly cross-linked polyethylene (HXLPE) in total hip arthroplasty (THA) has demonstrated decreased wear rates, resilience to cup orientation, and reduced wear-related osteolysis compared to conventional polyethylene. Sequential irradiation and annealing below the melting temperature is unique compared to most XLPE which is irradiated and remelted. The purpose of this study was to provide minimum 5-year femoral head penetration rates of sequentially annealed HXLPE in primary THA.

METHODS: A retrospective review of a prospectively collected database identified 198 consecutive, cementless primary THAs utilizing sequentially annealed HXLPE). Operative technique and perioperative protocols were standardized. Radiographic follow-up was obtained at one-month, one-year, and five-years postoperatively. Radiographs were analyzed utilizing the Martell method with one-year radiographs as baseline to remove bedding-in during the first year.

RESULTS: Seventy patients with minimum 5-year follow up were analyzed. Mean steady-state linear and volumetric head penetration rates were 0.10 mm/year and 82 mm^3/year, respectively at five-years. Mean acetabular cup inclination and anteversion were 54.0° and 19.6°, respectively. There was no difference in linear penetration rates by sex or femoral head size and material ($p \geq 0.16$). A positive correlation existed between linear rates and age (rho=0.246, p=0.045) but not for BMI, UCLA Activity Level, polyethylene thickness, cup inclination, or anteversion ($p \geq 0.14$) with numbers available. No radiographic osteolysis was present in any patient at minimum five years.

CONCLUSION: Surprisingly, linear head penetration rates of sequentially annealed HXLPE were nearly identical to the osteolysis threshold for conventional polyethylene and greater than reports of irradiated and remelted HXLPE. Our data corroborate reports that HXLPE is resilient to cup orientation and demographic variables. Longer term-followup is required as osteolysis is likely dependent on particle size, accumulation, and patient-specific host response of wear particles and may differ between HXLPE and conventional polyethylene.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Inpatient vs. Outpatient Hip and Knee Arthroplasty: Which Has Higher Patient Satisfaction?

Paper 152

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INTRODUCTION: More surgeons are offering patients the option of having adult reconstructive procedures performed as an outpatient at an ambulatory surgery center (ASC). However, it is unknown if these patients have higher or lower satisfaction with their care than patients having a traditional inpatient stay. The purpose of this study is to compare satisfaction between inpatients and outpatients undergoing hip and knee arthroplasty.

METHODS: Portions of the Health Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, the Friends and Family Test, and 8 additional questions were administered to 174 consecutive patients. There were 8 non-responders (95.4% response rate) leaving 102 who underwent inpatient and 64 who had outpatient surgery. Responses were stratified using the "boxes" scoring approach as recommended by HCAHPS and analyzed with a Chi-squared or Fischer's exact test where appropriate. Power analysis determined that 38 patients per group were needed to detect a one-point difference in overall satisfaction between groups with 80% power and alpha of 0.05 considered significant.

RESULTS: Outpatients responded with more top responses when asked about the staff's explanation of any medicines received (91.4% versus 77.5%, p=0.026), the staff's assistance with their pain management (98.3% versus 88.0%, p=0.022), the written health information they were given upon discharge (98.3% versus 90.1%, p=0.05), and the courtesy and respect from the nurses (100.0% versus 92.2%, p=0.022). Inpatients responded with more bottom responses when asked how prepared they felt for discharge home (8.9% versus 0.0%, p=0.014). Top responses in overall satisfaction with the facility (87.1% versus 93.4%, p=0.204) and overall experience (89.2% versus 95.2%, p=0.177) were similar between inpatients and outpatients, respectively. Not surprisingly, inpatients were older (64.1 versus 59.2 years old, p=0.001), heavier (BMI 32.7 versus 30.4, p=0.035), and had higher Charlson comorbidity scores (2.6 vs 1.9, p=0.002).

CONCLUSION: Although satisfaction was high in both groups, when differences were present they favored outpatient surgery in the ASC.

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MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
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Is There Benefit in Keeping Early Discharge Patients Overnight After Total Joint Arthroplasty?

Paper 153

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INTRODUCTION: With the increasing availability of outpatient total joint arthroplasty (TJA), whether next-day discharge patients receive beneficial medical interventions requiring an overnight hospital stay is of clinical and economic importance. This study quantified the frequency, nature, and outcome of medical interventions occurring overnight after total hip and knee arthroplasty.

METHODS: 1136 primary unilateral TJAs consecutively performed between 2011 and 2016 by a single surgeon in a rapid-discharge program, managed by a perioperative medicine specialist, were reviewed. Medical records were examined for diagnostic tests and results, procedures performed, treatments received, and all-cause readmissions. Interventions before 4 p.m. the day of surgery were excluded to avoid confounding the results since outpatient TJA patients could receive interventions prior to discharge. Recorded interventions included any that varied from the preoperative treatment plan, were beyond standard-of-care interventions, and those that could not be completed at home.

RESULTS: 329 patients were discharged on postoperative day one. 88% (291) received no medical interventions. Six (1.8%) received diagnostic tests, 8 (2.4%) received procedures, and 28 (8.5%) received treatments. One received a diagnostic test and a treatment, and 3 received a procedure and a treatment. All diagnostic tests were negative, all procedures were in/out catheterizations for preventable urinary retention, and 75% of treatments were intravenous fluids for hypotension. 30-, 60-, and 90-day readmission rates did not differ based on whether interventions were received ($p \geq 0.524$).

CONCLUSION: The majority of patients received no overnight interventions suggesting unnecessary costly hospitalization. The most common issues addressed were urinary retention and hypotension. Protocols to prevent these conditions would facilitate TJA and improve safety in the outpatient setting. This study directs focus and effort in the immediate postoperative care of TJA patients which could improve healthcare quality, patient safety, and reduction of healthcare costs through a more rapid discharge home.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Identifiable Risk Factors to Minimize Postoperative Urinary Retention in Modern Outpatient Rapid Recovery Total Joint Arthroplasty

Paper 154

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INTRODUCTION: Postoperative urinary retention (POUR) following total joint arthroplasty (TJA) ranges from 0 to 75% reflecting variations in definition, measurement, and protocols. Further, POUR has been identified as a leading obstacle to outpatient and rapid discharge TJA. This study examined the incidence and risk factors for POUR in an established, evidence-based, rapid discharge outpatient TJA program.

METHODS: 617 consecutive primary TJAs performed at a suburban academic institution were retrospectively reviewed. The study population was limited to same or next day discharges with no additional inclusion/exclusion criteria. POUR was diagnosed by a perioperative internal medicine specialist whose practice focuses exclusively on TJA. Univariate analysis of potential predictors was performed, followed by binary logistic regression (BLR) testing of predictors with $p \leq 0.20$).

RESULTS: Mean patient age and BMI were 61 years and 32 kg/m^2. The overall incidence of POUR was 4.9% (30/617). Male sex, total hip arthroplasty, history of urinary retention, diabetes, coronary artery disease (myocardial infarction or stents), and use of sevoflurane or neostigmine during anesthesia were significant univariate predictors of POUR, while Foley catheter use was protective ($p<0.20$). Fourteen additional predictors, including fentanyl and morphine spinals, length of stay, and outpatient surgery were unrelated to POUR. In the final BLR model, the probability of developing POUR in patients with a history of urinary retention who received sevoflurane or neostigmine without a Foley catheter was 89%, which declined to probability of 0.7% without these four predictors ($p<0.001$).

CONCLUSION: These data add to the growing body of evidence regarding risk factors for POUR in rapid discharge TJA. Despite a relatively low incidence of 4.9%, patients with a history of POUR, and the use of sevoflurane and neostigmine by anesthesia should be carefully considered and potentially avoided in stand-alone ambulatory surgery centers.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 13, 2019

Use of a Mandatory Clinical Decision Unit Reduces Readmission Rates Following Total Joint Arthroplasty

Paper 155

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INTRODUCTION: In 2012, the Centers for Medicare & Medicaid Services (CMS) implemented the Hospital Readmission Reduction Program to reduce hospital readmission rates. This initiative was subsequently expanded in 2016 to incorporate elective total joint arthroplasty (TJA) through the Comprehensive Care for Joint Replacement (CCJR) model. Under this system, CMS retroactively assesses significant penalties based upon hospital readmission rates. Many hospitals in Michigan were subject to these penalties.

When postoperative TJA patients present to the emergency room, orthopedic staff may be unavailable to assist with medical decision making. This may lead to unnecessary hospitalization. It was hypothesized that by keeping patients in the CDU until they could be evaluated by the orthopedic team, there would be a reduction of the readmission rate after TJA at our institution.

METHODS: As a quality initiative project, Providence and Providence Park hospitals in Southfield and Novi, Michigan, mandated use of the Clinical Decision Unit (CDU) Program for all potential readmissions. A retrospective chart review was done on 269 patients that presented to the ED at Providence-Providence Park Hospital after either total hip or total knee arthroplasty. Patients presenting in the year prior to the implementation of the CDU Program were compared to patients presenting in the year after implementation. Demographics, length of stay, co-morbidities, and 30-day readmission rates were recorded. Fischer's test was done to assess categorical data and a student's t-test was used to compare age, BMI, and length of stay.

RESULTS: There were no significant differences between age, sex, BMI, or length of stay between any of the groups before or after implementation of the CDU Program. Other than a slight decrease in the prevalence of pre-existing diabetes among those receiving a total hip replacement after the implementation of the CDU program (40 before vs. 33 after; $p=0.012$), medical comorbidities were similar between the groups at all time-points. Overall, for total hip and total knee replacements, there were a combined 141 ER visits prior to the implementation of the CDU Program and 128 afterward; of those, 40 were readmitted before the CDU program and only 13 were readmitted afterwards ($p=0.0002$).

DISCUSSION: Hospital readmissions are costly and not always appropriate. Assessment by an orthopedic surgeon prior to readmission was expected to decrease the number of unnecessary readmissions. To accomplish this, the CDU was used as a "holding area" allowing for a complete orthopedic evaluation prior to readmission. During the first year of the CDU Project at our institution,

we significantly reduced readmission rates following TJA. This study suggests that the implementation of similar initiatives at hospitals may support improved medical decision making, help limit readmissions to those that are “appropriate”, and potentially save significant costs to the healthcare system and readmission penalties to the hospital.

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MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Femoral Nerve Block vs. Adductor Canal Block for Anterior Cruciate Ligament Reconstruction in Pediatric and Adolescent Patients

Paper 156

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PURPOSE: Adductor canal block (ACB) is an alternative method to femoral nerve block (FNB) for pos-operative analgesia after pediatric anterior cruciate ligament reconstruction (ACLR). The purpose of this study was to compare knee strength and function at 6 and 9 months after ACLR in pediatric patients who received FNB versus ACB perioperatively.

METHODS: Patients 18 years or younger who underwent primary ACLR between 2002 and 2017 at a single institution were identified. Isokinetic extension and flexion strength deficits and functional deficits in vertical jump, single hop, and triple hop between the two groups were compared at 6 and 9 months postoperatively. A strength deficit of 15% or less and a functional deficit of 10% or less compared to the contralateral side were considered satisfactory.

RESULTS: Of the 240 patients identified, 85 patients (64 FNB, 21 ACB) with a mean age of 15.9 years and 76 patients (40 FNB, 36 ACB) with a mean age of 15.5 years met inclusion criteria for comparison at 6 and 9 months, respectively. Univariate analysis showed greater deficits at 6 months in the FNB group with respect to fast isokinetic flexion strength (7.7% vs. -4.9%; p=.03), but no difference in slow isokinetic flexion (10.5% vs. 6.8%; p=.79), fast isokinetic extension (11.9% vs. 13.9%; p=.68), and slow isokinetic extension (19.3% vs. 12.0%; p=.24) strength deficits. There were no differences in deficits for vertical jump (8.4% vs. 4.3%; p=.55), single hop (7.4% vs. 9.3%; p=.65), or triple hop (6.0% vs. 7.1%; p=.77). Univariate analysis showed greater deficits at 9 months in the FNB group with respect to slow isokinetic flexion strength (9.6% vs. 0.4%; p=.01), but no difference in fast isokinetic flexion (-0.2% vs. 0.7%; p=.87), fast isokinetic extension (6.0% vs. 2.7%; p=.51), and slow isokinetic extension (17.3% vs -14.0%, p=.19) strength deficits. There were no differences in deficits for vertical jump (5.2% vs. 6.5%, p=.85), single hop (7.7% vs. 6.2%; p=.79), or triple hop (1.9% vs. 3.9%; p=.35).

CONCLUSION: Patients in the FNB group had statistically significant deficits in isokinetic flexion at 6 and 9 months compared to those who received ACB. Patients treated with FNB also showed clinically relevant greater deficits in slow isokinetic extension strength at 6 and 9 months postoperatively compared to those who received ACB if 85% strength return is used as criteria to return to sport. Pediatric and adolescent patients could benefit from undergoing perioperative analgesia with ACB instead of FNB.

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MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Use of Tranexamic Acid for Hip Reconstruction Surgery in Children with Cerebral Palsy: A Pilot Study

Paper 157

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INTRODUCTION: Children with cerebral palsy (CP) often develop hip subluxation, dislocation, and degeneration, which may require hip reconstruction surgery to relieve pain and restore function. Lower-extremity osteotomies are associated with high blood loss, evident by transfusion rates up to 31.1%. While tranexamic acid (TXA) has been demonstrated to be effective in adult total hip and knee reconstruction, efficacy data in the CP population is limited. The purpose of this pilot study is to review the effects of TXA on perioperative blood loss in patients with CP undergoing femoral and acetabular osteotomies before multicenter expansion.

METHODS: Our group retrospectively reviewed the charts of male and female CP patients between the ages of 1 to 18 years old that underwent femoral and acetabular osteotomies at a single tertiary referral children's hospital between June 2000 and June 2018. The following characteristics were measured: sex, gender, age at surgery, Gross Motor Function Classification System (GMFCS), weight, osteotomy type, surgeon, estimated blood loss, pre-/postoperative hemoglobin, intraoperative use of tranexamic acid, and transfusions. Estimated total blood volume (EBV) was calculated as 70 mL/kg X bodyweight. The estimated blood loss was thus reported as estimated percent blood loss of total blood volume (%EBVL)- equal to ((EBL/EBV) X 100).

RESULTS: 121 cases (64 males [53.9%], 57 females [47.1%]) met our inclusion criteria. 10 patients (8.3%) received IV TXA intraoperatively and 111 (91.7%) did not. The TXA group showed no significant difference in age at time of surgery (10.4 vs. 9.1 P=0.36), number of osteotomies (1.9 vs. 2.0 P=0.66), and median GMFCS. The mean %EBVL was higher for the TXA group (17.7% vs. 14.3% P=0.34) while the transfusion rate (10% vs. 14.5% P=0.69) and volume transfused (1.0 vs. 1.2 Units) tended to decrease with TXA administration. Furthermore, no significant difference was observed in postoperative hemoglobin (9.8 vs. 9.8, P=0.95).

CONCLUSION: In this retrospective pilot study, we found trends towards decreased transfusion rates and volumes with the use of TXA, without demonstrating decreased intraoperative blood loss. As our and other collaborating medical centers continue to gain experience in TXA use in hip reconstruction surgery, we plan to expand our study to include a larger number of patients to better elucidate the efficacy of TXA. Such work may ultimately support the utility of a randomized controlled trial sufficiently powered to detect significant differences in %EBVL.

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MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Has the Introduction of the Ponseti Method Influenced the Type of Clubfoot Procedures Performed in the United States?

Paper 158

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INTRODUCTION: Recent studies suggest rates of operative intervention of clubfoot within the first year of life have significantly declined. However, a dearth of information remains on which operative procedures continue to be performed during childhood and adolescence. Our purpose was to analyze trends in specific operative clubfoot procedures in the United States from 1997-2012.

METHODS: The HCUP KIDS' Inpatient Database was used to identify discharges associated with idiopathic clubfoot and one or more of 28 clubfoot procedures performed between 1997-2012. Clubfoot procedures were grouped into 6 broad categories: tenotomy, soft-tissue releases, tendon transfers, osteotomy, external fixation and fusions. Odds ratios were utilized to compare clubfoot operative procedures performed in 2012 compared to 1997.

RESULTS: There were 5,417 total procedures reported for clubfoot. Clubfoot patients had significantly increased odds of having a tendon transfer and fusion (OR 1.66, $p=0.0003$ and OR 1.46, $p<0.0001$ respectively) in 2012 compared to 1997. Conversely, patients had significantly decreased odds of undergoing a clubfoot release (OR 0.12, $p<0.0001$). There was no difference in odds ratios for tenotomy, osteotomy, or external fixation.

CONCLUSIONS: Clubfoot soft-tissue releases decreased significantly from 1997-2012. However, the odds of having a tendon transfer or fusion significantly increased. Most interestingly, the odds of undergoing a specific procedure varied from year to year, but the absolute number of specific procedures remained relatively unchanged—indicating a persistent trend of operative management of clubfoot in the United States.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Pediatric Septic Arthritis of the Knee: Can Predictors of Septic Hip Be Applied?

Paper 159

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INTRODUCTION: The early diagnosis and treatment of septic arthritis in pediatric patients is paramount to prevention of long-term sequela. While much of the literature has focused on markers of the hip, little is known of the application of these to the knee. The purpose of this study is to investigate if the Kocher criteria can be used for screening children suspicious to have septic arthritis of the knee.

METHODS: We retrospectively reviewed the charts of male and female patients under the age of 18, between June 2002 and June 2017, who presented to a major tertiary-care children's hospital and received the diagnosis of septic arthritis of the knee with either a positive synovial culture from the knee, synovial White Blood Cell (WBC) count > 50,000, or synovial WBC count > 25,000 cells per mm^3 and clinical agreement from Infectious Disease and orthopedic colleagues. The collected laboratory data included Kocher's initial criteria: history of fever, non-weight bearing, erythrocyte sedimentation rate (ESR), and serum WBC as well as a modified criteria of the hip: C-reactive protein (CRP). Univariate analysis determined the quality of these variables in ruling out septic arthritis of the knee.

RESULTS: 104 patient charts were found to meet our inclusion criteria. Of these, 65.38% revealed history of fever, 63.46% non-weight bearing status of the affected joint, 59.80% with ESR > 40mm/hr, 48.54% with WBC >12,000 cells per mm^3, and 75% with CRP>20 mg/dL. With the 36 different combinations of these predictors adjusted for, in an escalating fashion, zero predictors suggested a sensitivity of 0.021, one predictor a sensitivity of 0.063, two predictors a sensitivity of 0.2, three predictors a sensitivity of 0.316, four predictors a sensitivity of 0.295, and five predictors a sensitivity of 0.105.

CONCLUSION: According to the Kocher Criteria of the Hip, at 3 or more criteria the probability of septic arthritis becomes 93.1% with a sensitivity of 0.84 provoking many physicians to use this cutoff in their clinical assessment of hip pain. This study suggests that if this criteria were applied to the knee, 51.5% of septic knee cases could be missed. There is a need for further investigation of specific criteria of the knee to allow clinicians to be vigilant in ruling out septic arthritis of the knee as markers of hip septic arthritis, are not necessarily applicable in the knee.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Predictors of Total Hip Arthroplasty Following Surgical Treatment of Pediatric Developmental Hip Dysplasia

Paper 160

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SUMMARY: At mean 30 years after surgery for hip dysplasia, predictors for total hip arthroplasty were: age at surgery, type of surgery, and prior treatment before transfer to a tertiary care center.

INTRODUCTION: The long-term outcomes for the surgical treatment of pediatric developmental dysplasia of the hip (DDH) are not well defined. In addition, DDH may predispose patients to early osteoarthritis and total hip arthroplasty (THA) at a young age. The purpose of this study was to report long-term radiographic and clinical outcomes, survivorship free of total hip arthroplasty, and predictors of subsequent THA for patients that underwent prior surgical treatment for DDH.

METHODS: This study was a single-institution retrospective review of patients who underwent surgical treatment for DDH. Surgeries included closed and open reductions, pelvic osteotomies (Salter and Pemberton), femoral osteotomies or a combination of the above. There were 256 hips identified, excluding syndromic and neuromuscular disorders. The electronic medical records as well as a patient survey were used to obtain most recent follow-up, which was available for 119 hips. Demographic data, type of surgery, prior treatment or diagnosis, age at treatment, need for additional femoral osteotomy, and revision surgery were evaluated as predictors of subsequent THA.

RESULTS: Of the 119 hips, 12 were male, and the average age at treatment was 3.3 years. There were 66 pelvic osteotomies (55 Salter, 8 Pemberton, 2 Sunderland, and 1 Steele); 14 were combined with a femoral osteotomy. A femoral osteotomy alone was used for 10 hips, and 11 hips had a subsequent femoral osteotomy as a separate procedure. Of the remaining 41 hips, 28 were closed and 15 were open reductions alone. There were 32 hips treated at an outside facility before being referred to a tertiary care center. Of these, 8 had already undergone a prior pelvic osteotomy.

At the time of review, 24 hips had undergone THA at a mean age of 32.5 years, and a mean 26 years following surgery for DDH. The prior DDH surgeries for these patients were a femoral osteotomy alone (5), a pelvic osteotomy alone (7), a combined femoral and pelvic osteotomy (8), and an open reduction alone (3). Logistic regression demonstrated that older patients (> 4 years old) at time of surgery (7.6 vs. 2.7; $p < 0.001$) and type of treatment ($p = 0.02$) were associated with subsequent THA. Specifically, femoral osteotomy was associated with subsequent THA (OR 9.5, $p < 0.001$). Additionally, revision surgeries and treatment elsewhere, were predictive of subsequent THA ($p < 0.01$).

CONCLUSION: THA is a common sequela following surgery for DDH. Age and prior treatment

elsewhere were predictive of subsequent THA. These factors may emphasize the importance of early diagnosis and surgical treatment of DDH.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Biomechanical Comparison of Partially-Threaded and Fully-Threaded Cannulated Screws in Pediatric Hip Fractures

Paper 161

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INTRODUCTION: Pediatric femoral neck fractures are rare injuries, but have devastating complications without prompt diagnosis and surgical treatment. Most studies advocate for anatomic reduction, either through open or closed reduction, with percutaneous screw fixation within 24 hours. It is common practice at our institution to utilize partially-threaded screws, as this construct provides compression at the fracture site. In our clinical practice, we have identified and treated several patients with broken cannulated screws, both partially and fully threaded, after fixation for femoral neck fractures. To our knowledge, no studies have compared the biomechanical properties of three partially-threaded versus three fully-threaded screw constructs for pediatric femoral neck fractures.

METHODS: Twelve small, left-sided fourth generation synthetic composite femora were used for this study. A 70-degree vertically oriented basicervical femoral neck osteotomy, based off the horizontal axis, was created in each specimen. Six specimens received three 6.5 x 65 mm partially-threaded screws each, while the remaining six specimens received three 6.5 x 65 mm fully-threaded screws each. Each sample was incrementally loaded up to 600 Newtons (N), with 600N simulating the force of a single-leg stance in a 30-kg child. The specimens were then loaded with 600N at 3Hz for 10,000 cycles (amplitude 100N). They were then incrementally loaded up to 1050N (a force 3.5 times body weight to simulate single leg stair climb), then loaded with 1050N at 3Hz for 10,000 cycles. Finally, femora that survived the testing cycle were then loaded to failure up to 8000N.

RESULTS: None of the constructs failed cyclic loading. Ten of the 12 specimens failed in the subtrochanteric region, while 2 specimens survived 8000N of load. The partially threaded group failed at an average of 5590 ± 1963N, while the fully threaded group failed at an average of 6050 ± 1892N. There was no significant difference in load to failure between the groups. There was no fracture gapping nor broken screws in any of the constructs.

CONCLUSION: The current study found no statistical difference in ultimate load to failure between partially threaded and fully threaded cannulated screws for fixation of pediatric femoral neck fractures. All constructs survived physiologic loading, and the constructs that failed did so at supra-physiologic loads. Interestingly, 10 of the 12 femurs sustained failure in the subtrochanteric region, indicating a potential stress riser at the starting point of the screw construct.

MAOA BREAKOUT SESSION #12
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April 13, 2019

Load to Failure of Fully-Threaded vs. Partially-Threaded Cannulated Screws in SCFE

Paper 162

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INTRODUCTION: Fixation failure, such as screw breakage, in the treatment for Slipped Capital Femoral Epiphysis (SCFE) can lead to long-term complications. In our clinical practice, we have encountered patients with screw breakage. Therefore, the purpose of the study was to determine the load to fixation failure of fully-threaded versus partially-threaded cannulated cancellous screws for fixation of nondisplaced SCFE.

METHODS: Twelve pediatric-size synthetic composite femora were used for this study. An osteotomy recreating the physis was made in each specimen. Six specimens received one 6.5 x 80 mm partially-threaded screw with at least five threads crossing the physis, while the remaining six specimens received one 6.5 x 80 mm fully-threaded screw. Each sample was incrementally loaded up to 1600 Newtons (N), with 1600N simulating the force of a single-leg stance in an 80-kg child. The specimens were then fatigue-loaded with 1600N at 3Hz for 100,000 cycles. Lastly, they were loaded to failure up to 8000N.

RESULTS: None of the constructs failed cyclic loading, while all constructs failed max loading. Two screws broke in the partially-threaded group, while one other bent. One screw broke in the fully-threaded group, while three others bent. The remaining constructs failed at the bone interface with intact screws. The partially-threaded group failed at an average of 3763 ± 604N, while the fully-threaded group failed at an average of 4457 ± 789N. There was no significant difference in load to failure between the groups.

CONCLUSIONS: There was no statistical difference in ultimate load to failure between partially-threaded and fully-threaded cannulated screws for fixation of SCFE. Interestingly, two screws in the partially-threaded group and one screw in the fully-threaded group broke, while several bent. These findings were also encountered in our clinical practice, as several patients presented with broken screws requiring revision surgery. Future human studies are needed to further explore these findings.

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MAOA BREAKOUT SESSION #12
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Novel Enhanced Recovery After Surgery Pathway Significantly Reduces Length of Stay in Adolescent Idiopathic Scoliosis Patients Undergoing Posterior Spinal Fusion

Paper 163

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INTRODUCTION: Patients undergoing posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) have historically been hospitalized for 5-6 days. Recent studies suggest that enhanced recovery after surgery (ERAS) protocols decrease length of stay (LOS) and reduce opioid usage. We recently implemented a novel ERAS protocol for the management of PSF on AIS patients. This study compares patients' postoperative LOS and opioid requirements between our traditional pain (TPP) and ERAS pathways.

METHODS: We retrospectively compared TPP and ERAS pathways, assessing postoperative LOS, opioid usage, and pain scores. The TPP included intraoperative intrathecal morphine and variable postoperative pain medications. The ERAS pathway included four doses of methadone over 48 hours, hydromorphone patient controlled analgesia (PCA), methocarbamol, acetaminophen, ketorolac, ondansetron, and management by the Acute Pain Service. Data was collected from all AIS patients undergoing PSF performed by two surgeons between December 2013 and January 2018. Patients were excluded if they weighed less than 40 kilograms or had significant comorbidities. Nursing staff evaluated pain using Wong-Baker FACES scale.

RESULTS: There were 22 patients in the TPP group and 15 in the ERAS group. Hospital LOS was significantly shorter in the ERAS group, by an average of 1.7 days compared to the TPP group (3.3 ± 0.6 vs. 5.0 ± 1.9 days, respectively; $p < 0.01$). Between the groups, there was no difference in daily opioid consumption or pain scores postoperatively ($p=0.32$).

DISCUSSION: LOS serves as a surrogate for achievement of postoperative milestones, indicating satisfactory pain control and functional recovery. In our study, the significant decrease in LOS suggests that our ERAS protocol provides comparable quality of postoperative care while expediting patients' hospital discharge. We conclude from our preliminary findings that our ERAS pathway benefits our patients by decreasing LOS with no difference in postoperative opioid requirements.

CONCLUSION: The literature has indicated the value of evidenced-based algorithms and expedited pain management protocols applied to AIS PSF, but comparative evidence of independent pathways remains understudied. The preliminary results of this study provide additional insight while demonstrating an effective ERAS pathway.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Effect of Crosslinks on Lengthening Magnetic Spinal Growing Rods: A Retrospective Review

Paper 164

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INTRODUCTION: Magnetically controlled growing rods (MGRs) are a relatively new tool for the treatment of early onset scoliosis (EOS). An advantage they provide is a reduction in the number of surgeries required to continue spinal growth until definitive fusion. Crosslink connectors are known to increase the stiffness and torsional rigidity of posterior spinal constructs. Supplementation with crosslinks may be of importance in EOS because of the need to use smaller screws proximally. While crosslinks dissipate mechanical stress across anchor points, there is concern that they may limit rod lengthening. To our knowledge, there are no studies that assess the impact of crosslinks on the ability to lengthen magnetic growing rods implanted in patients. We hypothesized that there was no significant difference in the ability to length magnetic growing rod constructs with and without crosslinks as measured by average difference and percentage lengthened.

METHODS: Twelve patients instrumented with MGRs at our institution were assessed retrospectively. Of these 12 patients, 3 had crosslinks either proximal and distal or just proximal. Lengthening measurements were conducted by a single surgeon pre/post lengthening in office. Expected measurement was the distance set on the magnet to lengthen. Achieved lengthening was determined by the difference between pre/post lengthening measurements of the rods span on x-ray. The percentage lengthened was calculated as ([Expected–Achieved]/Expected)*100. The means of the treatment groups were analyzed via independent t-test on IBM SPSS Statistics 25.

RESULTS: The average difference between the expected and achieved lengthening with crosslinks was -0.71 mm +/- 0.96 mm compared to the control group achieving -1.25 mm +/- 1.69 mm ($p = 0.099$). When analyzing the percentage lengthened of the expected, there was also no difference between the crosslink (-23.32% +/- 27.64%) and control (-28.92% +/- 39.23%) ($p = 0.472$). This study found that the presence of crosslinks, either proximal and distal or just proximal, had no statistically significant difference in the ability to lengthen MGRs in pediatric scoliosis patients when compared to patients without crosslinks.

CONCLUSION: Both the crosslink and control group achieve less than expected lengthening on average at 0.71 mm and 1.25 mm less than expected, respectively, but there is no statistical significance between the two groups. Clinically this shortcoming of lengthening in both groups may be. This study shows that crosslinks on MGRs may not hinder the ability to lengthen the rods in the clinic setting.

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MAOA BREAKOUT SESSION #12
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The Safety and Efficacy of Liposomal Bupivicaine (EXPAREL) for Incisional Pain Relief Following Pediatric Spine Surgery

Paper 165

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SUMMARY: Liposomal bupivacaine (EXPAREL) is a long-acting, locally-injectable anesthetic that has been used successfully for postoperative pain control in the adult population; however, the FDA has not yet approved its use in children. We retrospectively studied 198 pediatric spinal surgery patients who received EXPAREL off-label and compared them to 129 pediatric spinal surgery patients who did not receive EXPAREL. The results clearly demonstrate that EXPAREL is both safe and effective in reducing incisional pain following pediatric spinal surgery.

HYPOTHESIS: EXPAREL is safe and effective in reducing incisional pain relief following pediatric spinal surgery.

DESIGN: A retrospective review of pediatric patients who underwent spinal deformity surgery.

INTRODUCTION: Liposomal bupivacaine is a timed-release form of bupivacaine designed for extended postoperative incisional pain relief lasting up to 72 hours. Although previous studies have demonstrated efficacy following surgery in adults, EXPAREL is currently not approved for use in children. We have been using EXPAREL off-label for incisional pain relief following spinal surgery in children since 2015. The purpose of this study was to determine if the use of EXPAREL in children was both safe and effective in relieving postoperative pain following spinal surgery.

METHODS: Between 2015-2016, 198 pediatric spine surgery patients were injected with EXPAREL (266 mg/20 ml) prior to wound closure, while between 2013-2014, 129 historical control patients were not injected. These 327 patient records were reviewed for daily postoperative analgesic requirements as calculated using morphine equivalents. The mean morphine equivalent dose for each postoperative day was compared using Student's t-test with the Bonferonni approximation to adjust for multiple comparisons. Potential adverse effects associated with local anesthetic systemic toxicity (LAST) were summarized as frequencies and percentages and statistically compared.

RESULTS: The mean age and BMI of the treated and control patients did not differ significantly. Mean postoperative analgesic requirements were significantly less at each postoperative day in the EXPAREL group compared to controls ($p<0.01$ at each postoperative day). No significant differences in the frequency of adverse effects were noted in the EXPAREL treated patients compared to controls ($p>0.05$ for each adverse effect). After adjusting for length of stay, no significant difference was noted in the adverse effect profile between groups ($p>0.05$).

MAOA BREAKOUT SESSION #12
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April 13, 2019

Effects of Human Recombinant Parathyroid Hormone (PTH) Treatment on the Osteoporotic Spine: A Rabbit Model of Spinal Fusion

Paper 166

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STUDY DESIGN: Experimental Animal Model

PURPOSE: The aim of our study was to investigate the effects of Human recombinant parathyroid hormone 1-34 (PTH) treatment on bone mineral density (BMD) and spinal fusion using a rabbit ovariectomy (OVX) model of post-menopausal osteoporosis. We hypothesized that PTH treatment would increase BMD and enhance spine fusion quality at macroscopic levels.

METHODS: Eighteen (18) female ovariectomized New Zealand White Rabbits were randomized to PTH or placebo therapy, and then underwent L4-L5 posterolateral fusion with corticospongious bone autograft taken from the iliac crest 8 weeks after starting treatment. Following 8 additional weeks of treatment, BMD and spine segment fusion were assessed.

RESULTS: Mean BMD values increased more in the PTH group, in both the proximal tibia and distal femur, compared to the saline control group. Nanoindentation showed no difference between groups or time points in cortical or trabecular Young's modulus or hardness. Solid fusion was only observed in the PTH group.

CONCLUSIONS: This study is the first to demonstrate the overall effects of PTH on BMD, intrinsic bone material properties, and spinal fusion rates using an osteoporotic rabbit model. Our results suggest that PTH administration improves BMD and increases the likelihood of spinal fusion in the OVX rabbit model.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

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

Paper 167

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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 May 2018. 132 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: 69 patients received IV TXA and 63 patients received PO TXA. Patient demographic factors were similar between groups except for BMI. The mean reduction of hemoglobin was similar between IV and PO groups (3.29 g/dL vs. 3.28 g/dL, respectively; $P < 0.001$, equivalence). Similarly, the calculated blood loss was equivalent (1215 mL vs. 1262 mL, respectively; $P = 0.013$, equivalence). In addition, higher ASA (American Society of Anesthesiologists) level and longer surgical time were associated with more hemoglobin reduction ($P = 0.01$ and $P < 0.001$, respectively) and blood loss ($P < 0.01$ and $P < 0.001$, respectively). This is an ongoing trial, so we predict that we will achieve over 200 patients by 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.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Does Prophylactic Administration of TXA Reduce Mean Operative Time and Postoperative Blood Loss in Posterior Approach Lumbar Spinal Fusion Surgery Performed for Degenerative Spinal Disease?

Paper 169

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BACKGROUND: Tranexamic acid is a systemic anti-fibrinolytic that competitively inhibits lysine binding sites on plasminogen, reversibly blocking its binding to fibrin and impeding fibrinolysis and clot degradation. TXA's role in routine spinal surgery remains poorly described. Most spinal literature on perioperative TXA administration has considered operations performed for major adult and pediatric spinal deformity. Although posterior lumbar fusion operations compose a substantial percentage of annual spine surgeries performed, little has been reported regarding the use of TXA as a means by which to reduce mean operative time and postoperative blood loss during these routine operations.

PURPOSE: To investigate whether prophylactic TXA administration prior to one and two-level posterior lumbar interbody fusion operations reduces perioperative blood loss and mean operative time. Also, to determine statistically significant differences between TXA and non-TXA groups in postoperative Hb/Hct, rate of postoperative transfusion, and postoperative thromboembolic events.

METHODS: Two groups, a study group composed of 75 patients who underwent one and two level posterior lumbar interbody fusion operations for degenerative indications who received TXA prior to the start of the procedure, and a control group composed of 75 patients who underwent similar surgeries for the same indications and did not receive TXA preoperatively, were retrospectively enrolled. Demographic, laboratory, and surgical 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 surgery type, home anticoagulation, postoperative anticoagulation, preoperative Hb and Hct, estimated intraoperative blood loss, postoperative day 2 drain output, postoperative day 3 drain output, and rate of postoperative transfusion. Statistically significant reductions were noted in the TXA group with regards to postoperative day 1 drain output ($p < 0.0041$), total postoperative drain output ($p = 0.027$), and mean surgical time ($p < 0.0001$).

CONCLUSION: In our study group, TXA administration prior to one and two-level posterior lumbar interbody fusion operations was associated with reductions in mean surgical time, postoperative day 1 drain output, and total postoperative drain output, with no associated increase in postoperative venous thromboembolic events. Based on the results of the current study, TXA's routine use should be considered in these operations performed for degenerative indications, as it is safe to administer routinely and effective in reducing postoperative drain output and mean surgical time.

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MAOA BREAKOUT SESSION #12
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An Empiric Analysis of Five Counter-Measures Against Surgical Site Infections Following Spine Surgery

Paper 170

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BACKGROUND CONTEXT: Surgical site infections (SSI) following spine surgery are debilitating complications to patients and costly to the healthcare system.

PURPOSE: Review the impact and cost effectiveness of five SSI prevention interventions on SSI rates in an orthopedic spine surgery practice at a major quaternary healthcare system over a 10-year period.

STUDY DESIGN: Retrospective observational study.

PATIENT SAMPLE: All of the surgical patients of five spine surgeons in our department over a 10-year period were included in this study.

OUTCOME MEASURES: SSI rates per year, standardized infection ratios (SIR) for laminectomies and fusions during the most recent 3-year period, year of implementation and frequency of use of the different interventions, cost of the techniques.

METHODS: The SSI prevention techniques described in this paper include application of intrawound vancomycin powder, wound irrigation with dilute betadine solution, preoperative chlorhexidine gluconate scrubs, preoperative screening with nasal swabbing and decolonization of S. aureus, and perioperative antibiotic administration. Our institution's Infection Prevention and Control (IPAC) data was analyzed for the yearly SSI rates for the orthopedic spine surgery department from 2006-2016. In addition, our orthopedic spine surgeons were polled to determined with what frequency and duration they have been using the different SSI prevention interventions.

RESULTS: SSI rates decreased from almost 6% per year the first year of observation to less than 2% per year in the final six years of this study. A SIR of less than 1.0 for each year was observed for laminectomies and fusions for the 2013-2016 period. All surgeons polled at our institution uniformly used perioperative antibiotics, Hibiclens scrub, and the nasal swab protocol since the implementation of these techniques. Some variability existed in the frequency and duration of betadine irrigation and application of vancomycin powder. A cost analysis demonstrated these methods to be nominal compared to the cost of treating a single SSI.

CONCLUSIONS: It is possible to reduce SSI rates in spine surgery with easy, safe, and cost-effective protocols, when implemented in a standardized manner.

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MAOA BREAKOUT SESSION #12
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Continued Inpatient Care After Elective 1-to-2 Level Posterior Lumbar Fusions Increases 30-Day Post-Discharge Readmissions and Complications

Paper 171

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INTRODUCTION: Discharge to an inpatient care facility may be associated with adverse outcomes as compared to home discharge. We sought to investigate 30-day post-discharge outcomes in patients being discharged to an inpatient care (skilled-care or rehabilitation) facility following an elective 1-to-2 level posterior lumbar fusion for degenerative pathology.

MATERIALS AND METHODS: The 2012-2016 American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) database was used to query for patients undergoing posterior lumbar fusions using Current Procedural Terminology/CPT Codes (22612, 22630 and 22633). Additional levels were identified using CPT-22614, CPT-22632 and CPT-22634. Records were filtered to include patients undergoing surgery for degenerative spine pathologies. Only patients undergoing a single-level or two-level posterior lumbar fusion (PLF) were included in the study. A total of 23,481 patients were included in the final cohort.

RESULTS: A total of 3,938 (16.8%) patients were discharged to an inpatient care facility following the primary procedure. Risk factors associated with inpatient care facility discharge were female gender, Black/African American race, Hawaiian or Pacific Islander, a BMI>35.00, Insulin-Dependent or Non-Insulin Dependent Diabetes Mellitus, partially dependent functional health status prior to surgery, history of severe COPD, open wound/wound infection, chronic steroid use, >10% weight loss in last 6 months, use of non-general anesthesia, surgery done during July-September, 2-level fusion, a total operative time >120 mins, a length of stay >3 days and occurrence of any pre-discharge complication.

Following adjustment for preoperative, intraoperative, and pre-discharge clinical characteristics, discharge to an inpatient care facility was associated with higher odds of any complication (OR 1.70 [95% CI 1.43-2.02]), wound complications (OR 7.73 [95% CI 1.36-2.20]), sepsis-related complications (OR 1.64 [95% CI 1.08-2.48]), DVT/PE complications (OR 1.72 [95% CI 1.10-2.69]), urinary tract infections (OR 1.96 [95% CI 1.45-2.64]), unplanned re-operations (OR 1.49 [95% CI 1.23-1.80]), and readmissions (OR 1.29 [95% CI 1.10-1.49]) following discharge.

CONCLUSIONS: After controlling for pre-discharge characteristics, discharge to inpatient care facilities vs. home following 1 to 2 level posterior lumbar fusion is associated with a higher odds of complications, re-operations and readmissions. These results stress the importance of careful patient selection prior to discharge to inpatient care facilities to minimize the risk of complications. Furthermore, the results further support the need for uniform and standardized care pathways to promote home-discharge following hospitalization for elective posterior lumbar fusions.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Can the American College of Surgeons Risk Calculator Predict 30-Day Complications After Lumbar Spine Surgery?

Paper 172

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INTRODUCTION: Surgical risk calculators exist in many fields 1-3 and may assist in the identification of patients at increased risk for complication and readmissions. Risk calculators may allow for improved outcomes, an enhanced informed consent process, and management of modifiable risk factors. The American College of Surgeons (ACS) NSQIP risk calculator was developed from a cohort of over 1.4 million patients, using 2,805 unique CPT codes. The risk calculator uses 21 patient predictors (e.g., age, ASA class, BMI, HTN) and the planned procedure (CPT code) to predict the chance that patients will have any of 12 different outcomes (e.g., death, any complication, serious complication, reoperation) within 30 days following surgery. The purpose of this study is to determine if the ACS NISQIP risk calculator can predict 30-day complications after lumbar fusion.

METHODS: A retrospective chart review was performed on patients that underwent primary lumbar fusion between Jan 2009-2015 at a single-institution, utilizing lumbar fusion CPT codes (22630, 22632-22634, 22612, 22614). Patients without 30 days postoperative follow-up were excluded. Descriptive statistics were calculated for the overall sample, anterior vs. posterior fusion, and single vs. multi-level fusion. Logistic regression models were fit with actual complication occurrence as the dependent variable in each model and ACS estimated risk as the independent variable. The c-statistic was used as the measure of concordance for each model. ROC curves were plotted to visually depict the predictive ability of the estimated risks. Acceptable concordance was set at $c > 0.80$. All analyses were conducted using SAS vs. 9.4.

RESULTS: A total of 237 patients were included in the analyses. Age, BMI, gender, and number of levels of fusion will be described, as well as descriptive statistics of the surgical risk calculator risk estimates and the observed outcomes for the overall sample.

The logistic regression results for the overall sample will be presented. Because there were no deaths or UTIs, no models were fit for these outcomes. Only PNA met the criteria for $c>0.80$ for acceptable concordance; however, due to small sample size and low event rate, this was not statistically significant and the confidence interval on the odds ratio was very wide.

CONCLUSION: The ACS risk-calculator only predicted complications in the categories of "any complication" ($p<0.0001$) and "discharge to skilled nursing facility" ($p<0.001$). However, the ACS risk calculator was unable to accurately predict specific complications on a more granular basis. The ACS risk calculator may be useful in the development of new institutional strategies for spinal fusion but does not provide accurate information for individual patient care.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

High Incidence of Intraoperative Hypothermia in Spinal Fusion Surgery Does Not Lead to Increased Complications

Paper 173

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INTRODUCTION: National guidelines recommend intraoperative normothermia to minimize morbidity and mortality. Previous studies in hip fractures have shown increased age and lower BMI to be risk factors for intraoperative hypothermia along with an association between intraoperative hypothermia and deep surgical site infection. However, limited evidence exists regarding the effects of intraoperative hypothermia in spine fusion surgery. The purpose of this study is to determine the incidence of intraoperative hypothermia in spinal fusions and to evaluate the impact of hypothermia on surgical outcomes.

METHODS: A retrospective chart review was performed on 547 patients who underwent spinal fusion at HFHS from 08/2013 to 04/2016. We recorded patient demographics, comorbidities, surgery-specific data, postoperative complications, length of stay, and 30-day readmission. Continuous data were described using means and standard deviations. Categorical data were described using counts and column percentages. Univariate associations with each continuous temperature variable were carried out using Wilcoxon rank-sum tests, Kruskal-Wallis tests for categorical variables, and Spearman's correlation coefficient for continuous variables. Statistical significance was set at $p<0.05$. All analyses were performed using SAS 9.4.

RESULTS: The incidence of intraoperative hypothermia was 53% (defined by temperatures <36°C). The mean temperature change was 1.65°C (SD 3.39°C). Hypothermic patients had lower BMI than normothermic ones (29.4 vs. 30.8 kg/m^2, $P = 0.01$). Diabetes mellitus (DM) was less prevalent in hypothermic patients (14% vs. 25%; $P < 0.01$). Surgical time was shorter for hypothermic patients (158 vs. 184 min; $P < 0.001$). No other risk factors for intraoperative hypothermia were identified, including levels involved, age, gender or ASA. 30-day readmission rate was higher for the hypothermic cohort, but did not reach statistical significance (10% vs. 6%; $P = 0.08$). Otherwise, intraoperative hypothermia was not associated with any complications including but not limited to transfusion rate, superficial and deep surgical site infection.

DISCUSSION AND CONCLUSION: The incidence of intraoperative hypothermia in spinal fusions was 53%. Lower BMI, lower prevalence of DM, and shorter case time were associated with hypothermia. However, hypothermia was not associated with any complications. Nonetheless, this high incidence of intraoperative hypothermia must be considered in light of the increased use of quality metrics and the importance of intraoperative normothermia in national surgical guidelines.

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MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Defining Sarcopenia Using Spinal Muscle Morphometric Measurements to Identify Risk of Post-Surgical Complications in Spine Surgery

Paper 174

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INTRODUCTION: Sarcopenia or decreased muscle mass has recently been acknowledged as a surrogate for patient frailty which in turn indicates the physiologic reserve that a patient possesses to withstand external and internal stressors. In the present study, we wanted to evaluate the association between spine morphometrics and vertebral compression fractures of cervical spine among patients with osteoporosis.

METHODS: Patients undergoing cervical fusion for osteoporosis related compression fractures, with available preoperative CT scans of the spine were considered eligible for this study. For controls, healthy young (aged 21-30) patients presenting to the emergency after minor trauma (Abbreviated injury score < 2). Preoperative CT were reviewed by 3 reviewers to make the following measurements: cross-sectional area of sternocleido-mastoid muscle (SCM), longus colli muscles (LCM) bilaterally and vertebral body (VB) at C4 mid-pedicle level. We used LCM-VB and SCM-VB ratios as markers of frailty which were divided into quartiles. Agreement between the reviewers was assessed using two-way intra-class correlation coefficient (ICC). Two-sided t-test and multivariable logistic regression were used to assess the association between morphometrics and osteoporotic fracture after adjusting for an array of patient factors.

RESULTS: Fifty-five cases and 113 controls were considered eligible for the study. Agreement among reviewers was found to be good for SCM-VB ratios (ICC=0.708,p<0.001), but poor for LCM-VB ratios (ICC=0.02, p=0.409). Mean SCM-VB ratio for cases was significantly lower in cases compared to controls (2.57±0.85 vs. 4.14±1.01,MD=1.56,p<0.001). Mean LCM-VB ratio was found to be slightly lower for cases compared to controls (0.998±0.382 vs. 1.161±0.464,MD=0.16, p=0.017). On multivariable logistic-regression, patients with low SCM-VB ratio were found to be at significantly higher risk of having an osteoporotic fracture (quartile-1:OR=121.01,95%CI=16.68-877.74,p<0.001; quartile-2:OR=14.73,95%CI=2.66-81.50,p=0.002). We did not find any difference in risk of osteoporotic fracture for LCM-VB ratios (quartile-1: OR=1,95%CI=0.19-5.30,p=0.99; quartile-2: OR=0.87,95%CI=0.16-4.61,p=0.87).

CONCLUSION: Our results indicate that morphometrics might have a role in risk-assessment for complications among patients with osteoporosis.

MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

Pelvic Incidence in Cadaveric Spines with an Abnormal Number of Lumbar Vertebrae

Paper 175

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INTRODUCTION: Aberrations in the number of lumbar vertebrae exist in modern populations. Modern humans may have four or six lumbar vertebrae and the manner in which this anatomical aberration affects spinopelvic sagittal balance is unknown. Additionally, the previously reported prevalence of these anomalies has been limited by small sample size and we sought to improve upon the prior literature with a larger cohort.

METHODS: We screened 2980 dry cadaveric specimens from an osteological collection. Two authors reconstructed each pelvis and took lateral photographs, from which they measured pelvic incidence (PI) independently in ImageJ 1.49v. All 2980 cadavers' vertebrae were screened three times and counted from C1 caudally, with the assumption of 7 cervical and 12 thoracic vertebrae. Attention was given to the presence or absence of costal facets in determining thoracic vertebrae. For cadavers with six lumbar vertebrae, PI was measured both without and with the sixth lumbar vertebra attached.

RESULTS: Of the 2980 specimens screened, 969 specimens were evaluated. All specimens with four or six lumbar vertebrae were included as well as 892 controls. Average age at death for all specimens was 50.4 ± 15.4 years. In our study population, 84% (n = 814) were male and 69% (n = 667) were Caucasian.

The authors calculated a total prevalence of 1.8% for four lumbar vertebrae and 0.8% for six lumbar vertebrae. The mean PI of the study population was 46.2 ± 21.1 degrees. Average PI was calculated as 38.5 degrees for specimens with four lumbar vertebrae, 46.7 degrees for specimens with five lumbar vertebrae, and 47.1 degrees for specimens with six lumbar vertebrae. PI was significantly different between specimens with four and five lumbar vertebrae ($p<0.001$), but not between specimens with five and six lumbar vertebrae ($p=0.673$). For six lumbar vertebrae specimens, when L6 was added to the sacrum, mean L6-PI was 27.4 ± 8.0 degrees and was significantly different from specimens with 5 lumbar vertebrae ($p<0.001$). This suggests a relative lordosis through the L6/S1 disc space and L6 vertebra of 19.3 degrees. ICC between two authors for all measurements was excellent (ICC > 0.85).

DISCUSSION AND CONCLUSION: In our large cadaveric study of 969 full spines, we reported a lower prevalence of spines with four and six lumbar vertebrae compared to previous studies. Our findings in specimens with six lumbar vertebrae suggest that L6 is more lordotic and as such, behaves more like a lumbar vertebra than sacral vertebra. Our findings in specimens with four lumbar vertebrae may have important implications for lumbar fusions when restoring appropriate sagittal balance in patients with four lumbar vertebrae.

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MAOA BREAKOUT SESSION #12
PEDIATRICS/SPINE
April 13, 2019

The Effect of Preoperative Education in Elective Spine Surgery

Paper 176

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INTRODUCTION: In total joint arthroplasty, preoperative education is commonly utilized. There is evidence that preoperative education has been successful to reduce length of stay and overall costs associated with those procedures. Preoperative education is also utilized for spine surgery, but what has not been shown is its effects on length of stay, 30-day readmission, and discharge location.

PURPOSE: The purpose of this study is to investigate the effects of preoperative education on length of stay, 30-day readmission, and discharge location for patients undergoing elective spinal surgery.

MATERIALS AND METHODS: Patients undergoing elective spinal surgery were given the option of attending a preoperative education class which discusses basic anatomy, explains the basic aspects of the procedure, helps guide patients on how to prepare for surgery, as well as what to expect after surgery. Patients undergoing elective spinal surgery from January 2014 – December 2017 were identified. Demographic data was obtained as well as whether they attended the optional preoperative education class, type of surgery, discharge disposition, length of stay, and whether there was readmission 30 days after surgery.

RESULTS: 2,904 patients who underwent elective spine surgery from January 2014 – December 2017 were identified. 287 patients underwent multiple operations during the study period and were excluded. Of the 2,617 patients who were included, 1,210 (46.24%) patients attended the preoperative education class. There was a statistically significant difference in length of stay ($p = 0.00012$). Average length of stay for those who attended was 3 days compared to 2 days for those who did not attend. There was a statistically significant difference in discharge disposition ($p = 0.00012$). 18.18% of patients who attended were discharged to inpatient rehabilitation/skilled nursing facility compared to 11.37% of patients who did not attend. There was no significant difference in 30-day readmission.

CONCLUSIONS: Those who attended preoperative education had a significantly longer length of stay and were more likely to be discharged to a skilled nursing facility or inpatient rehabilitation. There was a trend in those undergoing complex cases to have a shorter length of stay, higher percentage of discharge to home, and fewer emergency room visits with preoperative education. Offering preoperative education to all patients undergoing elective spine surgery does not appear to improve length of stay, discharge disposition to home, and readmission, but offering preoperative education to those undergoing complex procedures may provide some benefit.

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MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

What is the Price and Claimed Efficacy of Platelet-Rich Plasma Injections for the Treatment of Knee Osteoarthritis in the United States?

Paper 177

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INTRODUCTION: Platelet-rich plasma (PRP) injections are often used for the treatment of knee osteoarthritis (OA), despite clinical value and cost-effectiveness not being definitely established. PRP injections are considered as a potential means of reducing pain and improving function in patients with knee OA, in the hope of delaying or avoiding the need for surgical intervention. Centers that offer PRP injections usually charge patients out-of-pocket, and directly market services. Therefore, the purpose of this study was to quantify the current (1) prices and (2) marketed clinical efficacy of autologous PRP injections for knee OA.

METHODS: To identify United States-based centers providing PRP injections, we conducted systematic internet-based searches using the Google and Bing search engines between 9-1-2017 to 1-1-2018. With the goal of obtaining information of what is being marketed directly to patients by these centers, we imitated a 52-year old patient who claimed to suffer from moderate right knee osteoarthritis(5/10 VAS pain). Therefore, the simulated patient was seeking a PRP injection to help with his current knee problems. The contacted centers were consulted for same-day PRP injections, and specifically asked questions focusing on: (1) Price ("What is the cost of the therapy for one knee?"), and (2) Clinical-efficacy ("What is the success rate?"). We successfully contacted 179/210 (85%).

RESULTS: The mean price for same-day PRP unilateral knee injection for the treatment OA was $714 (median $685), with prices ranging from $380-$1390. The standard deviation was $144, with a margin of error of $23 and a 95% CI of $691-$736. The mean marketed clinical-efficacy for PRP knee injection for the treatment OA was 76% (range 49%-97%), with a median of 78%. There was no correlation between the marketed price of a PRP injection and the clinical-efficacy claimed ($R2 = 0.206$, $r = 0.003$).

DISCUSSION AND CONCLUSION: The clinical use of PRP injections for the treatment of knee OA has gained widespread popularity in the United States, even though its clinical value and cost-effectiveness have not been definitely established. To date, across the U.S., the mean price of a single PRP injection for knee OA was $714, with the majority of clinics claiming success in at least 70% of patients. These findings provide a unique and current perspective on the PRP market for the treatment of knee OA that is valuable to physicians and healthcare providers in providing better education to patients on the purported clinical benefits of PRP injections and the price of seeking this care.

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MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

The Utility and Cost of Magnetic Resonance Imaging of the Knee in Elderly Patients: A Retrospective Cohort Study

Paper 178

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PURPOSE: Knee pain is a common complaint amongst elderly patients. Radiography is a cheap and effective initial screening tool and is effective for diagnosing degenerative joint disease (DJD). Despite the utility of plain radiographs, magnetic resonance imaging (MRI) is often obtained in this clinical setting. The objective of this study is to determine the incidence of MRI studies performed on elderly patients with knee pain, assess the diagnostic utility of this imaging in comparison to plain radiographs, determine its effect on ultimate clinical management, and describe the financial implications associated with these studies.

METHODS: This is a retrospective cohort study performed at a tertiary referral county hospital over a 5-year period (2012 – 2016). All knee MRI studies completed on patients older than 60 years of age were included. Patient demographics, reason for studies, MRI findings, prior radiographs, details regarding surgical intervention, and cost associated with advanced imaging were among the data collected.

RESULTS: 1265 knee MRIs were obtained on 1066 patients, average age 66.1 (60-92.4) years. There were equal numbers of studies for right and left knees. Pain was the most common reason for ordering the MRI (84.9%), followed by oncologic concerns (7.8%). The most common finding on MRI was isolated degenerative changes (88.4%), followed by oncologic lesions (6.1%). Plain radiographs were obtained 48.8% of the time within 3 months of the MRI. The most common findings on plain films were isolated degenerative changes (79.9%), followed by oncologic concerns (7.9%). Of those patients with radiographs, 19.9% of MRI's produced a change in diagnosis. A surgical procedure was performed 11.7% of the time following these studies, with the most commonly performed procedures being total knee arthroplasty (73.6%) followed by oncologic surgery (9.5%) and knee arthroscopy (8.1%). Additional imaging was necessary in 51.4% of patients prior to surgery. Knee MRI studies cost our institution $6.48 million over this 5-year period. Per surgery completed, an average of $43,807.43 was spent on MRI.

CONCLUSION: MRI identified isolated degenerative changes 88% of the time and provided an alternative or additional diagnosis less than 20% of the time. In the absence of oncology, infection, or acute trauma, the authors recommend initial evaluation with standing knee radiographs for the evaluation of knee pain. In patients over 60 years of age with isolated degenerative arthritis of the knee, a subsequent MRI does not provide a clinically meaningful benefit to justify the increased costs over plain radiographs.

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MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Are Adult Reconstructive Surgeons Being Adequately Compensated for Single-Component vs. Double-Component Revisions? - An Analysis of Relative Value Units (RVUs)

Paper 179

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INTRODUCTION: While past research has elucidated that surgeons are reimbursed at a higher rate for primary total knee arthroplasty (TKA) vs. revision TKA, no study has explored differences in reimbursements between single-component and double-component revisions, considering that a double-component revision is likely to require more effort/skill as compared to a single-component revision.

MATERIALS AND METHODS: The 2015-2016 American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) files were queried using CPT codes for single-component revision TKA (CPT-27486) and double-component revision TKA (CPT-27487). A total of 1,962 single-component and 4,184 double component revisions were performed during this period. Total RVUs were calculated for each case. RVU/minute was derived by dividing the total RVU of each case of the total operative time. Dollar amount per min was calculated by multiplying the mean RVU/min of each procedure (single-component vs. double-component) by a preset CMS-defined rate of $35.8887/RVU.

A standard 10-hour (600 mins) operating day was used to calculate the total number of cases per day which could be performed completely. Reimbursement per case was calculated by multiplying the reimbursement rate (dollar amount/min) by mean total operative time. Total reimbursement/day was calculated by multiplying the reimbursement/case by total number of complete cases which could be performed in the period. A hypothetical annualized total cost-difference (using 160 operative days as reference) was retrieved by assessing the total reimbursement/year between the two procedures.

RESULTS: The mean RVU was 21.12 and 27.11 for single-component and double-component revision TKA, respectively. A statistically significant difference was noted in mean operative time (single-component=100.44 vs. double-component=144.29; $p<0.001$) between the two groups. Single-component revision had a significantly higher mean RVU/min (0.267) vs. double-component revision (0.223). The reimbursement amounts calculated for single-component vs. double-component revisions were per minute ($9.58/min vs. $8.00/min), per case ($962.22 vs. $1154.32), per day ($5773.32 vs. $4617.28) with a projected annualized cost-difference of $184,966.

CONCLUSIONS: Orthopedic surgeons are reimbursed at a higher rate for single-component revision TKAs as compared to double-component revision TKAs, despite the higher complexity and longer operative times required in the latter. Providers can utilize this data to better understand the financial and time aspects of revisions. The study also highlights the need for a change in the RVUs for either double-component or single-component revisions to ensure that all surgeons are adequately reimbursed per unit time for performing a complex case such as double-component TKA.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Anxiety and Depression Predict Chronic Postoperative Opioid Use in Total Joint Arthroplasty: A Systematic Review

Paper 180

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INTRODUCTION: Postoperative opioids are widely used in total hip and knee arthroplasty (TJA). Anxiety and depression affect pain perception. We performed a systematic review to determine the effect of preoperative anxiety and depression on chronic postoperative opioid use in TJA.

METHODS: Following PRISMA guidelines, searches were undertaken using 6 common databases to identify studies of TJA patients that had preoperative measures of anxiety and/or depression and postoperative quantification of opioid use. Two independent reviewers screened 391 abstracts for inclusion. We reviewed the complete text of 42 manuscripts, and extracted data for analysis from the 7 papers that satisfied inclusion criteria. These consisted of 100,621 TJA patients with follow-up ranging 6 months to 5 years. Two studies reported outcomes for THA alone, 3 on TKA alone, and 2 on both THA and TKA.

RESULTS: All 7 studies reported a significant difference in postoperative opioid use for patients with preoperative anxiety and/or depression. THA studies reported odds ratios from 1.6 (1.1-2.3) to 2.1 (1.6-2.9) for chronic postoperative use in patients with depression or anxiety. Two TKA studies reported risk ratios of 1.5 (95% CI of 1.4-1.6) and 2.5 (1.3-4.8) for depression and anxiety combined. The other TKA study reported an odds ratio of 4.0 (1.7-9.4) for anxiety as a predictor 5 year postoperative opioid use. Two studies suggest that TJA patients who are opioid naïve experience greater effect of mood disorders (odds ratio 2.1 vs. 1.6 in one study).

CONCLUSIONS: Preoperative anxiety and depression are associated with chronic postoperative opioid use, especially in patients that did not previously use opioids for pain control. Our review suggests that screening patients for preoperative mood disorders could identify at-risk patients for new chronic postoperative opioid use.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Patient Dissatisfaction After Total Knee Arthroplasty - Is Opioid Medication Use a Cause or Effect?

Paper 181

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INTRODUCTION: The Comprehensive Care for Joint Replacement (CJR) bundled payment initiative proposed the use of general health and joint specific patient reported outcome measures (PROMs) for assessment of patient care quality. The relationship between these outcome instruments and patient satisfaction following total knee arthroplasty (TKA) have not been widely assessed. Preoperative narcotic medications have been implicated in higher levels of postoperative pain, lower functional outcome, and potential contribution to chronic narcotic medication use for patients who experience heightened pain levels after TKA. We performed this study to assess whether dissatisfaction 1 year after TKA was associated with preoperative narcotic medication use, patient demographic features, or CJR-supported patient reported outcome scores. Our hypotheses were that lower patient satisfaction would be associated with preoperative narcotic medication exposure, younger patient age, higher patient body mass index, lower preoperative, and lower postoperative patient reported outcome scores.

METHODS: After obtaining Institutional Review Board (IRB) approval, patients undergoing TKA surgery at our institution were invited to participate in a joint replacement registry and to complete CJR-identified patient reported outcome instruments including the NIH-Global Health and KOOS-Jr at routine follow-up intervals (6 weeks, 3 months, and 1 year). Before surgery, patients were also asked to estimate the amount of improvement that they would expect for them to consider their TKA to be successful (100% improved, 75-99% improved, 50-75% improved, 25-50% improved, or < 25% improved). Patients were asked to indicate their amount of pain on a 10-point VAS scale during rest and with maximum activity, as well as their highest activity level using a UCLA score. They were asked to indicate their level of satisfaction with the surgical procedure during follow-up using a 5-point scale (very dissatisfied, a little dissatisfied, neutral, a little satisfied, very satisfied). One-hundred-seventy-eight (178) patients were prospectively enrolled in the registry and completed one-year postoperative PROM instruments. Mean patient age was 62.9 years, 67% of TKA patients were female, and mean BMI was 35.8 kg/m^2. One-hundred-thirty-seven patients (76.4%) reported being very satisfied or a little satisfied, 10 patients (5.6%) reported neutral satisfaction, and 32 patients (18.0%) reported being either a little dissatisfied or very dissatisfied with their TKA.

RESULTS: Dissatisfied patients were younger than satisfied patients (59.2 vs. 64.1 years, $p=0.03$), with no significant difference in mean BMI (37.0 vs. 35.8 kg/m^2, $p=0.48$) or proportion of male patients (21.9% vs. 33.1%, $p=0.29$). Before surgery, dissatisfied patients reported lower mean NIH-PROMIS mental health subscore (44.1 vs. 50.2 points, $p<0.05$) and lower familiarity with health care assessment instruments (3.8 vs. 4.5 points, $p<0.001$), but there were no preoperative differences in mean NIH-

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PROMIS physical function subscore (36.7 vs. 40.0 points, p=0.17), KOOS-Jr (38.4 vs. 45.9, p=0.15), UCLA activity (3.5 vs. 4.1 points, p=0.33), rest pain (5.0 vs. 4.0 points, p=0.31), activity pain (8.4 vs. 7.5 points, p=0.24), or preoperative narcotic medication use (9.5% vs. 10.9%, p=1.0). A similar proportion of patients expressed an expectation for 75% or greater improvement from their TKA procedure (75.0% vs. 68.2%, p=0.76). At one year follow-up, dissatisfied patients reported significantly lower mean NIH-PROMIS mental health (41.9 vs. 51.9 points, p<0.001), physical function (37.8 vs. 47.8 points, p<0.001), KOOS-Jr (54.5 vs. 75.6 points, p<0.001), and UCLA activity (3.8 vs. 4.8 points, p=0.03). Dissatisfied patients reported higher mean values for rest pain (2.7 vs. 1.5 points, p=0.05) activity-related pain (6.5 vs. 2.7 points, p<0.001), and were more likely to report continued narcotic medication use one year after TKA (52.4% vs. 9.5%, p=0.001). In our institution, the use of conventional instrumented TKA with contemporary implant systems, protocol-based care, and multimodal perioperative pain protocols resulted in a similar rate of patient dissatisfaction to previous reports. However, dissatisfied patients in this study did not report a different preoperative expectation for improvement from their TKA surgery. Preoperative narcotic medication exposure, elevated BMI, and lower preoperative PROM scores other than the mental health score were not associated with patient dissatisfaction. However, dissatisfied TKA patients experienced lower postoperative PROM scores, substantially higher activity related pain, and reported continued narcotic medication use beyond the time interval prescribed by their surgeon. Continued assessment is needed to understand how to decrease activity-related knee pain and chronic narcotic medication use among dissatisfied TKA patients.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Risk Factors for Opioid Misuse or Abuse Following Total Hip or Knee Arthroplasty

Paper 182

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BACKGROUND: Opioid misuse or abuse has reached epidemic levels in the United States, yet little is known about preoperative risk factors for opioid misuse or abuse following total joint arthroplasty. Therefore, we conducted this study to identify factors associated with hospital-based acute care for opioid misuse or abuse after total hip or knee arthroplasty.

METHODS: Using the Florida, Nebraska, and New York state inpatient and emergency department databases, we identified all adult patients who had a discharge for primary total hip and/or knee arthroplasty between 2009 and 2011. The primary outcome of interest was hospital-based acute care (either inpatient admission or emergency department visit) for a diagnosis of opioid misuse or abuse within two years of discharge. Multivariate logistic regression models were used to identify preoperative factors associated with this outcome.

RESULTS: The final sample included 242,863 patients who underwent either total hip (N=163,571; 67.4%) or total knee (N=79,292; 32.6%) arthroplasty. Overall, 1,003 (0.4%) patients had 1,673 visits to the hospital for opioid misuse or abuse within two years of discharge. Hospital admissions (81.1%) accounted for the majority of these visits with an average stay of 6.4 days and hospital charges of $35,596. In the overall model (c=0.844), a history of opioid misuse or abuse (adjusted odds ratio (AOR)=23.4 [95% CI=18.9-28.9]), chronic respiratory disease (AOR=1.62 [1.39-1.90]), smoking (AOR=2.40 [2.07-2.77]), chronic low back pain (AOR=4.11 [2.84-5.93]), fibromyalgia (AOR=3.32 [2.25-4.90]), and a history of medical non-compliance (AOR=2.23 [1.26-3.94]) were significantly associated with the outcome. Notably, incidence of the outcome increased with time from surgery.

CONCLUSIONS: Opioid misuse or abuse requiring hospital-based acute care after total hip or knee arthroplasty is relatively uncommon; however, patients with certain risk factors are more likely to experience these events. It often presents in a delayed manner following surgery (>120 days after discharge), likely due to the severity of this outcome and the time required to fulfill the requirements of diagnosis. Identifying these patients preoperatively may aid in appropriate postoperative treatment and prevention.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Unicompartmental Knee Arthroplasty Utilization in the Medicare Population

Paper 183

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INTRODUCTION: Unicompartmental knee arthroplasty (UKA) represents a surgical treatment option for patients who present with symptomatic unicompartmental knee osteoarthritis (OA). Indications for UKA include patients with lower activity demand patients, functional and near normal knee range of motion, and preserved joint alignment and stability. UKA allows patients a less invasive procedure than TKA with a faster recovery time. UKA utilization and survivability, however, remains unknown within the Medicare population. The purpose of this study is to analyze UKA practice patterns in a large U.S. insurance database between 2005 – 2014.

METHODS: A retrospective review of a Medicare patients reported within the PearlDiver database was conducted. PearlDiver is a national insurance database containing current procedural terminology (CPT) and International Classification of Diseases, Ninth Revision (ICD-9) codes related to orthopedic procedures. Medicare insurance database utilization data for UKA captured as part of the PearlDiver database between 2005 and 2014 were reviewed. The authors queried the database using CPT code 27446, which captures medial or lateral compartment UKAs and extracted patient age, gender, and region. Statistical analysis was performed using qualitative analysis and logistic regression. Survivability was defined as conversion to TKA.

RESULTS: Between 2005 and 2014, a total of 20,571 UKA procedures were performed in the Medicare population. Annual utilization trends were variable during the study period with the most dramatic increase in UKA utilization occurring in years 2012-2014. Most patients undergoing UKA were in the age 65-69 category (6,297), followed by the age 70-74 category (5,401). Geographically, most procedures were performed in the South (52%). Sex utilization was 51% female and 48% male. Overall implant survivability at eight years was 90%. Patients age 80 and above demonstrated the highest mean implant survival of 0.949 at 8 years of follow-up. For those patients undergoing conversion to TKA, the average survival was 819 days from UKA.

DISCUSSION AND CONCLUSION: Utilization of UKA has grown in the Medicare population from 2005-2014. UKA is more frequently performed in women, patients aged 65-69, and in the South region. Increasing numbers of older patients and female patients being indicated for UKA as opposed to TKA may reflect a demographic shift in UKA indications. Advantages of UKA include the opportunity for faster postoperative recovery, less narcotic use, and same-day outpatient surgery discharge. This study is limited by its retrospective nature and database review.

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MAOA BREAKOUT SESSION #13
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Surgical Outcomes of Patients on Acetylsalicylic Acid Therapy Undergoing Total Joint Arthroplasty

Paper 184

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INTRODUCTION: Currently, the AAOS recommends suspending acetylsalicylic acid (ASA) therapy 5-7 days prior to surgery in low risk patients; however, these recommendations have not been studied in elective orthopedic procedures. The purpose of this study was to determine if ASA dose or time discontinued preoperatively affected surgical outcomes in total joint arthroplasty (TJA). We hypothesized that ASA therapy worsens surgical outcomes in patients on higher doses and those who discontinue ASA closer to surgery.

METHODS: We performed a retrospective cohort analysis of 2853 patients that underwent primary total knee arthroplasty (TKA, 1802) and total hip arthroplasty (THA, 1051) at a university affiliated tertiary medical center from 2014 to 2016. A nurse data abstractor collected most data, including demographics, alongside individual chart review. All analysis controlled for age, hip/knee, preoperative American Society of Anesthesiologists' score, and body mass index (BMI). The study compared postoperative outcomes of patients based on the presence of ASA therapy prior to TJA, dosing of ASA (81mg, 325mg), and the time of preoperative discontinuation (no ASA, >/=7 days, 3-7 days, or <3 days).

RESULTS: There were 1749 patients never on ASA therapy and 1104 patients on ASA therapy prior to undergoing TJA. ASA was a risk factor for readmission (OR 1.86; 1.34-2.58; $p<0.001$) and 90-day postoperative events (90dPOE) (OR 1.26; 1.09-1.40; $p=0.004$). Among patients on ASA, the dose was not a risk factor for any of the studied outcomes. Discontinuing ASA 7 days or more prior to TJA was protective for hematomas (OR 0.64; 0.42-0.98; $p=0.038$), ER visits (OR 0.79; 0.66-0.93; $p=0.006$), readmission (OR 0.65; 0.54-0.78; $p<0.001$), and 90dPOE (OR 0.72; 0.53-0.88; $p<0.001$). These outcomes had a time effect, that is, the risk was greater on those who discontinued therapy closer to the operative date.

CONCLUSION: There is a significant effect on surgical outcomes with patients on ASA therapy, particularly with the time of discontinuation prior to TJA. Patients that discontinued ASA 7 days or more prior to TJA had a lower incidence of hematomas, ER visits, readmissions, and 90dPOE. There was no difference in postoperative outcomes based on dose of ASA. The current study's findings support discontinuing ASA therapy at least 7 days prior to TJA.

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MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Improved Outcomes Following a Novel Nerve Block Combination for Total Knee Arthroplasty

Paper 185

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INTRODUCTION: Postoperative pain is a concern for patients undergoing Total Knee Arthroplasty (TKA) and plays an important role in opioid consumption, length of stay, and postoperative function. The purpose of this study was to compare outcomes in patients who underwent primary TKA comparing femoral and sciatic (F+S) combination motor nerve block versus an adductor canal and the interspace between the popliteal artery and the capsule of the posterior knee (ACB+IPACK) combination sensory nerve block.

METHODS: 100 consecutive primary TKA cases performed by a single surgeon using the same surgical approach and implant design were reviewed. The first 50 patient received F+S nerve blocks and the second 50 received ACB+IPACK blocks preoperatively. Differences in opioid requirements, length of stay (LOS), distance walked, Western Ontario & McMasters University Osteoarthritis Index (WOMAC), Knee Society (KSS) function scores, Visual Analog Scores (VAS) for pain at rest and with activity, and postoperative complications were analyzed. There were no differences in the groups with respect to age, sex, or BMI.

RESULTS: 62% of patients were discharged on postoperative day #1 in the ACB+IPACK group compared to 14% in the F+S group ($p<.0001$). The ACB+IPACK patients had a shorter LOS (average 1.48 days versus 2.02 days, $p<0.0001$), ambulated further on postoperative day #0 (average 21.4 feet versus 5.3 feet, $p<0.0001$), required less narcotics the day after surgery (average 15.7 versus 24.0 morphine equivalents $p<0.0001$) and at 2 weeks postoperative (average 6.2 versus 9.3 morphine equivalents, $p=0.025$), and required less manipulations (1 versus 5, $p=0.204$). WOMAC, KSS, and VAS scores were not significantly different.

DISCUSSION: The use of combination adductor canal and IPACK sensory blocks demonstrated improved early ambulation with a decrease in opioid use, length of stay, and postoperative manipulations. This study suggests that use of motor nerve blocks in patients undergoing primary TKA should be avoided.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Total Knee Arthroplasty After High Tibial Osteotomy Resulted in Excellent Long-Term Survivorship and Clinical Outcomes

Paper 188

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INTRODUCTION: Some prior reports of total knee arthroplasty (TKA) after high tibial osteotomy (HTO) have shown high rates of aseptic loosening. As such, the goal of this study was to analyze the outcomes of contemporary TKA after HTO, with particular emphasis on (1) survivorship free of aseptic loosening, (2) survivorship free of revision, (3) complications, (4) radiographic outcomes, and (5) clinical outcomes.

METHODS: We retrospectively reviewed 207 patients undergoing 231 cemented TKAs after HTO from 2000-2010 through our total joint registry: 87% were after a closing-wedge osteotomy and 13% were after an opening-wedge osteotomy. Mean interval between HTO to TKA was 13 years; mean follow-up from TKA was 8 years. The mean age at TKA was 64 years, with a mean BMI was 31 kg/m^2. The majority of TKAs had a posterior-stabilized design (PS; 93%), while 4% had a varus-valgus constraint design. Tibial stems were utilized in 8% of cases.

RESULTS: Survivorship free of aseptic loosening was 97% at 10 years. Survivorship free of any revision was 90% at 10 years. Fifteen (6%) TKAs underwent aseptic revision, most commonly for instability (3%), aseptic loosening (2%), and periprosthetic fracture (1%). Patient age <60 years (HR=2.9, p=0.02) and TKA ≤5 years from HTO (HR=2.9, p=0.04) were significant risk factors for poorer revision-free survival. There were 18 (8%) complications, most commonly being a manipulation under anesthesia (MUA) in 9 cases (4%). No unrevised TKAs had definitive radiographic evidence of loosening. Knee Society Scores improved from a mean of 59 preoperatively to a mean of 93 postoperatively (p<0.001).

CONCLUSION: Contemporary cemented TKA after HTO demonstrated excellent durability with 10-year survivorship free of aseptic loosening of 97%. There was reliable improvement in clinical outcome, but perfect knee balance was sometimes challenging: reflected by a 4% prevalence of MUA versus 3% revision for instability.

SUMMARY: Contemporary cemented TKAs after prior HTO had reliable improvements in clinical outcomes and excellent (97%) 10-year survivorship free of revision for aseptic loosening.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Radiographic Comparison of Cementless Total Knee Arthroplasty in the Elderly (>70) vs. Adult (<70) Population

Paper 189

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PURPOSE: The purpose of this study was to radiographically compare component migration and the development of radiolucent lines between elderly and adult patients undergoing cementless total knee arthroplasty (TKA).

METHODS: This was a retrospective review of 123 patients, 43 elderly (>70 years old) and 80 adult (30-69 years old) who underwent cementless TKA at a single-institution over a four-year period. Patients were clinically and radiographically assessed for implant failure. The Knee Society's Total Knee Arthroplasty Roentgenographic Evaluation (KSRES) was used to component migration and the development of radiolucent lines.

RESULTS: More than 80% of patients had greater than 2-year follow up. There were a total of 3 implant failures. Two of these failures were from aseptic loosening (1 elderly, 1 adult) while one of these failures was traumatic. The tibial component and femoral component survival was 97.8% and 98.6%, respectively. The adult cohort demonstrated a significant change in the femoral flexion angle (91.72 vs. 92.14 degrees, p=0.0.0248) as well as posterior tibial slope (89.46 vs. 88.91, p=0.0473). There were no other significant indicators of implant migration. Excluding the two cases of aseptic loosening, all of the implants were classified as stable using the KSRES classification. There were no significant differences between groups in development of radiolucent lines at any location. Emergency department visits (p=1.0000), readmission rates (p=0.0699), and mortality (p=0.3140) rates did not show statistically significant differences between cohorts.

CONCLUSIONS: Cementless TKA is becoming an increasingly popular option for patients with good bone stock. Concerns regarding fixation in osteoporotic bone has limited its use in the elderly population. This study showed similar or improved radiographic outcomes in the elderly group. Cementless TKA is a promising alternative to cemented fixation in both the elderly and adult patient populations.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Prospective Validation of a Demographically-Based Primary Total Knee Arthroplasty Size Calculator

Paper 190

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INTRODUCTION: Preoperative planning for total knee arthroplasty (TKA) is essential for streamlining operating room efficiency and reducing costs. Digital templating and patient-specific instrumentation (PSI) have shown some value in TKA, but require additional costs and resources. The purpose of this study is to validate a previously published algorithm that uses only demographic variables to accurately predict TKA tibial and femoral component sizes.

METHODS: 538 consecutive patients undergoing elective primary TKA were prospectively enrolled. Three surgeon practices unaffiliated with the retrospective cohort were included in this study. Patient gender, height, and weight was entered into our published Arthroplasty Size Predictor algorithm. Accuracy of the algorithm was compared with the actual sizes of the implanted femoral and tibial components from 4 different manufacturers. Multivariate regression analysis was used to identify independent risk factors for inaccurate outliers for our model.

RESULTS: When assessing accuracy to within ± 1 size, the accuracies of tibial and femoral components were 87% (412/474) and 76% (360/474). When assessing accuracy to within ± 2 sizes of predicted, the tibial accuracy was 97% (461/474) and the femoral accuracy was 95% (450/474). Risk factors for the actual components falling outside of 2 predicted sizes include weight less than 70 kg [odds ratio (OR) = 2.47, 95% CI (1.21-5.06), $p = 0.01$] and use of an implant system with < 2.5 mm changes between femoral sizes [OR = 5.50, 95% CI (3.33-9.11), $p < 0.001$].

CONCLUSION: This prospective series of patients validates a simple algorithm to predict component sizing for TKA with high accuracy based on demographic variables alone. Surgeons can use this algorithm to simplify the preoperative planning process by reducing unnecessary trays, trials, and implant storage, particularly in the community or outpatient setting where resources are limited.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

An Experienced Surgeon Can Meet or Exceed Robotic Accuracy in Manual Unicompartmental Knee Arthroplasty

Paper 191

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INTRODUCTION: Existing studies report more accurate implant placement with robotic-assisted unicompartmental knee arthroplasty (UKA); however ,surgeon experience has not always been accounted for. The purpose of this study was to compare the accuracy of an experienced, high-volume surgeon to published data on robotic-assisted UKA tibial component alignment.

METHODS: 131 consecutive manual UKAs performed by a single surgeon using a cemented, fixed bearing implant were radiographically reviewed by an independent reviewer to avoid surgeon bias. Native and tibial implant slope and coronal alignment were measured on pre- and postoperative lateral and anteroposterior radiographs, respectively. Manual targets were set within 2° of native tibial slope and 0 to 2° varus tibial component alignment. Deviations from target were calculated as root mean square (RMS) errors and were compared to robotic-assisted UKA data.

RESULTS: 128 UKAs were analyzed. The proportion of manual UKAs within the target for tibial component alignment (66%) exceeded published values comparing robotic (58%) to manual (41%) UKA. RMS error for tibial component alignment (1.5°) was less than published RMS error rates in robotic UKAs (range 1.8 to 5°). Fifty-eight percent of study UKAs were within the surgeon's preoperative goal for tibial slope, closer to published findings of 80% for robotic UKAs vs. 22% of manual UKAs. RMS error for tibial slope in study UKAs (1.5°) was smaller than RMS error rates for tibial slope in robotic UKAs (range 1.6 to 1.9°).

CONCLUSIONS: These data demonstrate that an experienced, high-volume surgeon's accuracy in manual UKA can meet or exceed robotic-assisted UKA. Therefore, a surgeon's experience and aptitude should be taken into account when determining the value of robotics in knee arthroplasty. Further, the relationship between implant position and patient outcomes, and consensus on ideal surgical targets for optimal survivorship need further elucidation.

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MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Patient Satisfaction Following Total Knee Arthroplasty Using Technologic Innovation to Achieve Balanced Gaps

Paper 192

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INTRODUCTION: 20% of patients are dissatisfied with their total knee arthroplasty (TKA). Technologic innovation has been introduced in TKA to achieve the desired goal with real time intraoperative information on limb alignment and flexion/extension gap measurements. We compared patient satisfaction following TKA using these real time gap balancing and limb alignment tools versus TKA performed with manual instruments.

METHODS: 57 consecutive patients undergoing TKA using robotic-assisted technology (RA-TKA) with real time intraoperative limb alignment and gap balancing data were compared with 60 consecutive patients undergoing TKA with manual instruments during the same time period. There were no differences between the groups with age and BMI. Cases were performed by a single surgeon using the same implant design, anesthesia, and surgical technique. Postoperative ROM, complications, and operative times were analyzed. Patient satisfaction survey aspect of the Knee Society (KSS) and Likert scoring systems were completed by the patients at 1 year follow-up.

RESULTS: The Likert scoring system demonstrated 96% of patients in the RA-TKA group were either very satisfied or satisfied versus 75% in the TKA group ($p=0.001$). The recreational activity satisfaction question of the KSS was significantly better in the RA-TKA group ($p=0.015$). The RA-TKA group had a better average overall KSS Satisfaction survey ($p=0.058$). Operative time for RA-TKA (103 minutes) was significantly higher than the TKA group (88 minutes) ($p=0.001$). Following the learning curve, mean operative times in RA-TKA group diminished to 89 minutes in the last 25 cases. There were no significant differences in postoperative ROM or complications

DISCUSSION: There are multiple reasons patients are dissatisfied following primary TKA. Using technologic innovation to achieve the target limb alignment with precision flexion and extension gap balancing to within 1 mm, a significant improvement in patient satisfaction was demonstrated compared to TKA using conventional manual instruments.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Patient Optimization in Total Joint Arthroplasty: A Comparison of Episode Cost After Clinical Care Pathway Implementataion

Paper 193

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BACKGROUND: The Comprehensive Care for Joint Replacement model was introduced in 2016 as an initiative to decrease cost and improve quality care of total joint replacements. Total knee and total hip arthroplasties are performed in large volume in the United States; however, the quality and cost of these operations still vary greatly among providers. The purpose of this study is to determine whether implementing a clinical care pathway reduces episode cost for patients undergoing lower extremity total joint replacement. Episode cost as well as length of stay, discharge disposition, and readmission rate were compared to baseline data for performance year one and two after clinical care pathway implementation.

METHODS: The Centers for Medicare and Medicaid Services data at our institution was used for this study. Patients who underwent total joint replacement between 2012 and 2014 were defined as pre-pathway (n = 1,181) and compared to patients who underwent total joint replacement after implementation of our institution's clinical care pathway in 2016 (n = 246) and in 2017 (n = 508). Episode cost is defined by total cost in a 90-day period including acute hospital stay, inpatient rehabilitation, extended care facility, home health care (HHC), outpatient rehabilitation, and readmissions.

RESULTS: The average episode cost after clinical care pathway implementation was $19,078 in the first year and $18,055 in the second year compared to $23,524 for baseline pre-pathway patients ($p < 0.001$). In performance year 1 and year 2, discharge disposition shifted to more patients being discharged home with either home health care (57% and 61%, respectively, from 50% pre-pathway) or outpatient rehabilitation (22% and 21%, respectively, from 5% pre-pathway). Inpatient rehabilitation admissions decreased to less than 1% of patients compared to 13% before our clinical care pathway. Extended care facility utilization decreased from 32% of patients to 21% of patients after year 1 of pathway implementation and to 18% of patients after year 2.

CONCLUSION: A clinical care pathway protocol focuses on improving patient outcomes by placing an emphasis on pre-optimization, patient education, and prehabilitation before surgery. Preadmission testing, joint replacement class, and physical therapy assessment and plan are patient-centered and coordinated by designated nurse care navigators. Our institution found that implementing a clinical care pathway allowed total episode costs for total joint replacements to significantly decrease after 1 and 2 years.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Incisional Negative Pressure Wound Therapy Devices Improve Short-Term Wound Complications, but not Long-Term Infection Rate Following Hip and Knee Arthroplasty

Paper 194

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The potential value of incisional negative pressure wound therapy (iNPWT) on lower extremity total joint arthroplasty (TJA) wound healing has been supported in a few retrospective studies, but has not been definitively assessed with a blinded, prospective, randomized controlled trial designed to examine incisional healing and drainage, patient experience, complications, and re-operation rates for patients undergoing primary or revision hip or knee arthroplasties in the peer-reviewed literature. Therefore, we performed this study to assess whether a portable iNWPT device affects wound appearance, postoperative wound drainage, dressing related complications, wound healing complications, infection rates, and reoperation rates when compared to a standard of care (SOC) postoperative dressing. Our hypothesis was that the use of an incisional negative pressure wound therapy device would contribute to improved wound appearance and decreased wound complication rates compared with traditional incision management

After obtaining Institutional Review Board (IRB) approval, we performed this prospective, randomized study to compare the effects of an iNPWT device and a standard of care (SOC) conventional postoperative wound dressing on early wound healing, wound complications, and late infection rates for patients undergoing hip and knee TJA. 398 patients undergoing primary or revision lower extremity TJA were randomized into iNPWT or conventional wound dressing groups. Study inclusion criteria included consenting age and surgical treatment with primary or revision total hip arthroplasty, surgical treatment with primary or revision total knee arthroplasty. Patients were required to have an advanced technology device capable of digital photography. Study exclusion criteria included pregnancy, history of poor compliance with medical treatment, allergy to silicone adhesives or polyurethane films, and unwillingness to participate in a randomized clinical trial. Wound healing and early complication rates were assessed at 7, 14, and 35 days after the index surgery. Late infection rates were determined at a mean 2-year follow-up. Statistical analysis was accomplished using a paired student's t-test for continuous variables (age, wound score) and a two-sided Fisher's exact test for proportional comparisons between cohorts (diabetes, tobacco use, antibiotic use, complication rates). We accepted p-values < 0.05 as statistically significant.

Patients treated with an iNPWT device were more likely to report wound drainage at day 7 ($p=0.01$), but less drainage longer than 14 days ($p=0.04$). Wound drainage was significantly higher for total hip arthroplasty (THA) patients at day 7 ($p=0.04$), but differences were not sustained through the other time intervals. Total knee arthroplasty (TKA) patients with a BMI > 35 kg/m^2 treated with an iNPWT device

experienced fewer complications (1.3% vs. 21.6%, p<0.01) and fewer dressing related concerns (1.3% vs. 10.8%, p=0.02) compared with a conventional dressing. More patients in the iNPWT group reported moderate or severe incisional drainage at 7 days postop (14.0% vs. 2.0%, p=0.04), but there were no significant differences in the proportion of patients reporting wound drainage between 8-14 days (12.3% vs. 6.0%, p=0.73) or after 14 days (8.7% vs. 2.0%, p=0.21). There were no significant differences in the proportion of patients reporting dressing related complications (7.0% vs. 8.0%, p=1.0) or use of oral antibiotics (12.2% vs. 8.0%, p=0.53). No significant difference in late superficial or deep infection rates were identified between iNPWT and conventional dressing groups (4.0% vs. 3.4%, p=0.8). There was a significantly higher rate in late infection diagnosed after TKA compared with THA (6.1% vs. 0.9%, p=0.03). However, there was no significant difference between iNPWT and SOC dressing selection in the rate of either superficial (1.6% vs. 2.3%, p=0.74) or deep (2.7% vs. 2.8%, p=0.76) wound infection following lower extremity TJA

Our study findings support improved soft tissue healing response with the use of iNPWT devices, but no difference in infection rates was noted between the two groups. Incisional NPWT devices may have a benefit for elective TKA patients with a BMI > 35 kg/m^2. Specific study in this higher risk patient group may be helpful to define the value of iNPWT for patients undergoing elective total joint arthroplasty.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Predictors of Infection-Free Survival After Irrigation and Debridement of Revision Total Knee Arthroplasty

Paper 195

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BACKGROUND: Predictors of success following irrigation and debridement (I&D) with polyethylene liner exchange of revision total knee arthroplasty (TKA) are unclear. Our aims were to determine if infection-free survival following I&D with liner exchange of an acutely infected revision TKA is affected by: (1) postoperative antibiotic duration; and/or (2) patient characteristics/surgical factors.

METHODS: Of all patients who underwent revision TKA at our institution from 2007 to 2012 (n=1,417), 32 underwent I&D with liner exchange after aseptic revision TKA with minimum 2-year available followup. The two cohorts analyzed were patients who required reoperation for infection (n=14) versus those who did not (n=18). Fisher's exact test and one-way ANOVA were utilized to compare patient demographics, comorbidities, and surgical factors between the group that required reoperation for recurrent infection and the group that did not. Multivariate Cox regression was used to examine the association between duration of antibiotic therapy and infection-free survival. Surgeons' random effect was controlled in the Cox model. Stepwise selection with the prespecified criterion of $p<0.05$ was used to select predictive variables in addition to the main predictor. With a hazard ratio of 0.50, the power to detect an effect of antibiotic duration on infection-free survival was 0.80.

RESULTS: Increased duration of postoperative antibiotic therapy (HR 0.979, 95% CI 0.966 to 0.991, p=0.0032) following I&D with liner exchange of revision TKA decreased the risk of reoperation for infection. Atrial fibrillation (HR 41.675, 95% CI 2.471 to 702.93, p=0.0143) or more than 15 cells per high powered field (HPF) on intraoperative tissue pathology (HR 5.695, 95% CI 2.120 to 15.295, p=0.0026) increased the risk of reoperation for infection.

CONCLUSIONS: Chronic antibiotic suppression should be considered in all patients following I&D with liner exchange of aseptic revision TKA. Two-stage exchange may be favored in acutely infected revision TKA patients with atrial fibrillation or more than 15 cells/HPF.

MAOA BREAKOUT SESSION #13
KNEE ARTHROPLASTY
April 13, 2019

Impact of Antibiotic-Loaded Bone Cement on Antibiotic Resistance in Prosthetic Knee Infections

Paper 196

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INTRODUCTION: Antibiotic-loaded bone cement (ALBC) is commonly used to prevent prosthetic joint infections (PJI) in total knee arthroplasty (TKA), especially among high-risk patients. While previous studies have reported on the efficacy of ALBC in reducing the rate of PJI, its impact on antibiotic resistance has not been determined. The purpose of this study is to investigate antibiotic resistance among organisms causing PJIs in which ALBC was utilized.

METHODS: A retrospective review of patients from December 1998 through December 2017 at a single institution identified 36 periprosthetic knee infections that met inclusion criteria. Patients with culture-negative infection and unknown cement type were excluded. Patient characteristics, infecting organism, and antibiotic susceptibilities were recorded. ABLC included an aminoglycoside in all cases. Data were analyzed using Fisher Exact and Chi Square tests with significance for p-values < 0.05. There was no statistical difference in Charlson Comorbidity Index ($p=0.457$) or number of patient with diabetes ($p=0.445$) between ALBC and standard cement groups.

RESULTS: There was no difference in the infecting organism or antibiotic susceptibilities between the two groups. Staphylococcus species was the most commonly isolated, with 9/16 (56.3%) cases using non-ALBC and 14/20 (65.0%) cases using ALBC ($p=0.143$). Of those infected with staphylococcus, there was no difference in antibiotic susceptibilities between groups ($p=0.408$). Overall, there were only 3 cases where the infecting organism was aminoglycoside resistant (one standard cement, two with ALBC).

CONCLUSION: The use of ALBC did not significantly increase individual antibiotic resistance or alter the pattern of infecting organism in periprosthetic knee infection. These results give further support for the use of ALBC as a low-risk measure taken as part of a multi-modal effort to minimize PJIs in patients undergoing TKA.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Opioid Free Reverse Shoulder Arthroplasty: Optimizing Multimodal Pain Management

Paper 198

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BACKGROUND: While the United States represents only 5% of the global population, 80% of the global opioid supply is consumed in the U.S. Since the 1990s, the use of opioids has increased leading to the ensuing opioid crisis. Preoperative patient-targeted education on opioid use is an avenue yet to be explored. The purpose of this study is to evaluate whether implementation of preoperative patient education and multimodal pain management protocols can achieve an Opioid Free postoperative recovery after reverse shoulder arthroplasty (RSA).

METHODS: A prospective clinical trial of patients undergoing RSA by two fellowship-trained shoulder surgeons was performed. All patients received standardized multimodal pain management protocols. Patients included in the Opioid Free group received preoperative education tools on expectations of pain levels, non-opioid medications and alternate options to minimize pain. Patients were compared to control group for opioid consumption immediately postoperative, 48 hours and 7 days and on outcomes including ASES, PENN, and SSV. Students' t-tests were used to compare scores.

RESULTS: Forty patients were included in the study: 20 patients in the Opioid Free group and 20 patients in the standard care control group. There was no significant differences in age (avg 73.3) ($p=0.14$), ASA grade (avg 2.3) ($p=0.44$), gender, BMI (avg 29.5) ($p=0.96$), and comorbidity burden ($p>0.05$) between the groups. Preoperatively, there were significant differences in PENN and Constant Scores, but no differences see for ASES or SSV. Of the Opioid Free group, 26.7% of patients reported use of rescue opioids in the 48 hours following surgery, and 100% of patients reported no opioid use at 2 weeks postoperatively compared with 80% of the control group still taking opioids at 2 weeks postoperatively. Patients in both groups showed significant improvements in ASES pain scores (Opioid Free: $p=0.009$, Control: $p=0.003$) and ASES functional scores (Opioid Free: $p=0.046$, Control: $p=0.001$). At last follow-up, the Opioid Free group reported significantly higher Constant scores with an average of 33.2 compared to 22.5 in the control group ($p<0.001$). There were no significant differences in all other outcome measures.

CONCLUSIONS: Even though opioids have been a mainstay in postoperative pain management, our preliminary results suggest an opioid free postoperative course is possible. Better education and a structured multimodal pain management protocol, can achieve an opioid-free postoperative course following RSA without adversely affecting patient-reported satisfaction and outcomes.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Mechanical Tradeoffs in Reverse Shoulder Arthroplasty: A Finite Element Analysis

Paper 199

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INTRODUCTION: The range of motion achieved following reverse shoulder arthroplasty is influenced by component design features, implant positioning, bony constraints, cuff integrity, and soft tissue tension. The goal of this study was to investigate the mechanical influence of glenoid component lateralization and the use of a retentive humeral component on range of motion in reverse shoulder arthroplasty.

MATERIALS AND METHODS: A previously validated finite element modeling approach was used to analyze the influence of variations in component position for the Trabecular Metal reverse shoulder arthroplasty system. The baseplate was placed in neutral version and aligned with the inferior boarder of the glenoid. Glenosphere lateralizations of 2 mm, 4 mm, and 10 mm were investigated. With these same combinations of lateralization, two different humeral component augmentations were studied to examine the effects of a non-retentive (150°) versus retentive (155°) liner.

RESULTS: As expected, increased lateralization resulted in increased impingement-free range of motion. At 2 mm, 4 mm, and 10 mm of lateralization, the external rotation at which impingement first occurred was 43°, 48°, and 69°, respectively. Impingement-free range of motion was, however, decreased with the addition of a retentive liner. At 2 mm of lateralization, external rotation was decreased from 43° to 31° with a non-retentive versus retentive liner. Similar results were seen at 4 mm of lateralization as impingement free ROM decreased from 48° to 38° with the addition of a retentive liner.

CONCLUSIONS: Although multiple factors influence the range of motion achieved following reverse shoulder arthroplasty, our findings in a previously validated finite element model demonstrate that lateralization plays a critical role in maximizing impingement-free range of motion. Although the use of retentive liners may improve stability, they are associated with a decrease in impingement-free range of motion in this model.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Shoulder Arthroplasty for Proximal Humeral Fracture is Not a Typical DRG-483 – Implications for a Bundled Payment Model

Paper 200

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INTRODUCTION: Shoulder arthroplasty is a viable treatment for the management of glenohumeral degenerative arthritis (which includes osteoarthritis as well as rotator cuff arthropathy) and proximal humeral fractures. The Center for Medicare Services (CMS) currently bundles all shoulder arthroplasties, total (TSA) and reverse (rTSA), into one Diagnosis-Related Group (DRG) upon which re-imbursements are then further characterized. A shoulder arthroplasty performed for traumatic indications, such as fractures, may have a different postoperative course of care as compared to one being done for a degenerative pathology, despite this, they have the same CPT code.

MATERIALS AND METHODS: The 2012-2016 ACS-NSQIP databases were queried using CPT-code (23472) to retrieve records of patients undergoing a TSA/rTSA. Data was filtered to exclude patients with polytrauma, traumatic rotator cuff tears and inflammatory arthropathies. Only patients undergoing a shoulder arthroplasty for degenerative arthritis or proximal humerus fracture were included in the final cohort.

RESULTS: A total of 8283 (92.5%) and 667 (7.5%) patients underwent a shoulder arthroplasty for glenohumeral degenerative arthritis and proximal humeral fracture respectively. Following adjustment for baseline clinical characteristics, the fracture group was associated with a higher risk of a longer length of stay >2 days (OR 2.39 [95% CI 1.97-2.92]; $p<0.001$), 30-day surgical complications (OR 2.44 [95% CI 1.31-4.55]; $p=0.005$), re-operations within 30 days (OR 2.41 [95% CI 1.26-4.62]; $p=0.008$), 30-day medical complications (OR 3.58 [95% CI 2.72-4.72]; $p<0.001$), pulmonary embolism (OR 3.62 [1.31-10.02]; $p=0.013$), postoperative transfusions (OR 4.55 [95% CI 3.29 -6.27]; $p<0.001$), non-home discharge (OR 3.01 [95% CI 2.42-3.74]; $p<0.001$), and 30-day readmissions (OR 2.14 [95% CI 1.41-3.26]; $p<0.001$).

CONCLUSION: Following adjustment for baseline characteristics, shoulder arthroplasty for fracture, when compared to shoulder arthroplasty for degenerative arthritis, was associated with a longer length of stay, a higher odds ratio of surgical/medical complications and readmissions within 30 days as well as a more likely chance of a non-home discharge. The findings of the study point towards a higher resource utilization when this procedure is performed for a fracture. As we move towards the era of bundled payment models, appropriate risk adjustment based on indication of the surgery should be promoted to maintain the quality of care for all patients.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Minimum 10-Year Thin Cut CT Follow-Up of Total Shoulders with a Partially Cemented All-Polyethylene Glenoid

Paper 201

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BACKGROUND: Glenoid component failure is a known complication of anatomic total shoulder arthroplasty. To reduce cement-associated bone loss, an implant with radial fins about its uncemented central peg and minimal cement to anchor its peripheral pegs was developed. Our previous work with this cohort supported significant ingrowth between the central peg's radial fins at a 2 year minimum follow-up. The goal of the current study was to similarly evaluate these shoulders at a minimum 10-year follow-up.

MATERIALS AND METHODS: Of the previous cohort of 35 shoulders, 16 shoulders in 15 patients were available for study. All shoulders underwent an anatomic total shoulder arthroplasty for primary glenohumeral osteoarthritis with a minimum 10-year follow-up with the same technique and prosthesis. Patients were evaluated identically to 8 years prior: clinical exam, Simple Shoulder Tests Constant Score, plain radiographs, and thin-cut (0.625 mm) CT scans. Modified Lazarus scores were calculated from standard radiographs and Yian radiolucency scores were calculated from thin-cut CT scans. Radiographic findings were correlated with clinical metrics.

RESULTS: At mean of 11.6 years following surgery, plain radiographic and thin-cut CT data demonstrated varying radiolucencies with one grossly loose. Lazarus scores ranged from 0 (no radiolucencies) to 5 (Ave. 2.4 +/- 1.6). Yian scores ranged from 0 (no radiolucencies) to 18 (Ave. 7.9 +/- 5.3). The number of central peg radial fin compartments with bone ranged from 0 to 6 (Ave. 2.7 +/- 2.7).

Current scores were compared with scores from the previous radiographs and scans. There was a statistically significant decrease in the central peg's radial fin bone presence median score of 6 at mean 4.3 year follow-up versus a median of 3 at 11.6 mean year follow-up ($p<0.008$). There was a significant increase in mean Yian score from 1.8 to 7.9 over the 8-year follow-up interval ($p<0.002$). There was no significant progression in Lazarus radiolucency scores from 0.2 to 1.7 ($p<0.12$).

There was no correlation with progressive radiolucencies and clinical metrics declination. One shoulder was revised for aseptic glenoid loosening.

CONCLUSION: At a minimum 10 years postoperative, plain radiograph and thin cut CT scans revealed radiolucency progression for a partially cemented glenoid component with an uncemented central peg without a decline in shoulder function. Further study of this component is warranted.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Results of Total Shoulder Arthroplasty in Patients Under vs. Over 55 Years of Age: An Analysis of 1,135 Patients with Over 2 Years of Follow-Up

Paper 202

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BACKGROUND: Results of anatomic total shoulder arthroplasty (TSA) in younger patients have not been well defined. The purpose of this study was to compare early outcomes following TSA in patients younger than 55 years of age to patients older than 55 years of age.

METHODS: A total of 1135 patients treated with TSA for glenohumeral osteoarthritis were retrospectively reviewed with mean follow- up over 4 years. Indications included osteoarthritis (1,044), osteonecrosis (35), inflammatory arthritis (34), and post-traumatic arthritis (22). Validated outcomes measures, range of motion, and patient satisfaction were collected. Preoperative and postoperative metrics were compared and a multivariable analysis was done to isolate age, from gender, BMI, previous surgery, and diagnosis as an independent factor.

RESULTS: Female patients, prior surgical history, and patients with a diagnosis of osteonecrosis were more likely to undergo TSA under the age of 55. Preoperatively, no differences were found in outcomes or range of motion. Postoperatively, patients over 55 years had slightly greater active abduction and internal rotation. The incidence of previous surgery was greater in younger patients compared to older patients ($p=0.001$). A higher percentage of patients over 55 years rated their outcome as better or much better compared to those under 55 ($p = .003$).

CONCLUSIONS: Female gender, previous surgical history, and a diagnosis of osteonecrosis were associated with undergoing TSA under 55 years of age. Despite similar preoperative function and minor differences in postoperative range of motion and outcome scores, patients over 55 years reported lower overall satisfaction with their TSA.

Level of Evidence: Cohort study; Level of evidence 3
Keywords: Total Shoulder Arthroplasty, Outcomes, Glenohumeral osteoarthritis

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Evaluation of Gender Differences in Glenoid Remodeling in Patients with Primary Shoulder Osteoarthritis

Paper 203

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INTRODUCTION: Most common mode of failure of anatomic total shoulder arthroplasty is glenoid component loosening. The etiology for glenoid loosening is multifactorial and may include implant design and surgical technique. Previous work has evaluated glenoid dimensions and gender differences in young, non-arthritic, cadaveric specimens. To our knowledge, no previous study has compared gender differences in glenoid dimensions and morphology in patients with primary shoulder osteoarthritis. The purpose of this study is to compare glenoid morphology and wear patterns between male and female patients with primary shoulder osteoarthritis.

METHODS: Following IRB approval, we performed a retrospective review of all patients who underwent an anatomic total shoulder arthroplasty by a single surgeon for the diagnosis of primary osteoarthritis between August 2013 and July 2017. All patients had preoperative CT scans as part of their routine surgical planning. A total of 128 shoulders met our inclusion criteria. There were 59 male shoulders and 68 female shoulders. Glenoid version, inclination, and vault depth were measured by a fellowship-trained musculoskeletal radiologist. Glenoid wear pattern was also classified according to Walch et al. Glenoid version, inclination, and vault depth were compared between males and females using the independent sample t-test. The association of Walch wear pattern with gender were evaluated using Fishers exact test. Statistical significance was set at $p<0.05$.

RESULTS: Male shoulders had significantly greater glenoid retroversion (17 degrees) than female patients (10 degrees) ($p<0.001$). Male shoulders also had significantly deeper glenoid vaults (2.1 cm) than female shoulders (1.7 cm) ($p<0.0001$). There was no difference in average glenoid inclination between male and female shoulders (6.5 degrees inferior vs. 8.6 degrees inferior) ($p=0.20$). Overall, Walch classification demonstrated a greater posterior wear pattern amongst males and greater central wear amongst females, which was statistically significant (P-value <0.0001).

DISCUSSION: This data reveals differences in glenoid wear between osteoarthritic males and female shoulders. Males demonstrate preferential posterior glenoid remodeling whereas females remodel centrally. The posterior wear pattern in males likely contributes to the relative increased posterior glenoid version as compared to females. The central wear pattern in females likely contributes to the relative smaller glenoid vault depth. Data comparing glenohumeral morphology and wear secondary to osteoarthritis between sexes could provide valuable insight for glenohumeral implant design. Continued research evaluating glenoid osteoarthritis patterns between males and females is needed to improve longevity of total shoulder arthroplasty.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Mid-Term Radiographic Results of a Cementless Micro Humeral Component in Anatomic and Reverse Shoulder Arthroplasty

Paper 204

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INTRODUCTION: Ultra-short humeral components have gained increasing popularity. Potential benefits include bone preservation and easier implantation in patients with deformity, retained hardware, or prior elbow arthroplasty. However, short stems may be more prone to malalignment, and several studies have reported worrisome rates of loosening and bone resorption with certain short stem designs.

METHODS: The clinical and radiographic outcomes of 100 shoulder arthroplasties (35 anatomic, 65 reverse) performed with implantation of a proximally coated ultra-short (micro – 55 mm in length) stem were evaluated at mean follow-up of 3.5 years. The mean age of the patients at the time of surgery was 68 (range, 31 to 90) years. Implantation with 1.5 mm of underbroaching was routinely employed. Radiographs were reviewed by three observers for signs of humeral loosening or progressive humeral bone loss secondary to osteopenia or stress shielding.

RESULTS: Nine shoulders (9%) underwent reoperation for infection (3), humeral tray fracture (2), glenoid loosening (1), and instability (3). A total of 6 stems were removed in these 9 reoperations. No humeral component was revised for loosening or considered to be loose radiographically. Calcar bone loss was noted in 23% (mild – 21, moderate – 2). Tuberosity bone loss (stress shielding) was noted in 14% (mild – 9, moderate – 2, severe – 3). Ninety-five (95%) implants were considered to be well-aligned defined as < 5˚ of varus or valgus angulation which is similar to prior reports of a short stem (mini – 83 mm in length).

CONCLUSIONS: In this study, implantation of a micro (55 mm) humeral component with proximal ingrowth coating was associated with no instances of loosening in both anatomic and reverse arthroplasty. When observed, bone loss in the calcar region and greater tuberosity were mild in the majority of the shoulders. The results of this study cannot be extrapolated to other short stems with different design features.

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MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
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Opioid-Free Shoulder Arthroplasty: A Reality with Multimodal Pain Management

Paper 205

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BACKGROUND: Creation of pain as the 5th vital sign in the 1990s led to skyrocketing opioid prescriptions and a culture of opioids being a mainstay for pain control. This has led to a crisis with addiction and abuse among Americans. The purpose of this study is to evaluate whether implementation of preoperative patient education and multimodal pain management protocols can achieve an Opioid Free postoperative recovery after anatomic and reverse shoulder arthroplasty (SA).

METHODS: Patients undergoing SA received standardized multimodal intraoperative and postoperative protocols for their pain management. Patients included in the Opioid Free group received preoperative education tools on expectations of pain levels, non- opioid medications and alternate options to minimize pain. Patients were compared on opioid consumption in the immediate postoperative period, at 48 hours, and 2 weeks as well as patient-reported outcomes at 6 months postoperatively. Students' t-tests were used to compare scores between groups.

RESULTS: This study included 40 patients: 20 patients in the Opioid Free group and 20 patients in the control group. There was no significant differences in age (avg 70.9) ($p=0.10$), ASA grade (avg: 2.3) ($p=0.21$), gender, BMI (avg 29.8) ($p=0.46$), or comorbidity burden between the groups. Of the Opioid Free group, 30% of patients reported use of rescue opioids in the 48 hours following surgery, and 100% of patients reported no opioid use at 2 weeks postoperatively. In the control group, 100% reported using opioids in the 48 hours following surgery and 90% reported still taking opioids at 2 weeks postoperatively. Patients in both groups showed significant improvements on all outcome scores postoperatively. At last follow-up, the Opioid Free group reported significantly higher ASES Pain and Constant scores compared to the control group. There were no significant differences on all other outcome measures.

CONCLUSIONS: Our results demonstrate that pain control following shoulder arthroplasty is possible without the use of opioids when patients are educated preoperatively. In addition, our opioid-free patients reported lower pain scores postoperatively and better function without a negative effect on outcomes and satisfaction scores.

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Does the Use of a Peri-Articular Anesthetic Cocktail Provide Adequate Pain Control Following Shoulder Arthroplasty?

Paper 206

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PURPOSE: Interscalene nerve block (INB) and liposomal bupivacaine (LB) have been previously found to provide adequate pain control following shoulder arthroplasty. We hypothesized that local infiltration of a peri-articular cocktail (LIC) would provide equivalent pain control compared to INB and LB at a decreased cost.

METHODS: Eighty-six patients undergoing primary shoulder arthroplasty were consented for participation. Patients were treated with either LIC (200 mg of 0.5% ropivacaine/1 mg epinephrine/30 mg ketorolac), local infiltration of LB (20mL bupivacaine/20mL saline), or preoperative INB. The primary outcome of the study was postoperative average visual analog scale (VAS) scores accessed for 4 days. Secondary outcomes included opioid consumption, length of stay, and complications.

RESULTS: A total of 29 patients receiving LIC, 26 receiving LB, and 31 receiving INB were included in the study. Patients who received LIC had a significantly lower mean VAS on postoperative day (POD) 0 when compared to INB (2.46 vs. 3.95, $p<.001$) and LB (2.46 vs. 4.80, $p<.001$). The INB group also had significantly higher opioid requirements on POD 0 compared to the LIC group, mean 0.44 vs. 0.88 morphine equivalents ($p<.001$). There was no significant difference in opioid requirements when comparing LIC and LB. Length of stay was shorter in LIC group (1.0 vs. 1.5 vs. 1.5 days, $p<0.001$), and there was one complication of phrenic nerve palsy in the INB group.

CONCLUSION: A decrease in early postoperative pain was found with LIC when compared with INB and LB after shoulder arthroplasty. No differences were found in pain levels after POD2. These findings suggest that LIC provides similar pain relief and opioid requirements at a decreased cost compared to INB and LB.

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MAOA BREAKOUT SESSION #14
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Risk Assessment of Opioid Dependency in Revision Cases of Reverse Shoulder Arthroplasty

Paper 207

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INTRODUCTION: Reverse shoulder arthroplasty (RSA) is a relatively new and successful procedure that has seen a dramatic growth in use since its inception. Consequently, the number of RSAs performed and their associated complications have steadily increased. Some of these complications can be managed conservatively, whereas other complications necessitate surgical intervention including revision surgery. Pain control after revisions surgery can consequently be more difficult given patients typically are not narcotic naïve; however, narcotic usage after revision RSA procedures is poorly understood. The purpose of our study was evaluate opioid usage and dependency after revision RSAs.

METHODS: A retrospective review of 114 reverse shoulder arthroplasties (RSA) performed at a single institution between 2014-2016. The cohort was divided into two groups; group 1 revision RSA (n=58) and group 2 primary RSA (n=56). Demographics including age, gender, BMI, and ASA class were collected for all cases. Opioid consumption within 90 days was collected for the preoperative and postoperative period using a mandated state registry for opioid prescription. Total morphine equivalence (TME) was calculated as the sum of all prescriptions dispensed. Opioid dependency was defined as chronic opioid consumption for 3 continuous months. Independent t-test was used to compare means of TME between the two groups. Chi square test was used for all categorical variables. Statistical significance was considered for p values below 0.05.

RESULTS: Demographics were similar between the two groups for BMI (p=0.29), gender (p=0.35), and ASA class (p=o.64). There was significant difference in age between the groups (66.1 vs. 74.95; p<0.001). There was a significant difference in preoperative opioid dependence between the two groups with group 1 being higher (49.1%) compared to group 2 (22.2%) (p=0.005). Preoperative TME was also significantly higher in group 1 (138.69) compared to group 2(28.05) (p=0.007). Postoperatively, there was no significant difference in opioid dependence between group 1 (43.6% [n=24]) and group 2 (35.8% [n=19]) (p=0.44). In addition, there was no significant difference seen between the groups for postoperative TMEs (group 1= 200.1 vs. group 2 135.6) (p=0.08).

DISCUSSION: Although our results demonstrated a higher opioid dependence rate for revision RSA, it did not lead to increased postoperative dependency. Surgeons, however, need to be aware of the significant increase in postoperative consumption (5x) for these patients in the acute postoperative period. Our findings suggest revision surgery may be a successful treatment to decreases rates of opioid dependence for this patient population.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Ultrasound and Clinical Assessment After Subscapularis Sparing Anatomic Total Shoulder Arthroplasty

Paper 208

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INTRODUCTION: Anatomic total shoulder arthroplasty (ATSA) typically involves release and reattachment of the subscapularis tendon which may lead to postoperative complications including subscapularis dysfunction or rupture. Reports of ATSA using techniques that do not release of the subscapularis have involved small sample sizes and have not evaluated subscapularis tendon integrity. The purpose of this study is to examine the clinical outcomes and integrity of the subscapularis using ultrasound in a consecutive cohort of patients who received a subscapularis sparing ATSA.

METHODS: Out of 87 patients operated between October 2014 to March 2017, 46 patients (52.9%) agreed to receive ultrasound assessment of the operative shoulder, range of motion (ROM), and dynamometer strength testing. A fellowship-trained musculoskeletal radiologist performed all the ultrasound interpretations. Postoperative outcome measurements included the American Shoulder and Elbow Surgeons Shoulder Score (ASES-SS), the Simple Shoulder Test (SST), the Single Assessment Numeric Evaluation (SANE), the Visual Analog Scale (VAS) pain score, and the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) survey. The paired t-test was used to compare preoperative versus postoperative outcomes. Statistical significance was defined as $P<0.05$.

RESULTS: The average cohort age was 61.0 years (SD = 8.1) with 25 males and 21 females patients. The average length of follow-up was 24 months (range 12-41). Ultrasound inspection identified that all subscapularis deltoids were intact without evidence of injury. Clinically, all patients demonstrated adequate subscapularis function on internal rotation with no notable deficits as compared to the contralateral shoulder. As compared to the nonoperative shoulder, the operative shoulder demonstrated significantly worse abduction strength and ROM ($p<0.01$, $p=0.04$ respectively) and external rotation ROM ($p=0.03$). There were no differences between the operative and nonoperative shoulders in regard to external rotation strength ($p=0.06$) or strength and ROM of forward flexion ($p=0.21$, 0.63 respectively) and internal rotation ($p=0.33$, 0.31 respectively). Excellent outcome scores were reported with the ASES-SS (mean ± SD = 89.9/100±14.2), the SST (11.2/12±2.0), and the QuickDASH (7.8/100 ± 13.2). Patients reported a mean improvement in their SANE score of 58.3% (SD = 30.8) and a mean improvement in their VAS scores of 69.3% (SD = 26.6%).

CONCLUSION: Favorable early outcomes without clinical evidence of subscapularis dysfunction or rupture are demonstrated in this series of subscapularis sparing ATSAs.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

What Are the Costs of Shoulder Osteoarthritis in the Year Prior to a Total Shoulder Arthroplasty (TSA)?

Paper 209

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INTRODUCTION: With a current worldwide shift from fee-for-service to value-based payment models of healthcare, there is a need for identification of health-care utilization and associated costs incurred prior to undergoing a major surgery such as anatomic total shoulder arthroplasty (ATSA) for degenerative arthritis of the glenohumeral joint.

MATERIALS AND METHODS: The PearlDiver Humana database, a national administrative database of Medicare Advantage (MA) and Commercial (C) insurance beneficiaries, was queried for active records of patients undergoing a primary ATSA from the fourth quarter of 2010-2015 using the International Classification of Disease 9th Edition (ICD-9) procedural code 81.80. Data was filtered to ensure that only those ATSAs with enrollment data up to 1 year prior to surgery. A manual scan of records was done to ensure that all TSAs were being done for degenerative arthritis of the shoulder. Current Procedural Terminology (CPT) codes were used to categorized pre-operative health-care utilization into the following groups: (1) Procedures & Anesthesia, (2) Office visits, (3) Radiology, (4) Injections – further divided into (a) Steroid injections and (b) Hyaluronic Acid (HA) injections, (5)Physical Therapy, (6) Non-opioid pain medications, and (7) Opioids. Overall costs/reimbursement and per-patient average reimbursements (PPARs) were calculated for each category with regard to preoperative specified time periods (0-3 months, 0-6 months and 0-1 year).

RESULTS: A total of 3,920 patients (MA=3,691; C=229) undergoing primary ATSA were retrieved from the database. Based on defined categories, the total costs prior to ATSA were $368,137 and $2,812,617 for C and MA beneficiaries respectively. Overall 1-year PPAR for each category were as follows: Procedures & Anesthesia (MA=$1765; C=$5333), Office visits (MA=$441; C=$396); Radiology (MA=$253; C=$558), Injections (MA=$117, C=$173), Physical therapy (MA=$473; C=$372), Non-opioid pain meds (MA=$49; C=$147); and Opioids (MA=$26; C=$49). For all categories, the highest utilization was seen in the three months prior to the procedure with 42%-81% of overall PPAR being accounted for various categories. Of note, 63.3% (C)/61.5% (MA) of the overall PPAR for opioids and and 67.2%(C)/64.4%(MA) of the overall PPARs for steroid injections were accounted for in the last three months.

CONCLUSION: We observed a high utilization of glenohumeral OA-related care, particularly of opioids and steroid injections, in the three months prior to undergoing a ATSA. As we move towards adoption of value in health-care systems, judicious use of conservative treatment options, particularly in patients that ultimately require surgery, will be an effective way of optimizing costs.

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MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
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Bundled Payment Plans Produce Significant Cost Savings for Total Shoulder Arthroplasty in the Outpatient Setting

Paper 210

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INTRODUCTION: In the current economic climate, physicians face increasing pressure to provide cost effective care. One type of program to facilitate this efficiency is bundling of services, typically into a 90-day episode of care. We sought to determine the impact of a private insurance bundling program on the cost of outpatient TSA at a freestanding ambulatory surgery center.

METHODS: A cost minimization analysis was performed after retrospective review of a cohort of patients who underwent outpatient anatomic TSA by a single surgeon at a single freestanding ambulatory surgery center. Direct cost line-by-line comparison was performed for all patients treated within the 90-day episode of care. Age, sex, Charlson comorbidity index, BMI, smoking status, hand dominance, and other demographic data were compared. Complications and reoperations were also analyzed.

RESULTS: Seventy-six anatomic TSAs were included in the study. Thirty-nine patients were in the bundled group, and 37 patients were outside of the program. The bundled group (age 58 years) on average was older than the unbundled group (age 54 years, $p=0.021$), but the groups were otherwise similar in demographics. The average total implant charges were significantly less for the bundled group ($24,822.43 vs. $28,405.51, $p=0.014$). Both average total surgery supply charges and anesthesia supply charges were similar between groups ($p>0.05$). Mean total outpatient surgical day charges including surgical equipment, implants, and anesthesia equipment were significantly less for the bundled group ($29,782.43 vs. $33,238.68, $p=0.022$). Average OR staffing costs on the day of surgery were also significantly less for the bundled group ($135.37 vs. $162.55, $p=0.015$). During the 90-day postoperative period, charges were similar between the two groups. There was one complication (rotator cuff failure) within the 90-day period in a bundled patient that required conversion to a reverse TSA.

CONCLUSIONS: This study shows that anatomic TSA utilizing a bundled care program in the outpatient setting can significantly reduce costs. The primary driver of this reduction is implant pricing, which is negotiated as part of the bundle. Each surgeon must carefully navigate his or her unique practice in the changing economic health care environment when creating an outpatient TSA and/or bundling program.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Mental Health and Tobacco Use Are Correlated with PROMIS Upper Extremity, Pain Interference Scores in Patients with Shoulder Pathology

Paper 211

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PURPOSE: The purpose of our study was to examine the PROMIS domains of Pain Interference (PROMIS-PI), Depression (PROMIS-Depression), and Upper Extremity (PROMIS-UE) for non-operative patients. We also set out to determine if patient demographics have any predictive influence on reported outcomes scores.

METHODS: Patients presenting to clinic with shoulder pain that was treated non-operatively were recruited. PROMIS scores and patient demographics were compiled and statistical correlations were run between each domain.

RESULTS: A total of 638 CAT questionnaires (PROMIS-UE, PROMIS-PI, and PROMIS D) were collected and analyzed. PROMIS-UE had a strong negative correlation with PROMIS-PI ($R = -0.73$, $p < 0.001$). Additionally, PROMIS-PI and PROMIS-D were positively correlated with each other with moderate strength ($R = 0.54$, $p < 0.001$). Patients who never used tobacco had statistically significantly higher PROMIS-UE scores (34.5 vs. 30.6 and 31.9, respectively; $p < 0.001$), and lower PROMIS-PI (59.7 vs. 63.1 and 60.9, respectively; $p < 0.001$) and PROMIS-D scores (47.3 vs. 52.1 and 49.3, respectively; $p < 0.001$) than those who were current or former tobacco users. Patients with lower BMI (1st quartile: 15.8 - 24.8) had significantly higher PROMIS-UE scores than patients with a BMI larger than 24.8 ($p < 0.05$).

CONCLUSION: There is an inverse relationship between upper extremity physical function and pain and depression, as measured by PROMIS scores. Smoking is a significant contributor to worse outcomes in patients with shoulder pathology, even in non-operative populations. Weight loss and smoking cessation are important treatment modalities in this patient population.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Incidence of Positive Intraoperative Cultures in Primary Shoulder Arthroplasty Following Prior Ipsilateral Shoulder Surgery

Paper 212

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INTRODUCTION: The impact on implant survivorship is currently unknown in patients undergoing primary shoulder arthroplasty who have had prior shoulder surgery. To our knowledge, the rate of positive intraoperative cultures in patients undergoing primary shoulder arthroplasty who have had prior ipsilateral non-arthroplasty shoulder surgery has never been reported. The aim of this study was to determine the incidence of positive cultures in that patient population.

METHODS: We performed a retrospective review to delineate those patients who had undergone prior ipsilateral shoulder surgery in which intraoperative cultures were taken at the time of primary total shoulder arthroplasty. We analyzed all shoulder arthroplasties performed by a single surgeon over a consecutive three-year span. We evaluated all available culture results in addition to demographic data and number of prior surgeries. Revision arthroplasty, documented clinical signs of infection, and arthroplasty for fracture were excluded. Regression analysis was used to determine which patient-related risk factors could predict positive cultures.

RESULTS: 324 patients underwent primary anatomic or reverse total shoulder arthroplasty, 68 of whom had at least one prior ipsilateral shoulder surgery. Intraoperative cultures were available for 48 of these patients (64.6% male; mean age 61.6 years). An average of 3.3 tissue samples for culture were obtained for each patient. Cultures were positive in at least one tissue sample in 52.1% (25/48) of patients, with Propionibacterium acnes (80%, 20/25) the most frequent organism. Among the positive culture group, an average of 1.9 tissue cultures resulted positive (range 1-5), and 20% (5/25) had only one positive tissue culture (4/5 grew P. acnes and 1/5 grew Staphylococcus epidermidis). Male sex and a history of prior shoulder infection were predictive of culture positivity (odds ratios 5.5 and 23.4, respectively). Age, sex, medical comorbidities, number and type of prior shoulder surgeries, and time from index shoulder surgery were not predictive of culture positivity. At the time of follow-up, there were no associated complications in either the positive or negative culture groups.

CONCLUSION: More than half of patients with no clinical signs of infection and a history of prior ipsilateral shoulder surgery undergoing primary shoulder arthroplasty grew positive intraoperative cultures. Similar to unexpected positive cultures found during revision shoulder arthroplasty, the significance of these findings remain unclear in regard to risk of progression to clinically-meaningful infection and how these patients should be managed.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Clinical Characteristics and Long-Term Outcomes After Septic Arthritis of the Native Glenohumeral Joint: A 20-Year Retrospective Review

Paper 213

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INTRODUCTION: Septic arthritis (SA) of the native glenohumeral joint is a rare entity, but when present carries serious and potentially morbid long term complications. There is little information available reporting the history, natural progression and long-term joint outcomes in shoulders that experienced SA. Thus, this study aims to (1) identify the etiology, patient characteristics, and presentation of glenohumeral SA, and (2) to report long-term joint outcomes, complications, and later need for arthroplasty in this patient population.

METHODS: All cases of glenohumeral SA at our institution between 1995-2015 were retrospectively identified by the International Classification of Disease, Ninth Revision, Clinical Modification code 711.01. Medical records of 97 patients with a minimum follow-up of 1 month (mean, 83.1 months; range, 1-264 months) were reviewed. Demographics, clinical presentation, medical co-morbidities, infectious organisms, and perioperative laboratory studies were recorded for all patients. Operative records were reviewed to document postoperative complications, recurrences, and the number of patients who went on to undergo elective shoulder arthroplasty.

RESULTS: Patients were an average 58.2 years of age (range, 27-93 years), and 59.8% were males. Twenty patients (20.6%) were immunocompromised, and 27 patients (27.5%) were intravenous drug users (IVDU). Diabetes mellitus was present in 40 patients (41.2%), and 18 patients (18.5%) were on hemodialysis. Synovial fluid aspiration contained 121,656 white cells on average, with a mean differential of 92.6% neutrophils. All patients had an elevated erythrocyte sedimentation rate (mean, 81.9 mm/h [reference range, 0-10 mm/h]), and all but one patient had elevated C-reactive protein (15.9 mg/dL [<0.5 mg/dL]) levels. Staphylococcus aureus were the most common organism identified (62.9%), with 25.7% methicillin-resistant species.

Hematogenous spread of infection was the most common etiology of identified shoulder sepsis (40.2%). Seven patients (7.2%) developed shoulder sepsis of undetermined etiology in the absence of established risk factors. Sixteen patients (16.5%) developed recurrent glenohumeral SA at a mean 40 months following initial infection. Three patients (3.1%) underwent same-side shoulder arthroplasty at a mean 18 months following the septic joint. None developed a prosthetic joint infection with a mean 66 months prosthetic survival period.

DISCUSSION AND CONCLUSION: Septic arthritis of the glenohumeral joint is highly unlikely in the absence of medical risk factors and in the setting of normal inflammatory markers. Recurrence of shoulder sepsis after clinically successful treatment remained relatively low, with 16 patients developing recurrence; 7 of these cases were in chronic IVDUs. However, orthopedic surgeons can expect 30-40%

of patients to require multiple trips to the operating room to successfully treat the initial joint infection, regardless of treatment modality. Arthroplasty may be a viable means for long-term treatment of this rare condition in the correctly selected patient population.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Guidelines for Evidence-Based Prevention of Prosthetic Shoulder Infection are Lacking: A Survey of Shoulder Surgeons

Paper 214

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BACKGROUND: Infection following shoulder arthroplasty can be a devastating complication that increases patient morbidity and cost substantially. PJI may complicate up to 4% of primary and 15% of revision shoulder arthroplasties. The relatively high prevalence of Proprionibacterium Acnes (P. Acnes) in PJI around the shoulder further complicates agreement on prevention strategies. As there are no published consensus guidelines on prosthetic shoulder infection prevention, we sought to gain insight on the views of an international cohort of shoulder surgeons. The study aims were to highlight the need for consensus-based guidelines on the prevention of prosthetic shoulder infection, and to demonstrate the lack of solid evidence to determine best protocols for infection prevention and the lack of agreement amongst shoulder surgeons around the world.

METHODS: 752 shoulder surgeons were surveyed, including members from the American Shoulder and Elbow Surgeons (ASES), members of the Codman Shoulder Society, and former fellows from select ASES-sponsored fellowship programs. 218 surgeons (29%) responded. The survey was constructed with 28 questions focused on surgeons' perceptions towards the adequacy of current infection-prevention recommendations, as well as specific prevention modalities that surgeons have adopted in their own practices to prevent infection. Items for which > 50% of respondents agreed were determined to be a 'consensus' agreement.

RESULTS: 82% of respondents agreed that the currently-available data did not clearly support the use of one infection prevention strategy, and 67% felt that the available data guiding surgeons is insufficient. Only 59% based their infection prophylaxis regimen on the available literature on shoulder arthroplasty. The most common modalities of infection prevention, in addition to routine intravenous antibiotics, included antibiotic-impregnated cement when cementing (70%), routine topical vancomycin powder (58%), and dilute betadine lavage (28%).

CONCLUSION: There is consensus agreement that the available literature and guidelines on the prevention of prosthetic shoulder infection is insufficient. There remain multiple areas in which the knowledge and management of shoulder PJI is deficient relative to infections following hip and knee arthroplasty. Many of the guidelines that upper extremity surgeons follow are derived from the lower extremity arthroplasty experience, as there are published algorithmic guidelines for surgeons to follow if there is suspicion of lower extremity PJI. Part of the reason for this discrepancy is due to the fact that P. Acnes is more of a diagnostic challenge versus the detection of Staphylococcus or Streptococcus.

Additionally, the optimal management of shoulder PJI is evolving. For example, recent reports have demonstrated promising outcomes following single-stage revision in certain cases. Additionally, the clinical significance of isolated cultures of P. acnes remains unclear, as does the significance of certain types of the bacteria (i.e., hemolytic versus non-hemolytic). Despite these factors, our results highlight the deficiency in knowledge-base and identify it as a necessary area of focus for additional resources and research.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Locking-Plate Fixation of Proximal Humerus Fractures in Patients Over 60 Continues to be Associated with a High Complication Rate

Paper 215

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BACKGROUND: Locking plate technology has increased fixation (ORIF) of proximal humerus fractures (PHFs) dramatically. However, reported rates of success and complications continue to vary. A number of technical pearls have more recently been implemented in attempts to lower the complication rate of this technique. Few large, single-center studies exist capturing these efforts.

METHODS: Between 2005 and 2015, 173 consecutive PHFs in patients over the age of 60 were treated with ORIF with locked plating at our institution. Shoulders with less than 2 years follow-up were excluded unless they led to failure, leaving 131 shoulders for analysis. Average follow-up was 6.1 years. Mean age was 73 (60-95) years, and 84% were females. Failure was defined as reoperation, radiographic evidence of hardware failure, severe arthritis, or intra-articular screw penetration. Fractures were classified according to Neer's criteria into 2-part (n=61, 47%), 3-part (n=59, 45%), and 4-part (n=11, 8%) fractures.

RESULTS: There was an overall failure rate of 34%. This correlated with patient age and fracture type. There was no difference between the failure rate with and without fibular allograft (33% vs. 34%, respectively).

Among failures, complications were AVN ± screw penetration (23 patients, 52%), intra-articular screw penetration (6 patients, 14%), hardware failure (5 patients, 11%), post-traumatic arthritis (4 patients, 9%), cuff failure (3 patients, 7%), nonunion (2 patients, 5%), and malunion (1 patient, 2%). When all surgical complications were included, overall complication rate was 44%. The majority of complications not leading to failure were asymptomatic AVN (6 cases) and asymptomatic arthritis (3 cases). There was also 1 case each of tuberosity escape, asymptomatic loose screw, frozen shoulder requiring injection, and of asymptomatic rotator cuff failure.

Overall reoperation rate was 11% (14 patients), which correlated with fracture type. Revision operations included reverse total shoulder arthroplasty in 8 patients, hardware removal in 5 patients, and revision ORIF in 1 patient. Most "failed" patients did not undergo reoperation.

CONCLUSION: ORIF of PHFs with locked plating in patients older than 60 resulted in a 44% complication rate and 34% failure rate. Higher complication and failure rates were observed in older patients and more complex fractures. Reoperation was relatively low (11%). Improvements in ORIF techniques, implants, and instruments are required to improve the surgical management of PHFs.

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Thromboembolic Complications After Total Shoulder Arthroplasty: An Update

Paper 216

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INTRODUCTION: Venous thromboembolic (VTE) complications, including deep vein thrombosis (DVT) and pulmonary embolism (PE), are a feared complication of all orthopedic surgeries due to their significant morbidity and mortality. here is currently a paucity of data examining the operative and patient risk factors of VTE in shoulder arthroplasty. The purpose of this study was to review the incidence of VTE, determine the patient and operative risk factors for VTE, and report on the complications associated with VTE after shoulder arthroplasty.

METHODS: Over a 16-year period (2001-2017), 5,906 patients underwent primary total shoulder arthroplasty (TSA), reverse total shoulder arthroplasty (RTSA), and hemiarthroplasty (HA). Symptomatic VTE events were noted in 24 shoulders, all occurring within 90 days of surgery. Patient records were reviewed for surgical indication, patient and operative risk factors, and management of VTE.

RESULTS: The overall incidence of VTE after shoulder arthroplasty was 0.41%. There were 9 lower extremity DVTs, 4 ipsilateral upper extremity DVTs, 1 contralateral upper extremity DVT, 4 DVTs of unknown location, and 13 PEs. The most common symptoms were increased extremity swelling for DVTs and dyspnea for PEs. 7 VTEs were diagnosed as an inpatient and 17 as an outpatient. There were no deaths caused by VTE events. Patients with VTE events were older (74.75 vs. 68.51 years $p=0.0028$) than those who did not have a VTE. BMI and gender were not found to be risk factors for VTE. Operative risk factors for VTE included a traumatic indication (3.31% vs. 0.33% $p<0.001$) while laterality and type of arthroplasty were not found to be risk factors. Patients with a VTE where found to have a longer mean operative time (144 minutes vs. 112 minutes, $p = 0.04$) and anesthetic time (232.0 vs. 190.2 minutes $p=0.02$) compared to those with no symptomatic VTE. There were 11 readmissions resulting directly from the VTE events and patients diagnosed with VTE as an inpatient had longer hospital stays (13.71 days vs. 1.94 days $p=0.0002$).

DISCUSSION: The risk of VTE after shoulder arthroplasty remains low; however, these complications can lead significant morbidity, longer hospital stays, readmission to the hospital, and further complications. Elderly patients with significant risk factors for VTE such as prior history of VTE, cancer diagnosis, surgery for a traumatic indication, and prolonged anesthesia or operative times may be considered for VTE prophylaxis.

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MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
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Pulmonary Comorbidities Are Associated with Increased Major Complication Rates Following Indwelling Interscalene Nerve Catheters for Shoulder Arthroplasty

Paper 217

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BACKGROUND: There is no consensus for postoperative analgesia following shoulder arthroplasty among current methods. Early postoperative pain scores have been investigated recently, though little is known regarding the effect patient comorbidities have on their complications rates. Complication rates following ISCs range from 0.7-30% in the literature. The purpose of this retrospective study was to review the complications associated with ISCs to identify which patients may be predisposed to an increased complication profile.

METHODS: 154 patients who had an ISC and underwent primary shoulder arthroplasty were included in analysis. ISCs were kept in place three to four days postoperatively unless a complication necessitated removal. Major and minor complications, medical comorbidities, American Society of Anesthesiologists (ASA) class, age, and body mass index were documented. Major complications included death, pulmonary or cardiac issues, acute mental status changes, nerve injury, deep vein thrombosis, and surgery to remove an incarcerated catheter. Minor complications included malfunctioning catheters, catheters removed prematurely, or hematoma at the catheter site. Chi-squared tests were applied to determine association with complications, and statistically significance set for $p < 0.05$.

RESULTS: The overall complication rate was 30.5% (47 of 147). Most were minor mechanical complications involving catheter dysfunction, 18.8% (29 of 154). Major complications occurred in 11.7% of patients (18 of 154). Of these, 10 (55.6%) were pulmonary and included decreased oxygen saturation, respiratory distress, or pneumonia. Patients with a pulmonary comorbidity (lung disease, chronic obstructive pulmonary disease, asthma, and obstructive sleep apnea) had a 2-fold increased risk of having any complication (44.4% vs. 21.1%) and a major complication (17.8% vs. 9.2%) as those without pulmonary comorbidities ($p = .018$). A higher ASA Score was also associated with an increased risk of any complication ($p = 0.002$). Other factors and comorbidities were not related to the risk of any complication.

CONCLUSION: Optimal postoperative pain management following shoulder arthroplasty is without consensus. An ideal strategy avoids complications, provides adequate analgesia, and limits narcotic. Pulmonary comorbidities and increased ASA score were found to significantly increase the rate of a major complication following ISC placement, and should warrant special attention to avoid patient morbidity. These patients may benefit from alternative pain management strategies including periarticular injection or single shot interscalene block to avoid complications in the early postoperative period.

LEVEL OF EVIDENCE: Level III, therapeutic

MAOA BREAKOUT SESSION #14
SHOULDER ARTHROPLASTY
April 13, 2019

Does the Transfusion Rate Following Reverse Total Shoulder Arthroplasty Warrant Aggressive Perioperative Blood Management?: An Indications-Based Analysis

Paper 218

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INTRODUCTION: Reverse total shoulder arthroplasty (RTSA) has solidified itself as a valuable option for multiple advanced shoulder pathologies. However, one of the inherent risks with RTSA is the need for blood transfusion secondary to blood loss and the large associated dead space in a rotator cuff deficient shoulder. Although blood transfusions following RTSA have been studied, there is no data available to compare transfusion rates between traumatic, post-traumatic, and non-traumatic indications. Given the attendant risks of blood products, we proposed to investigate if certain operative conditions are more likely to require postoperative transfusion.

METHODS: A retrospective institutional database review identified 368 patients undergoing RTSA. Revision and tumor cases were excluded, leaving 291 for analysis. These were placed into one of three groups: traumatic (acute fractures and fracture-dislocations), post-traumatic (nonunions, malunions, chronic dislocations), or non-traumatic (chronic rotator cuff insufficiency, glenohumeral arthritis with advanced glenoid wear). Patient demographic information, operative indications, and the incidence of blood transfusion were then recorded from the medical record and compared between the three groups. Pearson's chi square test for categorical data was used to detect differences between groups. Differences with $p<0.05$ were considered statistically significant. Relative risk (RR) for transfusion was also calculated for the 3 groups.

RESULTS: Twenty-seven RTSAs were performed for traumatic indications, 37 for post-traumatic sequelae, and 227 for non-traumatic conditions. There were no statistically significant differences between groups regarding age, gender, laterality, body mass index, or co-morbidities ($p>0.05$). The overall incidence of blood transfusion was 6.5% (19/291). The incidences of blood transfusion in traumatic, post-traumatic, and non-traumatic groups were 22.2% (6/27), 18.9% (7/37), and 2.6% (6/227), respectively. Both the traumatic ($p<0.01$, RR=8.5) and post-traumatic ($p<0.01$, RR=7.3) groups had a significantly higher rate of blood transfusion compared to non-traumatic cases. No significant difference was seen when comparing transfusion rates between traumatic and post-traumatic groups ($p=0.74$).

CONCLUSION: Blood transfusion is required in approximately one-fifth of patients following RTSA for traumatic and post-traumatic indications; roughly 8 times more often than for non-traumatic conditions. Surgeons should be aware of this markedly elevated transfusion rate and may consider more aggressive peri-operative blood management and conservation strategies in patients undergoing RTSA for acute trauma or post-traumatic sequelae.

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MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
April 13, 2019

Smoking as a Risk Factor for Readmission in Arthroscopic Surgery: A Propensity Matched Analysis

Paper 219

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INTRODUCTION: Since the initiation of bundled payment systems, many studies have looked at risk factors for readmission following various orthopedic surgery. Smoking is one of the most interesting risk factors as it presents a modifiable risk factor as it can be stopped prior to an elective arthroscopic case. To the best of our knowledge, a propensity matched analysis has never been performed exploring smoking as a risk factor for readmission following hip, knee, and shoulder arthroscopy.

METHODS: Patients undergoing knee, shoulder, or hip arthroscopy between 2006-2016 were identified in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). Patient's smoking was analyzed for its effect on 30-day readmission using multivariate regression adjusting for demographics and comorbidities.

RESULTS: A total of 163,791 patients undergoing shoulder, hip, and knee arthroscopy met inclusion criteria and 28,156 (17.2%) were smokers. A propensity matched analysis controlling for age, sex, BMI, and ASA score identified 19,732 non-smokers to serve as the control group bringing a total of 39,464 patients for analysis. Age, sex, BMI, and ASA scores had no significant difference between groups. The readmission rate for the non-smoking cohort was 0.9% and 1.3% in the smoking group ($p=0.01$). In a multivariate analysis adjusting for baseline characteristics and medical comorbidities, smoking status was associated with increased risk readmission (Odds Ratio: 1.37 [95% CI: 1.133-1.657] $p=0.0012$).

DISCUSSION AND CONCLUSION: This study suggests that smoking increases chances of readmission in all arthroscopic surgery. The timing of cessation of smoking prior to arthroscopic surgery and its impact on readmission is unknown.

MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
April 13, 2019

Preoperative Albumin as a Risk Factor for Infection in Arthroscopy

Paper 220

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PURPOSE: Malnutrition is an important consideration during the perioperative period and albumin is the most common laboratory surrogate for nutritional status. The purpose of this study is to identify if preoperative serum albumin measurements are predictive of infection following arthroscopic procedures.

METHODS: Patients undergoing knee, shoulder, or hip arthroscopy between 2006-2016 were identified in the American College of Surgeons National Surgical Quality Improvement Program database. Patients with an arthroscopic current procedural terminology code and a preoperative serum albumin measurement were included. Patients with a history of prior infection, including a non-clean wound class, pre-existing wound infection, or systemic sepsis were excluded. Independent t-tests where used to compare albumin values in patients with and without the occurrence of a postoperative infection. Preoperative albumin levels were subsequently evaluated as predictors of infection with logistic regression models.

RESULTS: There were 31,906 patients who met the inclusion criteria. The average age was 55.7 years (standard deviation [SD] 14.62) and average BMI was 31.7 (SD 7.21). The most prevalent comorbidities were hypertension (49.2%), diabetes (18.4%), and smoking history (16.9%). The average preoperative albumin was 4.18 (SD 0.42). There were 45 cases of superficial infection (0.14%), 10 cases of wound dehiscence (0.03%), 17 cases of deep infection (0.05%), 27 cases of septic arthritis or other organ space infection (0.08%), and 95 cases of any infection (0.30%). The preoperative albumin levels for patients who developed septic arthritis (mean difference [MD] 0.20, 95% CI, 0.038, 0.35; P = 0.015) or any infection (MD 0.14, 95% CI 0.05, 0.22; P = 0.002) were significantly lower than the normal population. Additionally, disseminated cancer, Hispanic race, inpatient status, and smoking history were significant independent risk factors for infection, while female sex and increasing albumin were protective towards developing any infection. Rates of all infections were found to increase exponentially with decreasing albumin. The relative risk of infection with an albumin of 2.0 was 3.46 (95% CI, 2.74-4.38) when compared to a normal albumin of 4.0. For each albumin increase of 0.69, the odds of developing any infection decreases by a factor of 0.52.

CONCLUSION: This study suggests that preoperative serum albumin is an independent predictor of septic arthritis and all infection following elective arthroscopic procedures. Although the effect of albumin on infection is modest, malnutrition may represent a modifiable risk factor with regard to preventing infection following arthroscopy.

MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
April 13, 2019

The Incidence of Iatrogenic Cartilage Injury During Hip and Knee Arthroscopy

Paper 221

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INTRODUCTION: Advanced arthroscopic procedures in the hip and knee are continually evolving; joint-preserving procedures in constrained anatomical locations (including intra-articular hip and meniscus root) are becoming part of routine sports medicine practice. When operating within these constrained anatomical locations, there is heightened concern for iatrogenic cartilage injury. In 2016, a single-center study shows a 31% incidence of iatrogenic cartilage injuries in ankle arthroscopies [1]. However, no study to date has documented the prevalence and severity of iatrogenic cartilage lesions when performing arthroscopic procedures in other joints.

METHODS: Online technique videos on VuMedi and Arthroscopy Techniques were reviewed for hip and knee arthroscopic procedures. Cases involving intra-articular hip arthroscopy and arthroscopic meniscus surgery were included from 2008 to 2018. The incidence of iatrogenic articular cartilage lesions was noted and injuries were graded according to severity (low grade = cartilage impression, but no disruption in cartilage congruity; intermediate grade = disruption of cartilage congruity, but no visible subchondral bone; high grade = disruption of cartilage congruity with subchondral bone visible). Chi squared tests were used for analysis and significance was set to $p<0.05$.

RESULTS: Overall, the incidence of iatrogenic articular cartilage injury among all technique videos was 74.1% (83 videos out of 112, with a total of 137 iatrogenic cartilage injuries). The incidence of cartilage injury was similar in the knee compared to the hip (77.1% versus 71.9%, p=0.53). When comparing meniscus root repair to meniscus body repair, the incidence of cartilage injury was similar (81.3% versus 75%, p=0.63). The majority of the cartilage lesions were low grade (58.4%, n=80;, however, 37.2% were intermediate (n=51) and 4.4% were high grade (n=6).

CONCLUSIONS: The incidence of iatrogenic articular cartilage injury during hip arthroscopy and arthroscopic meniscus repair in published educational videos is 74.1%. Surgeons choose to publish these videos as teaching tools; therefore, we believe this may represent the 'best case' scenario in terms of mitigation of iatrogenic injury. Further prospective clinical studies tracking iatrogenic cartilage injury during arthroscopy are needed to accurately evaluate the prevalence of iatrogenic cartilage injuries and potential impact on postoperative outcomes. Additionally, future studies to evaluate the impact of arthroscopic iatrogenic cartilage injuries on cartilage viability may be warranted.

[1] Vega, J., Golanó, P. & Peña, F. Iatrogenic articular cartilage injuries during ankle arthroscopy. Knee Surgery, Sports Traumatology, Arthroscopy (2016) 24:1304. https://doi.org/10.1007/s00167-014-3237-5

MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
April 13, 2019

Long-Term Results After Repair of Isolated Meniscus Tears in Patients 18 Years and Younger: An 18-Year Follow-Up Study

Paper 222

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BACKGROUND: Meniscus repair is desirable over resection to prevent post-meniscectomy arthritis, especially in young and active patients. However, long-term data is currently lacking following isolated meniscus repair, particularly in the pediatric population. The purpose of this paper was to report long-term follow-up of isolated meniscus tears treated by meniscus repair in a pediatric population, and to compare those results to previous mid-term follow-up data reported. We hypothesized that these patients would have satisfactory function and reoperation rates at long-term follow-up.

METHODS: Patients less than 18 undergoing repair of an isolated (without concomitant ACL injury) meniscus tear performed between 1990 and 2005 were included. At the time of final follow-up, recurrent tear, reoperations, and IKDC and Tegner scores were determined. With logistic regression, the overall failure between different tear types was calculated. Wilcoxon signed ranks tests were performed to calculate the differences in clinical outcome for different time-points, and Spearman coefficients were calculated for Tegner and IKDC with different variables.

RESULTS: At an average follow-up of 17.6 years (13.1 - 26.0 years), 32 patients with 33 isolated meniscus repairs (29M : 3F) with an average age of 16.1 (9.9 – 18.7) were included in this study. At early follow-up, complex tears (80%) had a higher overall failure rate compared to simple tears (18.2%). However, no further failures occurred since mid-term follow-up with any tear type. At final follow-up, the average IKDC score was 92.3, which was significantly increased when compared to both preoperative 65.3 ($p<0.0001$) and mid-term scores, 90.2 ($p= 0.01$). However, the average Tegner score (6.5) was significantly lower than both preoperative 8.3 ($p< 0.0001$) and mid-term 8.4 ($p< 0.0001$) scores. There was no correlation for Tegner or IKDC values with any risk factors.

CONCLUSION: In conclusion, this study demonstrates overall good to excellent long-term clinical outcomes following isolated meniscus repair in a pediatric population. Early failure and reoperation rates were variable depending on tear type, with complex multi-planar tears having more failures at short-term follow-up. However, at long-term follow-up, IKDC and Tegner scores were not significantly different for those with complex tears compared to other tear types.

MAOA BREAKOUT SESSION #15
SPORTS MEDICINE
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Return to Sport and Sports Specific Outcomes After Osteochondral Allograft Transplantation in the Knee: A Systematic Review

Paper 223

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INTRODUCTION: Increased participation in sports among adolescents and young adults has resulted in increased frequency of articular cartilage defects, often leading to premature secondary osteoarthritis. Repairing or reducing cartilage damage through osteochondral allograft transplantation (OCA) has been shown to be beneficial in improving clinical outcome scores. Studies regarding OCA for treatment of articular cartilage defects in athletes have demonstrated mixed results. The purpose of this systematic review is to provide updated data on return to sport and sports-specific patient-reported outcomes following osteochondral allograft transplantation in active individuals.

METHODS: We performed a systematic review according to PRISMA guidelines including all studies from January 1975 to December 2017 that had a minimum 2-year mean follow-up and reported return to sport rates or sports specific patient-reported outcomes. The MINORS scoring system was used to assess bias and heterogeneity. Outcome measures, reoperations, and complications were provided in table format and a subjective analysis was performed.

RESULTS: This review included 13 studies with 772 patients who underwent osteochondral allograft transplantation at a mean 49 months follow-up. The average MINORS score was 77%. The return to sport rate was 76% (75-82%), and most studies reported improvements in sports specific outcomes including the KOOS Sport (27.4 to 60.5), Tegner Activity Scale (3.0 to 5.8), and Cincnnati Knee Score (49.2 to 69). For the MARX activity scale, 2 out of 3 studies reported a decrease. The reoperation rate was surprisingly high at 36%, with 142 instances of loose body removals or debridement, 38 conversions to arthroplasty, and 27 revisions.

DISCUSSION AND CONCLUSION: This systematic review suggests that OCA transplantation for cartilage defects allows most athletes to return to sport. Nearly all studies reported improvements in sports specific patient-reported outcomes at follow-up. However, the reoperation rate was surprisingly high, with a large percentage of patients requiring loose body removal or debridement. The long-term survival of the allografts is largely unknown, but this study suggests OCA transplantation consistently improves function in athletes with chondral injuries.

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Return to Sport Following the Adolescent Concussion: Findings from a High School Population

Paper 224

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BACKGROUND: High school athletes sustaining a concussion require careful attention when determining return-to-play (RTP) readiness.

HYPOTHESIS: As patients experience recurrent concussions, all ImPACT domains will show a predictable decline and athletes will require longer time prior to RTP.

STUDY DESIGN: Retrospective

LEVEL OF EVIDENCE: Level 3

METHODS: Clinical records of 357 consecutive high school patients who sustained concussions and presented to a single healthcare system between September 2013 and December 2016 were reviewed. Demographic data, RTP, and concussion related-variables were obtained via chart review. Neuropsychologists performed Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) scores at baseline and following concussions. A multivariate linear model was constructed to determine factors that affected RTP following a concussion.

RESULTS: The average age at injury was 15.5 years (range 14-18 years), and 61.9% of patients were male. The most common sport of injury was football (27.4%). Among athletes sustaining a concussion, 6.9% reported a loss of consciousness and 14.3% reported amnesia. Athletes required 30.4 ± 23.3 days of recovery prior to RTP. There was a high incidence of previous concussion (33.1%) in high school athletes and 32 athletes sustained a recurrent concussion. A multivariate model demonstrated that female athletes, players with a history of concussion and those diagnosed in-clinic rather than the game, required increased time to RTP. Memory ImPACT scores were found to increase as players had recurrent concussions, while visual motor speed and reaction time scores decreased with recurrent concussions.

CONCLUSIONS: One-third of high school athletes seen for concussion had previous concussions. On average, players required 1 month of recovery before RTP. Female athletes, players with a previous history of concussion, and those with a delayed diagnosis took longer to RTP. ImPACT scores for memory (visual and verbal) were found to increase with recurrent concussions, while visual motor speed and reaction time decreased.

Key Terms: high school, concussion, return-to-play, ImPACT, youth

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Professional Baseball Player Performance Outcomes and Return to Play Following Back Injury

Paper 225

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INTRODUCTION: Major League Baseball (MLB) players are at significant risk for back injury, and back injury accounts for a significant proportion of time spent on the disabled list. MLB players that sustain back injuries are either managed conservatively or surgically with the goal of returning to their full level of pre-injury performance. Performance data of MLB players is a readily available method of objectively comparing performance outcomes following recovery from back injury. The purpose of this study is to better understand differences in performance outcomes and ability to return to play following back injury in MLB players.

METHODS: In this retrospective cohort study, MLB players that sustained a documented back injury between 2010 and 2016 were identified. Conservative versus surgical treatment was determined from news media and team-affiliated reporting on injured players. Inclusion criteria required that players have statistical performance data available one year prior to the injury and following return to play. In-game performance was measured using hitting and pitching metrics. Hitting performance was assessed using at bats, hits, batting average, home runs, RBIs (Runs Batted In), and OPS (On-case Plus Slugging). Pitching performance was analyzed using win/loss ratio, ERA (Earned Run Average), saves, innings pitches, strikeouts, and WHIP (Walker plus Hits per Inning Pitched). Fastball velocity and pitch selection were also analyzed. Time on the disabled list and whether players returned to play were determined.

RESULTS: 187 players sustained back injury between 2010-2016. Of these, 126 players met the inclusion criteria. 100 and 26 players were treated with conservative and surgical management, respectively. The average age was 33. Surgeries included thoracic and lumbar fusion, and discectomy/microdiscectomy of the lumbar and cervical spine. Players undergoing surgery spent significantly longer time on the disabled list (126 days and 41 days, respectively, $P < 0.05$). Pitcher ERA was increased more in the conservative treatment group than the surgical treatment group (increases of 1.15 and 0.4, respectively, $P < 0.05$). Overall pitcher fastball velocity decreased and frequency of curveball and change-up pitch selection increased. Players undergoing operative management were less likely to return to play.

DISCUSSION AND CONCLUSION: Major league baseball player performance declines following back injury regardless of the form of treatment. Players undergoing surgery miss more playing time and are less likely to return to play than those undergoing conservative therapy. However, when indicated, surgery may be beneficial in maintaining pitching performance as opposed to conservative management.

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Influence of Tibial Tuberosity Distalization on Patellofemoral Tracking and Contact Pressures: A Dynamic Computational Simulation Study

Paper 226

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INTRODUCTION: The current study is based on the hypothesis that patella tendon distalization will reduce lateral maltracking during knee flexion and will not elevate patellofemoral contact pressures. Multibody dynamic simulation of function for knees with recurrent instability were utilized to characterize the influence of patellar distalization, with and without patellar tendon tenodesis, on patellar tracking and pressure applied to cartilage.

METHODS: Multibody dynamic simulation models were created to represent seven knees with patella alta (Caton-Deschamps index ≥ 1.3) being treated for patellar instability. Dynamic knee squatting was simulated for each knee in the preoperative condition, following distalization of the attachment points for the patellar tendon on the tibia (Caton-Deschamps index = 1.0), and following distalization combined with patellar tendon tenodesis. The simulated motions were used to characterize the bisect offset index (percentage of the patella lateral to the deepest part of the trochlear groove) and the patellofemoral contact pressure distribution (based on discrete element analysis). Friedman tests with post-hoc Student-Newman-Keuls tests were used to identify significant ($p < 0.05$) differences between the preoperative to postoperative data.

RESULTS: Tibial tuberosity distalization significantly reduced lateral patellar maltracking at 5°, 10°, and 20° of knee flexion. Tuberosity distalization significantly decreased the maximum pressure applied to cartilage from 20° to 35° of flexion, with each change approximately a 25% decrease. The pressure centroid was located more superiorly on the patella following distalization, and more medially at low flexion angles. The superior position was significantly larger for the distalization conditions through the full range of knee flexion from 0 to 90°, with a maximum difference of 5 mm at 15°. Distalization produced a significantly more lateral pressure centroid at 25° and 30° of flexion, with a change larger than 1 mm. Distalization also significantly increased contact area from 15° to 40° of flexion. Tenodesis overall had a relatively small influence on the kinematics and pressure, compared to distalization.

CONCLUSIONS: Based on the current simulations of dynamic knee squatting, tibial tuberosity distalization consistently decreases patellar lateral maltracking, with the largest changes occurring at low flexion angles. Tibial tuberosity distalization generally produces a decrease patellofemoral contact pressures but also increases medial contact pressures. Distalization was also shown to move the centroid of contact pressure proximal and lateral. The possibility of elevated contact pressures beyond 90° of flexion warrants further investigation.

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Variability of Non-Isometric Excursion in ACL Hamstring Autograft and Its Effect on Loading Through Knee Range of Motion: What is the Risk For Overloading the Graft?

Paper 227

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INTRODUCTION: Unexplained failures of anterior cruciate ligament (ACL) reconstructions remain. Overtensioning of the graft is a possible mechanism. The variability between patients in the amount of non-isometric graft excursion with anatomically placed tunnels during range of motion has not been explored and could have a significant effect on the amount of tensile load within the graft construct. We hypothesized that due to variation in graft excursion, variable and potentially significant loading of an ACL graft can accompany passive knee extension despite anatomic tunnel placement if tensioning and fixation is performed with the knee in flexion.

METHODS: Intraoperative excursion measurements were obtained from 196 patients to determine a population distribution of graft excursion. ACL reconstructions were performed on 10 cadaver specimens. Custom sensors were used to measure knee angle, excursion, and graft tensile load. Simplified stiffness values for the graft constructs were correlated with the population's graft excursion to estimate the tensile load experienced by the population's grafts if they were tensioned with the knee in flexion.

RESULTS: The mean measurement of intraoperative graft excursion in 196 patients was 2.73 mm ± 0.85 mm. 8.7% of these patients had graft excursion greater than 5 mm. The mean graft excursion in the 10 cadaveric specimens was 2.46 mm ± 1.10 mm. The mean for peak loads obtained in the cadaveric specimens was 167.6 N ± 37.2 N. Of note, the highest peak loads were observed in specimens with the highest amount of excursion. The mean stiffness of the cadaveric graft constructs was 83.5 N/mm ± 21.4 N/mm. We estimated the surgical population to have a peak graft tensile load mean of 205.3 N with a range from 84.5 N to 373.1 N.

CONCLUSIONS: Our data suggests that approximately 9% of patients will have an abnormally high amount of excursion that may place them at risk of producing very high tensile loads across the graft immediately after fixation with passive knee range of motion. Tensioning the graft at the anticipated point of maximal tension along the arc of motion may be prudent. This is particularly important considering the variation in excursion noted. Intraoperative measurement of excursion can provide information to identify the appropriate knee angle for tensioning. Our data would suggest that tensioning the graft with the knee in full extension would be a safe technique, even for patients with a high amount of excursion.

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Rotational Stability of the Knee Two Years After the ACL and Anterolateral Ligament Reconstruction

Paper 228

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PURPOSE: It is technically difficult to measure the rotational stability of the knee in vivo in weight-bearing condition. Navigation systems give us such an option. The aim of this prospective controlled blinded randomized study was to evaluate rotational stability at least 2 years after a single-bundle anterior cruciate ligament (ACL) reconstruction using bone-tendon-bone graft from the ligamentum patellae and after the same ACL reconstruction completed with a reconstruction of the anterolateral ligament (ALL) and to compare it with the contralateral healthy knee joint. We have postulated two hypotheses: (1) ACL reconstruction together with ALL reconstruction restores the knee stability in internal rotation (IR) sufficiently; (2) simple ACL reconstruction alone does not restore the knee stability in IR sufficiently in comparison to the healthy knee.

MATERIAL AND METHODS: In both groups (ACL and ACL+ALL), 40 patients selected prospectively at random were evaluated. Only cases with isolated intra-articular ACL lesions and healthy contralateral knees were included. The mean follow-up after the surgery was 26 months (range, 24 to 33 months). For all measurements, the navigation system was used. Measurements were done by the blinded investigator. Patients were asked to perform (in 30° weight-bearing flexion) the maximal external trunk rotation to develop the reverse rotation of the tibia against the femur. All measurements were taken on both the reconstructed and healthy knees. Cincinnati, Lysholm, and IKDC scores were used to evaluate clinical results. The nonparametric Wilcoxon test was used to evaluate results.

RESULTS: After the ACL+ALL reconstruction, the mean IR of the tibia was 8,1˚. In the contralateral healthy knee joint, IR was 8,6˚ at average. We did not find any statistically significant difference in IR stability between reconstructed and healthy knees ($p > 0.05$). After the simple ACL reconstruction, the mean IR was 9,9˚. In the contralateral healthy knee joint, IR was 8,7˚ at average. We found the statistically significant difference in IR stability between reconstructed and healthy knees ($p < 0,05$). In terms of clinical results (Cincinnati, Lysholm, IKDC), knees after ACL+ALL reconstruction behaved better but without any statistically significant difference between both groups.

CONCLUSION: The data confirmed both hypotheses. The ACL+ALL reconstruction restores the rotational stability of the knee joint without any significant difference in comparison to the contralateral healthy knee. We cannot state the same for the simple ACL reconstruction.

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The Cost Variability of Orthobiologics

Paper 229

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INTRODUCTION: There has been a tremendous growth in the use of orthobiologics over the past decade. Despite limited clinical data, many orthopedic practices offer orthobiologic injections. Such injections are not covered by insurance, and thus patients pay out of pocket for these treatments. The purpose of this study was to assess the variability in costs for platelet rich plasma (PRP) and stem cell (SC) injections across various sports medicine practices and evaluate for variables that may influence pricing.

METHODS: The AOSSM directory was used to compile a list of 1,345 orthopedic sports medicine practices across the United States. Calls were made to each of these practices inquiring into the availability of PRP or SC injections for the knee and the associated costs. In addition to pricing, the type of practice (academic or private), the number of providers within the practice, and the surrounding area's population and income demographics were recorded. Univariate statistical analyses were used to identify differences in PRP and SC injection availability and cost between variables.

RESULTS: Of the contacted offices, 268 (20.2%) offered both treatments, 550 (41.5%) offered only PRP injections, 20 (1.5%) offered only stem cell injections, and 487 (36.2%) did not offer either treatment. The mean (± SD) cost of a PRP injection was $707 ± $388 (range, $175 to $4,973), and the mean cost of a SC injection was $2,728 ± $1,584 (range, $300 to $12,000). Practices offering PRP and SC injections tended to be larger in size (for PRP - 11.6 physicians per practice vs. 8.1, $P<0.001$; for SC - 12.3 vs. 9.7, $P=0.006$). In addition, practices that offered PRP injections were located in zip codes with higher mean income ($67,500 vs. $64,300, $P=0.047$). Variables associated with higher cost of PRP injection included city population ($P<0.001$) and mean income of surrounding residents ($P<0.001$).

DISCUSSION AND CONCLUSION: While the majority of sports medicine practices across the United States offer some type of orthobiologic injection, there exists significant variability in the cost of these injections. The cost for PRP injections is higher in practices located in highly populated areas and in areas with greater mean incomes.

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The Effect of Intraoperative Platelet-Rich Plasma (PRP) Injections on the Surgical Outcomes of Orthopedic Soft Tissue Repairs and Reconstructions: A Systematic Review with Meta-Analysis.

Paper 230

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BACKGROUND: Platelet-rich plasma injections (PRP) are a widely used therapy in orthopaedic surgery. The annual number of publications studying the therapy has more than doubled over the last decade; however, the evidence supporting its efficacy for reducing the failure rates of soft tissue repairs and reconstructions remains inconclusive.

PURPOSE: The primary purpose of this review is to provide high level evidence on the clinical utility of PRP injections during soft tissue repairs and reconstructions of the shoulder, knee, hip, and ankle by quantitatively evaluating published outcomes on failure rates of procedures that utilized PRP.

METHODS: A systematic search was performed in the Embase and PubMed databases, and 263 studies meeting the search criteria were identified. Included studies were randomized control trials or cohort studies with greater than 10 participants evaluating soft tissue surgical repairs or reconstructions combined with PRP with a minimum of 6 months follow-up in men and women greater than 18 years old. A random effects meta-analysis was performed on the included studies to determine the pooled effect of PRP administration on postoperative failure rates according to surgical procedure.

RESULTS: Among 14 studies investigating rotator cuff repairs, PRP augmentation resulted in a 25% reduction in risk of repair failure (pooled risk ratio 0.75, 95% confidence interval 0.66, 0.86) with low heterogeneity among included studies (Higgins I-squared= 0%, p=0.73). One study of gluteus medius repairs had a near-significant reduction in failure rates with PRP augmentation (RR 0.51, 95% CI 0.26, 1.00; p=0.05). Augmentation with PRP was not shown to reduce failure rates for ACL reconstruction in 2 studies (RR 1.0; p=1.0), meniscus repair in 2 studies (RR 0.79, 95% CI 0.52, 1.16) (p=0.25), or Achilles repair in 2 studies (RR 1.02, 95% CI 0.38, 2.72) (p=0.38).

CONCLUSION: PRP augmentation reduces failure rates following rotator cuff repair and has a consistent effect across multiple studies. PRP augmentation may reduce gluteus medius repair failure rates but results are limited to a single study. Current evidence does not suggest an effect of PRP augmentation on failure rates following meniscus repair, ACL reconstruction, or Achilles tendon repair.

Level of evidence: II; systematic review of level I-II studies

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Collagen Nanofibers With and Without Bone Marrow Stromal Cells Enhance Bone Healing in a Rat Calvarial Bone Defect Model

Paper 231

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INTRODUCTION: The purpose of this study was to compare bone healing effects of collagen nanofibers with and without bone marrow stromal cells (BMSCs) using a rat critical calvarial defect model.

METHOD: Critical size calvarial defects were created in fischer344 rats. Twelve collagen nanofiber (CNF) discs (10 x 0.2mm) were used for defect repair of the experimental groups. Six discs were plain and 6 were loaded with rat BMSCs. Defects were either left empty (Group 1- control), covered on both sides with CNF discs (Group 2) or BMSCs loaded CNF discs (Group 3). Healing was evaluated by microcomputed tomography (MicroCT) at 0, 6, 12, and 16 weeks. Bone volume fraction (BVF) analyzed. Renderings of defects used to grade bony bridging. At 16 weeks, animals sacrificed and the defects with surrounding bone removed, fixed, decalcified, and processed for histology. Stained sections assessed for type and maturity of new bone.

RESULTS: MicroCT: bony bridging grades were 1.46 ± 0.2, 2.63 ± 0.6, and 2.33 ± 0.3 for G1, G2, and G3 respectively. Significant difference was found between control and CNF ($p=0.0385$). BVF was 0.058 ± 0.02, 0.111 ± 0.03, and 0.08 ± 0.02 for G1, G2, and G3 respectively. Significant difference was found between control and CNF ($p=0.047$).
Histology: Group 1- defects were filled mostly by fibrous tissue. In Groups 2 and 3, increased vascularization was noted and defects were filled with more mature bone. Histological grades were 9, 17, and 15 for G1, G2, and G3 respectively (max = 21).

DISCUSSION: Increased bone filling was observed in the two experimental groups. Significant difference was found in BVF and bony bridging only between control and the CNF. CNF allowed complete isolation of defect preventing fibrotic tissue invasion. Adding BMSCs to CNFs did not provide additional cues. Our results indicate CNFs can provide favorable stimulus for bone regeneration.

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Platelet-Rich Plasma Composition Using the Arthrex Angel System

Paper 232

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INTRODUCTION: Platelet-rich plasma (PRP) is a widely used orthobiologic intervention as it is an efficient, point-of-care treatment. Recent literature has provided the output of various PRP systems. One common system not represented was Arthrex Angel. Advantages include automated processing and an adjustable interface to change the composition of PRP output, although this has not been validated. The purpose of this study is to analyze PRP composition using the Arthrex Angel system at three settings (0 ,1, and 2%).

METHODS: 10 healthy male caucasian volunteers (average age 34.2) provided 125 cc of whole blood (WB). 5 cc of WB were placed in a standard EDTA tube. The remaining 120 cc was divided into 40 cc aliquots and run through the Arthrex Angel centrifuge at settings of 0% (PRP 0%), 1% (PRP 1%), and 2% (PRP 2%) hematocrit. For each sample, the WB, PRP 0%, PRP 1%, and PRP 2% were analyzed for platelets, leukocytes (with differential), and erythrocytes.

RESULTS: Platelet levels were increased approximately 5 times greater at all three system settings compared to WB ($P<.001$). Differences between the 0%, 1%, and 2% settings were not significantly different ($P=.143$-$.477$).

Leukocytes levels increased 2-5 times compared to WB ($P<.012$). The highest 2% level demonstrated an additional increase compared to 0 and 1% settings ($p<.004$).

Lymphocytes were concentrated approximately 2.4 times compared to WB ($p<.001$), and were not present at a different ratio between settings ($p>.863$).

Neutrophils were significantly reduced at all settings compared to WB ($p<.001$), and were not present at a different ratio between settings ($p>.863$).

Erythrocytes were significantly reduced below WB levels at all hematocrit settings ($p<0.001$). Differences in the levels of red blood cells between the hematocrit settings was not significant ($p=.063$-$.517$).

DISCUSSION AND CONCLUSION: PRP is a component of non-surgical and surgical treatment for many orthopedic conditions. There are many options for PRP preparation, and conflicting literature on optimal composition. In this study, the Arthex Angel system produces different output based on customization settings. Platelets are significantly increased at all system settings. There were not significant differences in the platelet levels at the settings tested. White blood cells showed increased levels, and were increased further at higher settings. Lymphocytes showed a significant increase in the

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PRP compared to WB, along with reduced neutrophil levels. Red Blood Cells were drastically reduced below WB at all hematocrit settings. The findings of this study demonstrate the ability of the Arthrex Angel system to produce a platelet-heavy, erythrocyte reduced PRP product with an increase in WBCs and increase in lymphocyte ratio. These data may be used clinically to determine which PRP products and settings are ideal for individualized patient care and advanced biologic intervention.

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Physiological Bone Health Parameters Among Elite Ballet Dancers

Paper 233

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BACKGROUND: Ballet dancers place significant stress on their bodies, and are at the extreme of body composition and physique. This cross sectional study surveys the comprehensive bone health of a professional ballet company. We hypothesized that females would have lower bone mineral density (BMD) than males, and that blood analysis markers would be correlated with and predictive of BMD.

METHODS: During routine physicals in 2017, 59 professional elite ballet dancers (M=30, F=29) were assessed with regional and total body BMD and body composition with DEXA, along with standard serology analysis, including complete blood count, comprehensive metabolic panel, coagulation profile, vitamin D, thyroid panel, lipid panel, and urinalysis. Statistical analysis was performed for correlation between serology and total and regional BMDs. An EAT26 questionnaire was performed to identify at-risk dancers for disordered eating. Stress fracture and menstrual history were also recorded.

RESULTS:
Bone: Females had lower BMD, T-scores, and age-matched percentile rankings compared to males ($p<0.05$). While 3% of females met criteria for osteopenia for total BMD, regional analysis revealed 76% of females met criteria for osteopenia in the pelvis, 10% in the spine, and 10% in the upper extremities.
Body Composition: All dancers were below the 3rd percentile for body fat, and below the 10th percentile for regional fat mass distribution.
Serology: 31% of males and 25% of females had low Vitamin D. Sodium, uric acid, anion gap, bicarbonate, protein, creatinine, total protein, thyroxine, high density lipoprotein, red blood cell count, hemoglobin, hematocrit, monocyte percentage, and eosinophil percentage were highly correlated with BMD ($p<0.05$). Using multiple linear regression, standard anthropometric measures alone and in combination with serology were highly predictive of total and regional BMD.
Nutrition: EAT26 scores in males had no effect on BMD, but females had a significant ($p<0.05$) difference in BMD between a score of 0-1 and 2-6.
Stress fracture: A stress fracture history showed a small, but not significant, decrease in BMD.
Menstrual: There was no BMD difference contributed by oligomenorrhea.

CONCLUSION: Females, on average, have increased rates of osteopenia compared to males. Dancers demonstrated increased BMD in the lower extremities and decreased BMD in the pelvis and spine both in comparison to population matched norms. Stress fracture history and oligomenorrhea have no effect on BMD. Dancers at risk for disordered eating have slightly lower BMD. Anthropometric measures alone or in combination with blood analysis can predict BMD in the absence of DEXA scans.

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Epidemiology of Foot and Ankle Injuries in NCAA Jumping Athletes in the United States from 2009-2014

Paper 234

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BACKGROUND: Foot and ankle injuries comprise a significant proportion of all injuries suffered by NCAA athletes. Sports that combine jumping and rapid changes in direction (e.g., volleyball, basketball) were associated with increased lower extremity injuries. This study describes the epidemiology of foot and ankle injuries in men's and women's NCAA basketball, women's volleyball, and women's gymnastics during the 2009-2010 through 2013-2014 seasons.

METHODS: Injury surveillance data was obtained from the NCAA Injury Surveillance Program (ISP) for the 2009-2010 through 2013-2014 seasons. Distributions of injuries were examined by injury mechanism, activity during injury, participation restriction time, and recurrence. Injury rates per 1000 athlete-exposures (AEs) and injury rate ratios (IRRs) with 95% confidence intervals were calculated. Reported sex differences were calculated for men's and women's basketball.

RESULTS: During the study period, 1136 foot and ankle injuries (483 male, 653 female) were reported for a combined rate of 1.85/1000 athlete-exposures (AEs; 95% CI 1.75-1.97). Ankle sprains were the most common injury overall (63.7%), with lateral ligamentous complex (LLC) sprains comprising 77.1% of all ankle sprains. The most common foot injury varied based upon sport and sex. Ankle injury rates were higher in men than women (RR=1.33, 95% CI 1.13-1.57), but foot injury rates did not differ. Foot injuries occurred at half the rate of ankle injuries, but were significantly more likely to be severe (RR=3.37, 95% CI 1.91-5.949). Overall chronic ankle injury rates were significantly higher in female athletes (RR=1.29, 95% CI 1.12-2.14), specifically during competitions and the preseason. Female gymnasts suffered significantly higher chronic injury rates than all other sports (0.485/1000 AEs, 0.304-0.735). Player contact occurred during the majority of injuries suffered while engaging in jumping activities (rebounding, shooting, blocking, spiking) in all sports except gymnastics, where surface contact was the most common injury mechanism.

CONCLUSIONS: Significantly higher LLC sprain rates suggest that jumping sport athletes are at higher risks for foot and ankle injuries. Deterring player contact while athletes are jumping and landing by way of coaching and rule changes would likely appreciably reduce injury rates and improve player safety. The increased prevalence of chronic injuries in female collegiate athletes competing in jumping sports necessitates further investigation in order to identify opportunities to reduce injury rates through prevention and training programs, as well as identifying the biological basis for such differences.

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The Relationship Between Age and Activity Level on Meniscus Repair Failure Rates and Patient Reported Outcomes at Five Years

Paper 235

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PURPOSE: To determine whether patient age group (40 years or older versus under 40 years) and pre-injury activity level are predictive of meniscus repair failure rates and patient-reported outcomes at mean 5 years follow-up.

METHODS: 225 patients (n=61 age 40 years or older; n=164 under age 40) (11% sedentary, 64% recreational athletes, 26% competitive athletes) (72% cutting-pivoting sports, 28% non-cutting or pivoting sports) who underwent meniscus repair were assessed for meniscus repair failure and patient-reported knee function at 5.4 years follow-up (SD 2.8). Knee symptoms were assessed with the Knee Osteoarthritis Outcome Score (KOOS) and International Knee Documentation Committee (IKDS) scores, and postoperative activity scores were assessed with the Marx Activity score. The independent effects of patient age and activity level on meniscus failure risk and patient-reported outcomes were determined by multivariate modeling with adjustment for weight, sex, ACL status, tear pattern, chondral status, and number of implants utilized at the time of surgery.

RESULTS: Meniscus repair failure was 20% overall with no association with age under 40 (adjusted odds ratio [aOR] 1.64, 95% confidence interval [CI] 0.50, 5.38; p=0.41) or level of competition compared to sedentary patients (recreational athlete aOR 2.02 CI 0.50, 8.17; p=0.31) (competitive athlete aOR 3.26 CI 0.62, 17.3; p=0.16). IKDC-symptom scores were not associated with age group (p=0.12) but were lower among sedentary patients (adjusted mean 59.6 SE 2.5) compared to recreational (78.9 SE 2.5; p=0.007) or competitive athletes (79.2 SE 3.8; p=0.02). Marx activity scores were not associated with age group (p=0.11) but were preoperative activity level dependent (sedentary adjusted mean 2.3 SE 1.7; recreational 6.4 SE 0.8, p=0.30; competitive 8.1 SE 1.2, p=0.008) and higher among men (adj. mean 7.4 SE 1.0) versus women (adj. mean 3.8 SE 1.1; p=0.002).

CONCLUSIONS: Meniscus repair failure rates and patient reported outcomes do not differ substantially between older or younger patients of similar activity level. Sedentary patients regardless of age have worse self-reported subjective outcomes compared to active patients following meniscus repair.

MAOA BREAKOUT SESSION #15
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Delay in Surgical Management of Multiligament Knee Injuries is Associated with Cartilage and Meniscus Injury

Paper 236

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INTRODUCTION: Multiligament knee injuries (MLKIs) are potentially devastating injuries that may lead to significant functional impairment. Long-term outcomes and reconstructive options for MLKIs have been well described; however, limited data exists on meniscus and chondral injuries in the setting of a multiligament deficient knee. The purpose of this study was to describe the pattern of meniscus and cartilage pathology in MLKIs and determine the relationship between surgical timing and degree of intra-articular injury.

METHODS: Consecutive patients with surgically treated MLKIs involving two or more ligaments (ACL, PCL, MCL, or PLC) over a 15-year period at a single large academic institution were retrospectively reviewed. Subjects were grouped based on their ligament injury pattern and the presence or absence of meniscus and chondral injury were recorded. The degree of chondral injury was quantified using the Modified Outerbridge Classification system. Surgical intervention within 6 weeks of injury was deemed acute, while surgery occurring more than 6 weeks from injury was classified as delayed. Chi square and logistic regression were utilized for statistical analysis, with significance set at $p<0.05$.

RESULTS: In the 15-year study period, 207 patients with MLKIs (age: 28.4 + 12.1 years; 74.9% male) were surgically treated at our institution. There were 104 meniscal (50.2%) and 70 chondral (33.8%) injuries in the cohort. The most common ligamentous injury pattern was ACL/MCL (n=47, 22.7%) and ACL/PCL (n=47, 22.7%), followed by ACL/PCL/MCL (n=35, 16.9%). Meniscectomy (n=52, 50.0%) was the most frequently performed procedure for meniscus injuries followed by meniscus repair (n=32, 30.8%). Compared to acutely managed patients, the delayed intervention group had significantly more meniscus pathology (57.1% vs. 42.1%, $p=0.03$) and were more likely to undergo meniscectomy compared to repair ($p=0.002$). Eleven cartilage injuries (15.7%) required surgical debridement. Chondral pathology was more frequently present in the delayed intervention group compared to the acutely managed group ($p=0.003$). Meniscus injury rates in MLKIs sustained during sporting activity did not differ from non-sporting injuries ($p=0.59$); however, the non-sporting group had significantly more cartilage injuries (42.0% vs. 18.1%, $p<0.001$).

DISCUSSION: Surgical reconstruction of MLKIs delayed for more than 6 weeks was associated with increased meniscus and cartilage pathology. This may be the result of the severity of the initial injury, which may warrant surgical delay in more severe cases, or persistent knee instability placing the meniscus and chondral surface at risk for injury.

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Comparison of Tendon Lengthening with Traditional vs. Accelerated Rehab Following Achilles Tendon Repair: A Randomized Controlled Trial

Paper 237

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INTRODUCTION: Operative repair of Achilles tendon ruptures has shown successful outcomes. However, little is known about the amount of tendon or repair site lengthening after repair and if lengthening is affected by rehab protocols. The purpose of our study was to compare lengthening of the Achilles tendon after surgical repair, comparing traditional and accelerated rehab protocols.

METHODS: Fourteen patients undergoing primary repair of Achilles tendon ruptures were assessed for participation. We performed a prospective randomized controlled trial in accordance with the CONSORT (Consolidated Standards of Reporting Trials) 2010 statement. The study arms included operative repair of Achilles tendon rupture with either accelerated (graduated weight bearing at 2 weeks) or traditional rehab (weight bearing at 6 weeks). During repair, two 2-mm tantalum beads with laser-etched holes were sutured to the Achilles tendon at the repair site. Beads were evaluated via CT scans immediately postoperatively and at 12 weeks. X-rays were obtained at time 0 and then at 2, 6, and 12 weeks. The primary outcome of the study was the difference in tendon lengthening between the study arms. Randomization was by a computerized algorithm. The observer was blinded and the patient was not blinded to the intervention.

RESULTS: Zero patients declined participation and all 14 patients were included for final analysis. All patients showed statistically significant lengthening at two weeks following surgery. There was a trend toward increased lengthening at 6 weeks in the accelerated rehab group (9.9 mm, range 2.6 -13.9 mm) compared to the traditional rehab group (4.1 mm, range 1.5 -9.0 mm), although this was not statistically significant; $p = .07$. However, the final amount of tendon lengthening at 12 weeks after surgery was not different between the accelerated rehab group (14.4 mm, range 11.7 -17.0 mm) and the traditional rehab group (13.4 mm, range 10.7 -17.0 mm); $p = .38$.

DISCUSSION AND CONCLUSION: This study's findings suggest that all patients undergoing operative repair of Achilles tendon ruptures have significant lengthening after surgery. Although there was a trend toward increased lengthening at 6 weeks in the accelerated rehab group, there was no difference in tendon lengthening at final follow-up between the two groups.

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Body Mass Index as a Risk Factor for Postoperative Complications in Arthroscopy

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INTRODUCTION: The obesity epidemic in the United States has made the body mass index (BMI) an important preoperative consideration when evaluating a patient for elective surgery. This study aimed to utilize the National Surgical Quality Improvement Program (NSQIP) database to determine if body mass index (BMI) is associated with 30-day postoperative complications following arthroscopic surgery.

METHODS: The NSQIP database was queried for elective arthroscopic procedures of the shoulder, hip, and knee. A retrospective cohort analysis was conducted with patients categorized by BMI class. Overall 30-day morbidity, mortality, readmission, and reoperation were compared using a univariate analysis, and a binary logistic regression was used to ascertain the adjusted effect of BMI classification on morbidity, readmission, and reoperation.

RESULTS: There were 141,335 patients who met criteria. The overall morbidity rate was 0.92% and the most common complications were deep vein thrombosis (382 cases, 0.27%), superficial surgical site infection (234 cases, 0.17%), urinary tract infection (185 cases, 0.13%), and pulmonary embolism (151 cases, 0.11%). Obesity class III with diabetes was an independent risk factor for morbidity (OR 1.522, 95% CI, 1.101-2.103; P = 0.011) and readmission (OR 2.342, 95% CI, 1.998-2.745; P = 0.040). Increasing age was also an independent risk factor for morbidity (OR 1.009, 95% CI, 1.005-1.013; P < 0.001) and readmission (OR 1.020, 95% CI, 1.014-1.025; P < 0.001). ASA class 3-5 was an independent risk factor for morbidity (OR 1.394, 95% CI, 1.218-1.597; P < 0.001), readmission (OR 2.342, 95% CI, 1.998-2.745; P < 0.001), and unplanned reoperation (OR 2.034, 95% CI, 1.585-2.610; P < 0.001). Obesity class I alone was protective towards unplanned reoperation (OR 0.687, 95% CI, 0.485-0.973; P = 0.034).

CONCLUSION: Arthroscopic procedures are safe with very low complication rates, regardless of BMI class. However, patients with class III obesity plus diabetes have an increased risk for postoperative morbidity and readmission, and thus, should be given careful consideration when being evaluated for elective surgery.

SUMMARY: Complication rates in arthroscopy were very low, regardless of body mass index. However, class III obesity plus diabetes was an independent risk factor for postoperative morbidity and readmission.

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Systematic Review of Medial Patellofemoral Ligament Reconstruction Techniques: Comparison of Patellar Bone Socket and Cortical Surface Fixation Techniques

Paper 239

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PURPOSE: To compare patellar bone socket [S] and cortical surface fixation [F] techniques for isolated MPFL reconstruction and determine if there is a difference in: (1) complication rate, including fracture of the patella; (2) re-dislocation rate; or (3) patient reported outcomes.

METHODS: A literature search was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We included patients who underwent isolated medial patellofemoral reconstruction (MPFLR) for recurrent patellar instability. Patients with confirmed concomitant or prior, ipsilateral knee procedures, multi-ligament injury, or less than 3 months of follow-up were excluded. Risk of bias assessment was performed using The Methodological Index for Non-randomized Studies (MINORS) system. Studies were classified by surgical technique ([S] group vs [F] group) and complications, re-dislocations, and patient reported outcomes were collected.

RESULTS: 29 studies yielded 981 patients with MPFL reconstruction for inclusion. 620 underwent a [S] technique and 361 underwent a [F] technique. Patient age ranged from 11-68. Patellar fracture rates in the [S] group ranged from 0-17% (12/598 patients) and were 0% in all studies of the [F] group (0/361 patients)($p<0.01$). Mean Kujala scores in [S] group ranged from 83.5 to 93.6 and 84.4 to 94.5 in the [F] group. Mean Lysholm scores in the [S] group ranged from 84.6 to 91.7 and 83.5 to 95 in the [F] group. Re-dislocation rates ranged from 0-21% in the [S] group (10/620 patients) and 0-13% in the [F] group (6/339 patients)($p=0.99$). Although heterogeneous in nature, complication rates in the [S] group ranged from 0-28% (26/507 patients) and 0-4% in the [F] group (4/340 patients)($p<0.01$).

CONCLUSIONS: MPFL reconstruction techniques with patellar bone sockets demonstrated small, but higher complication rates to cortical fixation techniques. Overall, the bone socket group had comparable postoperative re-dislocation rates and clinical outcomes to those with cortical fixation techniques.

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Injury Characteristics and Radiologic Outcomes of Carpometacarpal Fracture-Dislocations Treated Surgically

Poster 001

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PURPOSE: To investigate the demographics, injury characteristics, and early radiographic outcome of patients with carpometacarpal (CMC) fracture-dislocations at our institution over a 10-year period.

METHODS: We conducted a retrospective review of all patients sustaining a carpometacarpal fracture-dislocation of the 2nd-5th digits between 2005 and 2015. Demographic data, carpometacarpal joint injury, associated injuries, method of treatment and complications were recorded. We evaluated the injury, intraoperative and postoperative films. The adequacy of reduction was judged by a grading system which we developed and included grades 1-5 (grade 1= anatomic, grade 2= 0-25% subluxation, grade 3=25-50% subluxation, grade 4=50-75% subluxation, grade 5= 75-100% subluxation/dislocation) based on lateral x-rays.

RESULTS: Eighty patients were included in this study. Delivering a blow with a closed fist was the most common mechanism of injury followed by fall from height, motor vehicle accident, and motorcycle accident, respectively. The most common patterns of injury included fracture-dislocation of the 4th and 5th CMC joints (45%), 5th CMC joint (38.8%) and 2nd through 5th CMC joints (15%). Fractures of the metacarpal base or distal carpal row were seen in 86.4% of patients with fractures of the metacarpal bases and hamate being the most common. All injuries were treated surgically with either closed reduction and percutaneous pinning (CRPP) or open reduction and percutaneous pinning (ORPP). CRPP was found to have a significantly higher percentage of patients with concentric reduction at time of pin removal compared to ORPP (91.2% vs. 33.3%, p=.002). Time to surgery was significantly different between the CRPP group and ORPP group (6.43 days versus 15.57 days, p=.0027). There was a trend toward increased infection rate in the ORPP group (p=.07).

CONCLUSION: Carpometacarpal fracture-dislocations are injuries that can be associated high-energy mechanism and can easily be missed. When evaluating x-rays, fractures of the metacarpal base and distal carpal row are commonly seen with CMC fracture-dislocations. These most common patterns of injuries affect the 4th and 5th CMC joints. With early diagnosis, closed reduction and percutaneous pinning is a good option for obtaining concentric radiographic reduction. Delayed diagnosis can lead to difficulty with closed reduction and may lead to the need for open reduction which was associated with a poorer radiographic outcome.

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Trapezial Excision Suture Suspensionplasty for Thumb Carpometacarpal Osteoarthritis: A Small Cohort Prospective Review

Poster 002

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PURPOSE: Osteoarthritis of the thumb basilar joint is one of the most common problems encountered by hand surgeons. A range of surgical options currently exists to treat thumb carpalmetacarpal (CMC) joint osteoarthritis. According to a recent survey of the ASSH members (Yuan et al 2017), 89% of surgeon survey respondents prefer trapeziectomy with ligament reconstruction and tendon interposition (LRTI) when surgically treating thumb CMC osteoarthritis. Trapezial Excision with Suture Suspension (TESS) has more recently been described as a surgical alternative to LRTI. This series presents a prospective evaluation of the surgical results of a single experienced hand surgeon preforming 26 consecutive cases of TESS over an eight-month collection period.

METHODS: All patients were followed prospectively until release from care for a minimum of six months. Data was collected from 26 patients by a certified hand therapist at 6 week, 3 month, and 6 month intervals including: NRPS and mini DASH; range of motion measurements including MP Flexion, IP Flexion, Abduction, and Opposition of the thumb; and strength measurements including Grip, Lateral Pinch, Tip Pinch, and 3 Jaw Pinch.

RESULTS: The average age for our cohort was 62, with two-thirds of the patients being female. Clear trends in the data showed improvement by all objective measures. A paired T test was conducted on DASH, NPRS, Grip Strength, Lateral Pinch, and Tip Pinch at the 95% confidence level. Only DASH scores did not display statistical significance with a p-value of .063. However, mean DASH scores improved from 51 to 7 at 6 month follow-up. No complications nor revision procedures were noted.

CONCLUSION: Although this series represents a small cohort with relatively short-term follow-up, the outcome measures corroborate the perceived positive outcomes of a much larger population of patients undergoing TESS. The senior author has completed greater than 200 TESS procedures over the past 5 years with very favorable results comparable to other techniques of thumb CMC reconstruction. Based upon the reported outcomes of the study, these results suggest that, at early follow-up, TESS is a satisfactory alternative to LRTI for operative treatment of basilar thumb arthritis.

Arthroscopic Repair of Longitudinal Split Tears of the Ulnotriquetral Ligament: A Series of 228 Wrists

Poster 003

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INTRODUCTION: Ulnar sided wrist pain is a common cause of upper extremity disability. While the mechanism and clinical presentation of ulnotriquetral (UT) ligament split tears has been described, there is limited data regarding the outcomes of this condition. The purpose of this study was to assess the functional and clinical outcomes of patients undergoing arthroscopic UT ligament split tear repair.

METHODS: 228 wrists (142 right and 86 left) in 221 patients (100 males and 128 females, mean age 35 ± 15.5, range 14-77 years) underwent UT ligament split tear repair between 2007 and 2016. Mayo wrist score, Visual Analogue Scale (VAS) pain scores, and objective measures including grip strength and range of motion were obtained. Patients were followed with a mean follow-up of 10.3 months. The comparison between preoperative and postoperative outcomes was performed with a paired t-test. The α level was set to 0.05. All statistical analyses were conducted using JMP®, Version 13.0.0, SAS Institute Inc., Cary, NC, 1989-2007.

RESULTS: Ulnotriquetral split tear repair resulted in substantial improvements in pain and function. Mayo Wrist Score for the cohort improved from 56 preoperatively to 82 postoperatively ($p<0.0001$), and 83% of patients achieved a good or excellent outcome. VAS pain scores decreased from 6.0 preoperatively to 1.4 postoperatively ($p<0.0001$). Grip improved from 26.1 kg preoperatively to 29.8 kg postoperatively ($p=0.003$). There was no significant change in range of motion of the wrist. Complications were noted in 13 patients with 8 experiencing continued pain, 4 with dysesthesia of the dorsal sensory ulnar nerve and 1 superficial infection.

CONCLUSION: In the largest series reported to date, arthroscopic UT split tear repair significantly reduced pain and improved Mayo Wrist Scores.

SUMMARY: Arthroscopic repair of UT split tears provides predictable pain relief, improved function, and low complication rate.

Keywords. Ulnar sided wrist pain, arthroscopic repair, ulnotriquetral split tear

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Risk Factors for Revision After Finger Amputations

Poster 004

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BACKGROUND: Finger amputations are indicated for several reasons, including trauma, infection, ischemia and failed replantation. Amputations are simple, inexpensive, and rarely cause functional impairment for single digit involvement; however, amputations may be associated with persistent pain and dysfunction with dexterity. Scarce data show if a more aggressive initial amputation can reduce the need for revisions and hospital costs while improving overall patient outcomes. Understanding the revision rates and predisposing factors for amputations can alter clinical and surgical decision-making. We hypothesize that the need for finger amputation revision is affected by the specific digit, initial amputation level, type of insurance, and presence of medical co-morbidities.

METHODS: A retrospective review was conducted of 392 digit amputations performed in 281 patients by fellowship-trained hand surgeons at a level 1 trauma center from 2011 to 2017. Mean follow-up was 2.4 months. All patients undergoing a revision amputation were identified. Demographics, co-morbidities, surgical indications, examination findings and complications were collected for the primary and revision amputation cohorts.

RESULTS: Of the 281 patients undergoing finger amputations, 236 patients underwent 326 primary digit amputations (Group A), and 45 patients underwent 66 revision amputations (Group B). Over half of the revision amputation patients (Group B) had Medicare. Group B had more medical comorbidities, including hypertension (48.9%), heart disease (42.2%), and diabetes mellitus (40%). Revision amputations were performed in 16.8% of the total digit amputations identified. The index finger was the most common amputated digit overall with 23.6% of primary amputations and 25.55% of revisions. Revision amputations by level were as follows: ray 16.7%, metacarpophalangeal joint 18.2%, proximal phalanx 24.2%, interphalangeal joint 3.1%, proximal interphalangeal joint 6.1%, middle phalanx 10.6%, distal interphalangeal joint 21.2% and distal phalanx 0%. Wound healing complications were the most common indications for revision (75.6%). The most common complication at follow-up was persistent pain in 71.4% of all patients.

CONCLUSION: Revision finger amputations were more prevalent in male patients with Medicare insurance and co-existing comorbidities. The index finger was the most common amputated digit overall. Revision amputations were performed most frequently at the level of the proximal phalanx. Patients who underwent a revision amputation reported fewer overall complications compared to the single primary amputation cohort. These data may serve as a prediction model to aid surgical decision-making when identifying patients at risk for revision amputation.

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Distance of the First Motor Branch of the Ulnar Nerve to the Flexor Carpi Ulnaris from the Medial Epicondyle

Poster 005

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INTRODUCTION: Knowledge of the location and any common anatomical variations of the first motor branch to flexor carpi ulnaris (FCU) is advantageous in successfully decompressing the ulnar nerve at the medial elbow. The purpose of this study was to identify the location of the first motor branch of the ulnar nerve to the FCU in relationship to the medial epicondyle and to recognize any anatomical variants. We hypothesize that there will be no variation between gender or laterality and, thus, a consistent distance from the medial epicondyle can be ascertained.

METHODS: Twenty-two embalmed cadavers were used that had been previously used by dental students for dissection of the head and neck and were undissected otherwise. The distance from the most prominent aspect of the medial epicondyle to the axilla of the first motor branch to the FCU was measured using a digital caliper.

RESULTS: A total of 44 cadaveric elbows were dissected, 11 males and 11 females. Three elbows (7.5%) identified the first motor branch to the FCU to be proximal to the medial epicondyle, all of which were female. The average distance from the medial epicondyle to the first motor branch of the FCU in the remaining 37 cadavers was 20.33 mm distal to the medial epicondyle (range 11.19 – 31.05 mm, standard deviation 4.49, 95% confidence interval 18.89 – 21.78). There was no statistical difference between males and females (p-value = 0.53) or between right compared to left elbows (p-value = 0.68). All of the first motor branches innervated the medial head of the FCU.

DISCUSSION AND CONCLUSION: In this study, we have demonstrated the location of the first motor branch to most consistently occur 18 to 22 mm distal to the most prominent aspect of the medial epicondyle and always innervating the medial head of the FCU. This location was independent of gender and laterality. Interestingly, this study identified branching of the nerve to the medial FCU occurring proximal to the medial epicondyle; an observation previously reported. It is, therefore, not a unique variation; however, its prevalence is unknown. In our study population, the proximal branching variant occurred 7.5% of the time. The data collected from this study helps elucidate a specific location of the first motor branch of the ulnar nerve by narrowing the range where it will be found distal to the medial epicondyle and further identified the most common anatomic variant.

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Variability in Baseball Throwing Metrics During a Structured Long-Toss Program: Does One Size Fit All?

Poster 006

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INTRODUCTION: The variability of throwing metrics, particularly elbow torque and ball velocity, during structured long-toss programs is yet to be fully elucidated. The primary aims of this study were to assess various throwing metrics through a structured long-toss program using wearable technology and to quantify the intra- and inter-thrower variability of these metrics at each stage of throwing.

METHODS: This was a descriptive laboratory study in which 60 high school and collegiate pitchers participated in a pre-determined, structured, progressive long-toss program. All players wore a motusBASEBALL sleeve, which measured arm slot, arm velocity, shoulder rotation, and elbow varus torque. Radar guns were used to measure ball velocity. These metrics were compared within and between all pitchers at each of the following throwing distances: 90 ft, 120 ft, 150 ft, 180 ft, and maximum effort mound pitching. Intra- and inter-thrower reliabilities were calculated for each throwing metric at every stage of the program. Excellent intra-thrower reliability was defined by an Intra-class coefficient (ICC) >0.750. Acceptable inter-thrower reliability was defined by a Coefficient of Variation (CV) <5%.

RESULTS: Ball velocity significantly changed at each progressive throwing distance, but this did not consistently correlate with an increase in elbow torque. Pitching from the mound did not place more torque on the elbow than throwing from 120 ft and beyond. Intra-thrower reliability was excellent throughout the progressive long-tong program for each throwing metric. Ninety-one percent of throwers had acceptable inter-thrower reliability for ball velocity, whereas only 79% of throwers had acceptable inter-thrower reliability for elbow torque.

CONCLUSION: Based on trends in elbow torque, it may be practical to incorporate pitching from the mound earlier in the program (once a player is comfortable throwing from 120 ft). Ball velocity and elbow torque do not necessarily correlate with one another, so a degree of caution should be exercised when using radar guns to estimate elbow torque. Given the variability in elbow torque between throwers, some athletes would likely benefit from an individualized throwing program.

Key Terms: long-toss, elbow torque, ball velocity, inter-thrower reliability, intra-thrower reliability

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Comparable Clinical Outcomes Between Knotless and Knot-Tying Anchors for Arthroscopic Repair of Recurrent Anterior Glenohumeral Instability at Mean 4.8 Year Follow-Up

Poster 007

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INTRODUCTION: Arthroscopic Bankart repair for anterior glenohumeral instability is a common orthopedic procedure. Newer, knotless anchor devices offer an alternative to traditional knot-tying suture anchors, but results using these devices have been conflicting in the literature. The purpose of this study was to compare rates of recurrent instability, revision surgery, and functional outcomes following arthroscopic Bankart repair using knot-tying versus knotless suture anchor techniques.

METHODS: This retrospective matched cohort study used the institutional medical record database to identify patients who had undergone arthroscopic anterior labral repair for recurrent glenohumeral instability using knotless anchor devices. Patients with minimum 2-year follow-up were matched in a 1:2 ratio to control patients (who had undergone anterior labral repair with traditional, knotted suture anchors) on the basis of age, sex, and surgery date. Statistical comparisons were performed using data from the medical record and patient-reported outcomes.

RESULTS: The study included 102 patients (89 males: 13 females) (34 with knotless anchors in the study group, 68 control knot-tying anchors in the control group) with an average age of 24.3 (SD: 9.6) and a mean follow-up of 4.8±2.5 years (range: 2.0–12.4). There was no significant difference in the rate of re-dislocation between groups (15% in the knotless anchor group vs. 9% in the control group, p=n.s.), but the control group showed a significantly higher rate of recurrent subluxation (p=0.039). There were 12 (18%) revision shoulder procedures performed in the control group at a mean 2.9 years after surgery, and 1 (3%) revision in the knotless anchors group at 1.4 years (p=0.055). There was no differences between groups in the final mean VAS, SANE, QuickDASH, UCLA Shoulder Score, or Rowe scores (p=n.s.) except for a higher mean VAS at rest in the knotless anchors group (0.7±1.5 vs 0.1±0.4, p=0.021).

DISCUSSION/CONCLUSION: Arthroscopic anterior labral repair for recurrent glenohumeral instability using knotless anchors demonstrated similar, satisfactory rates of re-dislocation and revision surgery, and lower rates of recurrent subluxation, compared to conventional anchors. Patients achieved good-to-excellent functional outcome scores. These findings support the efficacy of knotless anchors as a reliable alternative to knot-tying anchors in the setting of arthroscopic anterior labral repair for recurrent anterior shoulder dislocation.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
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Secondary Meniscus Tears in Patients with Anterior Cruciate Ligament Injury: Relationship Between Operative Management, Osteoarthritis, and Arthroplasty at 18 Years Mean Follow-Up

Poster 008

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BACKGROUND: Anterior cruciate ligament (ACL) injury and meniscus tears are among the most frequent orthopedic injuries and carry significant implications including predilection for post-traumatic osteoarthritis (OA). Additionally, instability associated with ACL injury has been linked to the development of secondary meniscus tears. To date, no study has looked specifically at secondary meniscus tears that develop following ACL injury and their effect on osteoarthritis and arthroplasty risk. The purpose of this study was to describe the history of secondary meniscus tears in patients with prior ACL injury as well as to determine the effect of ACL injury management on the treatment of the secondary meniscus tears and on the development of OA and subsequent progression to total knee arthroplasty (TKA).

METHODS: The study population included 196 individuals who were diagnosed with primary ACL tears and a subsequent meniscus tear between January 1, 1990, and December 31, 2005. A chart review was performed to collect information about ACL treatment, characteristics of the secondary meniscus tears, and the outcomes arthritis or TKA. Kaplan-Meier and adjusted multivariate survival analyses were performed to test for the effect on survivorship free of arthritis or TKA.

RESULTS: 225 secondary meniscus tears in 196 patients were reported. A total of 57.8% were complex tear types, and 76.0% were treated with partial meniscectomy. Both early- and late-ACL reconstruction conferred a protective univariate effect on the development of OA ($p= 0.01$) and TKA ($p= 0.02$). In multivariate analysis, increased age was the most significant predictive factor for TKA and OA while ACL reconstruction (HR: 0.21 – 0.91, $p\geq 0.16$) and meniscus repair (HR: 0.00 – 0.47, $p\geq 0.36$) trended towards a joint protective effect.

CONCLUSION: Secondary meniscus tears following ACL injury often present as complex tears which are less amenable to repair and result in high rates of partial meniscectomy. Age at time of ACL injury is the only significant predictive factor for development of OA. Both early- and late-ACL reconstruction as well as meniscus repair demonstrate a trend towards protective long-term effect against the development of OA and subsequent TKA.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SPORTS

Medial Patellofemoral Ligament (MPFL) Reconstruction in Skeletally Immature Patients: A Systematic Review

Poster 009

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INTRODUCTION: Medial patellofemoral ligament (MPFL) reconstruction is effective for stabilizing the patellofemoral joint to prevent recurrent dislocation. Given the proximity of the femoral MPFL to the physis, multiple techniques for femoral fixation have been described. The purpose of the present study was to systematically review the literature and evaluate outcomes and complications following MPFL reconstruction in patients with open physes.

METHODS: A comprehensive literature search was performed of PubMed and Embase databases. All original English-language studies reporting outcomes or complications of MPFL reconstruction in adolescents were included. Studies of MPFL reconstruction in skeletally mature individuals were excluded. Two independent reviewers collected demographic data, information regarding surgical technique, graft type, outcome data, and complications. Outcome variables analyzed included Kujala scores, redislocation and pooled complications. Statistical analysis was performed using Chi-square and weighted mean pooled cohort statistics where appropriate, with significance set at $p<0.05$.

RESULTS: Ten studies met inclusion criteria representing 370 MPFL reconstructions performed in 337 skeletally immature patients (206 females; 61.1%) with a mean age of 13.9 years (range 6-18). Mean post-operative follow-up was 37.3 months (range 16-180). The most common MPFL autograft was gracilis tendon (n=257; 69.5%) followed by quadriceps tendon (n=62; 16.8%), semitendinosus tendon (n=19; 5.1%), and adductor magnus tendon (n=32; 8.6%). Pooled Kujala scores improved significantly after MPFL reconstruction (61.1 vs 84.0; $p=0.0006$). The total reported complication rate was 14.9% (n=55) including 17 redislocations (4.6%) and 8 subluxation events (2.2%). Five patients (1.4%) with recurrent instability were revised using the adult technique with semitendinosus tendon autograft. There were no cases of pre-mature physeal closure and only 3 reports of donor site pain (0.8%). The reported rate of recurrent instability was not statistically different based on graft type ($p=0.431$). Furthermore, 246 (66.5%) MPFL reconstructions utilized interference screws, as compared to suture anchor (n=57, 15.4%) or suspension (67, 18.1%), with a lower rate of recurrent instability (3.3% vs. 8.8% and 17.9%, respectively, $p=0.001$).

CONCLUSION: Our results suggest MPFL reconstruction in skeletally immature patients is a viable treatment option, with significant improvement in patient-reported outcomes and a redislocation rate of <5%. Further studies may be needed to determine the impact of graft type and fixation techniques on outcomes after MPFL reconstruction.

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SPORTS

Is Hip Arthroscopy an Option for Pediatric Septic Arthritis?

Poster 010

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INTRODUCTION: Septic arthritis of the pediatric hip is an orthopedic urgency with high risk of long-term sequelae if treatment is delayed. The current treatment gold standard is large-volume irrigation and debridement via an open arthrotomy and intravenous antibiotics. The purpose of this study was to systematically review the literature to determine the efficacy and morbidity of arthroscopy for the management of septic arthritis of the hip in children.

METHODS: A systematic review was performed utilizing PubMed and Embase according to PRISMA guidelines. All original studies reporting outcomes or complications of hip arthroscopy for pediatric hip septic arthritis were included. Patients were deemed pediatric if 18 years of age or younger. Studies of hip arthroscopy for septic arthritis in adults and studies reporting outcomes after arthroscopy for septic arthritis of other major joints were excluded. Two independent reviewers collected demographic data, culture results, outcome data, and complications. Complications were differentiated by whether they were secondary to the arthroscopic procedure or the natural history of septic arthritis.

RESULTS: Eight studies met inclusion criteria. There were 76 septic hips treated arthroscopically in 76 pediatric patients with a mean age of 6.5 years (range 1-18). Mean follow-up was 25.4 months (range 6-90). The most commonly isolated organism was Staphylococcus aureus (49.3%) followed by Streptococcus pyogenes (8.5%). All but one study advocated for a postoperative suction drain for at least 24 hours. The only reported complications secondary to the arthroscopic procedure were 2 femoral nerve palsies (2.6%) that resolved within 2 weeks. Four patients (5.3%) with delayed presentation (>7 days) had cartilage destruction from hip septic arthritis. There was 1 intraoperative conversion to an open arthrotomy for debridement of femoral neck osteomyelitis. The revision rate was determined to be 7.9% (n=6) with 4 patients undergoing a second hip arthroscopy while 2 patients were revised with open arthrotomies. All revision patients went on to a full recovery.

DISCUSSION: Arthroscopic irrigation and debridement appears to be a safe and effective treatment option for pediatric hip septic arthritis with outcomes and revision rates similar to those reported in the literature for open arthrotomy. Our review highlights the importance of expedient irrigation and debridement, as all reported poor outcomes occurred in patients with a delayed presentation.

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SPORTS

Epidemiology of Hand and Wrist Injuries in National Collegiate Athletic Association Football Players from 2009 to 2014: Incidence and Injury Patterns

Poster 011

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INTRODUCTION: National Collegiate Athletic Association (NCAA) football athletes experience a substantial injury burden with many of these injuries affecting the upper extremities. The purpose of this study was to describe the epidemiology of hand and wrist injuries in NCAA football in an effort to provide meaningful data for tailoring effective injury prevention strategies.

METHODS: An epidemiologic study utilizing the NCAA Injury Surveillance Program (NCAA-ISP) database was performed to investigate rates and patterns of hand and wrist injuries in NCAA varsity football teams participating in the NCAA-ISP from 2009 to 2014. Injury rates were calculated per 1000 athlete-exposures (AEs) using statistical cross-referencing between injury-level and event-level data.

RESULTS: 725 hand and wrist injuries were captured in 899,225 AEs. The observed practice hand and wrist injury rate was 0.51 injuries per 1000 AEs compared to the game injury rate of 3.60 ($p < 0.01$). Comparing player demographics for injuries sustained during practice as opposed to game time revealed significant differences based on player year, player position, activity performed at the time of injury, and mechanism of injury ($p < 0.01$). Player-on-player contact was the most common injury mechanism reported with blocking being the most common activity at injury. Offensive linemen were most likely to experience injury. Of all sustained injuries, 71.4% resulted in no time loss from competition whereas 9.8% of injuries resulted in greater than 7 days of time loss. Fracture resulted in the greatest time loss from competition (8.3 ± 24.0 days for injuries sustained in practice setting, 7.7 ±15.8 days for injuries sustained in game setting). When comparing injury by location, hand injury resulted in greater time loss (3.7 ± 15.1, 4.4 ± 13.8) than to nail/subungual (0±0, 0±0), finger (1.6 ± 6.7, 1.1 ± 4.2), and wrist injury (1.2 ± 3.8, 1.8 ± 4.9).

CONCLUSIONS: Hand and wrist injury was found to be significantly more common in games when compared to practice. Results demonstrate a relatively low rate of injuries leading to loss of significant playing time. This study provides valuable prognostic data regarding expected time loss on a per injury pattern basis. Further investigation on specific injury subtypes and expected time loss as a result of these injures would provide trainers, players, and coaches with useful information on an expected post-injury recovery and rehabilitation timeline.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SPORTS

A Systematic Review of Clinical Outcomes and Re-Operation: Meniscus Repair in a Pediatric and Adolescent Population

Poster 012

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INTRODUCTION: Historically, meniscus pathology has been treated with meniscectomy to improve associated symptoms such as locking and pain. This trend has shifted towards meniscal repair, especially in the young patient, as partial meniscectomy has been shown to be a risk factor for development of osteoarthritis (OA). In the adult population, there is substantial evidence to support the success of meniscal repair at short, mid- and long-term follow-up. In comparison, there is limited data regarding the clinical and functional outcomes of meniscal repairs in pediatric and adolescent populations. Therefore, the purpose of this systematic review was to determine clinical and functional outcomes for meniscus repair in a pediatric and adolescent population.

METHODS: A comprehensive search of the literature following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was conducted. Patients who underwent meniscus repair, were under the age of 19, and were identified as either “pediatric” or “adolescent” by the study authors were included. Included studies also provided patient reported outcomes (PRO) and complications. Exclusion criteria consisted of patients with concomitant osteotomies, revision surgeries, multiligamentous injury, and studies including less than 10 patients. Risk of bias assessment was performed using The Methodological Index for Non-randomized Studies (MINORS) scoring system.

RESULTS: A total of 11 studies, consisting of 456 meniscus repairs (447 patients) were included in this review. The average postoperative follow-up time was 52 months (Range: 22-96 months). All studies reported on meniscal re-tear as a primary endpoint and a total of 65 failed repairs were reported (14% failure rate). Time to failure was reported in six studies and was a mean of 20 months. Postoperative Lysholm scores were reported in 7 studies and IKDC scores in 3 studies with weighted means of 93 and 90, respectively. Mean pre-injury Tegner score was 6.0.and improved to 7.2 postoperatively. Tegner Activity Scale scores changed on a range from -0.3 to +4.3. Average return to sport was reported in 3 studies for a mean of 5.9 months.

CONCLUSION: This review showed an 86% success rate of meniscal repair in the pediatric and adolescent population, at a mean follow-up of 52 months. This success rate is reported in conjunction with “good” to “excellent” clinical outcome scores as measured most commonly by Lysholm and IKDC scores. Taken together, these results suggest that meniscus repair is a suitable option for meniscus injury in a young population.

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SPORTS

MRI Lag Times for Knee Pathology Increased After Implementation of the Affordable Care Act

Poster 013

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INTRODUCTION: The Patient Protection and Affordable Care Act (ACA) ushered in a new era of healthcare practice. Although passed in 2010, its more impactful resolutions took effect in January 2014. The ACAs clinical and economic impact is widely experienced by orthopedic surgeons, yet not well quantified. We proposed to evaluate the impact of the ACA on magnetic resonance imaging (MRI) timing for knee pathology by comparing lag times for imaging before and after implementation of the legislation.

METHODS: We performed a retrospective analysis of all knee MRIs performed at our institution from 2011 to 2016 (three years before and after implementation of the ACA). These dates were compared to the respective initial clinic visits for knee pathology for each patient to determine the MRI lag time. The groups were subdivided based on insurance payer status (Medicare, Medicaid, commercial payers). Statistical analyses using an independent sample T-test with Levene's test for equality of variances were conducted to detect differences in average lag time before and after ACA implementation. Chi-squared tests were used to compare the proportions of completed MRI scans at 2 week, 6 week, and 12 week intervals.

RESULTS: A total of 5543 knee MRIs were included; 3157 (57%) scans were performed before January 1, 2014, while 2386 (43%) were performed after ACA implementation. Commercial payers were most heavily represented at 79% (4372), followed by 14% Medicaid (787) and 7% Medicare (384). The average MRI lag time was 108 days (range 0-1074). Patients waited 14 days longer for MRI scans after ACA implementation (116 vs. 102 days, $p=0.008$). There were increased lag times for patients in the commercial payer (113 vs. 100 days, $p=0.028$) and Medicaid (131 vs. 96 days, $p=0.017$) groups. There was no significant difference in the Medicare group. In total, fewer patients had received MRI scans after ACA implementation within 2 weeks (46% vs. 54%; $p<0.001$), 6 weeks (61% vs. 66%; $p<0.001$), and 12 weeks (71% vs. 74%; $p=0.04$) of their initial clinic visits.

CONCLUSIONS: The lag time between initial clinical evaluation and MRI scan completion for knee pathology has increased since the implementation of the ACA, particularly for patients with commercial insurance or Medicaid coverage. Longer wait times could lead to diminished patient satisfaction, delayed treatment, and increased morbidity, while fewer MRI scans performed could reduce healthcare costs. As healthcare policy changes continue, their effects on orthopedic patients and providers should be closely scrutinized.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SPORTS

Use of Bovie to Facilitate Needle Passage Through Bone

Poster 014

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INTRODUCTION: Electrosurgical devices are routinely employed during surgery to cut and coagulate tissue. Use of a Bovie Electrosurgical Unit (ESU) ESU to facilitate the passage of a suture needle through bone has yet to be described in the literature. This study aimed to identify if the force required to pass a suture needle through bone is reduced by electric current applied to the suture needle.

METHODS: The peak and average axial force required for a suture needle to penetrate cadaveric proximal humeri was measured using a custom setup. Six trials were repeated without and 12 trials with a Bovie ESU applying current through the needle. Needle size, loading rate, and Bovie power settings were varied to assess the effect of such variables. Peak axial force was measured and mean axial force was calculated. T test, ANOVA, and linear regression was performed on SPSS with $P = 0.05$ denoting statistical significance.

RESULTS: Application of electricity reduced the peak and average axial force needed for a needle to pierce bone by 55.5% and 60.9% ($p<0.001$), respectively. There was no difference between a Bovie power setting of 90 Watts compared to 30 Watts in peak ($P = 0.29$) or average ($P = 0.46$) axial force. Increasing the needle size was associated with higher peak ($p = 0.03$) and average ($P = 0.02$) axial force required for Bovie assisted bone penetration. Increasing needle loading rate was negatively associated with peak ($P = 0.001$) and average ($P < 0.001$) axial force.

DISCUSSION AND CONCLUSION: Use of the Bovie ESU provides a greater than 50% reduction in the amount of axial force required to pass a suture needle through bone. Such a technique may reduce the need for power tools to help pass suture through bone.

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SPORTS

Are Baseball Statistics an Appropriate Tool for Assessing Return to Play in Injured Players: An Analysis of Statistically Variability in Healthy Players Using a Machine Learning Approach

Poster 015

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INTRODUCTION: Traditional pitching statistics (ERA, WHIP, etc) have been used as surrogates for pitcher performance without being validated. Even amongst healthy pitchers, the normal variability of these parameters has not yet been established. The purpose of this study was to determine the normal variability of basic and advanced pitching statistics in non-injured Major League Baseball (MLB) pitchers. It is our hope that this work will serve as the foundation for the identification and implementation of validated, pitcher dependent statistical measures that can be used to assess return to play performance following injury.

METHODS: Publicly available data from MLB Statcast and Pitch/Fx databases was used to analyze all non-injured MLB pitchers during 2015 and 2016 seasons who pitcher greater than 100 innings each season without injury. Traditional and advanced baseball pitching statistics were analyzed. The variability of each parameter was assessed by computing coefficient of variation (CV) between individual pitchers and across all pitchers. A CV below 10 is typically indicative of a relatively constant parameter, and parameters with a CV > 10 are generally considered inconsistent and unreliable.

RESULTS: A total of 118 pitchers met all inclusion criteria. For each of these healthy pitchers, 38 basic/traditional parameters and 17 advanced parameters were analyzed. Of the traditional pitcher statistics, only 1 (3%) demonstrated a CV value < 10 (average fastball velocity [FBv]; CV 1.5). In advanced statistics, 9 of 17 (53%) variables demonstrated acceptable consistency as evidenced by a CV value < 10. Release position from plate along with velocity from the plate were the two most constant advanced parameters. When separated by pitch type, these two parameters were the most constant (lowest CV) in every pitch type.

CONCLUSION: The validity and variability of baseball statistics as surrogate markers for performance after injury/surgery have not yet been evaluated. It is critical that baseball statistics undergo proper vetting prior to being used to assess recovery. This study reveals average fastball velocity and release position from the plate to be the least variable basic and advanced baseball statistics in MLB pitchers. In total, only 10 of the 55 statistics analyzed demonstrated acceptable consistency and reliability. This study can be further used to determine the minimum time that each of these variables needs to be followed to ensure an appropriate sample size is obtained to detect significant differences in pre- and post- injury performance.

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TRAUMA

Sacroiliac Implant Length and Loosening: CT Analysis of Radiographically Loose Components Compared to Controls

Poster 016

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PURPOSE: The variation of sacroiliac arthrodesis implants available to surgeons is vast. Hardware loosening in the setting of post-traumatic reconstruction of the pelvis is a common complication and little is known about the biomechanics of the loosening process. This study aims to better understand the relationship of sacral bone density and implant length in order to improve the odds of achieving a stable construct.

METHODS: From 2012 to 2016, all revision sacroiliac arthrodesis cases at a tertiary academic center were reviewed. Cases were selected if an independent radiologist found obvious implant loosening on preoperative radiographs or CT scans. Patient demographics, implant type, and implant length were recorded. A matched cohort of patients with CT scans of the pelvis who had not undergone bony pelvic or spine surgeries was analyzed as a control comparison along the safe iliosacral screw corridor.

RESULTS: The distribution of bone density along the safe sacroiliac screw corridor will be shown on the poster. The softest bone was found to be in the 3rd zone (sacral ala), while the hardest bone was found to be in the sacral body (HU = 0±37 vs. 175±42, $p < 0.0001$). The records of 13 patients with symptomatic and radiographically loosened sacroiliac hardware were reviewed. Of the 33 loose implants analyzed, the average implant was 45 mm long, with 20.2 mm of fixation into the sacrum. 100% of the implants ended in the 5th zone or lateral, with the average implant falling into the 3rd zone.

CONCLUSION: Along the sacroiliac screw safe trajectory, the sacrum has distinct areas of bone density. Symptomatic patients with radiographically loosened hardware typically have implants that only have purchase in the soft lateral bone of the sacrum. Implants with sacral ala purchase and no sacral body purchase may fail due to poor local bone quality.

Back

Racial and Social Disparities in Operative Fixation of Calcaneal Fractures

Poster 017

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INTRODUCTION: Race and ethnicity have been suggested to contribute to differences in healthcare utilization for several elective orthopedic procedures. Reports on disparities in utilization of orthopedic trauma procedures remain limited. The purpose of our study is to assess the roles of clinical and socio-demographic variables in utilization of operative fixation of calcaneus fractures.

METHODS: The National Inpatient Sample (NIS) dataset was used to analyze all patients from 2005-2014 with closed calcaneal fractures. Multivariate logistic regression analyses were performed to evaluate the impact of clinical and socio-demographic variables on the treatment utilized by healthcare providers.

RESULTS: A total of 17,156 patients with closed calcaneus fractures were identified. Operative treatment was rendered in 7039 patients (41.03%). A multivariate logistic regression demonstrated that African Americans had a significantly lower chance of receiving surgical fixation as compared to Caucasians (odds ratio [OR]: 0.819, confidence interval [CI]: 0.726-0.924, $p<0.001$). Hispanics were also less likely to receive surgery, but the effect was not statistically significant ([OR]: 0.906, [CI]: 0.817- 1.005, $p=0.062$).

DISCUSSION: African Americans and Hispanics with calcaneus fractures are less likely to undergo surgical fixation as compared to Caucasians. Further studies need to identify the specific patient-related, provider-related, and system-related factors leading to these disparities.

Key Words: calcaneus; fracture; healthcare utilization; race; disparities

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TRAUMA

Sensitivity and Specificity of Modified RUST Score Using Clinical and Radiographic Finding as a Gold Standard

Poster 018

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BACKGROUND: The modified RUST score was developed in order to assess progress to union and define a numerical assessment of fracture healing of metadiaphyseal fractures. The range of scores is between 4 and 16. This score has been shown to be valuable in predicting radiographic union; however, there is no information on the sensitivity, specificity, and accuracy of this index for various cut off scores in predicating fracture union.

OBJECTIVE: To evaluate sensitivity, specificity, accuracy, and cut-off points of the modified RUST score for the diagnosis of metadiaphyseal fractures healing. In addition, the study assessed the clinical effectiveness of this score.

METHOD: A cohort of 143 consecutive patients with 146 distal femur fractures were retrospectively identified at our institution from 2011-2016. After excluding patients with (AO/OTA Type B fractures, nonunions, follow-up less than 12 weeks, and patients less than 16 years old), 107 patients were included for analysis. AP and lateral knee and femur radiographs at 6, 12, 24 weeks and final follow-up when available were separately scored by 3 surgeons using the modified RUST score to evaluate callus formation.

The sensitivity and specificity of mean modified RUST score were calculated using clinical and further radiographic findings as a gold standard for ultimate fracture healing. An ROC curve was also performed to determine the cut-off points of the modified RUST score at each time point. Interclass correlations for the three observers (ICC) were also calculated.

RESULTS: The mean modified RUST score of 9 at 24 weeks revealed a 97.3% sensitivity, 85.7% specificity, and 96.3% accuracy of predicting ultimate fracture healing. A cut-off point of 13 points revealed 41.1% sensitivity, 100% specificity and 46.3% accuracy at the same time point. The modified RUST score demonstrated Interclass correlation (ICC) of 0.57, 0.52, 0.56, 0.62 at 6, 12, 24 weeks and final follow-up respectively—indicating moderate to substantial agreement between each of the three investigators.

CONCLUSION: The modified RUST score obtained from radiographs could be used as a screening method for healing of metadiaphyseal femur fractures at a score of 12. At a score of 13, the specificity increases to 100% but the sensitivity is lower. The modified RUST should not be used at 6 weeks because it was too early to accurately predict eventual fracture healing with this score.

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TRAUMA

Clinical Outcomes Following Intramedullary Nailing of Select Tibial Pilon Fractures

Poster 019

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PURPOSE: There is growing enthusiasm for treating distal tibia shaft fractures via less invasive means in an attempt to minimize soft tissue insult and risk of wound complications. Few reports have shown lower rates of infection with an intramedullary nail (IMN) compared to plates for distal third tibia fractures while others have shown no difference. The purpose of this study was to report outcomes of tibial pilon fractures treated with IMN.

METHODS: Patients > age 17 that underwent IMN for a tibial pilon fracture (OTA/AO 43-A, 43-B with an ipsilateral shaft component, and 43-C1/2) at a Level 1 trauma center from 2013-2017 were retrospectively reviewed. Patients with follow-up less than 12 months were excluded. Demographics, injury characteristics, and clinical outcomes were obtained from chart review. Radiographic analysis included OTA/AO fracture classification, union (evaluated by the radiographic union scale in tibial [RUST] fractures), and alignment. Normal coronal alignment, measured by the lateral distal tibia angle, was 89 degrees (deg). Normal sagittal alignment, measured by the anterior distal tibia angle, was 80 deg. The visual analog scale (VAS) was utilized to quantify pain (0-10). The Physical Function (PF) and Pain Interference (PI) domains of the PROMIS score assessed functional outcomes.

RESULTS: 127 patients were screened and 70 met inclusion criteria. The mean clinical follow-up was 24.5 months (range: 12-56). Average age was 50.3 years, mean BMI was 29.7, gender distribution was nearly equal (53% male; 47% female), and 39% were smokers. There were 38 (54%) OTA/AO 43-A fractures, 3 (4%) 43-B, and 29 (41%) 43-C. Median time to fixation was 1 day. 26% of patients had an open fracture and 20% were initially treated with external fixation. There were 5 (7%) deep infections and 4 (6%) nonunions. The rate of malreduction >5 deg in the coronal plane and sagittal plane postoperatively was 9% and 4%, respectively; malunion > 5 degrees at final follow-up was 10% and 5%, respectively. The mean PROMIS PI was 55.4, PF 44.4, and VAS 3.0. The mean RUST score on final radiographs was 10.0.

CONCLUSION: This study found a low rate of malalignment, nonunion, and infectious complications with IMN treatment of tibial pilon fractures. Functional outcome scores approached those of a normal population. This study suggests that good outcomes with a low risk of complications can be expected following IMN of select pilon fractures, although prospective trials comparing IMN to plates are needed.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TRAUMA

Is Cheaper Always Better for Clavicle ORIF?

Poster 020

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PURPOSE: To determine the clinical outcomes of a single 2.7 mm non-locking plates and compare to anatomically precontoured and 3.5 mm plates including cost and secondary surgery rate. Our hypothesis was that 2.7 mm fixation would be as good, or better, than precontoured and recon plates from a cost perspective and/or secondary surgery rate.

METHOD: After IRB approval, an institutionally-based database search was initiated utilizing the CPT codes for closed (0123500) and open (0123515) treatment of clavicle fractures from September 1, 2005, to July 1, 2016. Inclusion criteria included patients over 18 who were treated with plate fixation within 8 weeks of injury, and survived their hospital course. Exclusion criteria included patients under 18, surgery performed after 8 weeks from injury, revision surgery, distal and medial clavicle fractures, patients who underwent intramedullary nailing, and those who died during their initial hospital stay. Data points included the primary construct used, secondary surgery rate, and the reason for secondary surgery. The list price for the most common anatomic plating constructs from multiple vendors, as well as the 2.7 mm non-locking constructs was obtained. The cost of the implants was determined by assuming a standard construct of a plate with three screws on either side of the fracture. Statistical analysis was performed utilizing chi square and Fishers exact tests on all data collected.

RESULTS: After inclusion/exclusion criteria were applied, 469 clavicles were identified--176 precontoured plates, 219 mini-frag plates, and 74 3.5 mm reconstruction plates. Although fracture type varied, all fractures met the classic indications for ORIF clavicle. Average follow up for mini-frag, precontoured, and recon plates were 23, 25, and 44 days, respectively. Secondary surgery rates for precontoured and mini-frag plates were similar (9.7% and 9.1%), with similar hardware removal vs. revision ORIF (5% vs. 5%, 4% vs. 4%), while recon plates had a much higher rate (27.6%). There was no statistical significance between precontoured and mini-frag plating in terms of single surgery, HWR, or revision surgery. Cost differences varied between implant companies used, with the difference in construct cost between mini-frag and precontoured plating constructs. Mini-frag cost difference was between $10-1,800 for nonlocking constructs between vendors. The difference increased to a range of $700-$2,600 for locking constructs. Recon plate constructs were similar in cost to 2.7 mm plating constructs.

DISCUSSION: There was no statistical difference between precontoured and 2.7 mm non-locking plates in terms of either hardware removal or revision ORIF. Our study confirmed that 3.5 mm reconstruction plates have an unacceptably high failure rate when compared to other plating constructs. 2.7 mm plates were cheaper than their precontoured locking counterparts, and varied between vendors. With the cost of healthcare at the forefront of medical discussions, 2.7 mm plating should be considered for clavicle fractures, due to lower cost and similar reoperation rate to precontoured locking plates.

Back

Rotating Hinge Distal Femoral Replacement vs. Open Reduction and Internal Fixation for Comminuted Distal Femur Fractures

Poster 021

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INTRODUCTION: Distal femoral replacement (DFR) and open reduction and internal fixation (ORIF) are surgical options for comminuted distal femur fractures. However, comparative outcomes of these techniques are limited. The aims of this study were to compare implant survivorship, perioperative factors, and clinical outcomes of DFR vs. ORIF for comminuted distal femur fractures.

METHODS: Between 2005 and 2015, ten patients treated with rotating hinge DFRs for AO/OTA 33-C fractures were identified, excluding periprosthetic fractures. These patients were 2:1 matched based on age and sex to 20 ORIF patients. Patients treated with DFR and ORIF had similar ages (80 vs. 76 years, p=0.2), follow-up (20 vs. 27 months, p=1.0), and active smokers (10% vs. 15%, p=1.0), respectively. Survivorship, length of stay (LOS), anesthetic time, estimated blood loss (EBL), ambulatory status, knee range of motion (ROM), and Knee Society scores (KSSs) were assessed at final follow-up.

RESULTS: Survivorship free from any revision was 90% and 65% for the DFR and ORIF groups at 2 years, respectively (p=0.59). Survivorship free from reoperation at 2 years was 90% and 50% for the DFR and ORIF groups, respectively (p=0.16). Three ORIF patients (15%) went on to nonunion and two went on to delayed union. Mean anesthesia time was 238 minutes for the DFR group and 271 minutes for the ORIF group (p=0.71). Mean EBL and LOS were significantly higher for DFR group: 592 mL vs. 364 mL (p=0.02), respectively, and 13 vs. 6.5 days (p=0.04), respectively. At final follow-up, 100% of DFR patients were ambulatory compared to 85% of ORIF patients (p=0.62). Knee ROM (p=0.71) and KSS (p=0.36) were similar between groups.

CONCLUSIONS: Comminuted distal femur fractures treated with DFR resulted in lower revision and reoperation rates compared to ORIF. Functional outcomes were slightly better for DFR, but EBL and LOS were higher compared to ORIF.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Abdominal Wall Endometriosis within Orthopedic Oncology: A Case Series

Poster 022

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INTRODUCTION: Abdominal wall endometriosis (AWE) is a rare occurrence in women, and is defined as endometrial tissue superficial to the peritoneum. AWE occurs either spontaneously, or more commonly as a sequela to pelvic surgery such as Cesarean section and hysterectomy. Patients with AWE present with abdominal pain and a pelvic mass. This condition is commonly benign; however, some cases of AWE have been known to undergo malignant transformation, making the recommended treatment surgical resection with wide margins. This condition is often initially misdiagnosed due to the rarity of cases, with final diagnosis only being made after histopathological investigation. We present three cases of AWE at our regional hospital, with patients presenting with an abdominal mass and pain.

METHOD/CASE: We present the cases of a 3 post-menarchal women for the purposes of our case series. Our investigation began with extensive chart review as well as chronologic collection of radiographic imaging. Case presentation includes initial presentation, workup and differential, histologic results, surgical management, and final outcomes. In order to provide a more comprehensive presentation, we additionally describe other potential differential diagnoses for abdominal wall endometriosis that have been described in literature.

RESULTS: Patients were menstruating females 27 years old, 35 years old, and 39 years old. All three patients presented with the initial complaint of an abdominal mass with associated complaints of pain that increases with menses, or mass size that increases with menses. One patient was noted to have two abdominal wall masses, which were both found to be endometriomas. Workup for the patients was varied; one patient had an MRI and another patient had a CT scan. All three patients underwent resection of the abdominal wall mass. Follow-up showed no recurrence, with no signs of hernia or neurovascular compromise.

CONCLUSION: Abdominal wall endometriosis is a rare occurrence that affects menstruating women, commonly with a history of abdominal or pelvic surgery. Presentation is that of an abdominal mass that fluctuates in size or painfulness during the onset of menses, similar to presentation of endometriosis of other sites. The definitive diagnosis is made by final histopathological section which shows endometrial tissue. There is a risk of malignant transformation into clear cell adenocarcinoma or serous carcinoma, thus recommended treatment is resection with wide margins. The diagnosis should be considered in any patient with an abdominal mass who is being worked up for sarcoma or desmoid tumor.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Subcutaneous Soft Tissue Sarcoma: A Review of Literature and Alternative Treatment Options

Poster 023

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BACKGROUND: Soft tissue sarcomas are neoplasms of mesenchymal origin that occur in various sites, most notably the extremities and trunk. Subcutaneous soft tissue sarcomas (SSTS) represent a specific subgroup of soft tissue sarcomas, characterized by superficial location and lack of fascial invasion. Over time, as medical and surgical technologies have advanced, the management of SSTS has progressed. Surgical resection remains the cornerstone of treatment. However, the role of adjunctive therapies, such as radiotherapy and chemotherapy, and alternative non-operative treatment remains a subject of discussion. In this review, we cover the evolution of SSTS management, consisting of wide surgical excision as well as possible adjuvant treatments.

METHOD/CASES: After extensive literature review, including both basic science as well as clinical research, we provide an up to date synopsis of the current state of subcutaneous soft tissue sarcomas including differential diagnoses, grading/staging, imaging modalities, treatment protocols, adjuvants, as well as a possible algorithm based on literature for treatment of these lesions. Clinical experience supported by current literature has helped guide management of these lesions whose optimal treatment is still debated.

RESULTS: Our review suggests that for many patients, the standard treatment of wide resection with adjuvant/neoadjuvant radiation therapy is an acceptable treatment. However, based on tumor and/or patient factors, other adjuvants are available that may mitigate the associated morbidity of radiation therapy. There may also be a subset of patients who will benefit from wide resection alone, without an adjuvant, despite a high-grade soft tissue sarcoma diagnosis. Based off the current literature, and the clinical experience of our institution's orthopedic oncologist, we provide a possible algorithm to guide work-up and treatment of these lesions.

CONCLUSION: Subcutaneous soft tissue sarcomas represent a common subset of soft tissue sarcoma in which treatment has evolved as improved imaging, adjuvants, and better knowledge of their natural course has developed. Although a combination of wide resection and adjuvant radiation therapy has tradition

Back

Orthopaedic In-Training Examination (OITE) Preparation and Study Habits of Orthopedic Residents: Revisited

Poster 025

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The Orthopaedic In-Training Examination (OITE) is well-established as the cornerstone for educational evaluation of orthopedic surgery residents. Great significance has been placed on the OITE as it has been found to correlate closely with successful completion of the American Board of Orthopaedic Surgery Part I Exam. Our study correlated different aspects of OITE study preparation, including resources and habits, with performance. An online survey was created to assess these different aspects and distributed to 163 programs across the United States for distribution to orthopedic residents in each program. Data analysis showed a positive correlation between OITE ranking and greater total hours devoted to studying ($r = 0.26$, $p= 0.0003$), earlier start time for exam preparation ($r = 0.25$, $p = 0.0005$), orthopedic journal review (including Journal of Bone and Joint Surgery [$r = 0.17$, $p=0.02$] and American Academy of Orthopaedic Surgeons [$r = 0.15$, $p = 0.0475$]), review of prior OITE examinations ($r = 0.20$, $p = 0.0054$), and use of Orthobullets ($r = 0.31$, $p < 0.0001$). 58% of respondents changed their study habits significantly over the course of residency. Most respondents stated they were able to study most effectively on primarily outpatient rotations, as well as pediatrics, sports, and hand orthopaedic rotations. The results of this study may assist residents and residency directors to develop their individual study plans and curricula to ensure success on the OITE and, ultimately, optimize their chances for success on ABOS board certification.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Where are the Female Surgeons?

Poster 026

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INTRODUCTION: Female representation in medicine has increased with women now making up over 50% of medical school classes; however, surgical careers remain predominantly male. Orthopedic Surgery specifically continues to have the lowest female representation with 14-15% female residents and 6% AAOS membership. The purpose of this study was to delineate female surgeons completing common surgical procedures using the Medicare database.

METHODS: Current Procedural Terminology (CPT) codes were selected for commonly performed procedures on adult patients in Hip (7), Knee (5), Shoulder (5), Wrist and Hand (13), Spine (6) and Foot & Ankle (7). The 2015 Medicare Provider Utilization and Payment Database was used for data collection. Data was filtered by provider type (orthopedic and general surgeons), then by CPT code. The total number of providers and total procedures performed for each code were calculated. Data was then further filtered by gender, where total number of female providers and total procedures performed were again calculated. This process was repeated for all 43 codes.

RESULTS: A total of 43 codes across 6 subspecialties were included. A total of 1,307 889 procedures were performed; 16,401 (1.25%) by female surgeons. The percentage of females performing Primary THA and TKA were 0.57% and 0.68%, respectively. Reverse and total shoulder arthroplasty had 1.2% female surgeons. Dupuytren's procedures had 25% and carpal tunnel release 12% females. Spine procedures had 0.57% females. Finally, foot and ankle procedures had 5.2% females.

CONCLUSION: Despite females making up 14-15% of orthopedic residents annually and 6% of AAOS membership, there is a paucity of procedures performed by female surgeons in the Medicare database. Primary total knee and hip arthroplasty and spine procedures had the lowest percentages performed by female surgeons. Hand and Foot & Ankle had the highest number of procedures performed by females. These results are consistent with the number of females pursuing fellowships in these areas, although questions remain as why these numbers are so low. These results emphasize the continued need for recruitment to improve diversity in the field of orthopedics.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Correlation of Appointment Time and Subspecialties with the No-Show Rates in Orthopedic Ambulatory Clinic

Poster 027

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BACKGROUND: Unexpectedly missed appointments (no shows) are a common occurrence that strains the health care system by decreasing clinic efficiency, wasting resources, increasing provider dissatisfaction, and creating lost time and revenue. No-shows can be associated with multiple factors such as miscommunication, transportation difficulties, employment status, age, race, and socioeconomic status. The purpose of this study was to determine possible associations between no-show rates and patient, appointment (e.g., month of the year) and provider characteristics.

METHODS: Data for all scheduled appointments at a university hospital orthopedic clinic were analyzed for the 2016 calendar year. Appointments which the patient failed to attend were counted as no-shows. Cancelled appointments were not included in the analysis. The patient demographic data and appointment characteristics analyzed included: patient age, gender and race; appointment hour; appointment month; and orthopedic subspecialty being seen.

RESULTS: There were 25381 scheduled at the university hospital orthopedic clinic in 2016. The overall no-show rate was 11.5% (2909/25373). Young age ($p<0.0001$), African American race ($p<0.0001$), and foot and ankle and sports subspecialties all showed statistically significant associations to higher no-show rates. Statistically significant differences were not observed for gender, appointment time, or month of appointment.

CONCLUSION: Patients at a higher risk of missing scheduled appointments may require extra attention from health care providers when scheduling and confirming appointments in advance or through providing incentives to decrease risk: accommodating patient's schedules when making appointments, confirming their appointments several days in advance, and/or incentivizing patients.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Orthopedic Residents' Pursuit of Fellowship Training in the United States: Results from a National Survey

Poster 028

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PURPOSE: Orthopedic surgery residents have a high rate of pursuing fellowships with as much as 90% of residents completing a one year fellowship prior to entering independent practice. There are many factors that go into the decision to pursue a fellowship, and the purpose of this study is to determine the major factors residents consider when pursuing a fellowship. Anecdotally, there seems to be an increase in residents pursuing multiple fellowships so called "super-specialization", this study will quantify this phenomenon and determine factors that residents consider when making this decision as well. This work represents a national survey of trainees in orthopedic residency training.

METHODS: Institutional Review Board exemption was obtained to administer a survey to all PGY-1-5 residents in the United States in the 168 programs that participate in the Electronic Residency Application System (ERAS). For this survey, orthopedic surgery residents were contacted via email with a link to an online multiple choice survey, and were offered the possibility of a nominal financial award for completing the survey. 271 residents started, and all 271 residents completed the survey, leading to a response rate similar to other internet based surveys of orthopedic surgeons.

RESULTS: Responses were equally distributed from all years of training, predominantly male (83%), age 25-34. MD degree holders in allopathic training programs, and DO degree holders in osteopathic programs were represented by 15% of respondents. 18% planned on arthroplasty fellowship, 16% sports, and 12% planned on hand and trauma fellowships. 21% were undecided on which specialty, but nonetheless knew they were planning on completing a fellowship. Only 1.5% had definite plans to enter general practice directly from residency. Many residents (52%) would still pursue a fellowship even if residency was extended to 6 or 7 years in length.

CONCLUSION: Nationwide residents in training have plans for fellowship that are consistent with previously reported national trends, with greater than 92% planning on completing one year and 8% planning on completing multiple fellowships. Residents report skill development (44%), employment/marketability (20%), and personal interest/lifestyle factors (13%) as the top three reasons for seeking fellowship subspecialty training. Interestingly, over half of residents stated that they would still pursue a fellowship even if residency was extended by 1-2 years.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

An Anatomical Study on the Sagittal Plane Orientation of the Medial and Lateral Proximal Tibial Surface and Their Relationship to Coronal Plane Orientation

Poster 029

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INTRODUCTION/BACKGROUND: Both medial proximal tibial angle (MPTA) and tibial slope are commonly analyzed when deformity correction is planned. There is limited data regarding the differences between tibial slope of the medial and lateral aspects of the proximal tibia, and whether tibial slope has any association with varus or valgus of the tibia. This study utilized a large cadaveric collection to explore relationships between tibial slope and coronal plane deformity of the tibia.

METHODS: We utilized 462 well preserved skeletons (924 tibiae), excluding any with fracture or obvious rheumatologic or infectious findings. Custom cards were made with different sized arcs on the bottom surface, so that they could rest on the anterior and posterior aspects of the medial and lateral tibial plateaus each bone, while avoiding any concavity of the bony surface. Photographs were then taken from the lateral direction, and the angles between the cards (representing the tibial slope) and the tibial shaft were measured using Image J to represent medial and lateral tibial slope. Previously measured MPTA values for the same bones were also utilized.

RESULTS: The mean age was 56 ± 10 years, with 13% female and 31% African-American (remainder Caucasian). Mean medial tibial slope was 81.3 ± 3.7 degrees, and mean lateral tibial slope was 81.5 ± 3.8 degrees. The absolute difference between the lateral and medial tibial slopes was 3.4 ± 4.6 degrees. Mean MPTA was 87.2 ± 2.4 degrees. Regression analysis found that MPTA was associated with both medial and lateral slopes (standardized betas 0.197 and 0.146 respectively, $P<0.0005$ for both), but not the difference between both ($P=0.19$).

CONCLUSION: There is a correlation between MPTA and medial and lateral tibial slope, such that a more valgus tibia is associated with more recurvatum of the tibia. We observed a large range of absolute differences between medial and lateral tibial slope, suggesting that a single value for tibial slope does not fully describe the complexity of sagittal plane tibial alignment.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Why Choose Orthopedics? An Analysis of the Factors Regarded as Important

Poster 030

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INTRODUCTION: Orthopedic surgery has been historically male dominated. This trend, unlike other surgical subspecialties continues to persist. Orthopedic surgery continues to have one of the lowest participation of female surgeons despite equal enrollment of female medical students in medical schools. The persistent underrepresentation of female orthopedic surgeons indicates that there may be additional influences that specifically influence this large group of physicians to not select orthopedics as their specialty of choice.

OBJECTIVE: An e-mail survey consisting of 55 questions was sent to the medical students (n=640) and residents at a level 1 trauma center at a major metropolitan university. The student population at all class levels was nearly evenly split between male and female. The survey was sent out by e-mail several times over a period of two months. The survey consisted of basic demographic and relationship questions and questions regarding respondent's perception of an orthopedic residency and orthopedic practice. Descriptive analysis was performed using Mann-Whitney U test an alpha of 0.05 was considered significant.

RESULTS: 205 residents (41.0% n=84) and medical students (59.0%, n=121) responded to the survey. A Mann-Whitney U test was run to determine if there were differences in the responses among male and female respondents. Female respondents were more likely to find practice options, continuity of care with their patients, and diversity in their patient population as important values when considering a specialty. Additionally, females were more likely to believe that role models of the same sex were important in selecting a residency (p=.0005), and were also much more aware of female orthopedic surgeons practicing at their school (p=.001) than their male counterparts. Conversely, male respondents were more likely to consider specialty prestige and income potential when selecting a residency. When asked about their perceptions of orthopedic surgery, females were more likely to view the subspecialty as requiring physical strength and being dominated by males.

DISCUSSION: The perception that orthopedic surgery requires physical strength is still a prevalent perception among medical students, which may serve to cause some qualified students to self-select from the field. Many of the values concerning work life balance were no different amongst those surveyed. Having visible and accessible female mentors in the field of orthopedics is essential to the recruitment of highly qualified female applicants. The field of orthopedics offers a wide range of practice options and a diverse patient population that can appeal to many female medical students if they are made aware and have the opportunity to explore the field.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Trends in the Orthopedic Surgery Fellowship Match 2013-2017

Poster 031

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INTRODUCTION: This study describes trends in the postgraduate orthopedic surgery fellowship match from 2013-17.

METHODS: We determined the numbers of applicants and positions in Adult Reconstruction/Oncology, Foot and Ankle, Pediatrics, Shoulder and Elbow, Spine, Sports Medicine, and Trauma. We also defined the odds of matching in each subspecialty. We determined the applicant's odds of matching in their first or second choice by year and specialty. We determined the number of applications made by applicants in each subspecialty. Data was obtained from the San Francisco (SF) Match. Differences between specialties were determined using ANOVA.

RESULTS: In 2017, Adult Reconstruction/Oncology was the most selective with a 68% match rate in 2017 whereas Pediatric Orthopedic Surgery had a 93% chance of matching. The odds of matching in one's first (14-41%) or second (8-16%) choice was low in the study period. The average range of applications made by applicants varied from 18-28 applications depending on year and specialty. Sports applicants made significantly more mean number of applications than all specialties (range +5-9.8 applications; $p<7.59X10-7-0.011$).

DISCUSSION: The numbers of positions and odds of matching in postgraduate orthopedic surgery fellowships are variable by year and subspecialty. Applicants need to consider their entire match list carefully due to low odds of matching in their 1st or 2nd choices. These trends are valuable to applicants and training programs as they determine the number of applications and interviews for a successful match.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Developing Resident Competency in Fracture Reduction and Casting Using Independent Work Modules: A Two-Year Study

Poster 032

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BACKGROUND/PURPOSE: The treatment of a distal radius fracture, including the closed reduction and immobilization, is an ACGME developmental milestone in orthopedic surgery. It is one of the most common fracture patterns encountered by orthopedic residents. Therefore, it is important to determine the optimal combination of didactic training with multiple practice opportunities to guide faculty as to when residents are proficient and competent to treat patients directly. The purpose of this study is to determine whether our current didactic training protocol followed by practice sessions known as independent work modules (IWMs) with or without mentorship is adequate to achieve proficiency and competency when tested by simulation-based exercises.

METHODS: A prospective, longitudinal, double blind study was performed over two years to evaluate resident performance in fracture stabilization with casting as part of A Resident's Transition to Orthopedics study. Four residents in our PGY1 Class of 2022 (Test Group 1) were placed through didactic training and IWMs with mentorship and tested using simulation-based exercises biannually. A similar group of residents (Control Group 1) were also evaluated. Multiple evaluation instruments were used including the validated Global Rating Scale, fiberglass casting instrument and a non-validated instrument customized to the exercise called a Flashpoint Milestone Evaluation. Performance data was gathered, and proficiency and competency deficiencies were calculated with patient safety issues in mind. The performance of Test Group 1 was compared to the previous year's four residents in the PGY1 class of 2021 (Test Group 2) who were trained with IWMs alone. A similar group of residents (Control Group 2) were also evaluated.

RESULTS: Test Group 1 performed significantly better than Control Group 1 in both simple casting and complex casting skills ($P<0.05$) with all 4 residents in Test Group 1 achieving overall competency compared to 1/4 in Control Group 1.

Test Group 1 also showed a significant improvement compared to Test Group 2 in both simple casting and complex casting skills ($P<0.05$).

None of the residents in Test Group 1 or Control Group 1 could stabilize the fracture using casting.

CONCLUSIONS: The Test Group outperformed the Control Group when tested using simulation-based exercises implying that an IWM-based curriculum may be helpful in improving performance. The improvement seen in Test Group 1 implies that adding IWMs with mentorship may be helpful in improving performance. The observed inability to hold reduction in casting suggests the need to add reduction casting to the IWM program.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Safety and Communication in the Operating Room: A Questionnaire After the Implementation of a Blood-Borne Pathogen Exposure Checkpoint in the Surgical Safety Checklist

Poster 033

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INTRODUCTION: The Surgical Safety Checklist (SSC), introduced in 2009, demonstrated a decrease in patient morbidity and mortality and an improvement in communication in the operating room. However, the SSC does not currently include checkpoints focused on employee safety. A key component of employee safety in the operating is prevention of disease progression, including Blood-Borne Pathogen Exposure (BBPE) incidents via sharps sticks. Cleveland Clinic Akron General has implemented a BBPE checkpoint in the SSC to establish the announcing and method of sharps transfers in order to decrease sharps stick occurrences and to further improve communication. The aim of this study was to determine if the implementation of a BBPE checkpoint improves employee safety and communication in the operating room, as well as to determine differences in compliance between elective surgeries and emergent/trauma surgeries.

METHODS: This was a multi-disciplinary prospective survey study in which an anonymous questionnaire was distributed to all operating room personnel who handle sharps. Survey responses were collected and analyzed to determine the demographics and general BBPE safety attitudes. The study also investigated the frequency of reported BBPE incidents, collected from quality improvement data, 12 months before and after the implementation of the BBPE checkpoint.

RESULTS: Analysis of the survey results demonstrated that caregivers feel safer in the operating room after the implementation of the BBPE checkpoint ($p<0.001$). There were also trends towards a feeling of improved communication in the operating room and decreased compliance in emergent/trauma surgeries compared to elective surgeries. Analysis of quality improvement data suggests implementation of the BBPE moment is associated with a significant decrease of reported BBPE incidents ($p=0.045$).

DISCUSSION: The SSC was developed to improve patient outcomes by preventing mistakes and improving communication in the operating room. However, it does not include details that improve safety among employees. Although our results demonstrate responders strongly believed getting stuck with sharps was not part of their job, a majority of people reported a history of BBPE incidents. Therefore, the BBPE checkpoint was implemented in the SSC at Cleveland Clinic Akron General in order to emphasize employee safety and improve communication. The results shed light on the attitudes of operating room personnel by suggesting an improvement in safety and communication. Additionally, there has been a significant decrease of reported BBPE incidents among operating room personnel. Universal implementation of a BBPE checkpoint could improve provider safety and communication in all operating rooms.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Resident Involvement and Publication Rates at the Mid-America Orthopaedic Association Annual Meetings

Poster 034

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INTRODUCTION: The Mid-America Orthopaedic Association (MAOA) traditionally has a large number of residents presenting their research. The purpose of this study is to determine the percentage of podium presentations by residents which resulted in a publication.

MATERIALS AND METHODS: All 1,113 presentations that have taken place at the MAOA annual meetings from 2012 to 2016 were catalogued in a database. For each presentation, the database included the title, subspecialty category, presenting author and their category (medical student, resident, fellow, or attending), and additional authors. This information was then used to direct a search to determine which of these presentations led to publications. If the presentation was associated with a publication, then the publishing journal, the date of publication, and the search engine used to find the publication were all entered into the database.

RESULTS: Of the 1,113 presentations from 2012 to 2016 at the MAOA annual meetings, 635 of them were presented by residents which was 57% of the presentations. In total, 654 presentations were associated with a publication which is an overall publication rate of 59%. These presentations and publications covered a wide variety of subspecialties within orthopedic surgery and were published in over 30 different journals. Of the total publications, 378 were presented by residents. In other terms, 60% of resident presentations resulted in a publication.

CONCLUSION: The 59% publication rate of the presentations at the MAOA annual meeting is comparable to the publication rates of other reputable orthopedic meetings such as 46% at the annual meeting of The American Academy of Orthopaedic Surgeons, 52% at the American Society for Surgery of the Hand annual meeting, and 66% at the Orthopaedic Trauma Association annual meeting. The similar publication rates validate the quality of research being presented at the MAOA; however, these other studies did not further categorize the data by presenting author category. The large amount of resident involvement is apparent at the MAOA and an interesting future study would delineate the amount of involvement of residents at these other orthopedic society annual meetings.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Which Subspecialties Do Female Orthopedic Surgeons Choose and Why?

Poster 035

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INTRODUCTION: Previous studies have examined why women pursue orthopedic surgery after medical school; however, there is limited data delineating the reasons women choose subspecialties within this field.

PURPOSE: To perform a survey that determines which subspecialties female orthopedic surgeons selected, analyze the motivations behind their choices, and identify additional factors that influence these decisions.

METHODS: A ten-question survey was distributed via e-mail to all active members of the Ruth Jackson Orthopaedic Society (RJOS), Texas Orthopaedic Association, and a private internet based social media platform group for women in orthopedics. Questions in this survey included specific area of subspecialty practice, the top-ranked reasons for selecting a subspecialty as well as motivations against choosing other subspecialties, years in practice, and additional demographic data. Physicians included in this study were required to be practicing female orthopedic surgeons, fellows, or residents who were fellowship-matched. Responses from individuals of male gender, or those currently in residency training who were not fellowship-matched were excluded. Results were collected on SurveyMonkey© and compared with data from the 2016 AAOS Orthopedic Surgeon Census across a number of categories. Analysis of specialty selection by experience classification was performed using a Chi-square test. Comparisons determined to be significant were followed by using post-hoc pairwise comparisons. In instances where response numbers were small for a given comparison (<5), data was analyzed using a Fisher's exact test. Type I error was set at $\alpha = 0.05$ for all statistical analyses.

RESULTS: 304 survey responses were received, of which 288 met inclusion criteria. The most common subspecialties noted were hand (24.4%), pediatrics (23.0%), and sports medicine (16.6%). A significantly higher proportion of recently graduated surgeons are electing to subspecialize in sports medicine, while a significantly lower proportion are pursuing general orthopedics.The top-ranked reasons for selecting a subspecialty were personal satisfaction (20.8%), intellectual stimulation (17.2%), and strong mentorship (9.0%). The most common reason for not selecting a different orthopedic subspecialty was lack of interest in other subspecialties (59.8%).

CONCLUSION: Despite an increase in the number of women pursuing a career in orthopedic surgery, they are still choosing similar subspecialties. Our study showed that strong mentorship in a subspecialty is the largest extrinsic factor that affects a female orthopedic surgeon's decision-making. A continued focus on mentorship will be necessary to both encourage and broaden interest for future female orthopedic surgeons.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Development of Spine Surgical Skills Assessment for Orthopedic Surgery Residents

Poster 036

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INTRODUCTION: Goal-oriented simulation training is increasingly becoming a core component of resident physician education. The objective of this study was to develop an assessment module for orthopedic surgery residents learning spine surgery that is cost-effective and can safely and reliably test surgical skills.

METHODS: Our proposed assessment module is a combination of ten multiple choice questions to test cognitive skills, and a hands-on spine sawbones task to test surgical skills. We prospectively administered the module to PGY-3 and PGY-4 residents before and after their eight-week spine rotation. The pre-rotation assessment began with a brief introductory didactic session followed by the written and hands-on assessment. Residents repeated both assessments after their spine rotation. The written exams and sawbones models were de-identified and scored. Pre- and post-rotation scores were compared using the paired t-test.

RESULTS: Twenty-one residents participated. The mean pre-rotation written test score was 7.38± 1.53 (range: 5-10); the mean post-rotation written score was 9.24± 0.83 (range: 7-10). The improvement in written test scores was statistically significant ($p<0.00001$). The mean pre-rotation surgical skills assessment score was 95.4%± 4.7 (range: 83.3-100); the mean post-rotation surgical skills assessment score was 97.1%± 2.6 (range: 91.7-100). The improvement in saw bones skills assessment was trended towards significance ($p=0.10$). Seven residents completed the assessment modules over two consecutive years, first as a PGY-3 and then as a PGY-4. Among these individuals, there was no statistically significant improvement in scores from PGY-3 to PGY-4.

DISCUSSION: This novel resident assessment dedicated to spine surgery demonstrates improvements in resident written exam and surgical skill scores. Employing this exercise prior to a spine rotation provides residents with the opportunity to hone anatomic knowledge and engage in hands-on practice without increased costs of a cadaveric specimen or first-time exposure in vivo.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Improved Psychomotor Proficiency in Novice Subjects with Two, Four, or Six Weeks of Fundamentals of Arthroscopic Surgery Training (FAST)

Poster 037

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Recent studies have shown benefits of non-anatomic simulators as part of arthroscopy training. The Fundamentals of Arthroscopic Surgery Training (FAST) workstation is a training module that parallels various arthroscopic maneuvers. Our previous work showed that 6 weeks of FAST training in M1 medical students resulted in skill retention up to 6 months post-training. We also observed the largest improvements between weeks 1 and 2, and peak skill was achieved by week 4 with no further gains. To determine if shorter training could still be effective, we conducted a follow-up study comparing 2- and 4-week training protocols to the 6-week data. Twenty-six M1 medical students were randomly assigned to either the 2- or 4-week group and trained on four modules: Probing/Targeting, Maze, Vertical Ring Transfer, and Resection Passage. Outcomes were total time, total errors, and time and errors in each task. Repeated measures mixed models were used to test for differences between groups in degree of improvement from the first to last weeks of training. Groups differed significantly for the manner in which total time improved ($P<0.001$). The 6-week group started off significantly slower than the others ($P<0.001$), but made the most gains, reducing total time by 1313 s at the last week ($P<0.001$), compared to 518 s in the 4-week group ($P=0.011$) and 249 s in the 2-week group ($P=0.433$). The 2-week group was the slowest at the end of training at 1182 ± 321 s, vs. the 4-week (765 ± 113 s) and 6-week (920 ± 177 s) groups, but the differences were not significant. Total errors improved from the first to last weeks ($P<0.001$), but did not differ between groups. Results for time in each task largely mirrored those for total time, whereas error rates were less consistent. The results suggest that 4-weeks may be sufficient for significant gains in psychomotor proficiency in arthroscopic simulations. Ongoing research will compare retention of skills at 6 months between the three training groups.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
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Survey Results on Orthopedic Sharps Injuries: Are We Properly Reporting Our Accidents?

Poster 038

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INTRODUCTION: The surgical literature outside of orthopedics has demonstrated that proper reporting of sharps injuries remains a difficult task. Few studies have investigated whether this occurs in the orthopaedic setting. The purpose of this study is to determine the incidence and reporting rates of sharps injuries in the orthopedic operating room.

METHODS: A cross-sectional survey was circulated electronically to orthopedic residents at a single institution. The survey was completed by 40% (12/30).

RESULTS: An average of 3.83 years of operating room experience was reported, with a range of 'less than 1' to 6 years. 92% had experienced a sharps injury in their career. A total of 33 sharps injuries were reported, yielding an average of 2.75 sharps injuries per person. 66.67% reported that they experienced a sharps injury in the 2017 calendar year, for a total of 12 sharps injuries in 2017. Survey data demonstrated that 8.3% of these injures were from blade injuries in 2017. 45.5% of residents who have had a sharps injury responded that they reported it to the hospital system. Of the 6 people (54.5%) that did not report their sharps injury, the reasons for not reporting are as follows: 50%-embarrassment/intimidation, 50%-time expense, 0%-fear of losing employment, 33.3%-difficulty in reporting injury, and 83.3%-perception of low risk. 83.3% of respondents have witnessed a sharps injury in the operating room, and 58.3% have witnessed an unreported sharps injury. 66.7% of responders reported that they would report a sharps injury if harmed in the future. On a 1-10 rating, with 10 being "extremely concerned," an average response of 4.67, with a range of 1 to 10, was reported when asked about the level of concern that "you will incur a sharps injury while in the operating room."

CONCLUSION: This survey has demonstrated that the majority of the residents at our institution have experienced a sharps injury, even in the past year. Additionally, the under-reporting of sharps at our institution is a considerable problem, as a majority of these injuries are not reported. These data indicate that further investigation is warranted on why those injured by sharps do not always report the incident. Investigation into orthopedic specific technology to reduce sharps injury may also be beneficial. This study will soon have additional data from the entire orthopedic department, OR staff, PAs, attending physicians, and resident physicians from across the country.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Implementation of Procedure-Specific Opioid Guidelines: A Facile Strategy to Improve Consistency and Decrease Excess Prescribing Following Orthopedic Surgery

Poster 39

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INTRODUCTION: Evidence-based, procedure-specific guidelines for opioids are urgently needed to optimize pain relief and minimize excess opioid prescribing and the potential for opioid diversion in our communities. A multidisciplinary institutional panel recently developed procedure-specific guidelines for discharge opioid prescriptions. The purpose of this study was to evaluate postoperative opioid prescription quantity, variability, and 30-day refill rates following common orthopedic surgical procedures before and after implementation of prescription guidelines.

METHODS: This retrospective cohort study was conducted at a single academic institution from January 2016–March 2018. Guidelines were established in mid-2017 with a recommended maximum prescription for 14 common orthopedic procedures. All patients in 2016 represented the preguideline era cohort (n=4,555) and all patients from August 2017–March 2018 comprised the postguideline era cohort (n=3,133). Opioid prescription quantities were reported as oral morphine equivalents (OME) with medians and interquartile ranges (IQR).

RESULTS: In the preguideline era, the median opioid prescription across all procedures was 675 OME (IQR: 450-875) for all patients and 640 OME (IQR: 450-850) for opioid naïve patients. These quantities decreased by 53% at the end of the postguideline era for all patients to a median of 320 OME (IQR: 188-388) and 300 OME (IQR: 188-388) for opioid naïve patients ($p<0.001$). This relationship was consistently observed separately for every evaluated procedure. The 30-day refill rate did not change significantly from a rate of 21.8% in the preguideline era to 22.9% in the postguideline era ($p=0.33$). Adherence to the guidelines has improved with time. In the preguideline era, prescriptions below the subsequent guideline recommended maximums occurred in 13% of cases. This rate increased to 51% in the first postguideline month, 67% in the third month, and 76% in the most recent two months ($p<0.001$).

CONCLUSIONS: This study demonstrates that creation and implementation of procedure-specific guidelines are capable of substantially decreasing opioid prescription size and variability. Furthermore, the absence of change to refill rates suggests pain remains similarly controlled to preguideline prescribing practices. Evidence-based guidelines are a facile, readily-employable solution that can drive rapid change in practice and enhance the ability of orthopedic surgeons to provide responsible pain management. Procedure-specific efforts such as these are increasingly important as orthopedic surgeons have the opportunity to shape and inform evolving local and nationwide restrictions regarding opioid prescribing practices.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
TUMOR/OTHER/EDUCATION

Is it Safe? Outpatient Total Joint Arthroplasty with Discharge Home at A Free-Standing Ambulatory Surgical Center

Poster 041

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INTRODUCTION: Total joint arthroplasty (TJA) is trending toward shorter hospitalizations, which has been facilitated by refinements in surgical techniques, advancements in anesthesia and pain regimens, and necessity to reduce costs. There are many ambulatory surgical centers (ASC) starting to perform outpatient TJA. However, there are limited studies examining the safety of outpatient TJA in the free-standing ASC setting. This study aims to evaluate 30-day and 90-day complication rates in patients who underwent outpatient TJA which included, total hip arthroplasty (THA), total knee arthroplasty (TKA) or uni-compartmental knee arthroplasty (UKA) at a freestanding, independent ASC with direct discharge home.

METHODS: Retrospective cohort review using health records was performed on the first 115 TJAs performed between August 2015 and March 2017 by one of four orthopedic surgeons. Prior to the first TJA, the ASC developed a multidisciplinary TJA pathway.

RESULTS: Of the 115 TJAs, 37 (32%) were THAs, 53 (46%) TKAs, and 25 (22%) UKAs, with a mean age of 57 ± 7 years, and BMI of 30 ± 5 kg/m^2. There were no intraoperative or direct ASC related complications. There was one (0.9%) complication within 30 days of surgery. There were 2 instances of open reoperation (2%) and 2 instances of knee manipulation (2%) within 90 days of surgery. The single 30-day complication event involved a postoperative minimally displaced intertrochanteric femur fracture after THA due to a fall treated nonoperatively. Of the 90-day complication events, there were two patients with postoperative arthrofibrosis of the knee after TKA requiring manipulation under anesthesia, one postoperative patellar tendon rupture during therapy after TKA requiring surgical repair, and one delayed hematogenous infection after international travel after THA requiring two-staged exchange.

CONCLUSION: Outpatient TJA with discharge home at a freestanding, independent ambulatory surgical center is a safe option after development of a multidisciplinary TJA pathway.

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Sunshine Act and Orthopedic Residents: CMS Reporting of an Exempt Population

Poster 042

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INTRODUCTION: Congress passed the Sunshine Act in 2010 as part of the Patient Protection and Affordable Care Act (2010 ACA) to help preserve patient confidence in the care they receive by increasing the transparency of physicians receiving compensation from pharmaceutical and medical device companies. Part of the Sunshine Act was an exemption of residents from reporting on the open payments website. The purpose of this study was to analyze the publicly available CMS (Centers for Medicare and Medicaid) Open Payments website to determine how often orthopedic surgery residents are reported and the most common reasons for being reported.

METHODS: The websites of all 206 allopathic and osteopathic orthopedic residency programs in the United States were searched to determine if residents were listed on the CMS Open Payments website. If a resident was listed from the publicly available data from 2014-2016, the following data was recorded from the CMS Open Payments website: company providing the compensation, the amount of compensation, reason for compensation, number of transactions, number of companies compensation was received from, research funding, number of disputed payments, and ownership/investment interest information.

RESULTS: During the three-year study period, 3,216 of the 9,419 residents identified (34%) were found on the CMS Open Payments website. The percentage of residents identified ranged from 32-35% per year. The number of individual payments ranged from 6.4-7.6 per year. The range of industry payments to residents was $1,400-$2,029 per year. The total industry payment towards residents during this period was $5,038,999.40.

CONCLUSION: The Sunshine Act was intended to increase transparency of physicians' financial relationships with industry with the goal of providing insight into potential physician conflicts of interest. Per the Sunshine Act, resident physicians are currently exempt from reporting. However, we found that in many cases residents were reported on the CMS Open Payments website.

Key Words: Sunshine Act, CMS Open Payments Website

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
FOOT AND ANKLE

Outcomes of Surgical Repair in Non-Athlete Patients with Chronic Turf Toe Injury

Poster 043

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BACKGROUND: Turf toe injuries, though most common in athletes, occur in non-athletes when an abnormal force drives the great toe dorsally past its typical dorsiflexion range of motion (ROM) causing sprain/tear of the capsular ligamentous structure of the first MTP joint. While most of these injuries can be successfully treated by nonoperative means, some patients will fail conservative management and ultimately require surgical intervention to restore stability of the joint and continuity of the plantar plate structures. Few studies have investigated surgical outcomes in athletes with turf toe injuries; however, no studies exist in literature investigating surgical outcomes in non-athletes with chronic turf toe injury. In this study we present our outcomes on operatively treated turf toe injuries in non-athletes in the largest cohort yet studied.

METHODS: Using ICD-10 codes, we assembled a cohort of 11 patients who underwent operative repair of chronic turf toe injury from January 2012 through January 2018 at the investigating institution. These 11 patients were evaluated to determine demographic information, method of injury, length of time from injury to surgery, clinical and radiologic characteristics of the injury, and surgical outcomes, such as mean preoperative and postoperative VAS scores and postoperative complications.

RESULTS: On initial clinical presentation, all 11 patients had local tenderness at the base of the great toe with associated painful range of motion. Four patients had restricted ROM, five had a positive Lachman test, two had local edema, and nine had hallux-valgus deformity. All 11 of the patients included in our cohort underwent repair of the plantar plate. Additionally, sesamoidectomy was performed in six patients, and nine patients underwent bunion repair. Mean VAS improved from 4.6 (range 2-9) to 1 (range 0-4). All patients had a negative Lachman test at final follow-up. No patients developed any major complications.

CONCLUSION: Our study is the first to investigate surgical outcomes in non-athletes with chronic turf toe injury. Based on our study, surgeons and patients can expect a significant improvement in overall pain and foot function following surgery. Surgeons should also be aware of other pathologies that often co-present with the turf toe injury, such as injury to the flexor hallucis brevis or flexor hallucis longus, hallux valgus deformity, sesamoid fracture, or metatarsal head sesamoid arthrosis, which may require concomitant procedures at the time of plantar plate repair.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
FOOT AND ANKLE

Outcomes Following Treatment of the Infected Achilles Tendon

Poster 044

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BACKGROUND: Infection following Achilles tendon surgery is a devastating complication and can be difficult to treat. Our purpose was to evaluate clinical and functional outcomes of patients who have undergone treatment for an infected Achilles tendon.

PATIENTS AND METHODS: We retrospectively reviewed the medical records of 20 patients who had undergone surgical treatment for an infected Achilles tendon between 2000 and 2016. The mean follow-up time was 21 months (range 2-68 months). All patients underwent extensive debridement of the tendon with removal of all infected tissue and foreign material. Soft tissue wound coverage was utilized for large wounds that were not amenable to primary or secondary closure. All patients received culture specific intravenous antibiotics for three to six weeks. Postoperatively, the extremity was immobilized in a splint followed by a cast until the wound was healed. The cast was then replaced with a walking boot and the patients were provided a physical therapy program. Functional outcomes were measured using the Foot and Ankle Ability Measure (FAAM) Activity of Daily Living (ADL) scale.

RESULTS: All wounds had healed at the time of last follow-up. Three patients (15%) required an unplanned return to the operating room for repeat debridement. All patients were able to walk without the use of a gait aid. Five patients (25%) required continued use of a boot or brace during ambulation. The average FAAM score was 87 (range, 71.4-100). At last follow-up, most patients reported their overall function as “normal” or “nearly normal”.

CONCLUSIONS: Eradication of infection and satisfactory functional results can be attained after radical debridement, wound closure, and administration of culture specific IV antibiotics.

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Patient Reported Outcomes of Achilles Tendon Repair Using the Modified Gift-Box Technique with Non-Absorbable Suture Loop: A Consecutive Case Series

Poster 045

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PURPOSE: To determine early range of motion, complication rates, and 1 year patient-reported outcomes following Achilles tendon repair using a novel suture loop technique.

METHODS: A series of 60 consecutive patients from January 2013 to June 2017 (49 male, 11 female, mean age 36.2 years SD 9.9) who underwent Achilles tendon repair with suture loop/modified gift box technique performed by a single surgeon were prospectively enrolled. Exclusion criteria included patient age <18 years, recurrent or chronic Achilles injuries, and the presence of concomitant injuries. Range of motion at final in-office follow up (mean 6 months) and Achilles Tendon Rupture Score (ATRS) and complication rates at 1 year were obtained with 100% follow-up. Predictors of complications and ATR score were assessed.

RESULTS: Mean time from injury to surgery was 14.7 days (range 4-70 days). The most common injury mechanism was basketball (43%). The average operative time was 63.1 minutes (SD 10.8) which decreased throughout the case series ($R=0.46$, $p<0.001$). Average plantar flexion at final office evaluation was 31.7 degrees (SD 6.2), dorsi-flexion was 11.7 (SD 6.3), and total ankle arc of motion was 43.6 (SD 9.7); longer length of follow-up was associated with greater dorsiflexion ($p=0.008$) and total arc of motion ($p=0.008$) but not plantar-flexion ($p=0.16$). The overall re-rupture rate was 1.7% (1 patient), wound complication rate was 1.7% (1 patient), and overall complication rate was 6.7% (4 patients). No predictors of complications were identified; complication rates did not differ between the first 30 cases (6.7%) and second 30 cases (6.7%). The average ATR-score at 1 year was 81.8 points (SD 16.8). Diabetes was independently associated with lower ATR-scores (adjusted mean decrease 13.5 points; $p=0.03$); no other independent predictors of ATR-score were identified.

CONCLUSION: Operative time and short-term outcomes for this novel technique are comparable to previously reported Achilles repair procedures. Re-rupture and overall complication rates by 1 year were low. Range of motion, particularly dorsiflexion, improved through at least 6 months. Diabetic patients had lower 1 year ATR-S scores than non-diabetic patients with this technique.

Level of evidence: IV, prospective case series

Key Words: Achilles repair, Achilles rupture, modified suture repair, patient reported outcomes

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
FOOT AND ANKLE

Lisfranc Fixation Revisited: Is Joint Sparing Bone Fixation Possible? An Anatomic and Computational Study

Poster 046

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INTRODUCTION: Controversy exists with regards to the best operative strategy for Lisfranc injuries. Some studies cite articular joint damage during open reduction and internal fixation as a possible reason for persistent morbidity. To our knowledge, this concept has never been studied as the dimensions of the articular surface have never been reported. The purpose of the current study was to describe the morphology of the joints involved in Lisfranc fixation and to determine if it is possible to perform nonarticular transosseous internal fixation. Our hypothesis was that nonarticular transosseous Lisfranc fixation is possible with commonly available orthopedic implants.

METHODS: Twenty cadaver feet were dissected and the associated joints between the medial (C1) and middle (C2) cuneiform and first and second metatarsals were quantified by calibrated digital imaging using software (ImageJ, 1.48k). Additionally, utilizing CT scan data, a computational three-dimensional (3D) model of the foot was developed using 3D Slicer v4.8. The first and second metatarsals and cuneiform bones were isolated. The model was transferred to MeshLab, processed, and transformed into a solid part using FreeCAD, an opensource CAD platform. Based on cadaveric dissection, joint surfaces were quantified and mapped, and potential nonarticular screw paths between the bones were determined.

RESULTS: For the intercuneiform (C1-C2) connection, a mean of only 27.3% of the lateral face of C1 and 43.7% of the medial face of C2 was articular cartilage. Three variations of articular joint morphology were observed on C1 and two variations on C2. From the 3D models it was determined that a joint sparing, transosseous screw trajectory is possible between the medial cuneiform and the second metatarsal and between the medial and intermediate cuneiform. These screw paths were large enough to accommodate for even the largest clinically useful screw diameter (>5 mm). The screw trajectories are roughly perpendicular to the long axis of the foot and take a plantar-medial to dorsal-lateral orientation with one screw from the C1 to the second metatarsal and one screw from C1 to C2.

CONCLUSION: The articular surface was quantified for the first time and may be smaller than some surgeons realize. The clinical significance of the current study is that internal fixation with screws can be performed without causing articular joint damage. The orientation required to avoid articular damage was also demonstrated using 3D models.

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FOOT AND ANKLE

Hemi vs. Total Joint Arthroplasty for Moderate – Severe Hallux Rigidus: A Systematic Review and Meta-Analysis

Poster 047

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INTRODUCTION: Advanced-stage arthritis of the first metatarsophalangeal joint (hallux rigidus) is a common forefoot pathology that often resolves with non-operative measures. When surgery is indicated, toe arthroplasty is an alternative procedure to arthrodesis for patients who wish to preserve toe range of motion. Despite recent advancements in great toe arthroplasty, these devices have been associated with a higher rate of radiologic loosening and frequent conversion to arthrodesis. Our study investigated mid-term outcomes of first metatarsophalangeal joint (MTPJ) arthroplasty, in an effort to discern whether or not partial or total joint replacement confers benefit in patients with moderate to severe hallux rigidus.

MATERIALS AND METHODS: A systematic review of MTPJ arthroplasty was performed using Pubmed, EMBASE, SCOPUS, and Cochrane library for the years 2000 to 2017. Data was extracted from articles containing both preoperative and postoperative endpoints for either hemi or total MTPJ arthroplasty cases. To be eligible for inclusion, studies must have had a mean follow-up window of at least 24 months. A Forest plot was created comparing pre-and postoperative American Orthopedic Foot and Ankle Score (AOFAS), visual analogue scale (VAS), and range of motion (ROM) results for both hemi-toe and total-toe arthroplasty. Statistical analysis was performed using Microsoft Excel version 14.4.0 for Mac (Redmond, WA, USA) and Review Manager, version 5.3.3 for Mac (Copenhagen, Denmark).

RESULTS: Mean postoperative AOFAS scores in patients undergoing hemiarthroplasty improved by 50.7 points (95%CI: 48.5, 52.8), while the mean AOFAS score improvement in total joint arthroplasty patients was 40.6 points (95%CI: 38.5, 42.8). Mean postoperative VAS improvement in hemiarthroplasty was 6.05 points (95%CI: 5.92, 6.18), which was comparable to the mean VAS improvement of 6.29 points (95%CI: 6.02, 6.55) seen in total arthroplasty. Mean postoperative MTPJ ROM improved by 43.0 degrees (95%CI: 39.3, 46.6) in hemi-toe patients, which exceeded the mean ROM improvement of 32.5 degrees (95%CI: 29.9, 35.1) found in total joint arthroplasty cases. A meta-analysis of the data revealed no significant difference.

CONCLUSION: MTPJ implant arthroplasty can be considered for moderate to severe HR with reasonable improvement of postoperative AOFAS and ROM results.

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FOOT AND ANKLE

3D Joint Space Width on Weightbearing CT Correlates with Pain after Intra-Articular Calcaneal Fracture Treatment

Poster 048

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PURPOSE: Post-traumatic osteoarthritis (PTOA) is a serious, disabling, and frequent complication following intra-articular calcaneal fractures (IACFs), but its course of development is poorly understood. Plain radiographs are imprecise and insensitive in assessing the subtalar joint for PTOA, hindering progress toward improving treatment and assessing outcomes. CT scans provide much better assessment of 3D articular anatomy but are hampered by expense, higher radiation dose, and lack of weightbearing. The challenge of accurately assessing the complex, multi-faceted subtalar joint presents a compelling need for improved imaging capabilities. This study assessed how low-dose, weightbearing CT (WBCT) can be used to provide quantitative 3D measures of the subtalar joint space width (JSW). We obtained WBCT scans of the subtalar joints of patients following IACF and compared the resulting JSW measures to those from normal subtalar joints and to clinical outcomes.

METHODS: We studied 20 patients (age 28-70 years) who sustained IACFs and were treated with percutaneous surgical reduction. WBCT scans (pedCAT; Curvebeam) were obtained at follow-up visits 4-15 years (average 8.2 years) after surgical treatment. The JSW in the subtalar joint was measured by 2 expert raters in the coronal and sagittal planes. The average of their measurements was compared to Kellgren-Lawrence (KL) radiographic OA grade from standing radiographs, SF-Physical Function and to VAS pain scores. As a point of comparison, subtalar JSW from WBCT of 22 patients scanned for reasons other than IACF was used. For statistical analysis, we utilized Spearman's correlation, with significance set at $p<0.05$.

RESULTS: Mean JSW measured from WBCT for patients with IACF ranged from 0.90-2.51 mm (1.66±0.43 mm), while previous literature reported 2.3±1.2mm in non-fractured joints. JSW measurements showed good intra- and inter-observer reliability. Mean JSW were correlated with KL grade ($rs= -0.58$, $p= 0.0059$). There was a strong correlation between JSW and VAS ($rs= -072$, $p= 0.0002$). Interestingly, there was no correlation between KL grade and VAS pain scores ($rs=0.42$, $p=0.057$).

CONCLUSION: WBCT-based methods were used to more accurately quantify preservation/loss of JSW in patients with IACF. Patients with IACF had a decreased subtalar JSW compared to normal controls. Lower JSW values were strongly correlated with higher VAS pain scores. The results show the promise WBCT provides to objectively assess subtalar PTOA progression and help to better understand how arthritic changes affect actual patient experience.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
FOOT AND ANKLE

Tibialis Anterior Tendinosis: Clinical Characterization and Surgical Treatment

Poster 049

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INTRODUCTION: Tibialis anterior (TA) tendinosis and tendon rupture is rare and there exist few reports in the literature. We report here on nine patients with symptoms and clinical findings of severe TA tendinosis requiring surgical management. We present the senior author's preferred operative techniques and their respective outcomes in treating this condition.

METHODS: Between 2015 and 2018 9 patients (6 female, 3 male) with severe TA tendinosis underwent debridement and direct repair without augmentation (n=2), direct repair with fiber tape augmentation (n=2), PTT transfer (n=1), or TAT augmentation with tendon autograft (n=4). Autograft choice was EDL tendon (n=2), plantaris tendon (n=1), or both EDL and plantaris tendon (n=1). All 9 patients had a concomitant gastrocnemius recession. Three patients had concomitant hindfoot arthrodesis.

RESULTS: On presentation, all patients reported a history of peripheral neuropathy and at least one additional comorbid medical condition. Complete tendon rupture was identified in 6 cases. Preoperative ankle dorsiflexion strength was 0/5 for all patients, improving to 5/5 postoperatively in seven patients. One patient, the only current smoker, developed wound dehiscence 2 weeks postoperatively, with subsequent healing by 4 weeks. One patient had chronic subtalar nonunion, status-post concomitant subtalar fusion. The mean duration of postoperative follow-up was 21.3 (range, 8 to 31) months.

DISCUSSION AND CONCLUSIONS: Surgical treatment was effective for re-establishing function in individuals with TA tendinosis. Surgery offers great results, with a high level of satisfaction to patients with TA tendinosis in lieu of possible complications in this morbid patient group. Direct repair may be possible in many cases, but if the tendon gap is too large, then an autograft of extensor digitorum tendon and plantaris tendon can be efficiently utilized.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
FOOT AND ANKLE

Is Interposition Arthroplasty a Viable Option for Treatment of Moderate to Severe Hallux Rigidus? A Systematic Review and Meta-Analysis

Poster 050

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INTRODUCTION: Hallux rigidus is a painful arthritis of the first metatarsophalangeal joint, which causes stiffness and progressive loss of mobility. Treatment options for hallux rigidus include conservative therapy and surgery. Arthrodesis of the MTP joint, though reserved for advanced cases, is the gold standard. This systematic review is to investigate patient outcomes after undergoing interposition arthroplasty of the MTP joint.

METHODS: Studies were included that reported results of first MTP joint interposition arthroplasty with the following scoring systems: AOFAS, FFI or SF-36. Systematic review and data extraction were performed on all selected studies. A linear regression model comparing the change in preoperative to postoperative AOFAS scores between the autogenous versus allogenous interposition materials was performed.

RESULTS: Fifteen articles were included in the systematic review. Mean AOFAS scores improved from preoperative 41.35 to postoperative 83.17. Mean pain, function, and alignment score improved from preoperative values of 14.9, 24.9, and 10 to postoperative values of 33.3, 35.8, and 14.5. Mean dorsiflexion increased from 21.27 degrees (5-30) to 42.03 degrees (25-71). Mean ROM improved from 21.06 degrees to 46.43 degrees. Joint space increased from 0.8 mm to 2.5 mm. The most common postoperative complications included metatarsalgia (13.9%), loss of ground contact (9.7%), osteonecrosis (5.4%), great toe weakness (4.8%), hypoesthesia (4.2%), decreased push off power (4.2%), and callous formation (4.2%).

CONCLUSION: Interposition arthroplasty is a good treatment option in patients with moderate-severe hallux rigidus who prefer to maintain range of motion and accept the risk of future complications.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Does Medicaid Expansion Improve Access to Care for the First Time Shoulder Dislocator?

Poster 051

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INTRODUCTION: A growing body of evidence suggests that states offering Medicaid expansion have improved health outcomes and overall access to care for vulnerable populations. However, some studies have shown reduced access to care for Medicaid patients even under the Affordable Care Act. The purpose of this study is to access the effect of individual state Medicaid expansion status on access to care for acute shoulder instability.

METHODS: Four Medicaid expanded (Louisiana, Kentucky, Iowa, and Nevada) and unexpanded states (Alabama, Virginia, Wisconsin, and Utah) in paired geographic locations were chosen. Twelve practices per state were randomly selected from the AOSSM directory, resulting in 96 independent offices. Each office was called twice to request an appointment for a fictitious 16-year-old first time shoulder dislocator with either in-state Medicaid insurance or Blue Cross Blue Shield (BCBS) private insurance. Time until appointment (if given), information requested, and reason for appointment denial were recorded. The McNemar test was used to compare paired categorical data and repeated measures ANOVA was used to compare paired continuous data between the Medicaid and BCBS call results.

RESULTS: A total of 91 physician offices in 8 states were able to be contacted by telephone. An appointment was achieved at 36 (39.6%) offices when calling with Medicaid and at 74 (81.3%) offices when calling with BCBS ($p<0.001$). The mean time until appointment was 7 days when calling with Medicaid and 2 days when calling with BCBS ($p=0.062$). Thirty-five (38.5%) offices were able to make appointments for both types of insurance, 39 (42.9%) for only BCBS, 1 for only Medicaid (1.1%), and 16 (17.5%) for neither. For Medicaid patients, an appointment was booked in 13 (27.7%) clinics from Medicaid expanded states and in 23 (52.3%) clinics from non-expanded states ($p=0.016$). In attempts using Medicaid insurance, reasons for not obtaining an appointment included lack of insurance ID number (10), PCP referral (8), or ER records (9).

DISCUSSION AND CONCLUSION: For young, first-time shoulder dislocators, access to care is more difficult with Medicaid insurance compared to BCBS private insurance. Within Medicaid insurance, access to care is more difficult in Medicaid expanded states compared to unexpanded states. Medicaid patients in unexpanded states are twice as likely to obtain an appointment than those in expanded states.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Patient Understanding and Attitudes Toward Opioid Medications

Poster 052

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INTRODUCTION: With creation of pain as the 5th vital sign in the 1990s, opioid use skyrocketed and a culture of opioids primarily for musculoskeletal pain control was created. Unfortunately this has led to a crisis with addiction and abuse among Americans. The purpose of this study was to evaluate patient perceptions of opioid medications for pain control.

METHODS: Fifty-six patients visiting the orthopedic surgery department were anonymously surveyed using a 27 question survey adapted from the Maryland Public Opinion Survey on Opioids with additional demographic information. The opinion survey questions were individually collected, subgroups compiled and analyzed. The four analyzed areas were: expectations of pain following surgery, opinions on opioid abuse, perceptions on safe use of opioids, and reported access to and use of opioids.

RESULTS: Patients had high variability in expected pain scores following surgery (Mean: 73.2, StDev 21.3), and the majority (72%) believed they will experience significant pain following orthopedic surgery. Results showed 87% of participants are aware of opioid misuse and 76% of them believe opioids have the potential to cause harm when misused. Still 76% also believe opioids should be prescribed following surgery. There was high variation in responses for acquisition of opioids, safe storage, and disposal of opioids. Few patients (30%) reported receiving information from their doctors regarding opioid medications. Twenty-one percent of people also reported taking an opioid not prescribed to them and 10% report taking an opioid for the experience of feeling high.

CONCLUSIONS: Although the public is aware of opioid misuse, patients still believe there is extreme pain after surgery that warrants these medications. In addition, patients are unaware of appropriate use of opioid medications and further education from surgeons on appropriate use and potential dangers should be integrated when prescribing these medications.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Opioid Free Shoulder Surgery: Optimizing Multimodal Pain Management

Poster 053

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BACKGROUND: Creation of pain as the 5th vital sign led to skyrocketing opioid prescriptions and a crisis with addiction and abuse among Americans. Preoperative patient-targeted education on opioid use has become an avenue suggested with limited evidence on effectiveness. The purpose of this study was to evaluate whether implementation of preoperative patient education and multimodal pain management protocols can achieve an Opioid Free postoperative recovery after shoulder surgery.

METHODS: A prospective clinical trial of 50 patients patients undergoing shoulder surgery was performed. All patients received a new enhanced multimodal pain management protocol with regional block. In addition, patients included in the Opioid Free group received preoperative education on expectations of pain, non-opioid medications and alternate options to minimize pain. The control group included patients who underwent standard postoperative shoulder surgery protocols. Variables collected included: demographics, opioid consumption, and outcome scores. Patients were compared on opioid consumption immediately postoperative, at 48 hours, and 2 weeks. Patient reported outcomes including ASES, PENN, and SST were compared at 3 months postoperatively. Statistical analysis included students t-tests.

RESULTS: This study included 50 patients: 25 patients in the Opioid Free group and 25 patients in the control group. There was no significant differences in age (avg 69.76) ($p=0.14$), ASA grade (avg: 2.25) ($p=0.24$), BMI (avg 29.5) ($p=0.34$), or comorbidity burden. Preoperatively, there were significant differences in PENN and ASES Function Scores. Of the Opioid Free group, 24% of patients reported use of rescue opioids in the 48 hours following surgery, and 100% of patients reported no opioid use at 2 weeks postoperatively. In the control group, 100% reported using opioids in the 48 hours following surgery and 80% reported still taking opioids at 2 weeks postoperatively. Patients in both groups showed significant improvements in ASES pain and functional scores ($p< 0.05$). At last follow-up, the Opioid Free group reported significantly higher ASES pain ($p=0.036$) and Constant scores ($p=0.005$). There were no significant differences in all other outcome measures.

CONCLUSIONS: Even though opioids have been a mainstay in postoperative pain management, our results suggest an opioid-free postoperative course is possible with equivalent pain control and patient satisfaction. Better education and a structured multimodal pain management protocol, can achieve an opioid-free postoperative course following all shoulder surgery with improved patient-reported satisfaction and outcomes.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Prediction of Impingement-Free Range of Motion Prior to Reverse Shoulder Arthroplasty

Poster 054

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BACKGROUND: Increased attention and advancements over the past few years have focused on preoperative planning for shoulder arthroplasty using 3D automated software. Although innovative, the accuracy and reproducibility of these 3D simulation softwares is still unknown for surgeons. On top of that, new features are being added to commercially available software in order to aid surgeons in achieving better patient outcomes. The purpose of this study was to assess the accuracy of predicting impingement-free range of motion (ROM) of a 3D preoperative planning software.

METHODS: A shoulder arthroplasty database was reviewed to include 22 patients who underwent RSA with new ROM preoperative plan predictions and clinical follow-up. Preoperative plans for RSA were created based on patient CT scan to optimize correction of deformity, implant placement, and maximize impingement free range of motion. Each patient's impingement-free ROM from preoperative plan (PP) suggested by the software was recorded and compared to clinical range of motion exam (CE). Accuracy was assessed by comparison of forward flexion (FF), abduction (ABD), and external rotation (ER) between software and clinical exam at last follow-up visit available. Demographic data was recorded includingdiagnosis and Walch classification.

RESULTS: Our cohort included 64% males with mean age 73 years old and mean BMI of 29.4 kg/m^2. The predominant diagnosis was rotator cuff arthropathy (RCA: 72.7%) and remainder were osteoarthritis. Forty-one percent of patients were classified with a glenoid Walch type B2 or B3. Our results showed a mean difference between the two groups for FF of 53.6° (BP: 84° ±39; CE: 138°±34°; p≤0.001), ABD of 83.4° (BP: 73°± 27; CE: 157°±27°; p≤0.001), and ER of 19.6° (BP: 17° ±20°; CE: 36°±18°; p=0.004). We also found weak positive correlation between the groups for all measurements (FF: R=0.157; ABD: R=0.14; ER: R= 0.35).

DISCUSSION: Range of motion after reverse shoulder arthroplasty does not appear to be accurately predicted with the current preoperative planning 3D automated software feature. More advanced methods are needed to incorporate scapulothoracic motion and muscle factors into these predictive softwares to more accurately guide surgeons for implant selection and positioning. Based on these preliminary results, perhaps surgeons can incorporate a more accurate conversion factor to increase utility of this preoperative planning software feature for impingement free range of motion.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Does Socioeconomic Status Influence Opioid Use or Dependence Following Total Shoulder Arthroplasty?

Poster 055

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BACKGROUND: Socioeconomic status has been shown to have a significant impact on outcomes following shoulder arthroplasty. The purpose of this study was to determine if socioeconomic status influenced opioid use and abuse specifically following total shoulder arthroplasty (TSA).

METHODS: A retrospective review of 500 TSA cases from 2014-2016 was performed. Recorded variables included age, gender, ASA class, BMI, race, ethnicity, zip code, and complications. U.S. Census Bureau data was used to determine average income based on zip code and patients were classified into low, medium, or high income categories. Low and high incomes were defined as those below or greater than 2 standard deviations from the mean U.S. household income each year. Opioid prescriptions were recorded from PDMDs for 1 year before and after surgery. Opioid dependence was defined as continuous opioid prescriptions for 3 months before or after surgery. Statistical analysis included descriptive statistics and multivariate logistic regression.

RESULTS: The average age of the cohort was 68.7 years old with 269 females and 229 males and an average ASA class of 2.67. There were no significant differences seen in age, ASA class, or gender between the three socioeconomic groups ($p>0.05$). Preoperatively, 36.2% of the cohort was opioid dependent, and postoperatively this dropped to 30%. There were no differences seen in preoperative or postoperative dependence between socioeconomic groups ($p=0.54$). There were no significant differences seen between revision rates when comparing low income patients to medium and high income ($p=0.609$).

CONCLUSIONS: Low socioeconomic status did not have a detrimental impact on pre- or postoperative opioid use, dependence, or complications following TSA. Orthopedic surgeons need to be aware opioid education needs to be provided for all patients regardless of demographic or socioeconomic status to effectively impact opioid abuse in the U.S.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Magnetic Resonance Imaging vs. Ultrasound in the Diagnosis of Distal Biceps Tendon Rupture

Poster 056

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INTRODUCTION: As the incidence of distal biceps ruptures has risen over the past few decades, prompt diagnosis and treatment is critical to maximizing patient outcomes. Currently, diagnosis is centered around history and physical exam with imaging modalities, including ultrasound (US) and magnetic resonance imaging (MRI), often utilized to confirm the diagnosis prior to operative intervention. The purpose of our study was to determine which imaging modality was superior in diagnosis of distal biceps pathology based on correlation to intraoperative findings.

METHODS: We generated a report of all of the patients who had a distal biceps tendon repair performed at our institution between 1988-2016 yielding 927 patient who underwent distal biceps repair. We then performed a chart review to find the patients who received both an ultrasound and MRI of the affected arm up to 3 months prior to surgery. The results of the radiographic read were categorized as follows: no tear, unspecified tear, partial tear, or complete tear. The operative reports were reviewed and findings were categorized in a similar manner. Statistical analysis was performed to determine the accuracy, sensitivity, and specificity of each exam as compared to intraoperative findings.

RESULTS: In total, 31 patients had both MRI and US performed prior to surgery along with appropriate description of intraoperative findings and, thus, met inclusion criteria. The accuracy of MRI was 0.81 while that of US was 0.52 ($p=0.05$). The sensitivity and specificity of diagnosis of a complete tear were 0.86 and 0.78, respectively, for MRI and 0.45 and 1.00, respectively, for US. The sensitivity and specificity of diagnosis of a partial tear were 0.67 and 0.91, respectively, for MRI and 0.67 and 0.45, respectively, for US. These results favored MRI in sensitivity (p-0.04) in the diagnosis of a complete tear as well as specificity for diagnosis of partial tear (p-0.02).

DISCUSSION AND CONCLUSION: The findings of our study suggest that MRI is a more accurate imaging modality at correctly identifying the type of distal biceps tendon tear. It is also more sensitive and in diagnosing a complete tear of the distal biceps tendon and specific for diagnosing partial tendon tears.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Total Shoulder Arthroplasty for the Treatment of Juvenile Rheumatoid Arthritis

Poster 057

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INTRODUCTION: Juvenile rheumatoid arthritis (JRA) is the most common rheumatologic disease of childhood. It is defined as arthritis affecting multiple joints for over 6 months in children under 16 years old. JRA has long-term sequelae affecting multiple joints and often results in multiple total or partial joint arthroplasties by the time patients reach adulthood. To date, there are no series reporting outcomes of total shoulder arthroplasty (TSA) in patients with JRA.

METHODS: A retrospective review identified 13 patients (17 shoulders) with JRA who underwent TSA for severe inflammatory arthritis between 1970 and 2015. Clinical outcomes, radiographic results, implant survival, and complications were recorded. Mean age at the index THA was 40 years, with 100% being female. Mean follow-up was 8 years.

RESULTS: There was a statistically significant increases in pre- and postoperative range of motion including forward elevation which on average increased from 97 to 114 degrees ($p=0.013$) and internal rotation on average increased from the sacrum to L2 ($p=0.011$). Abduction which increased from 30 to 42 degrees ($p=0.112$) had a clinically significant increase which did not reach statistical significance. Patient reported outcomes were excellent in shoulders (35%), very good in 5 (29%), good in 4 (23%), and fair in one (6%) shoulder. No perioperative complications occurred. One proximal humerus fracture occurred which was greater than two years after the index procedure. There were 3 revisions; 2 for humeral component loosening and 1 for proximal humeral fracture with component loosening. Overall 5 and 10 year survivorship free from revision were 89% and 82%, respectively. There was evidence of glenoid loosening in 5 (30%) and 3 (17%) humeral components at final follow-up.

CONCLUSIONS: This is the first study to evaluate the outcomes of total shoulder arthroplasty in patients with JRA. The majority of these patients experience very good to excellent patient satisfaction. This patient population experienced more humeral component loosening than the general population but overall similar rates of complications and overall survivorship.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Arthroscopic Capsular Release for Refractory Adhesive Capsulitis: Speed of Recovery and Non-Responder Outliers

Poster 058

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BACKGROUND: Adhesive capsulitis of the shoulder is a very common condition that oftentimes responds to nonoperative management. However, some patients present with substantial pain and stiffness refractory to physical therapy and anti-inflammatories. Thus, the purpose of this study was to evaluate the outcomes of arthroscopic capsular release for adhesive capsulitis not responding to nonoperative treatment, understand the timeline of recovery, and identify non-responders.

METHODS: Between 2004 and 2017, 101 shoulders underwent arthroscopic capsular release performed by the senior authors. The mean age was 53 years. The mean duration of symptoms prior to surgical management was 10 months. Prior nonoperative management included physical therapy in 74 (73%) and corticosteroid injections in 66 (65%). A traumatic event leading to the development of symptoms was noted in 24 (24%), and recent shoulder surgery was the inciting event in 11 (11%). The mean body mass index was 28.3 kg/m^2, with 20% in the obese category. Diabetes mellitus was present in 22 shoulders (22%), and thyroid disease in 25 shoulders (25%). The mean follow-up in our cohort was 8 months (1-80).

RESULTS: Most patients reported almost complete resolution of pain within 2 weeks, and restoration of a functional arc of motion between 2 and 4 weeks. However, at most recent follow-up, 14 individuals reported persistent pain, and 10 shoulders had residual stiffness. The mean preoperative pain score was 3.7, which improved to 1.6 postoperatively. Prior to surgical management, the documented limitations in range of motion were a mean elevation of 103 degrees (20-165), mean external rotation of 29 degrees (20-90), and mean internal rotation to the sacrum. Following surgery, range of motion improved to a mean elevation of 154 degrees (20-175), mean external rotation of 70 degrees (10-90), and mean internal rotation to T12 ($p = <0.0001, <0.0001, <0.0001$, respectively). Revision arthroscopic capsular release was performed in 2 shoulders. Other complications included infection (n=1) and rapidly progressive chondrolysis leading to arthroplasty surgery (n=1).

CONCLUSION: Arthroscopic capsular release is a safe and effective surgical solution for the majority of individuals with adhesive capsulitis that fail to respond to nonoperative treatment. Improvement of pain and recovery of motion occur very quickly, within 2 to 4 weeks. Complications are extremely uncommon. However, persistent pain, stiffness, or both can be expected in 10-15 % of the patients, and revision capsular release is required in some.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Rout and Out: An Extraction Technique for Well-Fixed Humeral Stems in Revision Shoulder Arthroplasty

Poster 059

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INTRODUCTION: As the number of patients undergoing shoulder arthroplasty increases, the incidence of revision shoulder arthroplasty procedures continues to grow. Multiple methods have been described for the removal of well-fixed humeral implants, including the use of cortical windows and humeral osteotomies. The router bit technique utilizes a high-speed router bit to undermine the component at the bone-implant interface. Then, the stem is struck with a square-tip impactor and mallet in a retrograde fashion. The purpose of this study was to determine the characteristics and frequency of the techniques required for removal of well-fixed humeral stems in revision shoulder arthroplasty.

METHODS: A retrospective review of consecutive revision shoulder arthroplasties performed by a single surgeon was conducted. The study dates included an eight-year period (2010 – 2018) at a tertiary referral center. Revision shoulder arthroplasty procedures requiring the removal of well-fixed humeral stems were identified. Patient demographics and indications for surgery were collected. The method of extraction and implant characteristics were studied.

RESULTS: 288 revision shoulder arthroplasty procedures required removal of a well-fixed humeral component. 284 (98.6%) humeral stems were able to be removed with the router bit extraction technique alone. Four (1.39%) humeral stems required a cortical window for extraction. Humeral osteotomy was not required for any procedure. The mean time from component implantation to removal was 74.4 months. The type of fixation for the majority of the humeral stems removed was uncemented (79.9%). Of the four humeral stem removals that required a cortical window, three involved the removal of hemiarthroplasty components and there were an equal number of cemented and uncemented stems.

DISCUSSION AND CONCLUSION: The router bit extraction technique facilitates the removal of well-fixed humeral stems in revision shoulder arthroplasty in a very high percentage of patients. This method allows surgeons to avoid more invasive approaches, such as cortical windows or humeral osteotomies, and their associated complications.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Comparison of Magnetic Resonance Imaging and 3-D Computed Tomography for Assessment of Glenoid Bone Loss: Utilization of a Novel Predictive Measurement Technique

Poster 060

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BACKGROUND: The gold standard for assessing glenoid bone loss in the setting of instability is computed-tomography with 3-dimensional reconstruction (3-D CT). An ideal method for glenoid measurement would only require magnetic resonance imaging (MRI). Although predictive formulas have been developed for both imaging modalities previously, a novel predictive formula for MRI has not yet been compared to 3D-CT for accuracy and reliability of measuring bone loss.

PURPOSE: To determine if MRI can accurately measure glenoid bone loss in comparison to 3-D CT using this novel predictive formula.

STUDY DESIGN: Cross sectional study: level of evidence 3

METHODS: Imaging was acquired from 56 patients who were identified to have undergone both MRI and 3D-CT of an ipsilateral shoulder in the assessment of shoulder instability. Glenoid width and glenoid bone loss was calculated by 3 observers using validated predictive formulas specific to MRI or CT. Pearson correlation was performed to examine the correlation between the percentage of glenoid bone loss measured between 3-D CT and MRI.

RESULTS: The mean difference in percent of glenoid bone loss between MRI and CT was 14.5% ($p<0.05$). The intraclass correlation coefficient (ICC) for inter-rater reliability was excellent for MRI measured width (0.776, $p<0.0001$), CT measured width (0.880, $p<0.0001$), MRI measured height (0.813, $p<0.05$), CT measured height (0.829, $p<0.05$), MRI measured percent bone loss (0.854, $p<0.0001$), and CT measured percent bone loss (0.919, $p<0.0001$).

CONCLUSION: MRI using the described simple formula for predicting bone loss does not correlate closely with predicted glenoid bone loss using CT with 3-D reconstruction. Based on currently available methods, CT scan is still vital to accurate assessment of glenoid bone loss.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
SHOULDER

Tobacco Use is Associated with a More Difficult Postoperative Course Following Primary Reverse Total Shoulder Arthroplasty

Poster 061

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BACKGROUND: Reverse total shoulder arthroplasty (RTSA) has been shown to provide predictable pain relief and postoperative outcomes for a variety of rotator cuff deficient conditions. However, studies investigating patient-specific risk factors, including tobacco use, that may predict early postoperative outcomes are lacking. This is especially relevant in the evolution of bundled payment plans where global episode-of-care measures will be of particular interest. We proposed to evaluate postoperative pain, narcotic use, length of stay, complications, re-operations, and readmission rates in patients following reverse total shoulder arthroplasty who are either current tobacco users (TU), non-users (NT), or former users (FT).

METHODS: After IRB approval, a database search of primary RTSAs at our institution was conducted. Patients were identified as current tobacco users, non-users, or former users by health history on intake forms and clinical interview. Visual analog pain scores (VAS) were recorded at the preoperative visit and at the 2, 6, and 12 week visits after surgery. Oral morphine equivalents (OME) were recorded from in-hospital use, discharge medications, and prescriptions given at 2, 6, and 12 week visits and were augmented with a search of a statewide narcotics tracking database. Length of hospital stay, re-admissions, re-operations, and complications data were also recorded. Statistical analyses for preoperative and postoperative measurements were performed using student t-tests and ANOVA with $p<0.05$ considered statistically significant.

RESULTS: Following database search, 279 primary RTSAs were identified. There were 23 patients in the TU group, 150 patients in the NT group, and 106 patients in the FT group.

At 12 weeks following RTSA, VAS scores decreased from 7.2 to 3.4 ($p<0.0001$) in the TU group, 5.7 to 1.8 ($p<0.0001$) in the NT group, and 5.5 to 1.9 ($p<0.0001$) in the FT group. While the change in average VAS score (-3.85 TU, -3.91 NU, -3.55 FU, $p=0.58$) was not significantly different among the three groups, the preoperative VAS scores ($p=0.01$) and postoperative VAS scores ($p=0.007$) at 12 weeks were significantly higher in the TU group.

Cumulative OME use at 12 weeks was significantly higher in the TU group when compared to NT and FT groups (2643 mg vs. 2121 mg and 2015 mg, $p=0.04$). When controlling for confounding variables, specifically chronic pain, BMI and gender, current smokers still had a higher adjusted mean OME use (2797mg vs. 2391 mg and 2316 mg); however, the difference was no longer statistically significant

(p=0.16).

Length of stay was not significantly different among the three groups (1.3 TU, 1.3 NU, 1.2 FU, p=0.69). And no statistically significant differences were found between the TU group and the other two cohorts regarding complication rates (0% vs. 4% both, p=0.62), re-operation rates (0% vs. 0% and 2%, p=0.19), or hospital readmissions (0%, 0%, 2%, p=0.19).

CONCLUSIONS: Current tobacco use is a significant predictor of increased postoperative pain and narcotic use following RTSA. However, while pain and narcotic use was higher in the TU group, smokers had similar improvements from their baseline pain compared to their peers, indicating they still derive benefit from the intervention. Further, length of stay, complications, re-operations, and re-admission rates were similar among all groups. As risk stratification models evolve for bundled payment plans, current tobacco use should be identified as a predictor of a more difficult postoperative course. Additionally, former tobacco users were found to have a similar postoperative course as non-users, suggesting that discontinuation of tobacco use can improve a patient's episode-of-care performance following RTSA.

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SHOULDER

Early Outcomes of Patient-Reported Outcomes Measurement Information System (PROMIS) Scores in Patients Undergoing Rotator Cuff Repair

Poster 062

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BACKGROUND: Emphasis on patient reported outcome measures in orthopedics is rising. The Patient-Reported Outcomes Measurement Information System (PROMIS) computer adaptive test (CAT) scores has emerged as an efficient tool to assess outcomes while focusing on patient centered care. The purpose of this study is to prospectively observe early changes across several PROMIS domains in a cohort of patients who undergo rotator cuff repair.

METHOD: All patients undergoing arthroscopic rotator cuff repair by one of three fellowship-trained orthopedic surgeons in shoulder/elbow or sports medicine were enrolled in the study. Patients were stratified based on tear size (small, medium, large). Baseline demographic data along with PROMIS upper extremity physical function (PROMIS-UE), pain interference (PROMIS-PI), and depression (PROMIS-D) scores were collected at Preoperative, 1 week postoperative, 6 week postoperative, and 3 month postoperative visit.

RESULTS: A total of 78 patients were enrolled in the study. The average age was 60.3 years with 44 males (56%). PROMIS UE, and PI demonstrated no correlation with tear size. Preoperative PROMIS UE CAT scores improved from preoperative (31.2 ± 5.2) to 3-month postoperative (35.3 ± 8.0) ($p<0.01$) indicating improved postoperative upper extremity function. Preoperative PROMIS-PI score (62.82 ± 5.3) also demonstrated significant improvement compared to the three-month postoperative PROMIS PI score (54.6 ± 10.0) ($p<0.01$) indicating less pain interference postoperatively. Finally, depression (PROMIS-D) also improved from 48.4 preoperative to 45.2 three months postoperative ($p=0.03$).

CONCLUSION: This study is the first to report on changes across three different PROMIS CAT domains in patients undergoing rotator cuff surgery. All three domains (PROMIS-UE, PROMIS-PI, PROMIS-D) demonstrated significant improvements in the early postoperative period.

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PEDIATRICS

Safe Transport of Spica Casted Children is Possible: A Frontal Crash Test Analysis of Child Restraint Systems Using Casted Crash Test Dummies

Poster 063

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PURPOSE: Spica casts are often used in the treatment of hip dysplasia and for young children with femur fractures. The majority of parents report transportation is the biggest obstacle they encounter when caring for their spica casted child. While restraint devices for casted children are available, all federally mandated testing has been done using non-casted anthropomorphic test devices (ATDs), also known as crash test dummies. No current commercially available or specially designed restraint device has ever been tested using casted ATDs. The only approved and specially designed safety seat with published data using casted dummies was discontinued in 2015. In light of the significant lack of data available to guide transport of these patients, this study evaluated a series of car seats in a simulated frontal crash condition using a casted pediatric dummy.

METHODS: A crash dummy representing a 3-year-old child was casted with the hips at 60° of flexion and 30° of abduction in a double-leg fiberglass spica cast. Five restraint devices were identified that could accommodate the casted dummy and evaluated via dynamic crash tests simulating a 30 mph crash per federal crash-testing guidelines. Sensors within the dummy recorded data from the head, neck, chest, and pelvis to assess for the likelihood of injury.

RESULTS: Although the presence of the cast increased many of the injury metrics measured, all seats passed current federal guidelines for the head and chest. However, while not required as a part of current standard testing protocols, cervical spine injury metrics were elevated beyond generally accepted levels in all seats tested, both with and without a cast. No single seat performed best in all metrics tested.

CONCLUSION: These results suggest safe transport in commercially available seats is possible with the child properly restrained in a correctly fitting CRS. However, parents should not assume a CRS is automatically appropriate for use with their child as each child and the position of the child's cast are unique. While this work has the potential to reduce the number of spica casted children requiring ambulance transport, it is important to recognize that some children may still require emergency vehicle transport. Collaboration between caregivers, the orthopedic surgeon, and a trained child seat technician is vital to determine the best transport option for each individual child.

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PEDIATRICS

Longitudinal Analysis of Distal Radius Alignment Parameters in a Cohort of Serial Radiographs

Poster 064

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BACKGROUND: An understanding of the normal alignment of the immature pediatric distal radius is important for determining the adequacy of reductions in fracture management. However, no study has rigorously examined longitudinal pediatric distal radius alignment during growth. The purpose of this study was to assess for trends in four radiographic measurements of the distal radius using serial radiographs in subjects aged between 6 and 14 years of age.

METHODS: Annual radiographs from 68 healthy children (n=34 males, 34 females) growing up in Cleveland, Ohio, from 1929 to 1942 were analyzed. This radiographic database, known as the Bolton-Brush Collection, is the same historical collection used to establish the Greulich and Pyle bone age atlas. Children with a minimum of three annual radiographs between the ages of 6 and 14 years of age were included. A mean of 6.5 ± 2.0 radiographs were obtained for each subject, with only 16% (n=8 males, n=3 females) of subjects having a total number of radiographs less than one standard deviation below the overall mean. Measurements of radial height, radial inclination, and ulnar variance were performed in each available radiograph. Measurements were tested for intraclass correlation coefficient in 18 radiographs by two authors. The mean values and standard deviation for each measurement between males and females were recorded. Repeated measures analysis of variance (ANOVA) was performed to measure the association between alignment values and subject age.

RESULTS: Intraclass correlation coefficient was 0.892 for all measurements, demonstrating excellent inter-relator reliability. Measurements were performed on a total of 436 images in 68 subjects. Repeat measures ANOVA demonstrated that all variables changed with age ($P<0.001$). Of the parameters measured, ulnar variance demonstrated the most variability with negative ulnar variance in younger children, with the trend towards a more neutral ulnar variance by approximately 7 years in females and 11 years in males.

CONCLUSION: This is the first investigation examining serial changes to commonly performed distal radius alignment parameters using a longitudinal cohort of children. Distal radius alignment based on ulnar variance, radial height, and radial inclination change significantly with age based on analysis of longitudinally collected radiographs. These results may assist clinicians in better understanding and assessing malalignment after fracture treatment.

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PEDIATRICS

A Biomechanical Evaluation of Long Arm Immobilization Techniques Commonly Used in the Pediatric Orthopedic Setting

Poster 065

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BACKGROUND: There are multiple types of long arm immobilization used for pediatric elbow injuries. The optimal construct has not been established.

PURPOSE: The goal of this study was to biomechanically compare the strength of several long arm splints commonly used in the pediatric orthopedic setting and to evaluate the effect of reinforcing a long arm plaster splint with elbow struts.

METHODS: Five categories of long arm posterior slab splints were tested: 4-inch plaster without elbow struts, 4-inch plaster with a medial elbow strut, 4-inch plaster with medial and lateral elbow struts, 5-inch x 30-inch plaster without elbow struts, and 4-inch synthetic splint material without elbow struts. There were four splints in each group. Four bi-valved fiberglass long arm casts were also tested. Each splint/cast was mounted on an Instron 5543 machine and a three-point bending force was applied to simulate an extension moment at the elbow. Stress/strain curves were utilized to identify the maximum force (N) withstood prior to failure. An ANOVA model was used to analyze the differences in average maximum force between groups.

RESULTS: The 4-inch plaster splints reinforced with two struts had the highest average maximum force to failure (730.5 +/- 143 N), which was significantly higher than the 4-inch plaster splints with one strut (504.8 +/- 48 N) ($p = 0.01$) and the 4-inch plaster splints without struts (100.3 +/- 10 N) ($p < 0.001$). The bi-valved fiberglass casts failed at an average maximum force of 654.8 +/- 96 N; however, there was no statistically significant difference compared to 4-inch plaster splints with two struts ($p = .10$). The 5 inch x 30 inch plaster splints without elbow struts failed at a greater average maximum force (341 +/- 110 N) compared to the splints constructed with synthetic material without elbow struts (233 +/- 61 N) ($p = .03$).

CONCLUSION: In this lab-based biomechanical study, the addition of two elbow struts to a 4-inch long arm plaster splint significantly increased the maximum force to extension load failure by 630 N. The addition of one elbow strut significantly increased the force to failure by 404 N in comparison to a plaster splint without struts. Four-inch plaster splints with two elbow struts were of similar strength as bi-valved fiberglass casts.

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PEDIATRICS

Radiation Exposure in the Treatment of Pediatric Supracondylar Humerus Fractures

Poster 066

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INTRODUCTION: Supracondylar humerus fractures are the most common pediatric elbow fracture and is often treated by closed reduction and percutaneous pinning (CRPP). Radiation exposure follows a cumulative linear no-threshold model, thus methods to reduce exposure are of clinical interest.

METHODS: Charts of patients < 12 years old (n=199) with supracondylar fractures were retrospectively analyzed for multiple variables including position of C-arm, fracture pattern, pre- and postoperative neurovascular status, and number of pins to determine correlations between surgical variables and fluoroscopy time and radiation dose. Associations between independent variables and exposure outcomes were determined with Mann-Whitney tests or Kruskal-Wallis ANOVA. Variables that were significant in univariate analyses were then entered into multiple linear regression models to control for confounding.

RESULTS: After controlling for surgical technique and fracture pattern, an increase in 1 pin (from 2 to 3, or 3 to 4) results in a 10.443 (95% CI 3.236-17.650) second increase in fluoroscopy time (P=0.005). Similarly, an increase in 1 pin results in a 0.205 (95% CI 0.003-0.408) mGy increase in radiation dose (P=0.047). In addition, after controlling for total number of pins and surgical technique, a Type 3 fracture pattern is associated with an 8.303 second increase in fluoroscopy time compared to a Type 2 fracture (P=0.022). In the same way, a Type 3 fracture is associated with a 0.249 mGy higher radiation dose compared to a Type 2 fracture (P=0.020). Notably, however, position of the C-arm (biplanar versus uniplanar) did not show a statistically significant difference in fluoroscopy time (P=0.345) or radiation dose (P=0.290). Other notable independent variables that did not show a statistically significant increase in fluoroscopy time or radiation dose were comorbid ipsilateral fractures, surgical technique (open vs. closed), preoperative neurovascular compromise, or resident participation.

DISCUSSION: We hypothesized that surgical technique would be a major statistically significant factor in reducing radiation exposure among the six fellowship trained pediatric orthopedic surgeons involved in this study. However the only statistically significant factors were number of pins placed and severity of the fracture. Resident participation and comorbid fractures did increase fluoro time and radiation dose, but it was not statistically significant.

CONCLUSIONS: Understanding techniques to reduce cumulative radiation exposure in the treatment of pediatric fracture care patients is important for patient and surgeon safety alike.

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PEDIATRICS

Initial Evaluation by a Nonoperative Provider Does Not Delay the Surgical Care of Pediatric Forearm and Elbow Trauma in a Walk-In Orthopedic Clinic

Poster 067

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INTRODUCTION: Walk-in and "afterhours" clinics are a common setting in which patients may seek care for musculoskeletal complaints, and may be staffed by orthopedic surgeons or other nonsurgical care providers. This study assesses whether evaluation by a nonoperative provider delays the care of pediatric patients with operative elbow and forearm fractures when compared to those seen by an orthopedic surgeon.

METHODS: 98 patients who were initially seen in a walk-in setting and underwent closed reduction or fixation of an elbow or forearm injury were identified. The cohort was divided based on whether the initial clinic visit was conducted by an operative or nonoperative provider. Operative providers include orthopedic surgeons from a variety of subspecialties. Both groups facilitated transfer of patient care to a pediatric orthopedist after the initial visit, and did not definitively treat any injury. A second cohort of patients who were treated solely by a pediatric orthopedist was used as a control. Outcome measures included number of clinic visits before surgery, number of providers seen, days until evaluation by treating surgeon, and days until definitive treatment.

RESULTS: Of the 98-patient cohort, 36 were initially seen by an orthopedic surgeon, and 62 were seen by a nonoperative provider. No significant differences were found between the operative and nonoperative groups when comparing days to evaluation by treating surgeon (3.9 vs. 3.7, $p=.63$), or days until definitive surgical treatment (5.2 vs. 4.8, $p=.62$). Average number of providers seen (1.58 vs. 1.63, $p=.69$) and average number of clinic visits before surgery (2.08 vs. 2.06, $p=.76$) were similar between groups. The 64 control patients who were both initially seen and treated by a fellowship-trained pediatric orthopedic surgeon had significantly fewer days between evaluation and surgery compared to the walk-in groups (3.3 days vs. 5.2 days and 4.8 days, $p<.05$).

CONCLUSION: Initial evaluation in a walk-in orthopedic clinic setting is associated with a slightly longer duration between initial evaluation and treatment compared to evaluation by a fellowship-trained pediatric orthopedic surgeon, but this slight delay of just over 1 day may not be clinically significant. Evaluation by a nonoperative provider is not associated with an increased delay compared to an operative provider.

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HIP

Internal Validation of a Predictive Model for Complications After Total Hip Arthroplasty

Poster 068

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INTRODUCTION: Total hip arthroplasty (THA) is projected to increase in prevalence and associated complications will likely impose a significant burden on the U.S. healthcare system. The purpose of the current study was to validate a predictive model for postoperative complications utilizing a novel 11-component hip-specific questionnaire encompassing preoperatively available clinical and radiographic data.

METHODS: A retrospective case series including all primary THA patients between January 2014-January 2016 was used to test the hip questionnaire. Exclusion criteria included patients without questionnaire scoring variables and less than one-year follow-up. Patients were stratified into 4 tiers based on their questionnaire score: low-risk (>74), mild-risk (57-73), moderate-risk (41-56), and high-risk (<40). A binary logistic regression was performed to determine if the questionnaire predicted complications. Receiver-operator-curves were constructed to determine the threshold score below which there was a high likelihood of experiencing a complication. Chi-squared analysis was used to determine relationships between risk-tier and complications.

RESULTS: 450 patients were included in the final analysis with a mean (range) follow-up of 2.1 (1.0-5.9) years, age of 63.1 (25.7-9.17) years, and body mass index of 31.7 (17.8-64.5) kg/m^2. The overall complication rate was 13.6%. A hip questionnaire score of 73.8 conferred a 98.5% sensitivity and 98.5% negative predictive value (NPV) for complications. The questionnaire score was the strongest predictor of a decreased likelihood of complications (Odds Ratio = 0.94, 95% Confidence Interval = 0.90-0.97; $p<0.001$). Risk-tier was significantly associated with complications (low-risk: 0; mild-risk: 12; moderate-risk: 25; and high-risk: 24; $p<0.001$).

CONCLUSION: This novel hip questionnaire demonstrated a high sensitivity and NPV using preoperatively available clinical and radiographic variables to identify patients at risk for postoperative complications. Future studies should attempt to prospectively validate the use of this questionnaire, which may be a more suitable guide for setting exclusion criteria for bundled payment systems and alternative payment models.

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HIP

Midlevel Providers in Orthopedic Surgery: The Patient's Perspective

Poster 069

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INTRODUCTION: Midlevel providers (i.e., physician assistants [PAs] and nurse practitioners [NPs]) are being integrated into health systems due to the increasing demand for care. The purpose of this study is to assess patient perspectives toward physician extenders, including scope of practice, perceived differences between PAs and NPs, and pay equity with orthopedic physicians for the same services.

METHODS: Prior to their first visit, 538 consecutive patients of four orthopedic surgeons were administered an anonymous survey. Participants had no knowledge regarding midlevel roles at that initial visit or moving forward. Content included midlevel scope of practice, training backgrounds, and reimbursement equity with orthopedic surgeons for the same services. Patient responses, including means and percentages, were tabulated.

RESULTS: Of 538 consecutive patients, 415 (77%) responded. Most participants were female (57%) with mean age of 63.9±11.4 years. Nearly half of respondents (46%) perceived differences between PA and NP training levels, with 34% of overall respondents believing PAs are more highly trained than NPs and 19% the reverse. Most patients (84%) responded that the surgeon should be present in the operating room when an extender performs operative exposure and closure. Patient perspectives towards reimbursement equity for the same services were variable, with 25% responding in favor of equity, 37% neutral, and 38% against. This was despite 77% responding that the orthopedic surgeon provides a higher-quality consultation. Patients were amenable to specific services being midlevel-provided, including: preoperative teaching (73%) and minor in-office procedures (65%). Patients also responded that certain clinical services should always be physician-provided, such as: abnormal diagnostics follow-up (82%), initial postoperative appointments (81%), and determining need for advanced diagnostic studies (76% of patients).

CONCLUSION: As health care becomes consumer-centric and value-driven, a data-based approach in midlevel staff utilization will allow optimization of efficiency, quality, and patient satisfaction. Orthopedic surgeons may consider these results regarding which services patients prefer be provided by the physician or physician extender. It may be beneficial to include midlevel providers in marketing and educational efforts, as most patients considered the training background of the surgeon's midlevel provider when choosing a practice. Patients lacked a consensus towards reimbursement equity for orthopedic surgeons and midlevel providers, despite reporting that the surgeon provides a higher quality consultation. These findings are pertinent to providers, patients, and payors as the midlevel workforce increases.

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HIP

Meta-Analyses in Total Joint Arthroplasty: Are They Helpful?

Poster 070

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BACKGROUND: Meta-analyses and systematic reviews in total joint arthroplasty are commonly published in major orthopedic journals. This investigation assesses the quality and the clinical utility of meta-analyses in total knee and hip arthroplasty.

METHODS: A systematic review of all meta-analysis publications regarding total knee and total hip arthroplasty from three major orthopedic journals (Journal of Bone and Joint Surgery-American, Journal of Arthroplasty, and Clinical Orthopaedics and Related Research) from January 2000 to August 2017 was performed. Three blinded independent reviewers assessed the reporting and the manuscript quality of the studies that met the eligibility criteria using the Oxman and Guyatt Index (1-7) and the PRISMA statement (0-27).

In addition, two-fellowship-trained orthopedic surgeons assessed the clinical utility and relevance of the 24 most highly-rated articles (average PRISMA score of 25.8).

RESULTS: 25 meta-analyses were published from 2000-2009, and, since then, 90 studies have been published, representing 3.6 fold increase. The mean Oxman-Guyatt and the PRISMA scores were 3.89 (±1.47) and 22.2 (±2.64), respectively, and 79% of the studies were low-to-moderate quality. Both manuscript (OG) and reporting (PRISMA) quality were observed to significantly increase over time ($p<0.05$) AND were strongly correlated with one another ($r = 0.97$, $p<0.05$). However, only 23 out of 114 articles listed the level of evidence for the respective meta-analyses, and there were only eight Level 1 studies and nine Level 2 studies, as reported by the journals.

24 articles with highest quality were graded by two fellowship-trained arthroplasty surgeons, and 71 percent (17/24) was determined to be either clinically insignificant or inconclusive and often differed with expert assessments.

Lastly, the greatest deficiencies among all years for PRISMA criteria were (1) providing information on whether or not an established review protocol was used (<48%) and (2) accounting for or assessing risk of bias (39-46%).

CONCLUSION: Clinicians should question the utility of these studies, especially non-randomized, observational studies due to methodological limitations and lack of high quality investigations. The data presented here may be utilized to refine meta-analysis writing practices and highlight areas of needed improvement.

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HIP

Diagnostic Accuracy of a New Clinical Test (Resisted Internal Rotation) for Detection of Gluteus Medius Tears

Poster 071

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BACKGROUND: Existing literature describing clinical tests used for the detection of gluteus medius tears using their sensitivity, specificity, and diagnostic accuracy are minimal. With the advancements in management of gluteus medius tears during the last decade, there is a need to establish an early diagnosis. The objective of this study was to evaluate the diagnostic accuracy of a new dynamic clinical examination for detection of gluteus medius tears.

METHODS: A case group of 50 patients undergoing arthroscopy with gluteus medius repair was compared to a control group of 50 patients undergoing arthroscopy who had no peritrochanteric symptoms. Both groups were examined clinically, had magnetic resonance imaging studies performed, and underwent arthroscopic surgery. Recorded clinical examinations included abnormal gait (Trendelenburg), tenderness to palpation of the greater trochanter, resisted abduction and the test being studied, resisted internal rotation. For all clinical tests, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy rates were calculated and compared with the arthroscopic and MRI data for the case group, and the MRI data for the control group.

RESULTS: The Resisted Internal Rotation test had a sensitivity of 92%, specificity of 85%, and diagnostic accuracy of 88% in the detection of gluteus medius tears, with a low rate of false positive and false negative recordings. Other traditional clinical examination tests, with the exception of Trendelenburg gait, showed inferior rates. Trendelenburg gait had a higher specificity, but much lower sensitivity.

CONCLUSIONS: The Resisted Internal Rotation test aides in the early detection of gluteus medius pathology and avoids delayed diagnosis and surgical treatment, if needed. Due to the good results of the Resisted Internal Rotation test in all the diagnostic parameters, we recommend incorporating it on the physical examination of patients with hip pain.

Level of Evidence: Diagnostic Level I

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HIP

Constrained Liner Revision is Less Effective with Each Subsequent Constrained Liner Revision at Preventing Instability in Revision Total Hip Arthroplasty

Poster 072

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INTRODUCTION: Constrained liners have been used to treat reoccurring THA dislocations, but there is concern regarding its effectiveness. The aim of this study was to evaluate the rate and survivorship free of revision for dislocation because of constrained liner failure in patients who were revised to their first, second, or third constrained liner.

METHODS: From 1989 to 2016, using our institution's total joint registry, we identified 658 patients who were revised to their first constrained liner to prevent instability. During the same time period, there were 57 who were revised to a second constrained liner for dislocation because of one prior constrained liner failure, and 17 who were revised to a third constrained liner for dislocation because of two prior constrained liner failures. The mean follow-up was 5 years.

RESULTS: In patients receiving their first, second, and third constrained liners, the survivorship free of revision for dislocation at 5 years was 90%, 54%, and 38%, respectively. Patients with a second constrained liner were more likely to have a revision for dislocation (Odds-Ratio = 6.5; p=0.0001) compared to those receiving their first constrained liner. Patients with a third constrained liner had a trend towards being more likely to have a revision for dislocation (Odds-Ratio = 2; p=0.09) compared to those receiving their second constrained liner.

CONCLUSION: After revision to a second constrained liner, 1/2 will undergo revision at 5 years, and after revision to a third constrained liner, 3/5 will undergo revision for dislocation. Patients receiving their second constrained liner are 6.5-fold more likely to have a dislocation requiring revision because of constrained liner failure compared to those receiving their index constrained liner. When a THA becomes unstable after a constrained liner, surgeons should optimize all other implant factors, and exercise caution before revising to another constrained liner.

SUMMARY: Patients receiving their second constrained liner are 6.5-fold more likely to have a dislocation requiring revision compared to those receiving their first constrained liner.

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Conversion of Failed Hemiarthroplasty to Total Hip Arthroplasty has Similar Outcomes and Costs as Revision Total Hip Arthroplasty

Poster 073

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INTRODUCTION: There is limited data evaluating outcomes and cost of conversion total hip arthroplasty (THA) after hemiarthroplasty for femoral neck fractures (FNF) compared to primary and revision THAs. The aims of this study were to compare the (1) risk of complications, dislocations, reoperations, and revisions of conversion THA to a matched group of primary and revision THAs, and (2) costs between the three groups.

METHODS: From our institution's total joint registry, we identified 389 patients treated with conversion THA after hemiarthroplasty for FNF between 1985 and 2014. The mean follow-up was 6 years. This group was 1:2 matched by age, sex, BMI, and Charlson comorbidity index to 778 primary THAs and 778 first time revision THAs.

RESULTS: Conversion THA patients had a higher risk of complications (HR, 2.0; 95% CI, 1.63-2.46; $p<0.001$), dislocations (HR, 1.68; 95% CI, 1.10-2.56; $p=0.02$), and reoperations (HR, 1.86; 95% CI, 1.35-2.55; $p<0.001$) compared to primary THA patients. Conversion THA patients had a similar risk of complications (HR, 0.89; 95% CI, 0.75-1.07; $p=0.21$), dislocations (HR, 1.01; 95% CI, 0.68-1.49; $p=0.98$), and reoperations compared to revision THA patients (HR, 0.87; 95% CI, 0.66-1.16; $p=0.34$). Conversion THA patients had a similar risk of revisions compared to primary THA (HR, 1.24; 95% CI, 0.86-1.79; $p=0.25$), but a lower risk than revision THA patients (HR, 0.61; 95% CI, 0.43-0.86, $p=0.004$). The total inpatient cost of conversion THA per patient was higher than primary THA ($22,662 versus $18,694; $p=.001$), but similar to revision THA ($22,662 versus $22,071; $p=0.56$).

CONCLUSIONS: The costs and risk of complications, dislocations, and reoperations were similar between conversion THA and revision THA. Conversion THA is unique from primary THA and more similar to revision THA, and should be bundled in the same diagnosis related group as revision THA to allow for proper institutional reimbursement.

SUMMARY: Conversion of failed hemiarthroplasty to total hip arthroplasty has similar outcomes and costs as revision total hip arthroplasty.

Back

Administration of the Hip Disability and Osteoarthritis Outcome Score (HOOS) Physical Function Short-Form and Pain Subscale via Text Messaging

Poster 074

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INTRODUCTION: Validated patient reported outcome (PRO) instruments are an essential component of value-based healthcare. Current PRO completion formats are limited by the need for paper or computer interfaces and in office visits. The purpose of the present study was to validate the administration of hip specific outcome instruments over a mobile phone based text messaging platform delivered outside of a clinical encounter.

METHODS: Consecutive patients (n=72) presenting to a Hip Preservation Clinic for evaluation of hip pain were enrolled. Subjects completed the Hip disability and Osteoarthritis Outcome Score Short Form physical function and Pain subscales (HOOS-PS, HOOS-PAIN) via a hand held tablet. The subsequent day, patients were asked to complete the same PRO instruments via a custom-built text messaging software program. Automated reminders were sent to patients to encourage completion of unanswered questions. Correlation between in-office and mobile phone delivery of the PROs were assessed. We defined excellent reproducibility to be an intraclass correlation coefficient (ICC) of >0.75. Demographic data including age, gender, and diagnosis were retrospectively collected.

RESULTS: There was a 94.4% and 94.2% completion rate for patients who received both the in-office and phone surveys, respectively. The mean age was 31 years (range 15-55) and 70% of respondents were female. The ICC between in-office electronic and at-home mobile phone delivery of HOOS-PS was 0.72 (95% confidence interval [CI] 0.58-0.81) and HOOS-Pain was 0.80 (95% CI 0.69-0.87). The mean difference in scores between the in-office and mobile phone format were 8.7±12.6 and 7.5±12.1 for HOOS-PS and HOOS-Pain, respectively. Patients most frequently requested morning communication between 8AM-Noon (65%) to afternoon communication 4-8PM (35%).

CONCLUSION: HOOS-PS and HOOS-Pain PRO instruments administered via mobile phone text messaging demonstrates good to excellent reproducibility and an equal completion rate compared to traditional in office methods. Mobile phone delivery utilizing our software algorithms may be a valid method for administration of other PROs in this population and both eliminates in-office testing and allows for communication with patients anytime and anywhere.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Thirty-Day Major and Minor Complications Following Total Hip Arthroplasty – A Comparison of the Direct Anterior, Lateral, and Posterior Approaches

Poster 075

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INTRODUCTION: The choice of surgical approach during total hip arthroplasty (THA) remains highly controversial. The aim of the present study was to compare 30-day major and minor complications following primary THA between the direct anterior, lateral, and posterior approaches.

METHODS: Our hospital performs primary THAs using all three aforementioned approaches based on surgeon preference. Patients who underwent primary THA from August 2010 to August 2017 were identified using our institution's total joint registry, and their data was combined with prospectively collected data from the National Surgical Quality Improvement Program (NSQIP) database (which evaluates a random sample of approximately 20% of all surgical patients in our hospital). Baseline characteristics, operative variables, and postoperative complications were then compared between the three groups.

RESULTS: The analysis comprised 1,967 primary THAs (1,913 patients) whereby 56%, 29%, and 15% were performed through a posterior, lateral, and direct anterior approach respectively. Thirty-day major and minor complications occurred in 3.9% and 9.4% of surgeries, respectively. After adjusting for baseline patient characteristics, there was no significant difference in major or minor perioperative complications between the three approaches.

CONCLUSIONS: This study compared perioperative complications between the three most commonly used approaches for THA utilizing a synthesis of our institutional total joint registry and high-quality NSQIP data. Thirty-day major and minor complications were similar regardless of the surgical approach employed, which may help surgeons and patients simplify the multiple considerations taken into account when deciding on surgical approach for primary THA.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Primary and Revision Total Hip Arthroplasty with Uncemented Acetabular Components in Patients with Paget's Disease

Poster 076

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INTRODUCTION: Paget's disease affects 3-4% of the population, and occasionally total hip arthroplasty (THA) is required. Given the limited historical literature, and the known concerns with bleeding, heterotopic ossification (HO), and component loosening, we sought to describe our results with primary and revision THAs in Paget's disease with emphasis on implant survivorship, complications, radiographic results, and clinical outcomes.

METHODS: A retrospective review identified 25 THAs (17 primaries and 8 revisions) performed with contemporary uncemented acetabular components in patients with Paget's disease from 1999-2014. Mean age was 78, and 52% were male. Mean follow-up was 7 years. Kaplan-Meier survivorship analyses were performed. Clinical outcomes were assessed with Harris hip scores (HHS).

RESULTS: In primary THAs, survivorship free from acetabular aseptic loosening was 100% at 8 years. Survivorship free from femoral aseptic loosening was 94% at 8 years. Seven patients (41%) received blood transfusions. Heterotopic ossification (HO) was seen in 9 (53%), with Brooker I in 7 (41%), Brooker II in 1 (6%), and Brooker III in 1 (6%). In unrevised cases, there was no radiographic evidence of aseptic loosening. Mean HHS improved from 49 to 76.

In revision THAs, survivorship free from acetabular and/or femoral aseptic loosening was 100% at 5 years. Three patients (38%) received a transfusion. HO was seen in 5 (63%), with Brooker I in 3 cases (38%) and Brooker II in 2 (25%). In unrevised cases, there were no radiographic signs of aseptic loosening. Mean HHS improved from 52 to 77.

CONCLUSIONS: Our investigation demonstrates that prior concerns with acetabular fixation in Paget's disease have been mitigated with contemporary uncemented acetabular components. Complications previously noted, namely intraoperative bleeding and HO, continue to be of concern. As such, perioperative blood management and HO prophylaxis are essential.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Long-Term Outcomes of Constrained Liners Cemented into Retained, Well-Fixed Acetabular Components

Poster 077

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INTRODUCTION: Cementation of a constrained liner is a viable option to treat recurrent instability after revision total hip arthroplasty (THA) when the acetabular component is well-fixed and well-aligned. However, concerns regarding long-term mechanical failure and recurrent instability remain. The aim of this study was to determine the long-term aseptic survivorship of constrained polyethylene liners cemented into well-fixed acetabular components retained at the time of revision THA in a very large series.

METHODS: We identified 125 cases where a constrained liner of one design was cemented into a retained, osseointegrated acetabular component during revision THA between 1998 and 2006. The mean age at time of surgery was 70 years. Mean follow-up was 7 years. Survivorship data, the risk of instability, and clinical and radiographic outcomes were analyzed.

RESULTS: Survivorship free from revision for instability was 86% at 5 years and 81% at 10 years. Survivorship free from aseptic constrained liner revision was 80% at 5 years and 67% at 10 years, with the most common failure mechanism including dissociation of the constrained liner from the acetabular component. Survivorship free from any aseptic revision (including aseptic acetabular loosening) was 78% and 65% at 5 and 10 years, respectively. The most common indication for re-revision was instability. The most common complications were dislocation and periprosthetic joint infection with cumulative incidences of 18% and 5% at 7 years, respectively. Harris hip scores did not significantly improve (62 to 67; p=0.59). Pre-revision radiographs revealed that the acetabular components were within the inclination safe zone for 66%, version safe zone for 72%, and cup position did not affect implant survivorship or risk of dislocation.

CONCLUSIONS: Cementing a constrained liner into a retained acetabular shell at the time of revision THA has durable long-term results, with 8 in 10 patients free from instability at 10 years. However, aseptic acetabular survivorship was poorer (67%) at 10 years, primarily due to dissociation of the constrained liner from the acetabular component. Patients should continue to have postoperative radiographic follow-up to identify these failures.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Does the Timing of the Second Surgery of a Staged Bilateral Total Joint Arthroplasty Affect the Rate of Hospital Adverse Events and Perioperative Outcomes?

Poster 078

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INTRODUCTION: The optimal timing of the second surgery of a staged bilateral total hip (THA) or knee (TKA) arthroplasty remains uncertain. Perioperative hospital adverse events represents a significant issue, even "minor events" may lead to substantial expenses. Therefore, we sought to ascertain whether the timing of the second arthroplasty affects the rates of hospital adverse events and perioperative outcomes.

METHODS: A retrospective direct chart review was conducted on a consecutive series of 670 primary staged bilateral THA or TKA performed at a single institution (2010-2016) by two fellowship-trained surgeons. The days between the first and second arthroplasties were calculated for each pair of hips or knees. Baseline demographics and LOS, discharge disposition (home vs. other), hospital adverse events (i.e., nausea, pulmonary embolism), transfusion (all and allogeneic alone), and unplanned hospital readmissions and reoperations within 90-days were collected. The second arthroplasties (n=335) were compared between them based on the timing they were done with respect to their corresponding first surgery: (1) ≤90 vs. >90, (2) ≤180 vs. >180, and (3) ≤365 vs. >365 days. Outcomes were compared using independent t-tests, Fisher's exact test, and Pearson Chi-Square.

RESULTS: There were no significant differences on outcomes in comparisons made using either 90 or 180 days cut-off points. However, LOS (2.21 vs. 1.92 days, p=0.015), adverse event (26% vs. 15.3%, p=0.021), transfusion (7.4% vs. 1.5%, p=0.020), and allogeneic transfusion (6.9% vs. 1.5%, p=0.033) rates were significantly higher in second surgeries performed ≤1 year apart (n=204) from their corresponding initial arthroplasty compared to second surgeries done >1 year apart (n=131), respectively.

CONCLUSION: In the absence of external factors (i.e., health status, socio-economic support), our findings suggest that patients may be advised to have the second arthroplasty performed more than a year apart from the contralateral one to diminish the likelihood of perioperative adverse events.

Back

Patients Less Than 50 Years Old Undergoing Revision THA for Instability had a High Re-Dislocation Rate and Poor Long-Term Survivorship Free of Re-Revision

Poster 079

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INTRODUCTION: There is a paucity of literature on the outcomes of contemporary aseptic revision total hip arthroplasty (THA) for recurrent instability in patients ≤50 years old. As such, the goal of this project was to analyze these outcomes and risk factors in these patients, with specific emphasis on survivorship free of: (1) all-cause re-revision and (2) any instability.

METHODS: We retrospectively reviewed 47 non-oncologic revision THAs for instability performed in 132 patients ≤50 years old from 2002-2012 through our total joint registry. Mean age was 43 years. Mean BMI was 30 kg/m^2. Mean follow-up was 8 years. There were 26 (55%) first-time revisions and 21 (45%) re-revisions. Twenty-two (47%) had a posterior approach at revision THA. Articulations included: fixed-bearing with femoral head size ≤32-mm in 6 (13%) and ≥36-mm in 23 (49%), constrained device in 16 (34%), and dual mobility in 2 (4%). Univariate cox regression analysis was utilized to identify risk factors.

RESULTS: Survivorship free of all-cause re-revision was 56% at 10 years. Survivorship free of any instability was 47% at 10 years. An initial re-revision compared to a first-time revision (HR=5, p=0.0013) was a significant risk factor for poorer survivorship free of instability; operative approach or articulation type did not reach significance. Overall, 17 (36%) THAs underwent re-revision for re-recurrent instability in 11 (23%), PJI in 5 (11%), and acetabular loosening in 1 (2%). An additional 6 THAs dislocated but were successfully managed nonoperatively; therefore, the overall re-dislocation rate was 36%.

CONCLUSION: Revision THA for instability in patients ≤50 years had a high re-dislocation rate of 36%, even with use of a constrained device in roughly 1/3 of patients. 10-year all-cause re-revision survivorship was 66%; further, a concerning 11% of patients developed a PJI.

SUMMARY: Revision THA for instability in patients ≤50 years had a high re-dislocation rate of 36%. 10-year all-cause re-revision survivorship was 66%; further, a concerning 11% of patients developed a PJI.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Sleep Quality in Patients with Osteoarthritis of the Hip

Poster 080

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INTRODUCTION: Osteoarthritis is a common condition with the hip being frequently affected. The disease symptoms manifest as pain and loss of function, leading to a diminished quality of life. Sleep is well documented as a vital element of our daily function and overall health. Patients with hip arthritis often report nocturnal pain as the disease progresses, yet little is known how hip arthritis affects sleep quality. The purpose of this paper was to assess how hip arthritis affects sleep quality.

METHODS: This is a prospective review of patients with a chief complaint of hip pain and who were diagnosed with hip osteoarthritis by clinical and radiographic evaluation. Patients were evaluated using WOMAC, Hip Outcome Score (HOS), and Modified Harris Hip Score (mHHS). Sleep quality was assessed using Pittsburgh Sleep Quality Index (PSQI). A multiple regression model was used to assess factors associated with poor sleep quality.

RESULTS: A total of 106 patients were analyzed, with an average age of 63 years (20-82). All patients had a Tonnis Grade of two or three. The average ASA Classification was 2 and BMI of 29.01(+/-5.88). WOMAC, HOS, and mHHS were significantly correlated with PSQI ($p=<0.001$; $p=0.013$; $p=0.002$). WOMAC, SF-12, ASA Classification, and history of obstructive sleep apnea were associated with poor sleep quality in the multiple regression model ($p = 0.0185$, 0.0001, 0.0002, and 0.0041 respectively).

CONCLUSION: Patients with hip osteoarthritis, who endorse a more symptomatic and painful hip, are susceptible to reduced sleep quality. There is a direct correlation between worsening patient reported hip outcome scores and sleep quality. The WOMAC score is an independent predictor of poor sleep quality and patients with poor hip metrics should be screened for sleep disturbance. The positive effects of total hip arthroplasty may include a benefit to sleep quality in addition to pain control and activity.

Level of Evidence: Level II

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Staged Total Hip Arthroplasty: A Novel Technique in Managing Pelvic Discontinuity

Poster 081

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INTRODUCTION: Management of pelvic discontinuity presents a challenge in the setting of hip reconstruction. There is currently no consensus on how to best address these defects. Structural allograft, impaction grafting, and cemented fixation have been shown to have a high rate of loosening. Cup cage constructs and custom triflange implants rely on fixation to intact innominate bones which may not be feasible in the setting of ischial fractures. These techniques also require extensive exposure, soft tissue damage, and add significant cost to the procedure. We present a novel technique for management of pelvic discontinuity as well a cohort with minimum 2-year follow-up.

METHODS: Surgical Technique: In native hips, the hip is exposed via a modified Hardinge approach; in the revision setting the original exposure is utilized. A femoral neck osteotomy is made and, if present, columnar acetabular fractures are plated. Bone graft is reverse reamed into the defect and a porous coated acetabular shell is impacted into place. Screws are used for supplemental fixation. The wound is then closed and the patient is made toe touch weight bearing for 3-6 months. After the defect has healed, the patient returns for placement of the femoral component. Methods: All patients undergoing staged total hip arthroplasty for pelvic discontinuity during a 5 year period from 2010 to 2015 by a single provider were identified. Patients with less than 2-year follow-up were excluded. Implant survivorship, Merle d'Aubinge, Visual Analogue Scale scores and complications were recorded.

RESULTS: 9 patients met inclusion criteria with mean 40.9 month follow-up (range 24-89). Merle D'Aubinge scores improved from 5.6 (4-8) to 15.3 (14-18) and Visual Analogue Scale scores improved from 7.2 (6-9) to 0.8 (0-2). All implants were retained and all patients were ambulatory at terminal follow-up. Two patients sustained greater trochanter fractures, one sustained an intraoperative calcar fracture managed with circlage and one developed heterotopic ossification. There were no wound complications, deep infections or medical complications attributable to surgery. One patient died 3 years after the final stage of unrelated causes.

CONCLUSION: Staged primary or revision total hip arthroplasty can be used to address pelvic discontinuity with excellent short to mid-term outcomes. This technique allows for a more limited exposure and the use of primary hip implants. Fixation is by ingrowth and does not rely on intact ischial or pubic rami in the setting of associated fractures.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Uniformly Low Serum Cobalt Levels After Modular Dual-Mobility THAs with Ceramic Heads: A Prospective Study in High Risk Patients

Poster 082

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INTRODUCTION: Modular dual-mobility constructs reduce the risk of dislocation after total hip arthroplasty (THA). However, questions about metal ions from the cobalt-chrome (CoCr) liner persist, and are particularly germane to patients being revised for adverse local tissue reactions (ALTR) to metal. We determined the mid-term serum Co and Cr levels after modular dual-mobilities used in revision and complex primary THAs, and specifically included patients revised for ALTR.

METHODS: Serum Co and Cr levels were measured prospectively in 22 patients with a modular dual-mobility construct and a ceramic femoral head. Patients with CoCr heads or contralateral THAs with CoCr heads were excluded. Mean age 64 years with 50% female. The mean follow-up was 4 years. Indications for modular dual-mobility were: periprosthetic joint infection treated with 2-stage exchange and subsequent reimplantation (n=8), ALTR revision (n=7), complex primary THA (n=6), and periprosthetic femoral fracture (n=1). Mean preoperative Co and Cr in patients revised for an ALTR were 29.7 µg/L and 21.5 µg/L, respectively.

RESULTS: Mean Co and Cr levels were 0.26 µg/L and 0.82 µg/L, respectively, at most recent follow-up. No patients had a cobalt level ≥1 µg/L. Only one patient had a chromium level ≥1 µg/L. That patient's chromium level was 12 µg/L at 57 months after revision THA for ALTR (and decreased 10-fold from a preoperative Cr of 113 µg/L).

CONCLUSION: At a mean of 4 years, no patient with a modular dual-mobility construct and ceramic femoral head had elevated cobalt levels, including seven patients revised specifically for ALTR. While further studies are required, we support selective use of a modular dual-mobility construct in revision and complex primary THAs for patients at high risk for instability.

SUMMARY: At a mean of 4 years after revision or complex primary THAs with a modular dual-mobility construct and a ceramic head, none of 22 patients had serum cobalt levels that measured ≥1 µg/L.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Telemedicine Pilot Study: Six-Month Postoperative Complications Among Virtual Clinic Visit Total Hip and Knee Arthroplasty Patients

Poster 083

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PURPOSE: To evaluate 6-month postoperative events in a group of total hip and knee arthroplasty (THA/TKA) patients undergoing telemedicine follow-up as compared to a matched control group with standard in-office clinic visits.

METHODS: This is an ongoing study at a tertiary academic medical center. Patients undergoing THA and TKA by a single surgeon can opt to follow-up via telemedicine postoperative visits in the electronic medical record. We retrospectively reviewed patient charts in order to document postoperative events following joint arthroplasty. A control group was created with patients matched according to sex, age, BMI, surgery, and ASA. Retrospective chart review for both cohorts consisted of documenting 6-month postoperative events and readmissions. Events included superficial and deep surgical site infection (SSSI, DSSI), non-surgical site infection (NSSI), emergency department (ED) visit, dislocation, fracture, return to OR, hardware failure, hematoma, joint space infection (JSI), readmission, UTI, DVT, PE, and Death.

RESULTS: A total of 55 patients (31 females, 24 males) was in each cohort. For telemedicine vs. control patients, average [standard deviation]: age was 64.58 [7.75] vs. 64.55 [7.81], BMI was 32.79 [5.49] vs. 31.98 [4.68], preoperative ASA 1 for one vs. zero patients, 2 for 31 vs. 32 patients, and 3 for 23 vs. 23 patients. There was a total of three events in two patients during the 6-month postoperative period in the study cohort. These included right lower extremity swelling without DVT, and a patient with an isolated ED visit as well as a separate readmission for PE three weeks postoperatively. There was a total of 13 events in 12 patients in the control group. These included one readmission for a DSSI requiring incision and drainage with polyethylene exchange 45 days postoperatively. There were six ED visits without admission, one for DVT and one for sciatica at two days postoperatively, one for shortness of breath (without DVT/PE), and one for PVCs at one week postoperatively, and one with chest pain and one for head injury at 6 months postoperatively. There were five readmissions unrelated to the patient's surgery. In this group there were no SSSI, dislocations, hematomas, hardware failures, periprosthetic fractures, or deaths.

CONCLUSION: This ongoing study demonstrates that 6-month postoperative events after total joint arthroplasty are similar between patients with standard clinic postoperative visits to those undergoing telemedicine visits. Telemedicine visits provide patients with appropriate follow-up while reducing the inconvenience and expenses incurred with standard clinic visits.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

The Effect of Combined Administration of Tranexamic Acid on Blood Loss in Total Knee and Hip Arthroplasty. A Systemic Review and Meta-Analysis

Poster 084

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INTRODUCTION: Although administration of IV or topical tranexamic acid (TXA) is shown to reduce the total amount of perioperative blood loss in patients undergoing total joint arthroplasty (TJA), it remains to be clear whether combined treatment of TXA holds superiority. This meta-analysis assesses the effectiveness of combined administration of IV and topical TXA compared to single use of TXA in total knee and hip arthroplasty evaluating primary outcomes such as total blood loss, hemoglobin drop, and transfusion rate.

METHODS: PUBMED, MEDLINE, EBSCO, Cochrane Clinical Trail Register, and other databases were searched for randomized controlled trial (RCT) and retrospective observational cohort studies that compared the effect of combined use of IV and topical TXA vs. single use on outcomes of TJA patients. The main outcomes of interest included total blood loss, hemoglobin drop, and transfusion rate. We used 'Grading quality of evidence and strength of recommendations' to assess the quality of trials. Two authors independently abstracted data using a data collection form. Results from studies were pooled when appropriate.

RESULTS: Of 406 references identified through the search, 23 selected clinical trials met inclusion criteria. Total blood loss after combined administration of TXA was significantly less than IV TXA (-182.73 mL, $P<0.00001$) and topical TXA (-101.29 mL, $P<0.00001$) alone. A statistical difference in hemoglobin drop was noted when comparing the combined TXA group to the IV group (-0.44 dL, $P<0.00001$) and topical group (-0.46 g/dL, $P<0.00001$). Combined TXA was also shown to have lower risk in transfusion requirements compared to the IV group (RR = 0.37, $P<0.0001$) and topical group (RR = 0.29, $P<0.00001$). No serious adverse effects (such as thromboembolic events) associated with combined TXA group were reported in the included trials.

DISCUSSION AND CONCLUSION: Combined TXA regimen may be more effective than single TXA regimen in decreasing total blood loss, transfusion requirements, and shortening LOS following TJA. Utilization of combined TXA administration was not associated with increased incidence of thromboembolic complications.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
HIP

Effect of Pelvis and Limb Position on Radiographic Leg Length Discrepancy Measurement: A Sawbones Model

Poster 085

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INTRODUCTION: Leg length discrepancy (LLD) after total hip arthroplasty is a challenging problem, often resulting in nerve palsy, abnormal gait, hip instability, and litigation. Measuring LLD on pelvis radiographs can be challenging, especially because the obliquity of the pelvis and position of the corresponding limb can affect the measured leg length. A perfect pelvis x-ray with a level pelvis and neutral femur abduction is not always available or attainable. We sought to determine how varying pelvis and limb position would affect LLD measurement and determine a method to estimate true leg length discrepancy.

METHODS: A size large pelvis and bilateral femur sawbones model with high resolution radiopaque cortical shell with 2 mm metallic markers on the lesser trochanter, 25 mm calibration ball at hip joint, and equal leg lengths was utilized with fluoroscopy. Leg length was measured with a medical image PACS viewer from the acetabular tear drop to the tip of the lesser trochanter. Leg length discrepancy was measured with intentional malpositioning of pelvic obliquity (0°, 5°, 10°, 15°) and alternate femoral position including neutral, adduction of 5°, 10°, 15° and abduction of 5°, 10°, 15°. We then calculated the LLD measurement error for all combinations of pelvic obliquity and femur position.

RESULTS: Pelvic obliquity changes of 5° or less typically result in LLD measurement error <1 cm. As pelvic obliquity increases to 10°, LLD measurements error is <1 cm if the femur remains neutral. At pelvic obliquity of 10° and 15°, even minor limb malposition results in large measurement error >1 cm. Greatest LLD measurement error occurs when femur on high side of obliquity is adducted and low side femur is abducted.

CONCLUSION: LLD after total hip arthroplasty is a challenging problem for patient and surgeon alike, and careful leg length measurement on pelvis radiographs is critical. Pelvic obliquity greater than 10° can lead to significant LLD measurement errors >1 cm even with minor limb malposition. Error is increased in lower limb positions typically seen in a standing radiograph with pelvic obliquity where one femur is adducted and the other abducted. Accurate LLD measurement is critical but perfect radiographs are not always attainable. We offer methods to estimate true LLD using simple geometric calculations or correction tables obtained from our results.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
KNEE

Contemporary Revision TKA in Patients Less Than Age 50: A High Risk of Re-Revision by 10 Years

Poster 086

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INTRODUCTION: Despite the increasing prevalence of younger patients undergoing TKA, there is a paucity of literature on contemporary aseptic revision total knee arthroplasty (TKA) in patients ≤50 years old. We thought it timely to determine the risk factors for failure in this population, with specific emphasis on survivorship free of: all-cause re-revision, re-revision for instability, and re-revision for aseptic loosening.

METHODS: We retrospectively reviewed 135 non-oncologic revision TKAs performed at a single institution from 2000-2012 in 132 patients ≤50 years old through our total joint registry. Mean age was 43 years; mean BMI of 32 kg/m^2; 59% were females. Mean follow-up was 7 years. There were 99 (73%) first-time revisions and 36 (27%) re-revisions. Most common indications for aseptic revision included: instability (47%), aseptic loosening (29%), and arthrofibrosis (9%). Multivariate analysis was utilized to identify risk factors of poorer re-revision-free survivorship.

RESULTS: Survivorship free of all-cause re-revision was 66% at 10 years, with re-revision TKAs (HR=2.8, p=0.003) and revision for instability (HR=2.0, p=0.04) having poorer survivorship. Forty-three (32%) TKAs underwent re-revision including 10 (7%) for PJI, 15 (11%) for instability, and 10 (7%) for aseptic loosening. Survivorship free of re-revision for instability was 88% at 10 years, with revision for instability (HR=19.3, p=0.003), male gender (HR=2.9, p=0.05), and re-revision TKAs (HR=3.1, p=0.05) having poorer survivorship. Of the 64 TKAs revised for instability, 24 (38%) underwent re-revision, including 14 (22%) for recurrent instability. Survivorship free of re-revision for aseptic loosening was 87% at 10 years, with revision for aseptic loosening (HR=4.8, p=0.04) having poorer survivorship.

CONCLUSION: Patients ≤50 years undergoing contemporary aseptic revision TKA had a high risk of re-revision. At 10 years, the survivorship free of re-revision was 66% and included a 7% incidence of PJI. Patients specifically revised for instability had the highest risk of re-revision at 10 years.

SUMMARY: Patients ≤50 years undergoing contemporary revision TKA had a disappointingly low survivorship free of re-revision of 66% at 10 years, including a 7% rate of re-revision for PJI. Patients revised for instability had the worst prognosis with a nearly 40% re-revision rate.

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Revision Anterior Cruciate Ligament Reconstruction After Surgical Management of Multiligament Knee Injury

Poster 087

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PURPOSE: Multiligament knee injuries (MLKIs) are difficult injuries that often require multiple surgeries. The study purpose was to determine what factors correlate to revision ACL reconstruction (ACLR) after MLKIs and to evaluate final outcomes for those patients.

METHODS: An IRB-approved retrospective review of 231 MLKIs including 225 patients over a 12-year period was performed. Patients with two or more injured knee ligaments requiring surgical reconstruction, including the ACL, were selected. Statistical analyses were performed using R.

RESULTS: Overall, 231 knees with MLKIs underwent ACLR, with 10% (n=24) requiring revision ACLR. There were no significant differences in age, sex, smoking, diabetes, or BMI between revision ACLR and primary ACLR groups. When comparing patients with revision ACLR to primary ACLR: revision ACLR had longer follow-up duration (47 vs. 37 months, $p=0.004$), more ligament reconstructions/repairs (3 vs. 2, $p<0.001$) and more graft reconstructions (4 vs. 3, $p<0.001$). Patients in both groups had similar return to work ($p=0.17$) and activity ($p=1$) levels. Patients who had revision ACLR took longer to return to work at their highest level (18 vs. 12 months, $p=0.036$), but similar time to return to their highest level of activity ($p=0.33$). Range of motion (138 vs. 130 degrees, $p=0.14$), pain scale (2.5 vs. 1, $p=0.24$) and Lysholm scores (91 vs. 90, $p=0.24$) at final follow-up were similar between groups.

CONCLUSIONS: Patients requiring ACLR in the setting of a MLKI have good overall outcomes, with patients requiring revision ACLR at a rate (10%) only slightly higher than that of isolated ACLR. Patients requiring revision ACLR had similar final outcome scores to those who did not require revision; however, patients requiring revisions were likely to require more overall surgeries and other ligament reconstructions.

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KNEE

Five-Year Outcomes of Cementless Total Knee Arthroplasty

Poster 088

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INTRODUCTION: Cemented total knee arthroplasty (TKA) has served as the gold standard for end stage knee arthritis with excellent long term survivorship. With increased life expectancy, younger and obese patients undergoing TKA along with improvements in implant design and polyethylene, there has been great interest in the use of cementless TKA. The purpose of this study was to report mid-term outcomes and complications following cementless primary TKA.

METHODS: This was a retrospective study using a total joint database of patients with a posterior stabilized (PS) cementless TKA that had a minimum 5-year follow-up. There were 896 patients (604 females and 292 males) with a mean follow-up of 65.9 months, mean age of 65.4 years and mean BMI of 32.8 kg/m^2. All TKAs used in this study consisted of cementless tibial and femoral PS implants with hydroxyapatite coating. All patients were evaluated at postoperative intervals (2 weeks, 2 months, 6 months, 1 year, 2 years, and 5 years). Clinical outcomes, Knee Society scores, and radiographic measures were evaluated through final follow-up.

RESULTS: The average range of motion at latest follow up was 0 – 123 degrees. 13 patients had revision surgeries with infection being the most common reason (0.67%). There were 2 cases of aseptic loosening of the tibial component (0.22%). There were no cases of femoral component loosening. There were 3 patella component failures (0.33%). Other complications included neurologic palsy and chronic neurogenic pain (1.12%) with contracture, quad rupture, DVT, PE, and popliteal artery injury all less than 1%.

DISCUSSION: Primary TKA using PS cementless hydroxyapatite-coated implants demonstrated excellent results at a minimum 5-year follow-up in this study. With increasing life expectancy, modern design implants and improvement in polyethylene, cementless TKA, with its advantage of long-term biologic fixation, is an alternative to mechanical fixation with cement.

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External Validity of a New Prediction Model for Patient Satisfaction After Total Knee Arthroplasty

Poster 089

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INTRODUCTION: The ability to identify patients at risk of dissatisfaction after total knee arthroplasty (TKA) remains elusive. A recently published prediction model was reported to correlate strongly with patient satisfaction 3 months after TKA. This study's purpose was to determine the external validity of this model with the hypothesis that it would achieve similar predictive success.

METHODS: A 10-question Patient Satisfaction Prediction Model (PSPM) statistically derived from five patient-reported outcome questionnaires was tested for external validity in this prospective cohort investigation. The PSPM incorporates gender, age, and previously validated questions addressing pain, stiffness, noise, and pain catastrophizing, with a score of 20 or greater predictive of satisfaction. From October 2017 to February 2018, 145 patients (59% female, age 64.9, BMI 32.5) undergoing primary TKA for a diagnosis of osteoarthritis were administered the PSPM preoperatively. As in the original study, the 2011 Knee Society Score patient satisfaction subscale (KSS) was collected at 90 days postoperatively as the measure of satisfaction (range 0-40; 20 or greater = satisfied, less than 20 = dissatisfied). A Bland-Altman analysis of agreement between the PSPM and KSS scores was performed. Power analysis indicated 124 subjects necessary to demonstrate a correlation of 0.25 with 80% power and 0.05 considered significant.

RESULTS: Age and gender were not different between our study cohort and patients in the original publication ($p=0.8$ and 0.5), but BMI was increased in our study cohort (32.5+ 6.8 vs. 29.3+ 4.8, $p<0.001$). Of 145 patients enrolled, 133 were satisfied (91.0%) and 12 dissatisfied (8.3%) at 90 days postoperatively based on their KSS. The mean PSPM score was 27.6+4.2 and KSS was 31.2+7.7 ($p<0.001$). The mean difference between scores was 3.6 + 8, but with a 95% CI of -13.5 to 20.8 signifying almost no correlation between the two scoring systems ($r = -0.009$). The PSPM did not predict any of the 12 patients categorized as dissatisfied postoperatively. In addition, the PSPM falsely predicted 5 patients to be dissatisfied, of which 4 actually had a maximum KSS of 40 postoperatively.

CONCLUSIONS: A previously published and internally validated 10-question PSPM was unable to predict patient satisfaction after TKA in our external study population. This study emphasizes the difficulty of developing a simple, but robust questionnaire that consistently predicts patient satisfaction after TKA.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
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Utilizing the Time Trade-Off, Standard Gamble and Willingness to Pay Utility Measures to Evaluate Health-Related Quality of Life Prior to Knee or Hip Arthroplasty

Poster 090

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INTRODUCTION: The time trade-off, standard gamble and willingness to pay scores assess the number of years, risk of death, and income a patient would be willing to give up for perfect health. These questions were used as a proxy to assess the impact a patients' knee arthritis, hip arthritis or failed total knee (TKA) or hip arthroplasty (THA) had on quality of life as compared to other common health conditions.

METHODS: Time trade-off, standard gamble, willingness to pay and Short-Form-12 (SF-12) surveys were administered to 360 patients including 176 undergoing primary TKA, 127 primary THA, 31 revision TKA and 26 revision THA. Time trade-off and standard gamble scores were calculated as perceived quality of life with 1.0 suggesting perfect health and 0 suggesting preference for death rather than living in current state. Willingness to pay is the percentage of yearly income they would pay for perfect health. Statistical analysis involved an analysis of covariance with 0.05 considered significant.

RESULTS: The mean time trade-off, standard gamble and willingness to pay scores were 0.74 (95% CI: 0.71-0.77), 0.83 (95% CI: 0.81-0.85), and 32% (95% CI: 30-35%) without significant difference between primary THA, TKA and the revision procedures with the numbers available for study ($p= 0.16$, 0.31 and 0.41, respectively). Age ($p = 0.012$), gender ($p = 0.005$), body mass index (BMI; $p = 0.002$), and short-form 12 physical scores (0.029) were different between procedures, but BMI was the only statistically significant confounder and was only related to time trade-off scores ($p = 0.014$).

CONCLUSION: Patients undergoing primary and revision THA and TKA were willing to accept 17% risk of death, lose 2.6 years of an additional 10-year life expectancy, and pay nearly one-third of their income for perfect. Their time trade-off scores (0.74) were similar to patients with history of acute myocardial infarction (0.74) or minor stroke (0.72) and worse than those with chronic hepatitis C infection (0.83) or HIV/AIDS (0.86) as reported in the literature. These data highlight the value of adult reconstructive procedures.

Back

The Lack of Bone on Bone Contact in the Medial Compartment Should not be a Strict Contraindication for Mobile-Bearing UKA

Poster 091

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INTRODUCTION: Previous papers have recommended that mobile bearing unicompartmental knee arthroplasty (UKA) only be performed in patients with bone on bone arthritis. The purpose of this study was to compare the survivorship free of revision and clinical outcomes of mobile-bearing UKA in patients with bone on bone arthritis to patients with severe arthritis but no bone on bone contact preoperatively.

METHODS: We retrospectively reviewed a single surgeon's experience with medial compartment mobile bearing UKA in 223 patients (271 knees) implanted between 2007-2015. Preoperative standing AP radiographs were used to classify patients based on their IKDC osteoarthritis grade, and we separated patients with Grade D arthritis with bone on bone contact (group 1) and patients with Grade D arthritis but no bone on bone contact (group 2). There were 81 patients (94 knees) in group 1 and 81 patients (90 knees) in group 2. Survivorship free of revision between these groups was determined using Kalan-Meier curves. Functional outcomes were assessed using the knee society pain and function scores.

RESULTS: There were no significant differences between the groups in terms of age, gender, or body mass index. There were 5 (5.3%) revisions in group 1 and 2 (2.2%) revisions in group 2. The survivorship free of revision was 94.8% for patients in group 1 and 97.6% in group 2 ($p= 0.43$). The mean pain and function scores for group 1 were 80.3 (44-98) and 82.9 (14-100), respectively. The mean pain and function scores for group 2 were 79.3 (31-97) and 81.5 (30-100). There were no significant differences between the knee society pain ($p= 0.48$) and function scores ($p= 0.64$) between the two groups.

DISCUSSION AND CONCLUSION: The presence of less than 2 mm of joint space, but with lack of bone-on-bone arthritis should not be a contraindication for mobile-bearing UKA.

Posterior Cruciate Ligament Resection Does Not Consistently Increase the Flexion Space in TKA as Previously Thought: In Vivo Study in U.S. Patients

Poster 092

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INTRODUCTION: The effect of posterior cruciate ligament (PCL) sacrifice on tibiofemoral flexion gap opening in total knee arthroplasty (TKA) has been reported to be 3.8-4.8 in modestly sized cohorts of Asian patients. Further, conventional knowledge and understanding of flexion space opening with PCL resection is based on historical cadaveric studies. The purpose of this study was to compare the tibiofemoral flexion space dimension before and after PCL resection in an American cohort.

METHODS: Tibiofemoral joint space measurements were made in 33 patients undergoing TKA. A medial parapatellar approach, computer navigation, and provisional tibial and femoral bone cuts were performed in all cases. The tibiofemoral gap was measured at full extension, 45 degrees, and 90 degrees of flexion using a calibrated tensioning device, and then repeated after complete PCL resection in vivo prior to any further releases. Paired-t tests were used to compare groups with $p \leq 0.05$ as significant.

RESULTS: Most patients were female (22/33), with a mean age and BMI of 70 years and 34.0 kg/m^2, respectively. After PCL resection, the extension space opened a mean 0.3 mm (range, 0-2 mm; $p=0.01$), the mid-flexion gap at 45 degrees opened a mean of 1.0 mm (range, 0-3 mm; $p<0.001$) and the flexion gap at 90 degrees opened a mean 2.1 mm (range, 0-5 mm; $p<0.001$). The 90 degree flexion space opened <1 mm in 39% (13/33) of patients.

CONCLUSION: The tibiofemoral joint space increases progressively from extension, to mid-flexion through 90 degrees flexion after PCL resection and was substantially less than observed in Asian patients. However, large variation in the degree of flexion space opening was observed among patients with some failing to increase their 90-degree flexion space whatsoever with PCL resection. This runs counter to conventional understanding and teaching and should be considered in surgical techniques and education to enact optimal tibiofemoral gap balance when performing TKA.

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A Multi-Center Randomized Clinical Trial of Tranexamic Acid in Revision Total Knee Arthroplasty: Does the Dosage Regimen Matter?

Poster 093

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INTRODUCTION: Tranexamic acid (TXA) significantly reduces blood loss following total knee arthroplasty (TKA), but there data on the impact of different dosing regimens in revision TKA is limited. The purpose of this multi-center randomized trial was to determine the optimal regimen of TXA to minimize blood loss in patients undergoing revision TKA.

METHODS: A total of 233 septic and aseptic revision TKA from six U.S. centers were randomized to one of 4 arms: 1g of IV TXA prior to incision, 1g of IV TXA prior to incision and 1g IV TXA at wound closure, 1g of IV TXA prior to incision and 1g of topical TXA intraoperatively, or three doses of 1950mg oral TXA given 2 hours preoperatively, 6 hours postoperatively, and the morning of postoperative day 1. Randomization was performed based on type of revision (femoral component exchange, tibial component exchange, both component exchange, explant of both components and placement of antibiotic cement spacer, a second stage re-implantation procedure, or conversion of UKA to TKA) to ensure equivalent distribution among groups. Power analysis determined that 40 patients per group were necessary to identify a 1g/dL difference in reduction of hemoglobin with an alpha of 0.05 and 80% power. Statistics were performed with regression analysis and two, one-sided t-tests for equivalence using per-protocol analysis.

RESULTS: One patient withdrew, 3 canceled surgery, 16 were screen failures, and 17 did not receive the assigned treatment, leaving 196 patients for analysis. There was no significant difference in reduction in hemoglobin amongst treatment groups (2.88g/dL for oral TXA, 2.79g/dL for single-dose IV TXA, 2.59g/dL for combined IV/topical TXA, and 2.58g/dL for double-dose IV TXA; p=0.48). Similarly, calculated blood loss (p=0.63) and transfusion rates (4.1% for oral TXA, 6.0% for single-dose IV TXA, 2.1% for combined IV/topical TXA, and 2.1% for double-dose IV TXA; p=0.78) were not significantly different between groups. Finally, equivalence testing showed all possible pairings were statistically equivalent.

CONCLUSIONS: Despite the higher risk of blood loss in revision TKA, all TXA regimens tested had equivalent blood-sparing properties. Surgeons should consider using the lowest effective dose and the least costly regimen (cost of a oral TXA dose is $14 compared to $47 to $108 for a dose of IV and topical formulations) for TXA use in revision TKA.

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Evaluation of Obesity Measures in Relation to Clinical Outcomes in Total Knee Arthroplasty, A Prospective Study

Poster 094

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INTRODUCTION: Body mass index (BMI) is currently an inconsistent indicator for postoperative complications in total knee arthroplasty (TKA) outcomes. The purpose of this study was to investigate whether pre- and intraoperative central and subcutaneous adiposity measurements could predict patients at high risk for complications and poor functional outcomes following primary TKA.

METHODS: Sixty-six patients were prospectively enrolled in this cohort study. Three preoperative measurements taken were waist circumference at the level of L4, hip circumference at the apex of the gluteus maximus, and skin fold thickness lateral to the patella. Intraoperatively, the depths of the incision proximal and distal to the patella were measured. Additionally, BMI, radiographic pre-patellar measurements, and Kellgren Lawrence classifications were recorded. Patient outcome measures included operating room (OR) time, peri-operative complications within 90 days of surgery, and the increase from the baseline preoperative Knee Injury and Osteoarthritis Outcome Score (KOOS) to the postoperative KOOS at 6 weeks. Pearson correlations were used to assess relationships between pre- and intraoperative measurements and outcome measures. Linear regression analysis was used to identify significant predictors of patient outcomes.

RESULTS: Mean BMI was 35.25 (SD 9.01). Bivariate analysis showed significant positive correlations between BMI and OR time (R=.355; p=0.005, n=61) and waist-height ratio and OR time (R=.344; p=0.007, n=61). However, no significant correlations were found between any of the measures of weight and complications or KOOS score increase. Additionally, no significant correlations were found between the radiographic measurements and complications (R=-0.155; p=0.221, n=64) or KOOS score increase (R=-0.04; p=0.851, n=25). Linear regression analysis failed to find independent associations between either BMI or waist-height ratio and OR time.

CONCLUSION: Incision thickness, waist-hip and waist-height ratios, and radiographic measurements are not better predictors than BMI of functional knee scores or complications following primary TKA.

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Early Results of a Modern, Uncemented Total Knee Arthroplasty System

Poster 095

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INTRODUCTION: First-generation cementless technology, introduced decades ago, was found to be associated with implant settling and early total knee arthroplasty (TKA) failure. These failures, believed to be due to poor implant design, led to cemented TKA becoming the "gold standard". Implant manufacturers have since introduced newer, second-generation, uncemented technology that relies on a "press-fit" for early stability and includes a highly-porus tantalum or titanium coating to encourage long-term bony in-growth. Despite these technological advancements, early data has been limited. The purpose of our study was to compare the early results of a specific second-generation uncemented TKA implant to those of a cemented implant from the same manufacturer. We hypothesized that the uncemented implants would have equivalent early outcomes when compared to cemented implants without the early loosening and implant failure seen with first-generation uncemented TKA.

METHODS: To assess early outcomes of new uncemented implants, 252 of our patients in the Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI) database were reviewed. Inclusion criteria included the use of the Triathlon total knee arthroplasty system. Both cruciate retaining as well as posterior stabilized designs were included. Ninety-day outcomes were compared between uncemented knees and an age-matched group of cemented knees. Demographics, co-morbidities, length of stay, complications, ER visits, discharge disposition, readmission data, and financial data were reviewed. Fisher's exact tests were used for categorical data and paired t-tests were used for continuous data.

RESULTS: Uncemented knees had shorter length of stay (1.58 vs. 1.87, $p<0.0001$), were more frequently discharged home (90.48% vs. 68.75%; $p<0.0001$), and used less home care or extended care facilities (6.35% vs. 19.14%, $p<0.0001$; 2.78% vs. 11.72%, $p=0.0001$). During the 90-day follow-up, more patients with uncemented knees had no complications. Moreover, there were no reoperations in patients with uncemented knees, compared to the 19 reoperations in those with cemented knees and more manipulations (14 vs. 0, $p=0.0028$). Of patients with knee injury and osteoarthritis outcome scores (KOOS), uncemented scored higher than aged matched counter-parts (63.69 vs. 47.10, n=85 and 43, $p<0.0001$). Similarly, uncemented knees scored higher on Patient-Reported Outcomes Measurement Information System (PROMIS) T-physical and T-mental (44.12 vs. 39.45, n=95 and 59, $p<0.0001$; 51.84 vs. 47.82, n=97 and 59, $p=0.0018$). The cost of the surgery for uncemented knees was significant lower. Additionally, while there was no was no difference between the groups in terms of 90-day readmission costs or 90-day outpatient costs, the total 90-day cost was significantly lower for uncemented patients by over $1,300.

DISCUSSION: While the use of second-generation uncemented TKA implants has increased, data on their outcomes have been limited. Our study suggests that patients receiving an uncemented TKA have

a shorter length of stay, higher rate of discharge to home, better knee-specific outcome measures, fewer complications, and fewer reoperations than an age-matched group of patients receiving a similar, cemented TKA. Significance: Uncemented TKA, when successful, can lead to a long-lasting, biologic interface for an increasingly younger group of patients undergoing TKA, however, concerns remain about the potential for early loosening. The results of our study should alleviate fears of early failure, complications or poor outcomes with the use of a modern, second-generation, uncemented TKA.

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The Effect of Tourniquet Use and CO2 Preparation on Cement Penetration in Primary Total Knee Arthroplasty

Poster 096

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INTRODUCTION: Tourniquetless total knee arthroplasty (TKA) is experiencing resurgence in popularity due to potential pain control benefits. Further, optimal cement technique and implant fixation remain paramount to long-term cemented TKA success, as aseptic loosening continues to be a leading cause of revision. The purpose of this study was to determine how tourniquet use and/or novel bone preparation using sterile, compressed carbon dioxide (CO2) gas affected cement penetration in TKA.

METHODS: A retrospective review was performed on 303 consecutive primary TKAs of the same implant with identical perioperative protocols including tranexamic acid. Surgical technique varied only by whether a tourniquet and/or compressed CO2 gas bone preparation was used. This yielded three cohorts: (1) tourniquet only, (2) tourniquetless and CO2, (3) tourniquet and CO2. The tourniquet was not inflated at any time in the tourniquetless group, not even during cementation. Cement penetration was measured by two independent, blinded raters across the seven Knee Society Radiographic Evaluation System zones on anterior-posterior (AP) and lateral radiographs.

RESULTS: The three groups did not differ on age, body mass index, or proportions of sex or index leg ($p \geq 0.100$). Tibial AP Zone 2 ($p=0.007$) and Femoral Lateral Zones 3A and 3P ($p=0.034$ and 0.039, respectively) showed significantly more cement penetration for one of the groups that used CO2 gas compared to tourniquet only. In all zones, groups with CO2 gas used as bone preparation always showed equivalent or greater cement penetration compared to the tourniquet only group.

CONCLUSION: Bone prepared with CO2 gas showed significantly greater cement penetration in the three zones where bone tends to be more cancellous ($p \leq 0.039$). The results suggest the use of CO2 gas for bone preparation may achieve equivalent or greater cement penetration without the clinical risks of pain and quadriceps weakness using a tourniquet.

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What is the Role of Posterior Cruciate Ligament Integrity with Ultra-Congruent Tibial Inserts in Conforming Bearing Total Knee Arthroplasty?

Poster 097

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INTRODUCTION: Conforming and ultra-congruent bearings are the fastest growing tibial polyethylene in modern total knee arthroplasty (TKA), with many abandoning cam-post mechanisms of traditional posterior stabilized designs. While some conforming TKA bearings are designed for posterior cruciate ligament (PCL) resection, others are intended for PCL preservation. The purpose of this study was to determine (1) if patient reported outcomes differ in conforming bearing TKA with or without the PCL and (2) whether PCL release is affected by implant tibial slope.

METHODS: A retrospective review of 400 consecutive primary conforming bearing TKAs in a prospectively collected database was performed. All TKAs were performed with identical standardized perioperative protocols. A measured resection, posterior referencing technique targeting the native tibial slope was performed and PCL release titrated to enact symmetric measured flexion-extension gap balance. PCL resection/preservation was recorded, native and tibial implant slope were measured radiographically and minimum 1-year outcome scores obtained. Statistical analysis was performed with $p < 0.05$ significant.

RESULTS: After exclusions for confounds, 365 TKAs were analyzed. Mean age and BMI was 67.3 years and 33.8 kg/m^2, respectively. The PCL was preserved in 71.5% of TKAs. A mean native tibial slope of 8.2° was decreased to 6.7° postoperatively and surprisingly, increasing slope correlated with PCL release ($p=0.037$). There was no difference in UCLA scores, pain with level walking, pain with stairs and KOOS Jr. scores between groups ($p>0.1$) with numbers available; however, 70% of TKAs with PCL released stated their TKA “always” felt normal at minimum follow-up, compared to only 46% in those with PCL preserved ($p=0.07$).

CONCLUSION: These data suggest that conforming tibial bearing TKA perform optimally by avoiding increasing tibial slope beyond native and by resection of the PCL. This may optimize function by avoiding kinematic conflict between the tibiofemoral conformity and the intact PCL.

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Variability in Physical Therapy Protocols for Patellar Tendon and Quadriceps Tendon Rupture and Repair

Poster 098

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INTRODUCTION: In the case of both partial and complete rupture of the patellar tendon, physical therapy is indicated and critical for the complete recovery of the patient. The AAOS agrees that the type of exercises and the exact timeline for physical therapy will be individualized to the patient. Despite the importance of physical therapy in the management of patellar tendon injuries, there is a paucity of evidence-based studies that investigate the effect of various types of physical therapy protocols. The purpose of this study was to evaluate the variability in PT protocols amongst ACGME-accredited orthopedic programs.

METHODS: A list of PT rehabilitation protocols from ACGME-accredited academic orthopedic surgery programs was gathered. Additionally, the first ten protocols identified by the Google search engine for the term “patellar tendon repair physical therapy protocol” was also included. All protocols affiliated with a specific orthopedic surgery department at a given institution were evaluated for various components of immobilization and rehabilitation, such as time to first PT session, PT frequency per week, and weeks of no ROM. Additionally, the following parameters were analyzed at various time points: weight bearing status, brace ROM, PT ROM goals, therapeutic and functional exercises, and progression criteria. Protocols were excluded if they were not specific to patellar tendon repair or patellar and quadriceps tendon repair or if they lacked progression criteria with specific time points.

RESULTS: Of the 155 protocols identified from the ACGME programs and the ten non-academic protocols identified via Google search, a total of 28 protocols fit the inclusion criteria. The range, mean and mode were measured for the parameters listed in the methods. The average ROM at 2 weeks postoperative was 29 degrees, with a range of 0-90; average ROM at 6 weeks was 87 degrees, with a range of 70-90; average ROM at 12 weeks was 119 degrees with a range of 110-120.

DISCUSSION/CONCLUSION: This study found that there is significant variation in the PT protocols implemented by various ACGME-accredited programs. While it is imperative that each patient has an individualized protocol, it is equally critical that there is some level of standardization in order maximize the benefit to patients across the country.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
KNEE

Time to Set of Bone Cement with Varying Temperature of Irrigation

Poster 099

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NTRODUCTION: The use of bone cement is common in Adult Joint Reconstruction with respect to the proximal tibia, distal femur prosthesis in total knee arthroplasty, and femoral component in total hip arthroplasty. There is anecdotal evidence that using warmed irrigation during the curation of cement speeds the process.

METHODS: Twenty-eight batches of cement were mixed separately, then half allowed to set in room temperature water (72° F) and the other in standard warmed water (106° F). The time (seconds) cement was fully set was recorded and temperature at set time.

RESULTS: Two different manufactures cement used each were similar in the times and temperatures observed. The range of temperatures observed while at the time of cement set for room temperature saline was mean 70.4° F and warm saline mean 98.3° F. The time to set for warm water was a mean 5 minutes (min) 32 (sec); while the time to set for the room temperature water group was 12 minutes and 51 seconds, p value of < 0.001. There range of temperatures observed while at the time of cement set for room temperature saline was mean 70.4° F (66.9 – 72.9) SD 1.50 and warm saline mean 98.3° F (94.9 – 107.2) SD 2.79. The values for time to set with combined groups are illustrated in chart 1, the students t test was used to calculate for significance of differences with a p value of < 0.001. The time to set for warm water was a mean 5 minutes (min) 32 (sec); while the time to set for the room temperature water group was 12 minutes and 51 seconds.

DISCUSSION AND CONCLUSIONS: Time to set was considerably less (7 min and 19 sec) with the warmed water, and temperature at time of set was well below recognized temperature for osteonecrosis. Using warmed water produced a more consistent time to set. The use of warm water is safe and consistent with respect to cement hardening. We conclude that the use of warmed irrigation is both safe and efficacious for use during the setting process of bone cement.

MAOA POSTER PRESENTATIONS – 2019 ANNUAL MEETING
KNEE

Solid Organ Transplantation Increases Wound Complications and Early Revision Surgery After Primary TKA

Poster 100

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INTRODUCTION: With improvements in patient selection, perioperative care and immunosuppression, life expectancy after solid organ transplantation continues to improve. These patients may develop symptomatic osteoarthritis and be indicated for TKA; however, few studies have examined the risk of postoperative infection and early revision surgery. The purpose of this study was to compare the odds of postoperative infection and revision following TKA using a large commercial insurance database.

METHODS: The PearlDiver Research Program was utilized to query the Humana, Inc administrative claims database from 2007-2016. Patients who underwent primary TKA were identified using the CPT code 27447. ICD version 9 and 10 codes were used to identify patients with a prior kidney, liver, or pancreas transplantation. Periprosthetic joint infection (PJI), wound complications, and revision TKA occurring in the 6 months after TKA were identified using ICD-9, ICD-10, and CPT codes. Patients undergoing bilateral TKA or who were not in the database for the entire study period were excluded. Odds ratios were calculated by comparing transplant TKA patients to those who underwent primary TKA without prior organ transplant.

RESULTS: 78,755 patients who underwent primary TKA were identified. 155 had prior solid organ transplant and kidney was the most commonly transplanted organ (116/155, 74%). There were no differences in OR for PJI with prior solid transplant (OR: 1.8 [0.7-4.9], p=0.24). Odds of wound complications were higher in patients with organ transplant (OR: 4.2 [2.6-6.8], p<0.0001). Patients with solid organ transplant also had a higher odds of revision surgery within 6 months of index TKA (OR: 5.6 [2.5-12.8], p<0.0001].

CONCLUSIONS: Patients with prior solid organ transplant have a 4-fold increased risk of wound complications and a 5-fold increased risk of early revision surgery after primary unilateral TKA. We did not find increased risk of PJI in this patient population.

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Campfield, Brian D.	n
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Clark, Nicholas J.	n
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Cloran, Francis	n
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Giambini, Hugo	n
Gilbert, Shawn R.	n
Gillespie, Robert J.	2, 3b – DJ Orthopaedics; 3b – Shoulder Innovations
Gilot, Gregory	1 – Exactech, Inc., Zimmer; 2, 3b – DJ Orthopaedics
Glass, Natalie A.	n
Gleason, Scott	n
Glogovac, Georgina	n
Goitz, Henry T.	n
Goldstein, Jeffrey M.	2 – DePuy, a Johnson & Johnson Company
Goldstein, Wayne M.	1 – Smith & Nephew, Innomed; 1, 3b – DePuy, a Johnson & Johnson Company
Gonzalez, Mark H.	1 – Biomet, Johnson & Johnson, Zimmer; 3b – Smith & Nephew; 4 – Ortho Sensing Technology
Goodwin, Ryan C.	3b – K2M, Orthopediatrics, Stryker
Gordon, Alexander C.	3b, 4, 5 - OrthoSensor
Goyal, Kanu S.	n
Gradisar, Ian M.	3b – Exactech, Inc.
Graham, R. David	n
Grauer, Jordan	n
Grawe, Brian M.	n
Graziano, Gregory P.	3c – Medtronic Sofamor Danek
Greene, Joseph W.	3b – Arthrex, Inc.; 3b, 3c - Zimmer
Gregory, James R.	n
Griffith, Timothy B.	n
Guanciale, Anthony F.	n
Guattery, Jason	n
Gudeman, Andrew S.	n
Gulledge, Caleb M.	n

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DISCLOSURES

Gupta, Asheesh G.	n
Gurd, David P.	n
Guthrie, S. Trent	n
Habermann, Elizabeth B.	n
Hagan, David	n
Hagmeijer, Michella	n
Hajewski, Christina J.	n
Hakeos, William M.	n
Halawi, Mohammad J.	n
Hall, Jacob T.	n
Hall, James R.	n
Hamilton, Alex	n
Hammarstedt, Jon E.	n
Hanley, Jessica M.	n
Hannon, Charles P.	3b - ExplORer
Hansen, Benjamin	3a – Forest Pharmaceuticals, Myriad Genetics
Hanssen, Arlen D.	1 – Stryker; 7 - Elsevier
Harms, Kelly A.	n
Harold, Ryan E.	n
Harris, Joshua D.	2, 3b – Ossur; 2, 3b, 5 – Smith & Nephew; 3b – NIA Magellan; 5 – DePuy, a Johnson & Johnson Company; 7 – SLACK Incorporated
Hart, Adam	n
Hart, Radek	n
Hartigan, David E.	3b – Arthrex, Inc.
Hartley, Brandi R.	n
Hartline, Jacob T.	n
Hartman, Curtis W.	2, 3b, 5 – Smith & Nephew; 5 – Pfizer
Hartwell, Matthew J.	n
Harwin, Steven F.	1, 2, 3b, 4 – Stryker: 7 – Thieme, Inc., Journal of Knee Surgery, Journal of Hip Surgery
Hashmi, Sohaib Z.	n
Hassan, Maaz	n
Havey, Robert M.	n
He, Jun Kit	n
Heddings, Archie A.	n
Heenan, G. Matthew	n
Heiden, Eric	1, 3b – Genesis Innovative Group
Heidenreich, Mark J.	n
Heimdal, Tyler	n
Heindel, Koan J.	n
Helfrich, Mia	n
Hendrickson, Nathan R.	n
Hernandez, Clair	n
Hernandez, Fernando A. H.	n
Hernandez, Nicholas M.	n
Herzing, Karen	n
Hess, Matthew C.	n
Hettrich, Carolyn M.	n

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DISCLOSURES

Hevesi, Mario	n
Hewett, Timothy E.	n
Hidden, Krystin A.	n
Higuera, Carlos A.	2, 3b, 5 – KCI; 3b – Pfizer, TenNor Therapeutics Limited; 3b, 5 – Zimmer; 4 – PSI; 5 – 3M, CD Diagnostics, Cempra, Cymedica, Ferring Pharmaceuticals, OREF, Orthofix, Inc., Stryker
Hill, Brian W.	n
Hoegler, Joseph J.	n
Holloway, Calvin P.	n
Holt, Andrew M.	n
Holt, Joshua B.	n
Holte, Andrew J.	n
Holte, Pamela K.	n
Holy, Filip	n
Horberg, John V.	n
Horinek, Jeffrey L.	n
Horst, Patrick	3a – Arthrex, Inc.
Horton, Greg A.	1 – Wright Medical Technology, Inc.; 1, 6 – Acumed, LLC; 3b – Stryker; 3c – Arthrex, Inc.
Hosseinzadeh, Pooya	n
Houdek, Matthew T.	n
Hsu, Alan	n
Hsu, Wellington K.	1, 3b – Stryker; 3b – Allosource, Bioventus, Medtronic Sofamor Danek, Mirus, Nuvasive, Wright Medical Technology, Inc.; 5 - Medtronic
Huddleston, Paul M., III	n
Hudson, Brittany	n
Hudson, Parke W.	n
Hughes, Jessica L.	6 – Arthrex, Inc., DJ Orthopaedics, Globus Medical, Stryker, Synthes, Zimmer
Hughes, Jonathan D.	6 – Arthrex, Inc., DJ Orthopaedics, Exactech, Inc., Globus Medical, Stryker, Synthes, Zimmer
Hulse, Trent	n
Huntley, Samuel R.	n
Hurley, Richard	n
Husman, Regina	n
Hyde, Zane B.	n
Hymes, Robert	3b – Pacira, Stryker; 5 - Synthes
Hynan, Linda	n
Iannotti, Joseph P.	1 – Arthrex, Inc., DePuy Synthes, Tornier; 1, 2, 3b – DJ Orthopaedics; 4 – Custom Orthopaedic Solutions; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Incavo, Stephen J.	1 – Innomed, Kyocera, OsteoRemedies, Smith & Nephew, Wright Medical Technology, Inc., Zimmer; 4 – Nimbic Systems
Inouye, Sandra	n
Israel, Heidi	n
Ivanov, David	n
Jabara, Justin T.	n
Jacofsky, David J.	5 – Biomet, Johnson & Johnson, Smith & Nephew, Stryker; 7 – SLACK Incorporated

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DISCLOSURES

Jain, Nikhil	n
Jain, Sonu A.	4 – Allergan; 5 - Axogen
Jamieson, Marissa D.	n
Jastifer, James R.	3b - Stryker
Jaykel, Matthew N.	n
Jenkins, Tyler J.	n
Jha, Aaradhana	n
Jianguang, Peng	n
Jildeh, Toufic R.	n
Johnson, Bailey E.	n
Johnson, Daniel J.	n
Johnson, John L.	n
Johnson, Luke	n
Johnson, Mary Ann	n
Jonard, Brandon W.	n
Jones, Alvin C.	n
Jones, Clifford B.	1 – Lippincott; 1, 3b – OsteoConcentric; 2, 3b – Stryker;
Jones, Grant L.	5 – OrthoSpace; 6 – Musculoskeletal Transplant Foundation
Jones, Jaclyn M.	n
Jones, Travis J.	n
Jorgensen, Anton Y.	n
Ju, Minseon	n
Jue, Greg	n
Julka, Abhishek	n
Jupiter, Daniel C.	n
Kaar, Scott G.	n
Kadado, Allen A.	n
Kadri, Omar	n
Kaeding, Christopher C.	3b, 5 – Active Implants, Smith & Nephew; 5 – DJ Orthopaedics
Kafchinski, Lisa	n
Kakar, Sanjeev	3b – Arthrex, Inc.; 4 – Sonex Healthcare
Kalagara, Saisanjana	n
Kalainov, David M.	n
Kalra, Rishi	n
Kamath, Atul	1 – Innomed; 2 – Corin USA; 2, 3b – Heraeus Medical; 2, 3b, 4, 5 – Zimmer; 2, 3b, 5 – DePuy, a Johnson & Johnson Company; 3b – Pacira Pharmaceuticals; 4 – Johnson & Johnson, Proctor & Gamble; 5 – Orthofix, Inc.
Kane, Patrick A.	n
Kang, Jason R.	n
Kannan, Abhishek S.	n
Kanney, Jill	n
Kantor, Ariel	n
Karam, Matthew D.	4 – Iowa Simulation Solutions, LLC, Mortise Medical LLC
Karas, Vasili	n
Kattan, Michael	3b – Norvartis; 5 – Novo Nordisk, Otsuka
Kay, Kathleen	n
Keeney, James A.	3b – DePuy, a Johnson & Johnson Company, Flexion Therapeutics

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DISCLOSURES

Kelly, Anne M.	n
Kelly, Derek M.	2- Medtronic; 3b – WishBone Surgical; 7 – Elsevier Health
Kelly, Mick P.	n
Kennedy, Nicholas I.	n
Kha, Stephanie	n
Khalil, Lafi	n
Khan, Safdar N.	n
Khazi, Zain M. Z.	n
Khazzam, Michael S.	2, 3b, 5 – Wright Medical Technology, Inc.
Kheir, Matthew	n
Khlopas, Anton	n
Killen, Cameron J.	n
Kim, Christopher	n
Kim, Jeffery	n
Kim, Walter	n
Kirchner, Graham E.	n
Klag, Elizabeth A.	n
Klein, Sandra E.	n
Klika, Alison K.	n
Knapik, Derrick M.	n
Koen, Sandra	n
Kogan, Monica	n
Koh, Jason L.	3a, 4 – Marrow Access Technologies; 3b – Flexion; 3b, 4 - Acuitive
Kolaczko, Jensen	n
Kolowich, Patricia A.	n
Kolz, Joshua M.	n
Komzak, Martin	n
Konicek, John	3a – Arthrex, Inc.
Kozlowski, Ryan J.	n
Kraus, Kent R.	n
Krebs, Viktor E.	1, 2, 3b - Stryker
Krishnamurty, Anil B.	n
Krumm, Drew B.	n
Krych, Aaron J.	1, 3b, 5 – Arthrex, Inc.; 3b – JRF Ortho, Vericel; 5 – Aesculap/B. Braun, Arthritis Foundation, Ceterix, Histogenics
Kuivila, Thomas E.	n
Kukreja, Promil	n
Kuldjanov, Djoldas M.	n
Kunze, Kyle N.	n
Kurian, Emil B.	n
Kurland, Robert L.	n
Lacci, John V.	n
Lack, William D.	n
LaCorda, John	n
Lall, Ajay C.	6 – Smith & Nephew, Stryker
Lambert, Bradley	n
Lane, Mark K.	n
Lansing, Shan	n

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DISCLOSURES

Larrison, Matthew	n
Larson, A. Noelle	3b – K2M, Orthopediatrics
Larson, Dirk	n
Larson, Evan P.	n
Laseter, Joseph	n
Laughlin, Richard T.	2 – AO North America, Smith & Nephew, Synthes; 3b – Premier Health Partners Orthopaedic Institute, South Surgery Center, LLC, World Arthrosis Organization; 3c – Community Tissue Bank; 5 – AOFAS (Grants), Ohio Third Frontier, OTA, Wright State University Boonshoft School of Medicine
Lawler, Ericka A.	n
Lawton, Cort D.	n
Le, Daniel T.	3b – MicroPort Orthopedics
Leafblad, Nels D.	n
Leary, Emily V.	n
Lee, Julia	n
Lee, Kyla R.	n
Lee, Sung	n
Lehman, Thomas P.	n
Lehtonen, Eva J.	n
Leland, Devin P.	n
Leontovich, Alexey A.	n
Les, Clifford M.	3b – Innovative Health Technologies
Levine, Brett R.	3b – DJ Orthopedics, Link Orthopaedics, Medacta, Merete; 5 – Artelon, Biomet, Zimmer
Levy, Bruce A.	1, 3b – Arthrex, Inc.; 3b – CONMED Linvatec; 3b, 5 – Smith & Nephew; 5 – Biomet, Stryker
Lewallen, David G.	1 – MAKO/Stryker; 1, 3b – Zimmer Biomet; 3b, 4 – Acuitive Technologies; 4 – Ketai Medical Devices
Lewis, Thomas R.	n
Li, Jefferson	n
Li, Mengnai	n
Li, Xing	n
Liberman, Shari R.	n
Likine, Elive F.	n
Lima, Diego J. L.	n
Limberg, Afton K.	n
Limpisvasti, Orr	n
Lin, James S.	n
Lindsay, Christopher P.	n
Littlefield, Zachary	n
Liu, Raymond W.	1, 6 – Orthopediatrics Corporation (royalties paid to my institution, part of which are placed into a research fund that I control)
Livshetz, Isaac	n
Lizzio, Vincent	n
Lobrano, Charles M.	n
Loeffelholz, Zachary D.	n
Logli, Anthony L.	n
Long, Jake S.	n

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DISCLOSURES

Lopez, Miguel	n
Lovy, Andrew J.	n
Lu, Alex	n
Lubbe, Ryan J.	n
Lundgren, Mary E.	n
Ly, Thuan	3b – DePuy, a Johnson & Johnson Company
Lyden, Elizabeth R.	n
Lynch, Jonathan	n
Lynch, T. Sean	3b – Smith & Nephew
Lytle, Joseph B.	n
Maassen, Nicholas H.	n
Mabry, Scott E.	n
Mabry, Tad M.	n
Macbeth, Lisa	n
Macalena, Jeffrey A.	2 – Vericel; 5 – Arthrex, Inc.; 6 – Musculoskeletal Transplant Foundation
Maddie, Melissa	n
Magnussen, Robert A.	5 - Zimmer
Mahan, Michael Chad	n
Maheshwari, Kamal	n
Mahoney, Craig R.	4 – Trak Surgical, Inc.; 5 – Johnson & Johnson, Smith & Nephew
Mahoney, Sean P.	n
Maier, Lindsay M.	n
Makhni, Eric C.	3b – Smith & Nephew; 7 - Springer
Maldonado, David R.	n
Malik, Azeem T.	n
Malkani, Arthur L.	1, 2, 3b, 5 - Stryker
Mallet, Cindy	n
Malone, Danielle	n
Mangold, Devin R.	n
Manning, Blaine t.	n
Manning, David W.	1 – Biomet; 2 – Medacta; 3b – Medacta USA
Manoli, Arthur, III	n
Manzer, Melissa	n
Maradit-Kremers, Hilal	n
Marcantonio, Andrew	6 – AO Trauma North America (honorarium, travel expenses)
Mardjetko, Steven M.	1, 3b, 4 – Spinecraft Corporation; 3b – Nuvasive
Marigi, Erick M.	n
Markel, David C.	1, 2, 3b, 5 – Stryker; 2 – Halyard; 4 – Arboretum Ventures, The CORE Institute; 5 – OREF, US Veteran Administration
Markel, Jacob	n
Marley, Robert	n
Marsh, J. Lawrence	1 – Biomet, Tornier; 4 – FxRedux; 7 – Oxford Press
Marston, Scott B.	n
Martella, Anthony	n
Martinek, Melissa	n
Martinez, Jack R.	n
Maskill, John D.	3b – Wright Medical Technology, Inc.; 5 - Pfizer
Masters, Thao	n

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DISCLOSURES

Matar, Robert N.	n
Matrka, Alexis	n
Mayo, Zachary	n
McBride, Conor	n
McCarthy, Michael H.	n
McCarty, Scott A.	n
McCulloch, Patrick C.	2 – Vericel; 5 – Arthrex, Inc., DePuy, a Johnson & Johnson Company
McDermott, Sean	n
McGee, Andrew	n
McGill, Trevon	n
McGlaston, Timothy	n
McGwin, Gerald	n
Mciff, Terence E.	n
McKissack, Haley	n
McIntosh, Amy L.	2 – Globus Medical
McLain, Robert F.	3b – SI Bone
McLaughlin, Jeffrey R.	1, 2, 3b, 5 - Biomet
McLaughlin, Richard J.	n
McMillan, Logan	n
McMurtie, Thompson	n
Mehl, David	n
Meiyappan, Arjun	n
Meldau, Jason	n
Melugin, Health P.	n
Meneghini, R. Michael	1, 3b – Osteoremedies; 1, 3b, 5 – DJ Orthopaedics; 3b – KCI, Kinamed; 4 – Emovi, MuveHealth
Meredith, Joshua	n
Meta, Fabien	n
Metz, Rachelle M.	n
Meyer, Richard D.	3b – NuTech Medical
Milbrandt, Todd A.	3b – Orthopediatrics; 4 – Viking Scientific; 6 - Broadwater
Milinovich, Alexander	n
Miller, Benjamin J.	n
Miller, Eric T.	3b, 3c - Synthes
Miller, Timothy L.	n
Milligan, Heather	n
Mills, Gavin L.	n
Minaie, Arya	n
Minton, Heather	n
Mishra, Abhinav	n
Miskovsky, Shana N.	Arthrex, Inc.
Mitchell, Scott A.	n
Moeller, Amy T.	n
Moed, Berton R.	1 - Zimmer
Moen, Patrick	n
Mohr, Karen	n
Mohr, Mitchell	n
Molloy, Robert M.	2, 3b, 5 – Stryker; 5 – Zimmer

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DISCLOSURES

Momaya, Amit	n
Mont, Michael A.	1 – Microport; 1, 3b, 5 – Stryker; 3b – Cymedica, Flexion Therapeutics, Pacira, Performance Dynamics Inc., Pfizer, Skye Biologics; 3b, 4 – Peerwell; 3b, 5 – DJ Orthopaedics, Johnson & Johnson, Ongoing Care Solutions, OrthoSensor, TissueGene; 4 – USMI; 5 – National Institutes of Health (NIAMS & NICHD); 7 – Medicus Works LLC, Up-to-Date, Wolters Kluwer Health – Lipppincott Williams & Wilkins
Montgomery, Tyler	n
Moon, Andrew S.	n
Moore, Marc C.	n
Moran, Steven L.	1, 3b – Integra; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Morcuende, Jose A.	3c – Clubfoot Solutions
Morgan, Joseph A.	n
Mormino, Matthew A.	n
Morrey, Mark E.	4 - Tenex
Morris, Brandon L.	n
Morton-Gonzaba, Nicholas A.	n
Mosich, Gina M.	n
Mott, Michael P.	n
Moutzouros, Vasilios	n
Movassaghi, Kamran	n
Mu, Brian	n
Muh, Stephanie J.	3b – DePuy, a Johnson & Johnson Company, Exactech, Inc.
Mulcahey, Mary K.	2 – Arthrex, Inc.
Mullen, Scott M.	n
Mulligan, Edward	n
Mullikin, Ian A.	n
Mullis, Brian	2 – KCI, Smith & Nephew
Munaretto, Nicholas F.	n
Munsch, Maria	n
Muriuki, Muturi G.	5 - Zimmer
Murphy, Michael	n
Murray, Trevor G.	3b – Zimmer
Muschler, George F.	1, 5 – Fortus; 3b – NIH; 3c – Parker Hannifin
Nam, Denis	3b – Stryker; 3b, 5 – KCI, Zimmer
Nandi, Sumon	n
Naranje, Sameer M.	n
Narmore, Whitney	n
Nassr, Ahmad N.	3b – DePuy, a Johnson & Johnson Company; 5 – AO Spine, Pfizer, Premia Spine
Nau, Peter	n
Nayyar, Nimra	n
Neel, Robert	3b – Diamond Orthopedics, Wright Medical Technology, Inc.
Nelson, Andrew	n
Nelson, Clay G.	n
Nelson, Lauren	n
Nepple, Jeffrey J.	2, 3b – Ceterix Orthopaedics; 2, 3b, 5 – Smith & Nephew; 3b – Responsive Arthroscopy; 5 - Zimmer

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DISCLOSURES

Neviaser, Andrew S.	n
Ng, Kenneth	n
Ng, Mitchell	n
Nguyen, Ivy	n
Nguyen, Mai P.	n
Nguyen, Ngoc Tram	n
Nicolay, Richard W.	n
Niedermeier, Steven R.	n
Nielson, Mark	n
Noiseux, Nicolas O.	3b – Link Orthopaedics, MicroPort, Smith & Nephew; 5 – DePuy, a Johnson & Johnson Company, Zimmer
North, Wayne Trevor	4 - PeerWell
Nuelle, Clayton W.	n
Nunley, Ryan M.	1, 3b – Microport; 3b – Biocomposites, Cardinal Health, Halyard, Medtronic, Mirus; 3b, 5 – DePuy, a Johnson & Johnson Company, Medical Compression Systems, Inc., Smith & Nephew; 5 – Biomet, Stryker
Nunn, Thomas	n
Nwosa, Chinedu C.	n
Nyland, John	n
Nystrom, Lukas M.	3b – Onkos Surgical, Inc.
Obey, Mitchel R.	n
Obremskey, William	n
O'Byrne, Megan M.	n
Odom, Christopher K.	n
O'Driscoll, Shawn W.	1 – Aircast (DJ); 1, 2, 3b, 5 – Wright Medical Technology, Inc.; 1, 3c, 5 – Acumed, LLC
Ohliger, Andrew	n
Ohliger, James E., III	n
Okoroafor, Ugochi C.	n
Okoroha, Kelechi R.	n
Okroj, Kamil	n
Okunade, Kemi	n
Omari, Ali	4 – Smith & Nephew
Omslaer, Brian	n
O'Neill, Owen R.	1, 2, 3b – Medtronic; 4 – Proventus Software, Responsive Sports
Oreluk, Hazel	n
Ortiz-Declet, Victor	n
Osmon, Douglas R.	n
Ostrum, Robert F.	2, 3b – Bioventus; 7 – SLACK Incorporated, Wolters Kluwer Health – Lippincott Williams & Wilkins
Otero, Jesse E.	3b, 5 – DePuy, a Johnson & Johnson Company
Owens, Jessell M.	n
Padela, Muhammad	n
Padgett, Douglas E.	1, 2, 3b – DJ Orthopedics; 3b, 4 - PixarBio
Padley, Michelle A.	n
Padubidri, Anokha A.	n
Pagnano, Mark W.	1 – DePuy, a Johnson & Johnson Company, Stryker; 3b - KCI

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DISCLOSURES

Pallante, Graham D.	n
Panneton, Abigail	n
Paprosky, Wayne G.	1 – Innomed, Stryker; 1, 3b – Zimmer; 4 – Intellijoint; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Paradise, Christopher R.	n
Pareek, Ayoosh	n
Parikh, Harsh	n
Parilla, Frank W., III	n
Park, Kwan J.	n
Park, Miguel A.	n
Parkes, Chad W.	n
Parihk, Harsh	n
Parikh, Kisan	n
Parra, Mauricio	2 – Orthofix, Inc.
Parry, Joshua A.	n
Parry, Steve	n
Parsons, Theodore W.	n
Parvizi, Javad	1, 3b, 4 – Corentec; 3b – CeramTec, ConvaTec, Ethicon, Heron, Tenor, TissueGene, Zimmer; 4 – Alphaeon, Ceribell, Cross Current Business Intelligence, Hip Innovation Technology, Intellijoint, Invisible Sentinel, Joint Purification Systems, MDValuate, MedAp, MicroGenDx, Parvizi Surgical Innovations, Physician Recommended Nutriceuticals, PRN-Veterinary; 7 – Datatrace, Elsevier, Jaypee Publishers, SLACK Incorporated, Wolters Kluwer Health – Lippincott Williams & Wilkins
Pate, Matthew J.	n
Patel, Alpesh A.	1, 3b – Nuvasive, Zimmer; 1, 3b, 4 – Amedica; 3b – DePuy, a Johnson & Johnson Company; 4 – Cytonics, EndoLuxe, Nocimed, nView Medical Inc., Tissue Differentiation Intelligence, Vital5; 7 – Journal of American Academy of Orthopaedic Surgeons, Springer
Patel, Harshadkumar A.	n
Patel, Pratik B.	n
Patel, Preetesh D.	3b - Stryker
Patel, Ravi B.	n
Patel, Robin	3a – Mayo Clinic (my employer); 5 – Accelerate Diagnostics, Allergan, BioFire, CD Diagnostics, Curetis, HBMS, Merck, The Medicines Company; 6 – Acetelion DSMB (monies to Mayo Clinic)
Patterson, Brendan M.	3a – Disk-Criminator LLC
Pawloski, Jacob	n
Payne, William K.	n
Pearson, Jeffrey M.	4 - Stryker
Peault, Bruno	3b, 5 - Lipogems
Peck, Jeffrey B.	n
Peng, Jianguag	n
Pennock, Andrew T.	3b – Orthopediatrics; 4 - Imagen
Perets, Itay	n
Perez, Edward A.	2 – Smith & Nephew; 4 – Bristol-Myers Squibb, Cardinal Health, Johnson & Johnson, Pfizer, Stryker; 7 – Saunders/Mosby Elsevier
Perry, Kevin I.	n
Perry, Michael W.	n

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DISCLOSURES

Perry, Paul E.	n
Petak, Steven	n
Peters, Christopher	n
Petersen, Kyle A.	n
Peterson, Leif E.	n
Petrigliano, Frank A.	2 – Biomet, Stryker
Pettit, Robert R.	3a - Stryker
Pflederer, Caleb	n
Pharr, Zachary K.	n
Phieffer, Laura	3b – Johnson & Johnson
Phillips, Sierra	n
Piening, Alexander J.	n
Pinter, Zachariah W.	n
Pinto, Martim C.	n
Piuzzi, Nicolas S.	n
Pizzimenti, Natalie	5 - Stryker
Plowman, Brad	n
Plumarom, Yanin	n
Plummer, Darren	n
Poland, Sarah	n
Polenakovich, Filip	n
Ponce, Brent A.	1 – Wright Medical Technology, Inc.; 2, 3b – Tornier; 4 – Help Lightning
Porter, Noah	n
Power, Ian A.	n
Putnam, Ashley	n
Puzzitiello, Richard N.	n
Quade, Jonathan H.	n
Quellhorst, Max L.	n
Raab, David J.	n
Rahaman, Mohamed N.	n
Rahl, Michael	n
Rainer, William G.	n
Ransom, Erin F.	n
Rao, Karan	n
Rayan, Ghazi M.	n
Reddy, Manoj P.	n
Reddy, Nisha	n
Redler, L. H.	n
Redondo, Michael L.	n
Rees, Harold W.	n
Reich, Michael S.	n
Reinhardt, Daniel	n
Ren, Weiping	n
Rhee, Peter C.	2 - Trimed
Ricchetti, Eric T.	1, 2, 3b – DJ Orthopaedics; 7 – Journal of Bone and Joint Surgery - American
Richmond, John C.	2, 3b – Flexion Therapeutics; 3b – Histogenics Corporation, Mitek, Smith & Nephew, Visgo Therapeutics, Inc.; 7 – Springer, Wolters Kluwer

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DISCLOSURES

	Health – Lippincott Williams & Wilkins
Ridge, Ian	n
Rinehart, Kent	n
River, Nicholas	4 – Bristol-Myers Squibb
Rixey, Allison B.	n
Robb, William J.	1 – Innomed; 4 - Stryker
Roberts, Craig J.	7 - Elsevier
Robin, Joseph X.	n
Robinson, Matthew G.	n
Roche, Christopher	3a, 4 – Exactech, Inc.
Rogozinski, Jonathan A.	n
Romano, Joseph	n
Rose, Peter S.	3b – K2M, Inc.
Rosenberg, Aaron G.	1, 2, 3b, 4 – Zimmer; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Rosneck, James T.	n
Rossi, David	n
Rossi, Mario	n
Rudert, M. James	n
Rudraraju, Ravi Teja	n
Ryan, John M.	n
Rybalko, Danil	n
Ryssman, Daniel B.	n
Ryu, Robert C.	3a, 4 – Gilead Sciences, Inc.; 4 – Micro-C Imaging, LLC
Sabbag, Casey M.	n
Sabbag, Orlando D.	n
Sabesan, Vani J.	3b – Arthrex, Inc.; 5 – Exactech, Inc.
Sachdeva, Shikha	n
Sadaat, Ardavan	n
Sager, Brian W.	n
Salata, Michael J.	3b - Stryker
Saleh, Khaled	1, 3b – Aesculap/B.Braun; 2, 3b - BD
Saltzman, Bryan M.	n
Samia, Anna Cristina S.	n
Samuel, Linsen T.	n
Samuelsen, Brian T.	n
Sanchez-Sotelo, Joaquin	1, 2, 5 – Stryker; 2 – Acumed; 3b – Exactech, Inc., Wright Medical Technology, Inc.; 7 – Elsevier, Journal of Shoulder and Elbow Surgery, Oxford University Press
Sanders, Thomas L.	n
Sandvall, Brinkley K.	n
Sangimino, Mark J.	n
Saris, Daniel B. F.	3b – Cartiheal; 3b, 5 – Smith & Nephew; 5 – Ivy Sports
Sawyer, Jeffrey R.	2 – DePuy, a Johnson & Johnson Company, Nuvasive; 7 – Mosby, Wolters Kluwer Health – Lippincott Williams & Wilkins
Sayeed, Zain	n
Scharschmidt, Thomas J.	3b – Stryker; 5 – Millenium Pharmaceuticals
Schipper, Jaclyn	n

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Schmitt, Daniel R.	n
Schmucker, Alex J. D.	n
Schroeppel, J. Paul	n
Schumaier, Adam P.	n
Schwartz, Adam J.	n
Schwarzkopf, Ran	3b, 4 – Intellijoint; 3b, 5 – Smith & Nephew; 4 – Gauss Surgical
Schweser, Kyle M.	n
Scott, Elizabeth J.	n
Seering, Melinda	5 – GE Healthcare
Seifi, Ali	2 – Chiesi, La Jolla
Selley, Ryan A.	n
Sembrano, Jonathan N.	5 – Nuvasive, Orthofix, Inc.
Sems, S. Andrew	1, 3b - Zimmer
Sershon, Robert A.	n
Seth, Bhavya	n
Sgromolo, Nicole M.	n
Shah, Ashish	n
Shah, Nishant A.	2 – Smith & Nephew
Shah, Paras	n
Shah, Ritesh R.	2, 3b – Smith & Nephew; 5 – Biomet, Wright Medical Technologies, Inc., Zimmer; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Shah, Romil F.	n
Shaheen, Philip J.	n
Shamrock, Alan G.	n
Shannon, Steven F.	n
Sharma, Abhinav K.	n
Shaughnessy, William J.	n
Shaw, Jonathan H.	n
Sheena, Gabriel	n
Sheffer, Benjamin	n
Shehab, Ramsey	n
Sheppard, Evan	n
Shin, Alexander Y.	1 – Mayo Medical Ventures, Trimed
Shirley, Zachary	n
Shlykov, Maksim	n
Shukla, Dave R.	2 – Tornier, Wright Medical Technology, Inc.
Sidhu, Jaspreet	n
Siebler, Justin C.	n
Sierra, Rafael J.	1, 3b – Link Orthopaedics; 1, 5 – Zimmer; 2, 3b, 5 – Biomet; 5 – DePuy, a Johnson & Johnson Company, Stryker; 7 - Springer
Siff, Todd E.	n
Silverton, Craig D.	1 - Biomet
Sim, Franklin H.	7 – Saunders/Mosby-Elsevier
Singh, Partik	n
Sirignano, Michael N.	n
Sirois, Zachary J.	n
Slack, Grant M.	n

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Slager, Susan L.	n
Slattery, Michael E.	n
Small, Travis J.	n
Smith, Austin F.	n
Smith, Conor	n
Smith, Langan	n
Smith, Matt	n
Smith, Richard A.	n
Sochacki, Kyle R.	n
Sodhi, Nipun	n
Soobader, Mah-J	3a, 4 – DePuy, a Johnson & Johnson Company
Sorkin, Anthony T.	2, 3b, 4 – Stryker; 4 – Johnson & Johnson
Souder, Christopher D.	n
Sousa, Paul L.	n
Spence, David D.	7 - Elsevier
Sperling, John W.	1 – Biomet, DJ Orthopaedics, Wright Medical Technology, Inc.; 3b – Exactech, Inc., Zimmer; 3b, 4 - RA
Spindler, Kurt P.	1 – Nphase; 3b – Cytori-Scientific Advisory Board, Mitek, NFL; 5 – National Institutes of Health (NIAMS & NICHD)
Spisak, Kristen	n
Sporer, Scott M.	1, 3b – DJO Surgical, Osteoremedies; 1, 5 – Zimmer; 3b, 4 – Myoscience; 5 – Stryker; 7 – SLACK Incorporated
Stammen, Kari L.	n
Stankard, Matthew	n
Stannard, James P.	3b – DePuy, a Johnson & Johnson Company, Orthopedic Designs North America, Smith & Nephew; 3b, 5 – Arthrex, Inc.; 5 – Coulter Foundation, U.S. Department of Defense; 7 - Thieme
Stans, Anthony A.	n
Stasieluk, Conrad	n
Steffes, Matthew J.	n
Steinmann, Scott P.	1, 3b – Arthrex, Inc., Biomet; 3b – Acumed, LLC
Steinmetz, Raymond G.	n
Sterns, Philip	n
Stibolt, Robert	n
Stimac, Jeffrey D.	3b – Zimmer; 5 - Stryker
Stojanovic, Michael	n
Stolfi, Adrienne	n
Stover, Michael D.	2 – AO Foundation; 3b – DePuy, a Johnson & Johnson Company; 4 - Radlink
Streubel, Philipp N.	2 – Zimmer; 3b – Acumed, LLC
Strnad, Greg	1 – nPhase (cloud database platform used in clinical studies)
Stuart, Michael J.	1, 3b – Arthrex, Inc.; 5 - Stryker
Stubbs, Trevor	n
Stulberg, Bernard N.	1, 3b, 5 – Exactech, Inc.; 3b, 5 – THINK Surgical, Inc.
Styron, Joseph F.	n
Sultan, Assem A.	n
Summers, Hobie D.	n
Sweet, Matthew	n

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Swiergosz, Andrew M.	n
Tagliero, Adam J.	n
Tarakemeh, Armin	n
Taunton, Michael J	1, 3b – DJ Orthopaedics; 5 – DePuy, a Johnson & Johnson Company, Stryker
Taylor, Kevin A.	n
Teague, David C.	n
Teplensky, Jason R.	n
Terry, Dave	n
Terry, Michael A.	2, 5, 6 – Smith & Nephew: 7 – Saunders/Mosby-Elsevier
Terzic, Andre	n
Teusink, Matthew J.	3b – DJ Orthopaedics
Thacker, Jenna	n
Thomas, Matthew D.	n
Thompson, Samuel F.	n
Thompson, Thomas R.	4 - Medtronic
Throckmorton, Thomas W.	1 – Exactech, Inc.; 1, 2 – Zimmer; 4 – Gilead; 7 – Saunders/Mosby-Elsevier
Tibbo, Meagan E.	n
Tjong, Vehniah K.	3b – Smith & Nephew
Tofte, Josef N.	n
Tomov, Marko N.	n
Tonnos, Frederick	n
Torchia, Michael E.	n
Tornetta, Paul	1 – Smith & Nephew; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Tramer, Joseph S.	n
Trojan, Jeffrey	n
Trousdale, Robert A.	1 – Medtronic; 1, 3b – DePuy, a Johnson & Johnson Company
Tucker, Michael C.	n
Tucker, William A.	n
Turner, Norman S.	n
Ubl, Daniel S.	n
Uppaluri, Sarika	n
Ussef, Najib R.	n
Vaidya, Rahul	5 - Pfizer
Vajapey, Sravya	n
Van Citters, Douglas W.	5 – OrthoSensor; 6 – ConforMIS, DePuy, a Johnson & Johnson Company
Van Thiel, Geoffrey	1, 2, 3b – Zimmer; 2, 3b – Smith & Nephew, Vericel; 3b, 4 – Trainer Rx
Van Tienderen, Richard J.	n
Van Wijnen, Andre J.	n
Vang, Sandy	n
VanZweden, Daniel	n
Vargas, Juan	n
Vasileff, W. Kelton	3b, 5 - Zimmer
Villa, Jesus	n

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Villacis, Diego C.	n
Viner, Gean	n
Visperas, Anabelle	n
Volgas, David A.	n
Volkmar, Alexander J.	n
Vopat, Bryan G.	n
Vopat, Matthew L.	n
Voos, James E.	3b – Arthrex, Inc.
Walchak, Adam C.	n
Waldrop, Paul	3a - Medtronic
Walsh, Ryan M.	n
Walter, Norman	3a - Biomet
Walters, Jordan D.	n
Wanderman, Nathan R.	n
Ward, Christina M.	n
Warth, Lucian C.	3b – Link Orthopaedics, OsteoRemedies, Stryker
Watson, J. Tracy	1 – Advanced Orthopaedic Solutions, Biomet;1, 2 – Nuvasive; 1, 2, 3b – Smith & Nephew; 2 – Zimmer
Weber, Kristy L.	7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Weiner, Scott D.	n
Weinstein, James N.	n
Weistroffer, Joseph K.	n
Wells, Joel E.	n
Wera, Glenn D.	n
West, Christopher R.	n
West, Hugh S., Jr.	1, 3b – Linvatec; 1, 3b, 5 – Mitek; 3b - Stryker
Westermann, Robert W.	3c – Smith & Nephew
Weston, John T.	n
Whitaker, John E.	n
White, Melissa S.	n
Wichern, Emily M.	n
Wickramasinghe, Sameera	n
Wiggins, Adam	n
Wild, Josh	n
Wiley, Marcel R.	n
Wilkinson, Brandon G.	n
Willey, Michael C.	5 - Biomet
Williams, Robert C.	n
Williamson, Brooklyn	n
Wills, Bradley W.	n
Wilson, John T.	n
Winchester, Masako	n
Wise, Kelsey	n
Witmer, Daniel K.	n
Witten, Brent	n
Wojewnik, Bartosz	1, 3b – HD Lifesciences
Wolf, Brian R.	3b – CONMED Linvatec; 5 – OREF; 6 – Arthrex, Inc., Smith & Nephew
Wolf, Valeri L.	n

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Wolschendorf, Frank	n
Woodbury, Derrek	n
Worley, John R.	n
Worthen, James V.	n
Wright, Melissa	n
Wright, Thomas W.	1, 3b, 5 – Exactech, Inc.; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Wu, Bin	n
Wu, Isabella T.	n
Wyles, Cody C.	n
Yakubek, George A.	n
Yassir, Walid K.	n
Yaszemski, Michael J.	3b – K2M, Inc., Medtronic; 7 - Wolters Kluwer Health – Lippincott Williams & Wilkins
Yee, Elliott J.	n
Yerasimides, Jonathan G.	3b – DePuy, a Johnson & Johnson Company, Medtronic, Zimmer
Yokhana, Sanar S.	n
Young, Bradley L.	n
Young, Ernest	n
Yu,Charles C.	n
Yu, Elizabeth M.	5 Limiflex
Yuan, Brandon J.	n
Yuen, Leslie C.	n
Zajicek, Anna	4 - Allergan
Zamora, Rodolfo	n
Zarling, Bradley J.	n
Zarski, Mike	n
Zebala, Lukas P.	5 – Pacira Pharmaceuticals
Zekaj, Mark	n
Zelle, Boris A.	5 – DePuy, a Johnson & Johnson Company, KCI
Zeni, Ferras	n
Zhang, Feifei	n
Zhao, Chunfeng	n
Zielinski, Matthew R.	n
Ziemba-Davis, Mary	n
Zimmer, Joseph L.	n
Zuckerman, Joseph D.	3b – Musculoskeletal Transplant Foundation; 3c – Gold Humanism Foundation, J3Personica/Residency Select; 4 – AposTherapy, Inc., Hip Innovation Technology; 7 – SLACK, Inc., Thieme, Wolters Kluwer Health – Lippincott Williams & Wilkins