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Podium and Poster Abstracts

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

***Denotes presenter**

MAOA FIRST PLENARY SESSION
April 24, 2014

Bariatric Surgery May Decrease Acute Postoperative Total Knee Arthroplasty Complications in the Morbidly Obese: A Comparative Study Using an Electronically Pooled Database

Abstract ID: Paper 001

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INTRODUCTION: Obesity is a well-described risk factor for postoperative total knee arthroplasty (TKA) complications. To mitigate this risk, many surgeons recommend a trial of weight loss prior surgery. Morbidly obese patients unable to lose weight by diet and exercise alone are often considered candidates for bariatric surgery. However, bariatric surgery is associated with metabolic abnormalities and compromised wound healing that may also contribute to postoperative TKA complications. The purpose of this study is to determine whether morbid obesity or bariatric surgery is a greater preoperative risk factor for TKA complications. Our hypothesis is that patients undergoing a bariatric procedure prior to TKA will have decreased acute postoperative complications rates.

METHODS: A novel software platform was utilized to investigate a multicenter database of pooled electronic medical records of over 24 million patients from 14 major U.S. healthcare systems. A cohort of patients that had undergone a bariatric procedure and subsequent TKA was created, and the incidence of 30-day postoperative complications was calculated. This group was compared to a cohort of morbidly obese (BMI>40) patients that had not undergone a bariatric procedure prior to TKA. Procedures and diagnoses were identified through CPT and ICD-9 codes. Pearson's chi-squared test was used to determine statistical significance ($p=0.05$).

RESULTS: There were 20,340 patients in the morbidly obese patient cohort and 4,040 patients in the bariatric cohort. Patients with bariatric surgery were found to have a lower incidence of acute myocardial infarctions (3.96% vs. 5.26% $p<0.001$), acute renal failure (11.63 vs. 14.80 $p<0.001$), congestive heart failure (6.44 vs. 10.67 $p<0.001$), and pulmonary emboli (1.24 vs. 1.72 $p=0.027$) when compared to morbidly obese patients. Beyond the 30 day period, none of

the major complications studied showed significant differences.

CONCLUSION: Bariatric surgery patients that undergo TKA are less likely to be diagnosed with acute myocardial infarctions, acute renal failure, congestive heart failure, or a pulmonary embolism in the early postoperative period when compared to morbidly obese TKA patients. This study provides insight into the risks and benefits of bariatric surgery prior to TKA. This information can be used to council this high-risk population prior to proceeding to surgery.

Revision of Recalled Modular Neck Femoral Implants

Abstract ID: Paper 002

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INTRODUCTION: Femoral stems with modular necks were designed to provide more options for anatomic hip reconstruction. Increased revision rates associated with the modular neck stems suggested underlying adverse local tissue reactions (ALTR) related to the implant and led to a voluntary recall. This study describes the experience and findings associated with the revision surgery of a large cohort of patients who had been implanted with modular neck femoral stems.

METHODS: A retrospective review of prospectively collected data was performed on patients who were implanted with modular neck hip implants between October 2007 and February 2012 and have undergone subsequent revision surgery. Demographic data, metal ion levels, and metal artifact reduction sequence (MARS) magnetic resonance imaging (MRI), revision findings, and pathology findings were obtained and descriptive statistics performed.

RESULTS: A total of 361 hips (268 Stem #1, 93 Stem #2) in 350 patients (222 male, 139 female) were implanted with modular neck femoral stems over the study period. To date, 107 hips have undergone revision. The time from index surgery to revision ranged from 8 months to 5 years (mean 2.4 years). The cause of revision was ALTR (103), infection (2), and periprosthetic fracture (2). 83 of the patients revised for ALTR were found to have intra-articular joint effusions and 92 had metal ion levels (cobalt: mean 7.6 μ g/L, range 1.1-23 μ g/L; chromium: mean 1.8 μ g/L, range 0.1-6.8 μ g/L). At revision, a necrotic rind was found in 84 patients, synovitis in 102, bony erosion in 88, and tissue necrosis in 80. The femur was well fixed in all but 1 case and the acetabular component was well fixed in all but 5 cases. An osteotomy was required to remove the femoral component in 45 cases. The acetabular component was revised in 47 cases for concern over possible infection due to cobalt content and the polyethylene liner was exchanged in the other 56 cases. Black, metallic sludge and corrosion at the neck-stem junction was specifically noted in the operative report in 101 cases. On histologic analysis, 90 had chronic inflammatory changes, and 58 had degenerative changes.

CONCLUSION: The revision of modular neck femoral stems is likely to be complicated by tissue necrosis, synovitis, bony erosion, and stem-neck corrosion. Preoperatively, there is a high association with increased metal levels and effusion by MARS-MRI. Despite using advanced techniques to explant the stem, osteotomy was frequently required and, thus, there was associated morbidity from implant removal.

Unexpected High Rates of Corrosion-Related Revisions: Short-Term Results of the Modular Neck Rejuvenate Stem

Abstract ID: Paper 003

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BACKGROUND: The Rejuvenate modular neck stem was recently recalled due to corrosion at the neck-stem junction. The purpose of this study was to investigate the rate of corrosion-related failures and survivorship of this implant, and analyze the correlation between the implant and patient factors with serum metal ion levels.

MATERIAL AND METHODS: Between June 2009 and July 2012, 123 Rejuvenate stems (97 modular and 26 non-modular) THAs were implanted in 104 patients by a single surgeon via a modified anterolateral approach. Serum cobalt (Co) and chromium (Cr) levels (microgram per liter [µg/L]) were obtained in all patients. In cases of elevated serum metal ion levels or symptomatic hip, patients underwent magnetic resonance imaging (MRI) for assessment of osteolysis or adverse local tissue reactions (ALTR). Correlation between implant factors (implant size, head size, head length, offset), patient factors (age, gender, BMI) with serum metal ion levels and revisions were analyzed using logistic regression models.

RESULTS: The mean follow-up was 2.7 ± 0.6 years. The mean Co and Cr levels were 5.4 ± 5.7 µg/L (0.2 – 31) and 2.1 ± 1.5 µg/L (0.1 – 4.3), respectively. The differences between the Co and Cr levels in the two groups were statistically significant. 49% of THAs in the modular group had elevated metal ion levels (> 4.0 µg/L). There was a significant correlation between higher metal ion levels, younger age, and higher offset ($p<0.05$). Presence of pain and high cobalt levels were significant predictors for revision surgery. The rate of revision at the time of this study was 26%, the majority were in the second year after surgery. The Kaplan-Meier survivorship was 60% at the time of this study.

DISCUSSION AND CONCLUSIONS: The short-term high rate of corrosion related revision with Rejuvenate modular neck stems is extremely alarming. We anticipate more revisions in the near future.

Level of Evidence: Level III, Therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Diabetes Mellitus, Hyperglycemia, Hemoglobin A1c, and the Risk of Prosthetic Joint Infections

Abstract ID: Paper 004

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BACKGROUND: Although diabetes mellitus is a well-established risk factor for surgical site infections (SSI), evidence is conflicting to what extent perioperative hyperglycemia, glycemic control, and treatment around the time of surgery modifies the SSI risk.

OBJECTIVE: To determine the association between diabetes mellitus, perioperative hyperglycemia, glycemic control, insulin administration, and the risk of SSI in total hip and knee replacement.

METHODS: We studied 20,171 total hip and knee replacement procedures performed at a large tertiary care hospital between 1/1/2002 and 12/31/2009. All blood glucose and hemoglobin A1C (HbA1C) values around the time of surgery (±1 week) were retrieved. Glucose and HbA1c values were evaluated both continuously and using hyperglycemia cut-off value of >180 mg/dL and HbA1c cut-off value >7%. Medical records of all cases of SSI within 1 year of surgery were reviewed manually to validate diagnoses. Multivariable Cox models were used to estimate the hazard ratios (HR) and 95% confidence intervals (CI) for SSI associated with diabetes mellitus, hyperglycemia, insulin and oral antidiabetic drug use, pre- and postoperative blood glucose and HbA1c levels, adjusting for age, sex, body mass index, type of surgery, American Society of Anesthesiologists score, and operative time.

RESULTS: The risk of SSI was significantly higher among patients with diabetes mellitus (HR 1.55, 95% CI 1.11, 2.16). Perioperative hyperglycemia (HR 1.59, 95% CI 1.07, 2.35), diabetes medication (HR 1.56, 95% CI 1.08, 2.25), and insulin use were all significantly associated with the risk of SSI in age- and sex-adjusted analyses. After adjusting for body mass index, type of surgery, American Society of Anesthesiologists score, and operative time, the significant associations with diabetes status and hyperglycemia were no longer significant. Although data were limited, we observed no relationship with increasing HbA1c levels or a cut-off value of 7%.

CONCLUSION: In total hip and knee replacement, the association between diabetes mellitus, perioperative hyperglycemia, and the risk of SSI is confounded by other surgery related risk factors. Glucose control status as defined by HbA1c is not a reliable predictor of SSI risk.

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Morbidly Obese Patients Have a Higher Risk of Failure than Non-Obese Patients Following Revision Total Hip Arthroplasty for Infection

Abstract ID: Paper 005

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INTRODUCTION: Morbid obesity (BMI ≥40) is associated with a higher risk of complications including infection, and implant failure following primary total hip arthroplasty (THA). To our knowledge, this has not been examined in the revision setting. The purpose of this study was to compare the results of two-stage revision THA for infection in a morbidly obese (BMI ≥40) patient cohort compared to a non-obese (BMI ≤30) patients.

METHODS: Using an institutional total joint registry database, we reviewed the medical records of 631 patients undergoing a two-stage revision THA for a prosthetic joint infection over a 20-year period (1987-2007). Patients were stratified according to their preoperative BMI. Thirty-three patients were identified who had a BMI ≥40 and underwent a revision THA in a septic setting. These patients were then compared 1:2 with a cohort of sex-matched, age-similar (91% within 2 years) non-obese (BMI ≤30) patients (n=66). All patients had minimum 5-year clinical follow-up. Primary outcomes examined included reinfection, reoperation, and removal of components; while clinical outcomes were quantified using the Harris Hip Score. Statistical analysis was performed using Student t-test, Fisher Exact test, and Kaplan-Meier Survival Curve with statistical significance set at a P value of 0.05.

RESULTS: In the morbidly obese group, there were 14 males and 19 females, with an average age of 63.2 years and an average BMI of 44.9. There were 28 males and 38 females with an average age and BMI of 63.2 years and 24.8, respectively, in the non-obese group (Table 1). Average follow-up was 8.1 years in the morbidly obese group and 10.3 years in the non-obese group.

Compared to non-obese patients, morbidly obese patients had a statistically significant increased risk for reinfection (18% vs. 2%; p=0.005), resection of components (30% vs. 5%; p=0.0001), and reoperation for any reason (61% vs. 12%; p=0.0001). There was no difference in patient mortality during the follow-up period (22% vs. 19%, p=0.80).

Prior to surgery, the average Harris Hip Score was 50.6 in the morbidly obese group and 48.8 in the non-obese group. Hip scores significantly improved in both groups postoperatively (p<0.001), with no significant difference between the two groups at 2 (78.5 vs. 81.9) and 5 (77.9 vs. 80.9) years postoperatively. However, the average score was significantly lower (p=0.0007) in the morbidly obese group at the 10 year follow-up (64.3 vs. 81.3).

CONCLUSION: Morbidly obese patients have markedly increased rates of reinfection, reoperation, and component resection, along with worse mid-term clinical outcome scores compared to a similar non-obese patient cohort following revision THA for prosthetic joint infection.

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Direct Anterior vs. Mini-Posterior THA with the Same Advanced Pain Management and Rapid Rehabilitation Protocol: Some Surprises in Early Outcome

Abstract ID: Paper 006

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PURPOSE: Determining the effect of surgical technique on early outcome is confounded when advances in pain management, rapid rehabilitation, or patient education are introduced or applied asynchronously. We sought to determine the influence of surgical technique alone in contemporary cohorts of total hip arthroplasty (THA) done by two fellowship-trained surgeons each performing their technique of choice with the same advanced pain and rapid rehabilitation protocol.

METHODS: 126 consecutive direct anterior (DA) procedures were compared with 96 consecutive mini-posterior (MP) procedures done from July 2011 - February 2012. Groups did not differ ($p>0.2$ for all) in age (64+/-12 years), sex (50% female), BMI (30 +/-5.7), or preoperative Harris Hip Score (55+/-12). Operative details, in-hospital complications, visual analog scale (VAS) pain scores, and functional milestones at 2 and 8 weeks were reviewed.

RESULTS: No differences in length of stay (2.2 days), operative or in-hospital complications, intravenous breakthrough analgesia, stairs, maximum feet walked in-hospital, or discharge disposition (80% home) all $p>0.2$. The DA group had a higher VAS max pain (5.3 DA; +/- 2, vs. 3.8 MP; +/-2 $p=<0.0001$). At two weeks, more DA patients required gait aids (92% vs. 68% of MP; $p=<0.0001$). At eight weeks, DA had higher HHS (95 vs. 89), but a lower return to work and driving; no difference: gait aids, narcotics, ADLs, or walking 0.5 mile. More wound problems occurred in the mini-posterior ($p=<0.01$).

CONCLUSION: With the same advanced pain and rehabilitation protocol, it was somewhat surprising to find that direct anterior hip patients had more early pain and were more likely to continue utilizing gait aids at 2 weeks. The DA group had fewer early wound problems contrasting with the belief that anteriorly-based incisions would be more problematic.

SIGNIFICANCE: Advanced pain and rehabilitation protocols may trump surgical approach in determining most early outcomes after contemporary THA done by surgeons experienced in using direct anterior or mini-posterior techniques.

Patient Satisfaction and Residual Symptoms Following TKR and PKR: What Do the Patients Say When We Aren't Around?

Abstract ID: Paper 007

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(Presented by Marcus A. Rothermich, M.D., St. Louis, MO)

INTRODUCTION: Limited data exists comparing functional results of partial and total knee replacement. This study compared functional results, residual symptoms, and patient satisfaction between total knee replacement (TKR), fixed bearing partial knee replacement (FB-PKR), and mobile bearing partial knee replacement (MB-PKR).

METHODS: A multicenter study surveyed 1,263 patients (age 18-75) undergoing primary TKR and PKR for non-inflammatory DJD. An independent third party with expertise in collecting healthcare data for state and federal agencies collected data. We examined 13 questions regarding pain, satisfaction, and residual symptoms. Multivariate analysis was conducted, significance set at $p<0.05$ and power >0.8 was achieved. We controlled for gender, age, income, minority status, and surgical location.

RESULTS: Univariate analysis revealed PKR patients were more likely to be younger, male, and have income > $25,000/year than TKR patients. Multivariate analysis showed MB-PKRs were 1.81 times more likely to report their operative knee felt “normal” ($p=0.0109$) and 2.69 times more likely to report satisfaction with ability to perform activities of daily living (ADL) than TKRs ($p=0.0058$). MB-PKRs were 44% less likely to report grinding/popping/clicking ($p=0.0142$), 39% less likely to report swelling ($p=0.0351$), and 40% less likely to report stiffness ($p=0.0167$) in the last 30 days compared to TKRs. FB-PKR patients were 51% less likely to experience problems getting in/out of a car than TKR patients ($p=0.0129$). FB-PKRs were 60% less likely to be satisfied with the degree of pain relief than TKRs ($p=0.0113$). Remaining questions trended towards advantages for MB-PKR over TKR, but were not significant.

CONCLUSIONS: Patient satisfaction is higher for MB-PKR than TKR with more patients reporting the knee feels normal and more able to perform ADLs. FB-PKRs reported slightly less pain relief than TKR. MB-PKR had fewer residual symptoms than FB-PKR.

Characterization of Periprosthetic Femur Fractures in the 40,000 Primary and Revision Total Hip Arthroplasties: A 40-Year Experience

Abstract ID: Paper 008

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INTRODUCTION: Understanding the epidemiology of periprosthetic femur fractures allows development of prevention strategies. The goals of this study were to define the demographic and operative risk factors, chronology, nature, and treatment strategies of fractures in a large cohort of primary total hip arthroplasties (THAs).

METHODS: We retrospectively reviewed the total joint registry of an academic institution from 1969 to 2011. All patients undergoing primary THA were included. Periprosthetic fractures were analyzed based on demographics, timing, and type of fixation. Radiographs and the EMR were reviewed to determine the nature of the fractures and subsequent treatments.

RESULTS: During the study period, 32,644 primary THAs were performed. There were 564 intraoperative periprosthetic femur fractures (1.7%); 529 during placement of an uncemented stem (3.0%) and 35 during placement of a cemented stem (0.23%). Intraoperative fractures were more common in females and patients > 65 years. The majority occurred during placement of the femoral component (60%), and included the calcar (69%). 85% were non-displaced and 75% were treated with cerclage cables/wires.

There were 557 postoperative periprosthetic femoral fractures (40-year probability: 7.2%); 335 after placement of an uncemented stem (20-year probability: 7.7%) and 222 after placement of a cemented stem (20-year probability: 2.1%). The cumulative probability of a postoperative fracture with an uncemented stem compared to a cemented stem was 10X more likely within 30 days. The majority were Vancouver A_G fractures (29%), with 67% occurring after a fall. Of all postoperative fractures, 36% underwent ORIF and 21% had revision surgery.

CONCLUSIONS: Intraoperative periprosthetic femoral fractures occur 13.5 times more often with uncemented stems. They are most common in female patients > 65 years of age. Postoperative fractures are also most common with uncemented stems, but are independent of age or gender. By 40 years, approximately 7% of patients will have experienced a postoperative periprosthetic femur fracture.

New TKA Designs: Did the Patients Notice?

Abstract ID: Paper 009

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INTRODUCTION: Total Knee Arthroplasty (TKA) is one of the most commonly performed surgical procedures. Despite this, 15-20% of patients are not completely satisfied after surgery. Recently, new implant designs have been developed to potentially improve patient outcomes. The purpose of this study was to determine what, if any, impact these newer designs had on patient satisfaction and functional outcomes.

METHODS: A national multicenter study was designed to quantify the degree of residual symptoms and functional deficits in patients undergoing contemporary TKA at five total joint centers compared to a 10-year-old non-modernized TKA system. To eliminate observer bias, data was collected by an independent, third party survey center that had no affiliation with any of the participating centers and was blinded to implant type.

RESULTS: Satisfaction and function data were collected on 621 patients 1-3 years following surgery. Multiple TKA implant types were included (311 cruciate retaining [CR], 88 gender, 65 high flex, 157 rotating platform [RP]). CR TKAs were considered the standard since they had >10 years clinical use.

CR TKAs reported more frequently their knee felt “normal” compared to gender TKAs ($p=.02$) and RP TKAs ($p<.001$). Modern TKAs reported more residual symptoms than CR TKAs in the last 30 days including pain (gender, $p=.01$), grinding/popping/clicking (gender, $p<.001$; high flex $p=.04$; RP, $p<.001$), swelling/tightness (gender, $p<.001$; high flex, $p=.05$; RP, $p=.009$), and stiffness (gender, $p=.003$).

The only exceptions were high flex TKAs had less problems going up or down stairs ($p=.03$), and there was a slight trend for RP TKAs to experience less difficulty getting in and out of a car ($p=.05$) compared to CR TKAs.

CONCLUSION: When interviewed by an independent third party, patients with modern TKAs reported more residual symptoms and less satisfaction than those with traditional CR TKAs.

MAOA BREAKOUT SESSION #1
HAND
April 24, 2014

Proximal Row Carpectomy vs. Four-Corner Fusion for Traumatic Wrist Arthropathy: A Systematic Review

Abstract ID: Paper 010

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PURPOSE: Patients with advanced wrist arthrosis are a difficult patient population. Significant controversy over the most effective motion-preserving salvage procedure remains, and currently there is no “gold standard”. The purpose of this study was to analyze the clinical outcomes literature on proximal row carpectomy (PRC) in comparison to four-corner fusion (4-CF) for the treatment of advanced wrist arthritis in the setting of scapholunate or scaphoid nonunion advanced collapse.

METHODS: A systematic review was conducted using PRISMA guidelines. Studies reporting on clinical outcomes following PRC or 4-CF for advanced wrist arthrosis due to scaphoid nonunion advanced collapse (SNAC) or scapholunate advanced collapse (SLAC) wrist were included. Two reviewers selected studies for inclusion, assessed methodological quality, and extracted data. Statistical analysis was performed via Student’s t-test.

RESULTS: A total of 7 studies (Level I-III) were deemed appropriate for inclusion, with a total of 262 patients and 264 wrists (84.5% male; 15.5% female), and a mean follow-up of 40.7-months. A total of 44.6% of patients underwent 4-CF while 45.4% underwent PRC. The mean wrist extension was 38.8° and 43.2° for 4-CF and PRC, respectively. The mean wrist flexion was 32.4° and 36.6° for 4-CF and PRC, respectively. The mean wrist ulnar deviation was 22.0° and 22.5° for 4-CF and PRC, respectively. The mean wrist radial deviation was 14.0° and 9.9° for 4-CF and PRC, respectively. The mean handgrip strength (as percentage of contralateral side) was 73.9 and 93.3 for 4-CF and PRC, respectively. The mean Disabilities of the Arm, Shoulder, and Hand score was 27.8 and 18.6 for 4-CF and PRC, respectively. The complication rate (infection or requiring additional surgery for any reason) for 4-CF and PRC was 14.8% and 9.8%, respectively.

CONCLUSIONS: Both PRC and 4-CF demonstrate comparable outcomes with regard to wrist flexion, extension, and ulnar deviation. Patients undergoing PRC have significantly better handgrip strength compared to 4-CF, but decreased wrist radial deviation. In addition, patients appear to have greater satisfaction after PRC compared to 4-CF. Further, long-term comparative trials are needed to better understand if these outcomes hold over time.

Effect of Lunate Morphology in Kienbock's Disease

Abstract ID: Paper 011

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PURPOSE: Lunate morphology has been postulated to play an integral role in the pathogenesis of Kienböck's disease. The purpose of this study is to determine if the absence (type I) or presence (type II) of a medial (hamate) facet on the lunate will affect the radiographic characteristics and severity of Kienböck's disease.

METHODS: A retrospective review was performed on all patients evaluated and treated at our institution from 2002 to 2010 with a diagnosis of Kienböck's disease which was confirmed on magnetic resonance imaging (MRI) and/or bone scan. Study groups consisted of type I vs. type II lunates, as determined by MRI and/or computed tomography. Investigated variables included the modified Lichtman's stage on presentation, radioscaphoid angle, presence of a coronal plane fracture of the lunate, modified carpal height, ulnar variance, and ulnar translocation of the carpus.

RESULTS: A total of 106 wrists were included, 75 type I (71%) and 31 type II (29%) lunates. There was significantly more advanced disease (greater than stage 2) upon presentation in type I lunates (n=64, 86%) compared to type II lunates (n=19, 61%, $p < 0.05$). Coronal fractures of the lunate were present in 76 wrists (72%) and were more likely in type I (n=58, 75%) compared to type II lunates (n=18, 58%, p=0.05). In the absence of a coronal fracture, radioscaphoid angles were greater in type I (53°) vs. type II lunates (45°, p=0.04). There were no significant differences in modified carpal height, ulnar variance, or ulnar translocation of the carpus between both types of lunates.

CONCLUSION: Lunate morphology affects the severity of Kienböck's disease at the time of initial staging. The incidence of coronal fractures of the lunate is 72% upon presentation, with type II lunates being protective against coronal fractures. The medial (hamate) facet of a type II lunate may prevent against scaphoid flexion deformity, thus limiting the progression of Kienböck's disease.

Short-Term Outcomes of the RASL Procedure: Radiographic and Clinical Dichotomy

Abstract ID: Paper 012

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BACKGROUND: The management of scapholunate (SL) instability is controversial. One technique for surgical stabilization is the Reduction and Association of the Scaphoid and Lunate (RASL) procedure, which attempts to create a fibrous union of the scaphoid and lunate by dechondrifying the opposing articular surfaces and placing differential-pitch compression screw across the scapholunate (SL) interval.

Despite promising results, the reproducibility of this procedure has not been well documented in the literature, and remains to be widely embraced. The purpose of this study is to evaluate the success of the RASL procedure in an effort to evaluate the reliability and reproducibility of the RASL procedure.

METHODS: A retrospective case series of the senior author was performed by identifying patients who had undergone the RASL procedure for SL instability. Eight patients and a total of 9 wrists were identified, with an average follow-up time of 26.3 months. Static and stress grip radiographs of the affected and contralateral wrists were examined in the preoperative, immediate postoperative, and final follow-up setting to evaluate SL diastasis, SL angle, hardware position, and complications. At final follow- up, patients completed Disability of the Arm, Shoulder, and Hand (DASH) and the Patient-Rated Wrist Evaluation (PRWE) questionnaires.

RESULTS: Four of the 6 wrists available for final follow-up were found to have complete loss of reduction in both the coronal and sagittal plane, with an average time to failure of 5 months. Four of these 5 patients have required hardware removal for progressive lucency. Average DASH and PRWE scores were 16 and 28, respectively.

DISCUSSION: The RASL procedure is ineffective in providing stability about the scapholunate interval. With a majority of patients experiencing failure of the procedure in the short-term, our series suggests that the RASL procedure should be abandoned. Despite a high failure rate, the DASH and PRWE scores show a lower level of disability and pain than expected.

Outcomes of Ulnar Shortening Osteotomy for the Treatment of Ulnar-Sided Wrist Pain

Abstract ID: Paper 013

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PURPOSE: This retrospective study investigated the long-term outcome of ulnar shortening osteotomy for the treatment of ulnar-sided wrist pain. The etiology of this pain included, but was not limited to, ulnar-carpal abutment, ulnar-lunate impingement, triangular fibrocartilage complex (TFCC) tears, Volar Intercalated Segment Instability (VISI) deformities, or luno-triquetral instability. The purpose of the study was to investigate the long-term clinical outcomes of the ulnar shortening osteotomy for both pain relief and union of the ulnar osteotomy.

METHODS: Thirty-one patients who underwent ulnar-shortening osteotomy were respectively reviewed from 2001-2010. Patients presented complaining of ulnar-sided wrist pain. Plain radiographs, MRI, or diagnostic wrist arthroscopy confirmed the diagnosis. Conservative treatment included immobilization, NSAID medication, occupational therapy, and corticosteroid injection. Surgery was performed if conservative measures failed to provide adequate pain relief. Mean age at surgery was 38 years and 4 months (17 years – 68 years). Mean duration of follow-up was 12 months (3 months – 64 months). Outcome was considered successful if there was significant improvement of ulnar-sided wrist pain as well as radiographic union of the ulna at the osteotomy site.

RESULTS: Five of the 31 patients were lost to follow-up before resolution of pain or evidence of radiographic healing. Twenty-four patients went on to union at an average of 5.8 months (range: 5 weeks to 16 months). Two patients required the use of a bone-growth stimulator, but continued to union without additional surgical intervention. Two patients developed nonunion. One patient developed tendonitis of the extensor carpi ulnaris secondary to the plate and required removal following union. Of the 26 patients, 22 (85%) reported an improvement in pain following ulnar-shortening osteotomy. Two patients (8%) reported no change in pain while 2 more patients (8%) said pain became worse – especially with repetitive motion, lifting, and gripping. Three of the 4 patients who did not experience any pain relief had operations on their dominant hand. Of the patients who experienced an improvement in pain, 17/22 (68%) had their dominant side operated on while 5/22 (23%) patients had surgery on their non-dominant side.

CONCLUSIONS: Ulnar-shortening osteotomy achieved good pain relief for ulnar-sided wrist pain with 93% union at the osteotomy site. We recommend ulnar shortening osteotomy as an option for providing good pain relief as well as improved function for a variety of causes of ulnar-sided wrist pain.

Soft Tissue Distal Radioulnar Interposition Arthroplasty for DRUJ Instability

Abstract ID: Paper 014

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PURPOSE: Although soft tissue interposition arthroplasty has recently emerged as a viable salvage option for advanced distal radioulnar instability, there is little information assessing the outcomes. In this investigation, we compare the outcomes of 22 patients who underwent distal radioulnar interposition arthroplasty (DRIA) with either pronator quadratus or allograft.

METHODS: A review of the medical records with prospective questionnaires was performed of all patients who underwent soft tissue interposition procedures for distal radioulnar joint instability from 1998-2011 within a single institution. Outcome measures included pain levels, Disability of the Arm Shoulder and Hand (DASH), Patient Rated Wrist Evaluations (PRWE), satisfaction scores, complications, and revision surgeries were recorded.

RESULTS: Twenty-two patients underwent DRIA with an average follow-up of 58.2 months. Eleven (50%) patients underwent interposition with pronator quadratus (PQ) and 11 (50%) underwent allograft tendon interposition. There was no significant increase in the postoperative range of motion ($p<0.18$) or grip strength ($p<0.61$) from either the preoperative values or between the groups ($p>0.20$). Postoperative pain levels significantly decreased after interposition ($p<0.001$), with no difference between the postoperative pain levels of the two groups ($p=0.3$). The average postoperative DASH and PRWE scores were 34.8 (+/-17) and 45.4 (+/- 18), respectively. There was no difference in DASH ($p<0.80$) or PRWE ($p<0.75$) between the two interposition groups. Four (36%) patients in the PQ group reported moderate or severe limitations, including 3 reporting weakness and 1 instability. Two (18%) patients in the allograft group reported limitations, both reporting weakness. Two (9%) patients failed their interposition with 1 patient within the PQ group revised to an ulnar head replacement at 15 months and 1 patient within the Achilles group revised to a ulnar head and custom sigmoid notch arthroplasty after 19 months. In terms of secondary procedures, there was 1 tenolysis for extensor tendon irritation in the PQ group, while 2 patients in the allograft group underwent additional procedures, including 1 extensor tenolysis and 1 revision DRIA with allograft Achilles tendon. No variables had a significant impact on the risk for revision or postoperative procedure.

SUMMARY: Distal radius interposition arthroplasty with soft tissue is a reasonable option for patients with significant distal radioulnar instability. Patients experience good pain relief and functional outcomes in an intermediate to long-term follow-up period.

Superficial Dorsal Foot Vein Valves: Consideration in Use for Palmar Arch Reconstruction

Abstract ID: Paper 015

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HYPOTHESIS: Superficial dorsal foot veins arising from the saphenous venous system is a graft option in arterial reconstruction of the palmar arch of the hand.

METHODS: Eight fresh frozen cadaveric feet from five patients were dissected, exposing the dorsal superficial veins. The location of valves and the flat diameters of the veins were determined at three zones defined by the first tarsometatarsal joint and one centimeter proximal to the venous branch on the lesser saphenous side extending to the 4/5 webspace (Figure 1). India ink was injected retrograde into the vein starting proximally at the greater saphenous vein then repositioned just distal to a valve and iteratively repeated, recording the location of the valves. This was repeated from the side of the lesser saphenous vein.

RESULTS: Of the five patients, three were female and two were male. Mean age was 49.8 (±11.4SD) years, average weight 173.4 (±24.1SD) pounds and average height 67.2 (±5.1SD) inches. The venous structure was mapped out for each foot (Figure 1). The venous structure was grossly different from side to side in the three patients with bilateral foot dissection. Valves were commonly found near branch bifurcations on the branch and occasionally through the arch and proximal to the arch on the greater saphenous vein side. In the arch alone, there were a mean of 1.5 (±1.1SD) valves in Zone 1, 1.5 (±1.3SD) valves in Zone 2, and 0 valves in Zone 3. However, valves were found near the branch bifurcation on the branches off the arch in Zone 3. Valve diameters were 4.9 (±0.7SD, 4.1-5.9) mm in Zone 1, 3.0 (±0.6SD, 2.0-4.0) mm in Zone 2 and 2.3 (±0.6SD, 1.5-3.0) mm in Zone 3. The mean diameter of the branches coming off the arch was 2.2 (±0.6SD, 1.4-3.9) mm. There was an average of 3.4 (±0.9SD, 2-5) branches off the dorsal arch extending to the toes with 81% (22/27) of these branches having valves.

SUMMARY:
1. Valves are commonly located distal to bifurcations, but may occur along the arch and within long segments on the greater saphenous side.
2. The diameter of common digital arteries in the hand is approximately 1.6 (1.5 to 2.0) mm[1] which compares favorably with our measured branch flat diameters.
3. When reconstructing the palmar arch and its digital branches using a dorsal foot vein arch graft, the surgeon should be aware of these valves.

REFERENCES: 1 Fazan+ J Anat 2004.

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Early Complications After Open Treatment of Distal Radius Fractures

Abstract ID: Paper 016

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INTRODUCTION: Distal radius fractures are the most common fracture of the upper extremity with open reduction internal fixation representing a common treatment modality. The purpose of this investigation was to identify the incidence of and risk factors for 30-day postoperative morbidity and mortality following open treatment of closed distal radius fractures in a multicenter cohort.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) prospectively collects 30-day morbidity and mortality data from over 480 hospitals across the United States. The ACS NSQIP was retrospectively queried using Current Procedural Terminology (CPT) codes, which identified 1,673 cases of closed distal radius fracture with open treatment between 2005 and 2011. Postoperative complications were separated into categories of minor morbidity, major morbidity or mortality, and any complication. Risk factors were identified using univariate and multivariate analyses.

RESULTS: The overall incidence of having any early complication was 2.93% (49 patients). Major morbidity was 2.09% (35 patients), which included 4 patient deaths (0.24%), and minor morbidity was 0.84% (14 patients). The most common major morbidity was a return to the operating room (16 patients). The most common minor complication was urinary tract infection (6 patients). Risk factors for any complication identified in the univariate analysis included cardiopulmonary disease, recent chemotherapy, decreased hematocrit, dependent functional status, black race, and American Society of Anesthesiologists (ASA) Physical Status class of III or IV ($p<0.05$ for each). The multivariate analysis demonstrated ASA class III or IV (OR 3.01, 95% CI 1.06-8.60), dependent functional status (OR 4.37, 95% CI 1.38-13.83), hypertension (OR 4.09, 95% CI 1.34-12.52), and myocardial infarction/congestive heart failure (OR 13.78, 95% CI 1.21-157.64) to be significant risk factors for any early complication.

CONCLUSIONS: The incidence of early complication following open treatment for closed distal radius fractures is low. In the setting of an isolated injury to the distal radius, the data presented here should be useful for providing prognostic information for patients during informed consent for what is considered to be an elective procedure. Surgeons must consider risk of morbidity and mortality when considering surgery for patients with significant cardiopulmonary disease, increased ASA class, or poor functional status.

Level of Evidence: Prognostic Level II.

Intraoperative Periprosthetic Fractures in PIP Arthroplasty: Analysis of 382 Consecutive Arthroplasties

Abstract ID: Paper 017

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PURPOSE: Proximal interphalangeal (PIP) arthroplasty has been established as salvage operation for arthritis. The incidence and sequelae of intraoperative phalangeal fracture complications has not been established. This study examined the frequency, risk factors, and postoperative outcomes associated with intraoperative periprosthetic fractures during PIP arthroplasty.

METHODS: An examination of 382 consecutive PIP arthroplasties in 205 patients was performed using our institution's Joint Registry Database from 1998 to 2012. Periprosthetic fractures were confirmed by medical record review. Univariate logistic regression and Kaplan-Meier survival analyses were performed.

RESULTS: Intraoperative periprosthetic fractures occurred in 20 (5%) fingers of 16 patients, with 7 involving the proximal phalanx, 12 in the distal phalanx, and 2 in both phalanges. Female gender, increasing BMI, RA, and pyrocarbon implants had a significant effect on the risk of intraoperative fractures ($p<0.02$) (Table 1). For example, every patient who had an intraoperative fracture was a female ($p<0.001$), while increasing BMI (odds ratio [OR], 1.24; 95% confidence interval [CI], 1.09-1.44; $p=0.002$) and RA (OR 3.41, 95% CI 1.37-8.38; $p=0.009$) were also associated with a significantly higher risk of intraoperative fracture. The use of pyrocarbon implants also significantly increased fracture risk (OR, 6.99; 95% CI 1.99-44.26; $p=0.01$).

At a median follow-up of 4.4 years, there were no refractures in the patients who sustained an intraoperative fracture, compared to 3 (1%) postoperative fractures in the patients who did not have intraoperative fractures. There was no significant difference in incidence of complications between the patients with or without an intraoperative fracture ($p>0.25$), including infections (0% vs. 1%), dislocations 4% vs. 6%), contractures (43% vs. 39%), and heterotopic ossification (9% vs. 6%). Revision surgeries were performed in 6 (26%) patients with intraoperative fractures, compared to 19% of those without intraoperative fractures. Although the incidence was not statistically significant, there was a decrease survival rate at 2 and 5 years in the intraoperative fracture group of (76% and 64%, respectively), when compared to those without fractures (84% and 77%) ($p=0.13$).

SUMMARY: Intraoperative fractures occur in about 5% of PIP arthroplasties, and while they do not appear to influence the rate of refracture or clinical outcomes, they do slightly decrease the overall implant survival. Female gender, increasing BMI, patients with RA, and the use of pyrocarbon implants are associated with increased risk for these fractures.

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Evaluating Intraoperative Periprosthetic Fractures Associated in an Analysis of 818 Consecutive MCP Arthroplasties

Abstract ID: Paper 018

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PURPOSE: Metacarpal phalangeal arthroplasty (MCP) is a common treatment for end-stage joint degeneration. However, the risks for intraoperative complications and their effect on postoperative outcomes have not been well established. The objective of this study was to assess the frequency of and risk factors for intraoperative periprosthetic fractures during MCP arthroplasty.

METHODS: Through the institutional Joint Registry Database, 818 MCP arthroplasties were performed in 285 patients at the Mayo Clinic from 1998 to 2012. Periprosthetic fractures were confirmed by medical record review from our institution's Total Joint Registry. Univariate logistic regression and Kaplan-Meier survival analyses were performed.

RESULTS: Intraoperative periprosthetic fractures occurred in 23 (3%) fingers of 20 patients. The proximal phalanx was fractured in 8/23 while 15/23 sustained a metacarpal fracture. Univariate regression analysis demonstrated that DM, increasing age, cementless fixation, and use of bone grafting had an increased risk of intraoperative fracture ($p<0.03$). In particular, diabetes mellitus (odds ratio [OR], 4.5; 95% confidence interval [CI], 1.77-10.69; $p<0.002$) was associated with a significantly higher risk of intraoperative fracture. This risk was further increased when the patient had diabetes with end-organ damage (odds ratio [OR], 12.5; 95% confidence interval [CI], 1.76-58.03; $p< 0.01$;). The use of pyrocarbon implants also significantly increased fracture risk (odds ratio [OR], 5.35; 95% confidence interval [CI], 2.25-14.07; $p< 0.001$).

At a median follow-up of 4.9 years, no patient who had an intraoperative fracture sustained a refracture, whereas 3 patients who did not have intraoperative fractures went on to develop fractures. Of the 23 arthroplasties with an intraoperative fracture, there were no postoperative infections, 2 dislocations, and 1 case of postoperative heterotopic ossification. There was no significant difference increase in heterotopic ossification, dislocations, or infections between MCP arthroplasties with or without an intraoperative fracture ($p>0.2$). Three (13%) patients underwent a revision surgery, with reasons including recurrent ulnar deviation with extension lag, recurrent pain and stiffness, and pain with subluxation. There was no significant increase in overall revision rate when compared to MCP arthroplasties without an intraoperative fracture ($p>0.4$).

SUMMARY: Intraoperative fractures occur in about 3% of MCP arthroplasties. These fractures do not appear to influence the rate of complications or implant survival. The risk for these intraoperative fractures are increased by increasing age, use of pyrocarbon implants, cementless fixation, and patients who had DM with or without end-organ damage.

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Comparison of Open Drainage (OD) vs. Closed Catheter Irrigation (CCI) for Treatment of Purulent Flexor Tenosynovitis

Abstract ID: Paper 019

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INTRODUCTION: Purulent flexor tenosynovitis is a very common surgical emergency. However, there is a paucity of information regarding the different factors and treatment regimens that influence the outcomes. The purpose of this study was to review the outcomes associated with different surgical treatments for a positive culture of purulent flexor tenosynovitis.

METHODS: A review of all patients with culture positive flexor tenosynovitis treated from 2003 to 2009 at a single institution was performed. Two surgical techniques, open drainage (OD), and closed catheter irrigation (CCI) of the tendon sheath were examined. Variables examined included culture results, time to surgery, duration of hospitalization and antibiotic therapy, pain, reoperation, and functional outcomes were recorded. Statistical analyses used included parametric and nonparametric t-tests. T-tests, Fisher's Exact test, and univariate regression analysis was performed, with statistical significance of $p<0.05$.

RESULTS: Twenty-four patients were treated for purulent flexor tenosynovitis with a mean follow-up of 3 +/-2 years. There were 13 (100%) males in the OD group compared to 8 (72%) males within the CCI group. All 4 Kanavel signs were present in 17 (71%) patients at presentation. Most patients experienced excellent pain relief by final follow-up, with 92% who underwent OD and 100% who underwent CCI reporting none or mild pain. There were no differences between the two groups with regards to functional outcome scores, including the Mayo wrist score and Cleveland outcome score. Factors that worsened functional outcomes included prolonged time to receiving antibiotics and methicillin sensitive Staphylococcus aureus (MSSA) infection ($p<0.05$). Smokers required prolonged antibiotic treatment compared to non-smokers. Accounting for planned returns to the operating room, there was no difference in reoperation rates between the OD or CCI groups ($p=0.34$). Furthermore, there was no significant difference in patient reported limitations in activities of daily living ($p=0.65$). No factors had a significant impact on reoperations or limitations.

CONCLUSION: Surgical treatment of purulent flexor tenosynovitis with either OD or CCI resulted in similar outcomes for pain, function, and need for reoperation in this retrospective review. Factors that worsen outcomes include MSSA culture, prolonged time to antibiotics, and smoking.

Level of Evidence: Level IV

Keywords: Flexor tenosynovitis, catheter irrigation.

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The Boutonniere Deformity: Mid- to Long-Term Outcomes of Non-Operatively Treated Patients

Abstract ID: Paper 020

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PURPOSE: To determine the effectiveness of splinting for zone III (central slip) extensor tendon disruptions and the functional impact of this injury at final follow-up.

METHODS: Adult patients who sustained a zone III extensor tendon disruption initially treated non-operatively and had at least 1 year follow-up were eligible for inclusion. Patients with inflammatory arthritis and open tendon lacerations that had operative intervention were excluded. Final evaluation included range of motion of the digit, grip and pinch strength, and completion of the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire, and the Visual Analog Scale (VAS) for pain. They were queried regarding splint compliance during their treatment course and progression to surgery. Appropriate statistical analysis was completed to determine timing of treatment effect on final PIP extension, the correlation between final PIP extension and DASH, the correlation between splint compliance and final PIP extension, and the difference between initial and final PIP extension.

RESULTS: Twenty patients participated. The average follow-up was 5.3 years (range 1.2 to 11.3), and the average time from injury to treatment initiation was 8 weeks (range 2 to 64). The initial PIP extensor lag averaged 39°, and DIP hyperextension was 9°. These averages improved to 10° and 0°, respectively, following splinting and were maintained at final follow-up. Final DIP flexion averaged 55°. There was no correlation between final PIP motion and DASH score. There was a statistically significant difference between initial and final PIP extension ($p=0.0003$) and between splint compliance and final PIP extension ($p=0.006$). One patient had surgery.

CONCLUSIONS: (1) Splinting is a very effective treatment method for central tendon disruption. (2) Excellent compliance with splint wear will generally lead to improved range of motion that is maintained over time. (3) Final PIP range of motion does not correlate with functional outcome. (4) While not statistically significant, there was a trend toward better motion if treatment began within 6 weeks from the time of injury. (5) Progression to surgery is rare.

MAOA BREAKOUT SESSION #2
SPORTS LOWER EXTREMITY
April 24, 2014

The Biomechanics of Femoral ACL Graft Malposition: A Finite Element Analysis

Abstract ID: Paper 021

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INTRODUCTION: Femoral ACL tunnel malposition is related to clinical instability and graft failure. Given the prevalence of ACL reconstruction, there is a paucity of studies employing finite element analysis. While graft placement has been studied clinically and experimentally, quantitative information regarding differences in local biomechanics as a function of femoral graft placement has not been systematically evaluated. We hypothesize that simulated graft placement anterior to the anatomic footprint will result in pathologic knee biomechanics.

METHODS: An established non-linear contact finite element model used to evaluate 25 different tunnel loci representing primary ACL reconstructions; the first represented the center of the femoral anatomic footprint and loci diverged by 2.5 mm increments in 8 directions relative to the roof of the notch: anterior, anterior/superior, superior, posterior/superior, posterior, posterior/inferior, inferior, and anterior/inferior. A simulated Lachman maneuver was utilized to assess knee joint laxity, meniscal stress, in situ graft loading, and peak articular cartilage contact pressure for each of the tunnel positions.

RESULTS: Significant increased anterior tibial translation during Lachman testing was observed when the femoral graft was moved anterior, anterior/inferior, and posterior/inferior relative to the anatomic footprint. Cartilage contact pressure (MPa) and peak von Mises stress at the medial and lateral menisci increased significantly when the femoral graft was moved anterior and anterior/inferior. Peak von Mises stress in the ACL grafts significantly increased as a function of graft position when moving posterior (120%) and posterior/inferior (144%).

DISCUSSION: Femoral ACL graft malposition significantly affects local knee biomechanics. With regard to anterior tibial translation, there appears to be more tolerance/forgiveness when the graft is placed superiorly, superior/posterior, or posterior with respect to the anatomic footprint. Conversely, simulated ACL grafts experience higher von Mises stress when placed too far posteriorly or posterior/inferior. Graft malposition is least forgiving when placed anterior or anterior/inferior to the anatomic footprint, and most forgiving when placed posterior to posterior/superior with regard to simulated Lachman testing. Given modern trends towards anatomic reconstruction and moving grafts inferior and posterior, this data suggests excessive posterior/inferior graft placement may subject grafts to significantly higher stresses.

CONCLUSION: Femoral ACL graft malposition is biomechanically least forgiving anterior/inferior to the anatomic footprint; current trends towards low and posterior placement may subject grafts high stress.
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Bio-Enhanced Anterior Cruciate Ligament Reconstruction Utilizing an Animal Technique in Humans

Abstract ID: Paper 022

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INTRODUCTION: Anterior cruciate ligament (ACL) reconstructions are being performed in ever increasing numbers each year. It is commonly believed some of the reasons for ACL surgery failure are inadequate bony ingrowth, ligamentization, and revascularization. Attempts to solve this problem have included the use of platelet-rich plasma (PRP) with mixed results. The concept of a collagen-PRP composite (CPC) to repair ACLs in animal models was introduced with promising results. To date, there is no reported use of this concept in humans.

METHODS: Twenty-two patients underwent ACL reconstruction using autologous hamstrings and a CPC. Each patient was followed to completion of physical therapy (PT) and time to completion was documented. All patients underwent a magnetic resonance imaging (MRI) of the affected knee at the completion of PT. They were also assessed with Lysholm and IKDC knee scores. The MRIs were scrutinized for tunnel enlargement, bony edema, bony ingrowth, graft integrity, and homogeneity of graft signal. Three patients underwent a second look arthroscopy with biopsy of the reconstructed ligament.

RESULTS: The average time to complete PT and return to sports was 19 weeks with a range of 14 to 24 weeks. The average follow-up was 27.5 months with a range of 24 to 34 months. The mean IKDC and Lysholm scores were 95 and 97, respectively. MRI revealed a darker and thicker ligament appearing more like a posterior cruciate ligament. The reconstructed ligaments were much more homogenous than seen in the past with standard ACL reconstructions. A biopsy was taken of the ligament at second look arthroscopy with one patient six months postoperative and the other two eight months. Biopsy of the six-month ligament revealed two-thirds of the graft was vascularized and viable. The eight-month specimens demonstrated complete vascularization and cellularity of the graft.

DISCUSSION AND CONCLUSION: Successful ACL reconstruction requires bony ingrowth, revascularization, and ligamentization as quickly and completely as possible. Multiple studies have provided conflicting data on the value of PRP in ACL reconstruction. A CPC has shown promise in ACL repair in an animal model and is now showing promise in human ACL reconstruction. While it is a relatively small number of patients, it is the first such study in humans documenting by MRI and biopsy excellent bony ingrowth, maturation, and ligamentization of the graft in a much shorter time period than previously reported.

Radiographic Anatomy of the Native Anterior Cruciate Ligament: A Systematic Review

Abstract ID: Paper 023

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PURPOSE: We performed a systematic review of the literature to delineate the location of the native ACL femoral and tibial footprints on AP and lateral knee radiographs.

METHODS: A search was performed on January 2013 in Pub Med, the Cochrane Collaboration Library, and EMBASE to identify all studies that evaluated the native anterior cruciate ligament (ACL) anatomy on plain radiographs. Each of the studies used radiopaque markers to mark the ACL on plain radiographs or fluoroscopy images. Various measurement methods were used in each study, and averages were obtained of the data from studies with the same measurement methods.

RESULTS: Fifteen papers were identified in the literature review that met the inclusion criteria (which included data on 177 femora and 207 tibiae in total). There was large variability in the reported data from each study. Subgroups that used the same measurement systems were summarized and average measurements were identified.

CONCLUSIONS AND CLINICAL RELEVANCE: Clinical application of these data is difficult due to the large diversity of reported measurements. With regards to the more commonly used measurement systems, reliability of the methods are limited and should be further studied. With this being said, there is a significant increase in quality of studies with recent papers showing superior quality of radiographic studies compared to earlier studies, yet there is still not a census defining the radiographic double bundle anatomy of the ACL. Until more definitive answers are obtained, summation of the data can serve to tentatively guide surgeons about the anatomical location of the ACL when evaluating postoperative ACL tunnel reconstruction radiographs, or when using fluoroscopy intraoperatively to evaluate tunnel positions with guide wires prior to drilling.

Keywords: Systematic review; anterior cruciate ligament; radiograph; anatomy

Incidence and Trends of Anterior Cruciate Ligament Reconstruction in the United States

Abstract ID: Paper 024

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INTRODUCTION: Anterior Cruciate Ligament (ACL) injuries are common and are one of the most studied injuries in orthopedics. However, the previously reported incidence of ACL injuries in the United States has a wide range and is based on expert opinion or singular insurance databases. The goal of this study was to report the incidence of ACL injury and reconstruction in the United States using government databases. We also hoped to determine the most common age range, gender, and types of concomitant procedures performed in conjunction with ACL reconstruction. Finally, we hoped to determine if the incidence in the aforementioned groups have changed over a 12-year time span from 1994 to 2006.

METHODS: Using the National Center for Health Statistics (NCHS) annual health care surveys – the National Hospital Discharge Survey (NHDS) and the National Survey of Ambulatory Surgery (NSAS) – we determined the incidence of ACL reconstruction in 1994 and in 2006. International Classification of Diseases, Ninth Revision (ICD-9) codes of 844.2 and 717.7 were used for the diagnosis of ACL tear, and the procedure code of 81.45 was used to denote ACL reconstruction. We then stratified these results based on patient age, gender, facility, and concomitant procedures performed at the time of ACL reconstruction.

RESULTS: The overall incidence of ACL reconstruction in the United States rose from 86,687 (32.9 per 100,000 person-years) in 1994 to 129,836 (43.5 per 100,000 person-years) in 2006. The number of ACL reconstructions increased in patients under the age of 20 and over the age of 40 over this 10-year period, and dropped in the 20-39 year old population. The percentage of female ACL reconstructions increased from 31% of the total number to 42% over this period as well. While 57% of ACL reconstructions were performed in inpatient facilities in 1994, only 5% were in 2006, with the remainder performed in ambulatory surgical centers. The most common concomitant procedures in order of incidence were partial meniscectomy, meniscal repair, and chondroplasty.

CONCLUSIONS: The incidence of ACL reconstruction is increasing, particularly in females as well as those under 20 and over 40. Research efforts may be best served studying prevention in young females. Additional outcomes research should focus on those under 20 and over 40. Surgeons should be aware that concomitant procedures are common.

In Vivo Evaluation of Gold and Hydroxyapatite Nano-Grafts for Anterior Cruciate Ligament (ACL) Reconstruction

Abstract ID: Paper 025

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INTRODUCTION: A novel graft material composed of extracellular matrix and gold and hydroxyapatite nanoparticles has been developed as an improved scaffold material for anterior cruciate ligament (ACL) reconstruction. Nanoparticles have been shown to increase cellular integration and proliferation. Green fluorescent protein (GFP) expressing swine were used as a model showing enhanced biocompatibility and vascularity of nano-grafts.

METHODS: Nano-grafts derived from the decellularized extracellular matrix of either porcine diaphragm tendon or human anterior tibialis allograft were covalently crosslinked with gold (AuNP) and hydroxyapatite (nano-HAp) nanoparticles. Twelve GFP pigs were each implanted with a set of three allograft and three xenograft scaffolds. Each set contained samples without nanoparticles, with AuNP, and with both AuNP and nano-HAp. One month and three months after implantation, four pigs were sacrificed. Explanted allograft scaffolds were histologically scored for cellular infiltration, vascularity, fibrous encapsulation, scaffold degradation, foreign body giant cells, and connective tissue organization. Confocal microscopy was utilized to assess cellular integration by direct visualization.

RESULTS: Little to no foreign body giant cells were seen in one and three month histology results. Enhanced biocompatibility of nano-grafts compared to crosslinked scaffolds was seen by less encapsulation after one month. Grafts with nanoparticles had slightly higher vascularization compared to those without nanoparticles. Vascularity increased from one month to three months in all groups. Scaffold degradation was consistently minimal from one month to three months indicating graft stability. Other scoring categories did not display any trends. Evidence of cellular integration of host tissue into gold nano-grafts was seen in confocal microscopy images. Results are in progress for the remaining six month implants.

CONCLUSION: The addition of nanoparticles to extracellular matrix grafts resulted in enhanced cellular integration, biocompatibility, and vascularity one and three months after implantation. Nano-grafts did not degrade and show potential to be used as a graft for ACL reconstruction.

All-Arthroscopic Tibial Inlay Double-Bundle PCL Reconstruction: Early Experience with Two-Year Follow-Up

Abstract ID: Paper 026

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INTRODUCTION: The advantages of the all-arthroscopic tibial inlay double-bundle (DB) PCL reconstruction (PCL-R) include avoidance of the “killer turn”, circumvention of open dissection around neurovascular structures, and the biomechanical advantages of a DB graft. Despite the theoretical advantages, and sound time-zero cadaveric biomechanical data, there is a paucity of clinical data to suggest this reconstruction is a viable surgical option. The purpose of this study was to evaluate our results using the all-arthroscopic tibial inlay DB PCL-R. Our hypothesis was that the arthroscopic inlay DB PCL-R would be comparable to previously described PCL-R techniques.

METHODS: After obtaining approval from our Institutional Review Board, the initial 12 patients to undergo the aforementioned procedure with Achilles tendon allograft were enrolled. Demographic data, outcome scores, and PCL stress views (20 pounds of posteriorly direct weight on the tibia) were performed for each patient.

RESULTS: The first 12 scope inlay DB PCL-R patients were enrolled. There were 9 males and 3 females with an average age 30 years (range 14–56 years). Average time from injury to reconstructive surgery was 7 months (range 1–48 months), and the average post-surgical follow-up time was 3.1 years (range 2.0-4.6 years). Ten sustained knee dislocations. Nine underwent reconstruction of the PCL and 2 or greater additional knee ligaments, 2 underwent PCL-R with posterolateral corner repair (PLC-r), and 1 underwent PCL-R with PLC-r and lateral collateral ligament repair. Average Tegner, Lysholm, and IKDC subjective scores at final follow-up were 5, 79.4, and 72.0, respectively. The final IKDC objective scores included 8 (67%) nearly normal knees, 3 (25%) abnormal knees, and 1 (8%) severely abnormal knee (secondary to a flexion loss of 30°). The average flexion and extension losses at final follow-up were 10° and 1°, respectively. Radiographic examination at final follow-up demonstrated that 92% had normal or near normal IKDC knee findings. The average final side-to-side difference on PCL stress view radiographs was 5.1 mm. There were no graft ruptures or clinical failures necessitating revision surgery.

CONCLUSIONS: The scope inlay DB PCL-R affords the benefits of a DB graft, avoids the morbidity of open dissection adjacent to neurovascular structures, and eliminates the “killer turn” associated with previously described PCL-R techniques. In addition, the clinical and radiographic results of scope inlay DB PCL-R are comparable to those of previously described PCL-R techniques; therefore, we advocate for the use of this technique in patients with multiligamentous knee injuries.

MPFL Tears in the Setting of Multi-Ligament Knee Injuries Rarely Cause Patellar Instability

Abstract ID: Paper 027

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INTRODUCTION: Multi-ligament knee injuries (MLKI) are often the result of high energy trauma. These high energy injuries cause significant damage to multiple structures within the knee. There is a paucity of literature regarding medial patellofemoral ligament (MPFL) injuries and their treatment in the setting of multi-ligamentous knee injuries. The purpose of this study was to (1) identify the prevalence of MPFL injuries in MLKI and (2) report clinical and functional outcomes of patients with and without MPFL tears in the setting of MLKI reconstruction.

METHODS: The records of all patients who underwent surgical reconstruction of MLKI (defined as a grade 3 injury of two or more ligaments) at our institution from 2007 to 2010 were reviewed. Age, gender, Schenck classification, and MRI imaging findings were documented. All preoperative MRI scans were reviewed by a musculoskeletal radiologist to determine the presence or absence of MPFL tear. If present, the location and degree of MPFL tear and presence of patellar or lateral femoral condyle bone bruises were documented. Inclusion criteria were: MLKI treated with surgical reconstruction at our institution, presence of MPFL tear on preoperative MRI, and minimum 2 year clinical follow-up. Patellar instability symptoms were assessed with a subset of the Kujala Knee Questionnaire. Functional outcomes were recorded using the International Knee Documentation Committee (IKDC) and Lysholm scores.

RESULTS: 51 MLKI patients underwent surgical reconstruction during the study time period. 30 patients (59%) had an MPFL injury on MRI, and 21 (41%) had minimum 2-year follow-up. There were 13 complete (62%), 5 high-grade partial (24%), and 3 partial (14%) MPFL tears. 16/21 tears (76%) occurred at the proximal third with the remainder exhibiting diffuse signal abnormality/tearing throughout the length of the MPFL. The superficial MCL was torn in all patients. Eleven patients underwent repair or reconstruction of the MCL. No patient underwent surgical repair or reconstruction of the MPFL at the time of MLKI reconstruction.

At mean follow-up of 3.6 (range 2.0-5.7) years, only 1 of 21 patients (5%) complained of patellofemoral instability symptoms while 20/21 (95%) patients had no episodes of patellar dislocation, subluxation, or instability.

DISCUSSION AND CONCLUSION: MPFL tears occur frequently in patients with MLKI. They rarely cause clinical symptoms or instability and, thus, do not need to be addressed surgically at the time of MLKI reconstruction.

Cadaveric Measurements of the Peroneal Nerve in Posterior Lateral Corner Reconstructions

Abstract ID: Paper 028

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INTRODUCTION: The common peroneal nerve (CPN) and its branches innervate the muscles in the anterior and lateral compartment of the leg and allow dorsiflexion of the ankle and extension of the toes, both of which are the key components of normal gait. A thorough knowledge of the anatomy of the CPN and its branches is essential for surgeons operating within and around the knee joint. Previous studies have named Gerdy's tubercle, the fibular head, and the long head of the biceps femoris (LHBF) tendon as important landmarks in determining the location of the CPN in the lateral aspect of the knee. The purpose of this study was to measure the distance between the palpable posterior border of the fibula to the point where the CPN nerve crosses the LHBF tendon as this distance has not been quantified to our knowledge and would be useful in identifying the CPN when the zone of injury has made tissue identification more difficult. The hypothesis of this study is that this will be a reproducible and reliable measurement.

MATERIALS AND METHODS: Cadaveric lower extremities sectioned from mid-femur to mid-tibia were obtained. Eight right and eight left cadavers were utilized from 8 donors. After thawing of the specimens, the extremities were placed in the lateral position with the knee flexed to 90°. The CPN was dissected, taking care not to disturb the native anatomy. Using a digital caliper (Whitworth LCD Electronic Digital Calipers 0-6 inch Hardened Stainless Steel), the distance between the point where the CPN crossed under the biceps femoris (BF) tendon to the posterior aspect of the fibular head (at the level of the inferior aspect of the direct arm of the BF insertion) was measured. This measurement was then repeated for knee flexion angles of 0°, 30°, and 60°. Additionally, the distance between the fibular styloid and the CPN as it intersected the posterior border of the fibula was also measured with the knee in 90° of flexion. After measurement of half of the specimens, the average distance was determined (46 mm), this distance was used during the measurement of the other 8 cadavers. A needle was inserted prior to opening the fascia over the BF 46 mm from the fibular head the fascia was opened to determine if the needle had transected the CPN.

RESULTS: The CPN was identified in all specimens. The level at which the CPN crosses under the BF tendon was inversely related to the degree of knee flexion. This distance on average was found to be 62 mm +/- 8 mm, 56 mm +/- 9 mm, 46 mm +/- 6 mm, and 45 mm +/- 4 mm in 0°, 30°, 60°, and 90° of flexion respectively. The average distance from where the CPN crosses the posterior borer of the fibula from the fibular styloid was found to be 22 mm +/- 3.5 mm with 90° of knee flexion.

Following the first 8 dissections, a pin was placed at 46 mm proximal to the posterior border of the fibular prior to dissection of the fascia over the biceps femoris. 6/8 pins transected the CPN. The remaining two pins were within 2 mm of the nerve at the point where it exits from beneath the biceps femoris.

DISCUSSION: Nerve injury during posterior lateral corner (PLC) reconstructions can lead to significant morbidity and foot drop. Given the abnormal anatomy secondary to the zone of injury

in lateral-sided knee injuries, peroneal nerve identification and neurolysis during PLC reconstruction is an important first step to avoid CPN injury. To our knowledge, our study is the first to quantify the distance from the posterior border of the fibula to where the CPN crosses the LHBF tendon. With knowledge of this distance, safe and efficient identification and neurolysis of the CPN can be achieved.

CONCLUSIONS: With the knee in 90° of flexion, the common peroneal nerve reliably crosses the long head of the biceps femoris tendon 45 +/- 4 mm from the posterior border of the fibula. The common peroneal nerve crosses the posterior border of the fibula 22 +/- 4 mm from the tip of the fibular styloid process. With this knowledge, isolation of the CPN can occur quickly and safely to allow for protection during the remainder of the operative procedure.

Novel Radiographic and Anatomical Evaluation of the Tibia Tubercle-Trochlear Groove Distance

Abstract ID: Paper 029

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BACKGROUND: Lateralized tibial tubercle is an important anatomic predictor of patella instability and can be used as an indication for distal re-alignment procedure. Currently, TT-TG distance is measured on computed tomography (CT) scans; however, radiographs could be a more efficient modality. The aim of this study is to evaluate and compare TT-TG measurements obtained using a novel XR technique, CT scan, and anatomical dissections. Furthermore, it evaluates the effect of leg external and internal tibial rotation on these measurements.

METHODS: Eleven fresh cadaver knees were imaged with a novel XR technique and a helical CT scan. The TT-TG distance was measured on a modified sunrise XR view (knee in 90° of flexion) and compared to TT-TG distance derived on the CT scan. Anatomic measurements were obtained from the dissection of the cadavers in full knee extension and 90° of knee flexion. Both imaging and dissection derived TT-TG distance measurements were also obtained in neutral, external, and internal tibial rotation.

RESULTS: The TTTG distance (avg±SEM) obtained on a CT scan (13.00±1.05) was comparable to those derived from the anatomic dissections in extension (14.88±1.10) and 90° knee flexion (12.40±1.93) ($P \geq 0.05$). The XR derived measurements of TT-TG distance (5.62±1.16) were significantly different than those measured on a CT scan (13.00±1.05) ($P < 0.05$). TT-TG distance in neutral tibial position measured on CT scan (13.00±1.05) and anatomic dissection (14.88±1.10) was significantly different than the TT-TG distance measured in full external (19.79±1.33 and 20.92±1.15) and internal tibia rotation (6.45±1.00 and 10.33±1.19) ($p \leq 0.05$).

CONCLUSIONS: Our study is the first to confirm that CT scan derived TT-TG distance is comparable to TT-TG measurement from anatomic dissections with the knee in full extension and 90° of flexion. Future evaluation should yield similar concordance between XR and CT scan-derived TT-TG measurements. In addition, this study is the first to describe a novel XR technique for simultaneous visualization of both tibial tuberosity and trochlear groove. Finally, this study is the first to quantify the significant effects of tibial rotation on TT-TG distance measurement. This rotation-dependent variation in TT-TG distance can erroneously affect surgical indication; hence, careful consideration of tibial rotation is an imperative during clinical imaging.

Deep Vein Thrombosis Following Knee Arthroscopy: Evaluating Procedure-Specific Risk and a Thrombosis Risk Score

Abstract ID: Paper 030

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INTRODUCTION: Thrombosis risk scoring systems have been validated for multiple surgical subspecialties[1] by generating a score based on both patient-specific and procedure-specific factors[2] dictating the method and duration of thromboprophylaxis. The role of thromboprophylaxis after less invasive procedures such as arthroscopic knee surgery (AKS) is unclear. A thrombosis risk score applied to AKS patients would facilitate evaluation of both patient- and procedure-specific risk factors and help clarify the role of thromboprophylaxis after AKS. The purpose of this study was to evaluate risk of DVT following two AKS procedures and to retrospectively calculate Caprini[2] thrombosis risk scores to determine if the Caprini system would have recommended postoperative thromboprophylaxis in these patients.

METHODS: Records of 228 consecutive patients who underwent chondroplasty/microfracture (CPT 29879) and those of a matched cohort of 229 consecutive patients treated by the same single surgeon with medial or lateral partial meniscectomy (CPT 29881) were reviewed. Symptomatic DVT were confirmed by ultrasound. Caprini thrombosis risk scores were calculated and used to determine if the Caprini system would have recommended postoperative thromboprophylaxis.

RESULTS: Five patients (2.2%) developed DVT following chondroplasty/microfracture. No DVT occurred in patients after partial meniscectomy. There was a statistically significant relationship between chondroplasty/microfracture and DVT after AKS. This relationship did not remain present when postoperative non-weight bearing status (NWB) was considered. NWB was an independent risk for DVT. Patients with three or more patient-specific risk factors were at increased risk for DVT. The Caprini risk assessment would have recommended 7 days of postoperative thromboprophylaxis for 4 of the 5 patients who developed DVT.

CONCLUSIONS: These results demonstrate the importance of evaluating both patient- and procedure-specific factors when determining the risk of DVT after AKS. The Caprini thrombosis risk assessment system would have recommended postoperative pharmacologic thromboprophylaxis for 4 of the 5 patients who developed DVT in this series. Additional studies are needed to further define the role of thrombosis risk scoring systems for patients undergoing AKS.

1. Caprini, JA. Risk assessment as a guide for the prevention of the many faces of venous thromboembolism. The American Journal of Surgery. 2010 Jan;199 (1 Suppl):S3-10.
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3. Morgan JA, Krych AJ, May JH, Levy BA, Stuart MJ, Dahm DL. Incidence of Symptomatic Venous Thromboembolism After Knee Arthroscopy. Paper presented at: American Orthopaedic Society for Sports Medicine Annual Meeting; July 7-10, 2011; San Diego, CA.

Acute Complications of Pediatric and Adolescent Knee Arthroscopy

Abstract ID: Paper 031

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PURPOSE: Arthroscopic knee procedures are commonly performed in pediatric/adolescent patients. Reported complications following these procedures are low; however, no childhood specific data exists. Therefore, the purpose of this study is to determine the acute complications (within 6 months) of arthroscopic knee procedures in patients aged 17 years or less.

METHODS: This is a retrospective review of patients aged 17 years or less who underwent an arthroscopic knee procedure from 1997 to 2009 at a single institution. Demographic and surgical data was collected, in addition to specific data on intraoperative and postoperative complications. Minor complications included peripheral nerve block complications, regional anesthesia failure requiring conversion to general anesthesia, superficial wound infection/dehiscence, persistent knee effusion requiring aspiration, retained foreign body, arthrofibrosis not requiring manipulation, and sensory nerve dysesthesia unrelated to peripheral nerve block. Major complications included death, major medical complication, septic arthritis, wound requiring repeat closure, arthrofibrosis requiring manipulation, and revision surgery not related to recurrent trauma.

RESULTS: 1,002 procedures in 875 patients (399 males [45.6%], 476 females [54.4%]) with average age 15.4 (range 4-17) years were analyzed. The average operative time was 133.8 minutes (range 14-520). Of the 1,002 knee arthroscopies performed, 291 (29%) were for ligament reconstructions, 208 (20.8%) for meniscal treatments, 63 (6.3%) chondroplasties, 53 (5.3%) synovectomy and/or lateral releases, 103 (10.3%) OCD treatments with or without loose body removal, 222 (22.2%) combined ligament and meniscus treatments, 43 (4.3%) diagnostic arthroscopies, and 19 (1.9%) tibial eminence treatments.

There were 141 (14.1%) total complications recorded. Major complications occurred in 21 (2.1%) of patients and minor complications in 122 (12.2%) of patients. 2 patients had both major and minor complications, 4 had more than one minor complication, and 2 had more than one major complication.

Major complications included: septic arthritis (3) (0.29%) or wound complication in 9 (0.88%) patients, arthrofibrosis with manipulation in 4 patients (0.39%), unplanned subsequent surgery in 4 patients (0.39%), and death in 1 patient (0.09%). 2 patients were readmitted to the hospital (1 DIC, 1 a-fib and syncope). There were no DVTs, PEs, vascular injuries, or CRPS.

Minor complications included: intra-articular instrument breakage in 1 (0.09%) patient, sensory nerve paresthesias in 5 patients (0.49%), failed regional anesthetic in 10 (0.99%) patients, 15 (1.49%) patients with postoperative pain pump that required early discontinuation, 18 (1.79%) patients with superficial wound infection/irritation, 59 (5.88%) patients with persistent effusion/hemarthrosis requiring arthrocentesis, 1 (0.09%) patient with arthrofibrosis without manipulation, and 17 (1.69%) patients had minor medical problems that required intervention

(asthma exacerbation, urinary retention).

CONCLUSIONS/SIGNIFICANCE: Major complications following knee arthroscopy in children and adolescents are low 2.1%. Minor complications are more common (12.2%), but did not alter the postoperative course or recovery. DVT, PE, and CRPS did not occur in this patient cohort.

Age Differences in the Incidence of Isolated Meniscal Tears

Abstract ID: Paper 032

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INTRODUCTION: Meniscal tears are common, often with other diagnoses, with arthroscopic partial meniscectomy one of the most common procedures performed[1]. The incidence of lateral meniscal tears are thought to be higher in younger populations, with medial tears occurring in lower rates in younger people and increasing with age. To our knowledge, no study has evaluated the incidence of isolated meniscal tears with respect to age. Our hypothesis was that isolated medial meniscal tears are more common with increasing age, while lateral meniscal tears are more common in younger people. Our purpose was to determine the incidence of isolated meniscal injuries requiring treatment in comparison to patient age.

METHODS: Our patient database was reviewed for meniscal procedures performed from July 1, 2007 – July 1, 2012. Each chart was reviewed to document the incidence of isolated medial or lateral meniscal injuries. Patients were further classified by age into three groups: less than 20 years, 20-30 years, and greater than 30 years old.

RESULTS: Our search revealed 782 patients undergoing meniscal procedures, and these were divided into medial and lateral meniscal tear groups.

Of these 782 patients, 537 patients (68.7%) had medial meniscal tears, average age 37.6 years. 92 of these 537 (17.1%) were isolated medial meniscus injuries, average age 31.9 years. The remaining 445 patients had additional diagnoses and procedures performed (ligament injury, chondroplasty, etc.).

245 of the 782 (31.3%) patients had lateral meniscal injuries, average age 27.7 years. Of these 245, 46 had isolated lateral meniscal injuries (18.8%), average age 22.8 years. The remaining 199 patients had additional diagnoses/procedures.

When analyzed by age group, isolated medial meniscal injuries were more common in older patients (52.2% in patients older than 30 years and 34.8% of patients younger than 20 years old). Isolated lateral meniscal tears were more common in younger patients (63.0% in patients younger than 20 years and 15.2% in patients older than 30 years old).

CONCLUSION: Lateral meniscal tears occur in younger people, with the incidence of isolated lateral meniscal tears being more common in patients less than 20, and decreases with age. The incidence of medial meniscal tears increases with age, both in isolation and combined knee pathology.

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Comparing the Efficacy of Knee Cartilage Restoration Strategies: A Meta-Analysis

Abstract ID: Paper 033

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BACKGROUND: A number of new and established treatment options are currently available for the surgical management of articular cartilage lesions, yet few comparative treatment studies exist in the cartilage replacement literature.

PURPOSE: The purpose of this study was to use meta-analytic techniques to determine the difference in efficacy between common treatment modalities for cartilage lesions including first-, second-, and third-generation autologous chondrocyte implantation (ACI); microfracture; and osteochondral allograft.

STUDY DESIGN: Meta-analysis

METHODS: A systematic search of the current cartilage literature was conducted in Medline, Embase, and GoogleScholar. Eighty prospective knee cartilage replacement studies were identified that reported International Knee Documentation Committee Subjective scores (IKDC-S) at baseline and postoperative follow-up. Effect size (mean improvement in IKDS-S score) was pooled across studies by treatment modality (first-third generation ACI, microfracture, or osteochondral allograft) and adjusted for length of follow-up, baseline IKDC-S score, lesion size, and age in a generalized linear model.

RESULTS: A total of 2,349 patients (9,172.9 person-years) were included in the analysis. The strongest predictors of a patient's final IKDC-S score were the preoperative score (LR Chi square 993.7, $p<0.001$), followed by treatment choice (LR Chi square 773.7, $p<0.001$) and age (LR Chi square 417.4, $p<0.001$). After adjusting for age, baseline IKDC-S, lesion size, and length of follow-up, third generation ACI had the highest predicted improvement in IKDC-S score (42.1 points, CI 39.1 - 45.1), followed by second generation ACI (33.4 points, CI 33.0 - 33.8), osteochondral allograft (33.4 points, CI 32.7 - 34.0), microfracture (28 points, CI 27.3 - 29.0), and first generation ACI (22.6 points, CI 21.9 - 23.2).

DISCUSSION: There is strong evidence to support greater treatment efficacy of third generation ACI over microfracture for patients of a similar age, lesion size, and baseline symptom status. Use of first generation ACI is not recommended as it is less efficacious than the simpler and less expensive microfracture technique.

Key Terms: autologous chondrocyte implantation; microfracture; osteochondral allograft; articular cartilage; knee

MAOA BREAKOUT SESSION #3
TRAUMA
April 24, 2014

Periprosthetic Complications After Treatment of Trochanteric Hip Fractures with a Short Intramedullary Nail

Abstract ID: Paper 034

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OBJECTIVE: Previous clinical evidence has demonstrated an increased rate of periprosthetic fractures near the distal tip of short intramedullary nails used for fixation of pertrochanteric hip fractures. In particular, first generation designs had a particularly high rate of secondary fracture. Subsequently, manufacturers redesigned the implant in an effort to mitigate or eliminate implant-associated iatrogenic fractures. This study is a retrospective consecutive series of patients that sustained pertrochanteric fractures treated with a current, third generation short cephalomedullary nail. We hypothesized that the current version of this implant would not be associated with a high rate of periprosthetic femur fractures.

DESIGN: Retrospective consecutive case series.

SETTING: Multicenter (three community private hospitals).

INTERVENTION: Closed reduction and internal fixation with a third-generation short intramedullary nail.

METHODS: We analyzed 280 consecutive patients that underwent fixation of a pertrochanteric hip fracture with a third-generation short intramedullary nail. Three patients were excluded from the study (one passed away prior to first follow-up, one due to malignancy, and the last because another type of hardware used for fixation). Immediate postoperative x-rays and x-rays obtained at the patient's latest follow-up were reviewed to identify any implant-associated fracture or lag screw cut out. Tip-apex distance for the lag screw was measured using the method of Baumgartner.

RESULTS: We evaluated 277 patients with an average follow-up of 22 weeks. There were no peri-implant fractures in any patient. Two patients (0.7%) experienced a femoral shaft fracture in the distal femur remotely from the implant. These were caused by separate falls and occurred at 7 and 17 months after surgery. The average tip-to-apex distance (TAD) of all nails in the study was 13.59 mm ± 5.01 mm. Two patients (0.7%) had lag-screw cutout (TAD 9 mm and 19 mm).

CONCLUSION: The data supported the hypothesis that the revised design of this implant reduced the peri-implant fracture rate. In addition, the rate of screw cut-out was very low compared to published literature. Our numbers were adequate to answer the experimental question. In summary, for treatment of pertrochanteric hip fractures, the third-generation intramedullary nail is an option with a very low rate of screw cutout and peri-implant fracture.

Failures in High-Energy Intertrochanteric Femur Fractures♦

Abstract ID: Paper 035

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INTRODUCTION: Much literature has been published in recent years regarding the optimal implant choice for IT fractures. With the exception of reverse obliquity fractures (AO/OTA A3), both a screw and side plate (SSP) and a cephalomedullary nail (CMN) are efficacious. However, little has been published in younger patients with high-energy mechanisms of injury (MOI). No study to date has examined the efficacy of a SSP vs. a CMN in this patient group.

MATERIALS AND METHODS: We retrospectively reviewed all IT fractures at a single urban Level 1 Trauma Center between January 2008 and February 2013. We excluded patients age 65 or older, fractures from a simple fall, pathologic fractures, patients without follow-up to union or at least three months, reverse obliquity fractures, and fractures treated with a proximal femoral locking plate. Patients were grouped according to implant, either SSP or CMN. We compared differences in demographic data, fracture characteristics, measures of surgical quality, and complications. Data were compared using Independent T-tests and Pearson Chi Squared tests. P values <0.05 were considered significant.

RESULTS: We identified 19 patients in the SSP group and 18 fractures in 17 patients in the CMN group who met inclusion criteria. There were no differences in age, sex, follow-up, smoking status, body-mass index, MOI, or postoperative weight-bearing (all p values>0.05). Most fractures exhibited simple fracture patterns and were classified as AO/OTA A1 (SSP 89.5% vs. CMN 72.2%, p=0.18); however, they exhibited significant displacement in the sagittal plane (mean 53% displacement). Regarding surgical parameters, there was no difference in TAD (SSP 21.3 mm vs. CMN 21.7, p=0.79), the percentage of lag screws placed at 25 mm or less from the apex (SSP 78.9% vs. CMN 77.8%, p=0.62), reduction quality (SSP 68.4% good vs. CMN 61.1%, p=0.13), or position of the lag screw (SSP 50.0% center-center vs. CMN 47.4%, p=0.92). There were no differences in blood loss (SSP 400 vs. CMN 285, p=0.48) or surgical time (SSP 158 minutes vs. CMN 144, p=0.26). In the CMN group, 14 of 18 (77.8%) required an open reduction. In the SSP group, 3 patients exhibited medialization >3 mm, while none did in the CMN group.

No infections were identified, one intraoperative lateral wall fracture occurred in each group, and one patient in the SSP group went on to a delayed union at 4 months but was lost to further follow-up. In the SSP group, 3 patients (15.8%) developed varus collapse, two of which underwent revision surgery, and the remaining patient elected to not undergo revision. No fractures in the CMN group developed varus collapse. All 3 failures had a TAD of 25 mm or less (mean 20.3); two had good reductions, and one acceptable; and two had lag screws in the center-center quadrant, and one in the center-posterior quadrant.

CONCLUSION: Even with similar success of SSPs and CMNs in geriatric IT fractures, this group of younger patients with higher-energy injuries appears to have more unstable fractures despite relatively simple fracture patterns. In this subgroup of IT fractures, SSPs failed more often than CMNs, and failures occurred even in those with good reductions and TADs. Further prospective studies are required to examine these findings.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (Smith & Nephew, Traptan IM nail).

Intertrochanteric Hip Fractures: How Time to Surgery and Comorbidities Affect Mortality

Abstract ID: Paper 036

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INTRODUCTION: The goal of this study was to determine the survival after intertrochanteric fracture and risk factors for mortality. The hypothesis was that the time from injury to surgery has an effect on 90-day mortality and that medical comorbidities are significant predictors for 90-day mortality after hip fracture.

METHODS: The charts of 505 consecutive patients with intertrochanteric fractures treated operatively with cephalomedullary nails between January 2005 and October 2010 were retrospectively reviewed. The social security death index was used to determine death rates. Risk factors for 90-day mortality and medical comorbidities were analyzed. A Mann-Whitney Rank-Sum test was performed. A cox proportional model, then, a forward stepwise routine model was developed with all significant variables and a best multivariate model was performed. Finally, we generated a standardized mortality ratio.

RESULTS: Mortality rate at 90 days was 19.3%. The average time to surgery for patients who died before 90 days postoperatively was 2.71 days (SD = 2.91 days), and the average time to surgery for patients alive at 90 days was 2.06 days (SD = 3.08 days); the difference was statistically significant (p = 0.006). Age, gender, ASA, chronic kidney disease (CKD), and arrhythmia were all significant predictors of 90-day mortality as follows: age (HR 1.04 [95%CI = 1.01, 1.07], p = 0.015), female gender (HR 0.59, [0.37, 0.96], p=0.034), ASA (HR 2.15 [1.40, 3.31], p = 0.001), ASA E classification (HR 0.39 [0.17, 0.89], p = 0.026), CKD (HR 1.98 [1.15, 3.39], p = 0.013) and arrhythmia (HR 1.94 [1.16, 3.27], p = 0.012). Other comorbidities that were not statistically demonstrable include COPD (HR 1.45 [0.82, 2.56], p=0.206), diabetes (HR 0.85 [0.49, 1.49], p=0.581), coronary artery disease (HR 1.09 [0.66, 1.81], p=0.734) and hypertension (HR 0.88 [0.51, 1.50], p=0.637). Using a multivariate analysis to select the best combination of independent predictors for mortality (ASA score, age, and CKD), it was determined that patients who had surgery more than 48 hours after injury had statistically significantly higher mortality (HR 1.81 [1.09, 3.00], p=0.022). Standardized mortality ratio (SMR) was 9.60 (7.53, 12.22).

DISCUSSION/CONCLUSION: In patients with unstable intertrochanteric hip fractures treated with cephalomedullary nail, older age, higher ASA score, CKD, and time to surgery within 48 hours are associated with increased 90 day mortality. When compared to the general population matched by gender and age, these patients have significantly higher 90-day mortality.

Gait Abnormalities After Closed Reduction and Percutaneous Screw Fixation for Posterior Pelvic Ring Disruption

Abstract ID: Paper 037

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INTRODUCTION: The purpose of this study was to determine if patient's gait parameters are different from normal in asymptomatic patients with a posterior pelvis ring injury after closed reduction and percutaneous screw fixation (CRPSF). We hypothesized that gait parameters would be significantly different after CRPSF for posterior pelvic injury when compared to a control group.

METHODS: Twelve out of 72 consecutive patients with CRPSF for sacral fracture or sacroiliac fracture/dislocations met the following criteria: 18-65 years of age, not taking any pain medication regularly, no complaints of gait disturbance, unilateral injury, anatomical reduction on postoperative radiographs, no lower extremity trauma/surgery, no leg length discrepancy, and minimum one year follow-up. Six patients participated in the study (SG). A control group (CG) of six individuals was created from healthy volunteers. All participants completed SF-12 and two pelvis specific outcome questionnaires. Markers were then placed on the pelvic and lower extremities of all participants. All subjects were video recorded while walking barefoot. These data were then evaluated using computer-based gait analysis software. Maximum foot dorsiflexion during stance, maximum knee flexion during stance, knee angle at initial contact (KAIC), pelvic tilt, cadence, stride length, stride width, and pelvic drop (PD) were measured. Non-parametric statistical tests were used to analyze the data. A P-value <0.05 was considered significant.

RESULTS: The SG scored statistically worse than the CG on the PCS part of SF-12 questionnaire and on IOWA pelvic questionnaire. PD was significantly smaller in the uninjured side in SG when compared to injured side in SG and to either side in CG. There was no statistically significant difference between injured vs. uninjured side for other gait parameters in SG. KAIC was significantly greater on the injury side when compared to the CG. No statistically significant differences were found in other gait parameters between the SG and CG.

CONCLUSIONS: Asymptomatic patients after CRPSF for posterior pelvic ring disruptions were found to have an abnormal gait pattern with a statistically significant increase in knee angle at initial contact in the injured side and a decrease pelvis drop in the uninjured side. These changes were notable as there was no grossly evident gait abnormality or leg length difference. Further studies with a larger number of patients are indicated to evaluate the strength of muscle groups that are active in various phases within the gait cycle and to correlate these findings with gait parameters.

Predictors of Operative Blood Loss for Acetabulum Fractures Fixed Through an Anterior Approach

Abstract ID: Paper 038

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INTRODUCTION: Historically, some orthopedic surgeons have delayed operative fixation of acetabulum fractures beyond the acute care phase in an attempt to decrease blood loss. However, recent literature has debunked this notion, at least for surgeries performed through a posterior approach. The purpose of this study is to evaluate the relationship between time to surgery and other variables on operative blood loss for acetabular fractures fixed through an anterior approach.

METHODS: A retrospective review of our level I trauma center records from 2006 to 2012 identified 214 patients that had acetabular fracture repair via an anterior approach. Patients not meeting all study criteria were excluded, leaving 174 eligible patients for review. Data points collected include patient demographics (sex, age), body mass index (BMI), past medical history (PMH), fracture type, pre- and postoperative hematocrit, time from emergency department (ED) admission to surgery, reported estimated blood loss (EBL), length of surgery, and amount of transfused red blood cell (RBC) units as well as RBC unit requirements during the first postoperative week. Chi-2 and Fisher's exact test were used for categorical and dichotomous variables. Shapiro-Wilk test was used to determine normality for continuous variables. Outcome variables were analyzed with the unpaired t-test, Mann-Whitney U, Kruskal-Wallis and Spearman correlation. Additionally, multiple linear regression models were performed with EBL, amount of transfused RBC units, and postoperative RBC units required as the dependent variables.

RESULTS: The average EBL was 1321cc (± 784) with an average time from ED admission to surgery of 3.4 days (± 3.7). There was no significant difference between patient demographics, BMI, PMH, or time to surgery and EBL. An average operative period of 280 minutes (SD 95) was seen in two column acetabular fractures vs. 193 minutes (SD 62) in one column acetabular fractures, p=.001. Multiple linear regression analysis revealed that the only predictor for increased EBL was length of procedure, p=.001. Subgroup analysis revealed that time to surgery was not predictive of EBL for two column acetabular fractures, or for one column acetabular fractures. A post hoc power analysis demonstrated that our sample could detect a difference in EBL of 360 ml.

DISCUSSION AND CONCLUSION: Patient demographics, selected comorbidities, and timing of surgical intervention were not found to be associated with increased EBL, amount of RBC units transfused intraoperatively or RBC units transfused during the first postoperative week for acetabular fractures fixed via an anterior approach. Fractures involving both acetabular columns required longer operative periods and resulted in increased EBL in comparison to fractures involving one column when controlling for all other variables. Time to surgery was not predictive of EBL when analyzing the two column group separately. These results can be useful when planning the care of patients with acetabular fractures requiring an anterior approach.

Supplemental S1 Fixation for Type C Pelvic Fracture: Biomechanical Study of Long Iliosacral vs. Trans-Sacral Screw

Abstract ID: Paper 039

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INTRODUCTION: Iliosacral screw fixation into S1 body is a common method for pelvic ring fixation. Single screw fixation has been shown to be clinically unreliable for unstable Type C vertically oriented sacral fractures. Insertion of an additional screw into the S1 or S2 vertebral body has been widely used. Unfortunately, clinical fixation failures have also been reported using two iliosacral screws into the vertebral bodies. More recently, the use of a long iliosacral screw, extending to just short of the contralateral sacroiliac joint, or a trans-sacral screw, extending across the contralateral sacroiliac joint, have been advocated. To our knowledge, no biomechanical study has been performed to differentiate the effect of these two screw lengths on Type C sacral fracture stability. The objective of this study was to biomechanically compare the effect of supplemental S1 long iliosacral versus trans-sacral screw fixation in an unstable Type C vertically oriented sacral fracture model.

METHODS: A Type C pelvic ring injury was created in ten osteopenic/osteoporotic embalmed cadaver pelves by performing vertical osteotomies through zone II of the sacrum and the ipsilateral pubic rami. The sacrum was then reduced maintaining a two mm fracture gap to simulate a closed reduction model. All specimens were fixed using one 7.0 mm cannulated iliosacral screw into the S1 vertebral body. A supplemental long iliosacral screw was then placed into the S1 body in five specimens. A supplemental trans-sacral S1 screw was placed in the other five specimens. Each pelvis was mounted on an MTS and underwent 100,000 cycles at 250 N followed by loading to failure using a recognized unilateral stance testing model. Vertical displacements at 25,000; 50,000; 75,000; and 100,000 cycles and failure force were recorded for each pelvis. Non-parametric statistical tests were used to analyze the data. A P-value of <0.05 was considered significant.

RESULTS: Vertical displacement increased significantly within each group at each increase in number of cycles. However, there was no statistically significant difference between the two groups in displacement or load to failure.

CONCLUSIONS: The use of more than one iliosacral screw is recommended for the fixation of Type C vertically unstable sacral fractures. Long iliosacral screw or trans-sacral screw, rather than a standard iliosacral screw is thought to convey additional stability to the fixation construct. Although intuitively the trans-sacral screw may seem to be more advantageous, we were not able to identify any biomechanical advantages over the long iliosacral screw.

Nonoperative Treatment of Posterior Wall Fractures of the Acetabulum After Dynamic Stress Examination Under Anesthesia: Revisited

Abstract ID: Paper 040

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INTRODUCTION: Performing an examination under anesthesia using dynamic stress fluoroscopy (EUA) has been promoted as a tool to determine hip stability. The purpose of this study was to provide radiographic and clinical follow-up data mainly from a source other than the primary advocates of this method to further evaluate patient outcomes.

MATERIALS AND METHODS: Seventeen patients with an acute posterior wall fracture of the acetabulum who underwent an EUA and were found to be stable were treated nonoperatively. Posterior wall fragment size ranged from 6 to 42% with a mean of 24%. Five patients had an associated hip dislocation. Patient follow-up averaged 30 months (range: 6-64 months). Outcome evaluation included the modified Merle d'Aubigné clinical score (MMA) and the Short Musculoskeletal Function Assessment Questionnaire (SMFA). Radiographic evaluation consisted of the three standard pelvic radiographs; post-traumatic arthritis was graded according to the criteria described by Matta.

RESULTS: Radiographic evaluation showed all hips to be congruent joint with a normal joint space. Sixteen of the 17 patients had radiographic outcomes rated as "excellent"; one patient was rated "good" due to the presence of slightly increased sclerosis as compared to the normal side. The MMA could be obtained in 12 patients and the average score was very good, with only one having less than a good clinical outcome (fair). There was essentially no correlation between MMA and fracture size (Pearson correlation coefficient; $r = 0.199$), and there was no significant difference between those with or without history of hip dislocation. For the SMFA (completed in 11 patients), function index averaged 21 (range: 0-51) and the bother index averaged 27 (range: 2-81). The patient SMFA scores were not significantly different from (T-test) and were within the reported SMFA normals for all indices and categories (Z-test).

CONCLUSIONS: This study further supports the contention that hip joint stability after a posterior wall acetabular fracture determined by EUA is predictive of hip joint congruity, an excellent radiographic outcome, and a generally good-to-excellent early clinical outcome after nonoperative treatment. Furthermore, functional outcome was shown to be not significantly different from normal. Therefore, performing an EUA appears to be an effective means of determining candidates for nonoperative management of posterior wall fractures of the acetabulum and should be considered an important evaluative tool for patients with these fractures.

Acute Total Hip Arthroplasty for Select Acetabular Fractures

Abstract ID: Paper 041

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INTRODUCTION: Acute total hip arthroplasty (THA) holds significant promise for select patients with acetabular fractures. Specifically, elderly patients undergoing acute total hip arthroplasty for various acetabular fractures appears to result in good outcomes. However, very little information is available in the literature regarding this treatment modality. Due to the lack of literature, further studies are needed to analyze the role and outcome of acute THA for acetabular fractures. The purpose of our study was to review clinical and radiographic results of patients who had undergone acute THA for select acetabular fractures at our institution.

METHODS: An IRB-approved retrospective review was performed to identify patients who had undergone acute THA for select acetabular fractures at our institution from 1999-2012. Information was obtained regarding age, sex, mechanism of injury, assessment of initial radiographs/CT scan to determine acetabular fracture pattern, clinical outcomes, and complications.

RESULTS: Of 70 patients who were identified that had undergone THA for an acetabular fracture, 14 patients were found to have underwent acute THA. Acute was defined as having underwent THA within 30 days of injury. A standard posterior Kocher-Langenbeck approach was utilized in all cases. For posterior wall fracture patterns, the acetabulum was medialized prior to placement of arthroplasty components. For transverse and both column injuries, the fractures underwent plate and screw fixation prior to placement of components. There were 11 men and 3 women with an average age of 63.1 years (range 50-82). The mechanism of injury was motor vehicle collision (8) or fall (6). The most common fracture patterns were posterior wall (7, 50%) and transverse posterior wall (5, 36%). Of the 14 patients to undergo acute THA, there were 7 (50%) patients with no pain, 2 (14%) with mild pain, 1 (7%) with moderate pain, and 0 with severe pain at a minimum of 1 year of follow-up. Four patients did not follow-up or were treated at an outside institution following initial treatment. One patient required a revision THA due to loose acetabular component resulting in recurrent dislocations.

CONCLUSION: Acute total hip arthroplasty is a valid treatment option for elderly patients with select acetabular fractures. Further research is needed to further investigate this treatment modality.

Femoral Head Bone Density Variance and Correlation with Proximal Femur Cortical Diameter

Abstract ID: Paper 042

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PURPOSE: Humeral head density correlates with proximal cortical diameter. Fixation failure and nonunion are the most common reasons for revision surgery following internal fixation of femoral neck fractures. Rigid fixation depends on femoral head bone density which is poorly estimated on x-rays. Using computed tomography (CT) Hounsfield units (HU), shown to correlate with bone mineral density, we determined normative femoral head bone density measures by age and gender and tested the hypothesis that the proximal femur cortical diameter correlates well with femoral head density.

METHODS: 4,733 adult (≥ 20 years old) pelvis CTs (December 1996 - August 2011) were analyzed automatically using a custom MATLAB script. To assess the central and subchondral bone, the centers and radii of bilateral femoral heads were determined. The mean HU within a sphere centered in each femoral head of 75% the femoral head radius was determined. The proximal femur cortical diameter was measured at 10 and 20 mm distal to the most prominent point on the lesser trochanter on AP pelvis x-rays, obtained within 7 days of the pelvis CT scan, of 125 randomly selected patients aged 50-90 representing normally distributed femoral head densities. Univariate analysis was performed for gender, age, and their interaction. Linear regression and prediction intervals were determined for head HU, age, and gender.

RESULTS: 1,996 (42.2%) females, 2,737 (57.8%) males. Mean age (years) was 51.6 (±17.5SD) for females, 52.0 (±17.7SD) for males. Head HU was dependent on gender ($p=0.02$), age ($p<0.001$), and their interaction ($p=0.002$). Peak femoral head HU occurred in the fourth decade for females (405.9), in the third decade for males (413.4). The rate of decline from peak HU was lower in males than in females ($p=0.002$) with the largest decline in males occurring between the seventh/eighth decades (5.6%) and in females between the eighth/ninth decades (8.6%). 23%/37% of males and 27%/39% of females in the sixth/seventh decades respectively, were below the mean HU of females in the eighth decade (335.4). Proximal femur cortical diameter ratio and femoral head density had poor correlation ($r^2=0.04$-0.11) at either level.

CONCLUSION: There is a large subset of patients younger than 60 years who have a femoral head density lower than that of the mean density for females in the eighth decade of life, demonstrating the poor value that age may play in predicting femoral head density for an individual patient. Proximal femur cortical diameter may be a poor predictor of femoral head density.

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Systemic Proteomic Profiles Associated with Healing and Nonunion of Mid-Shaft Femur Fractures

Abstract ID: Paper 043

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PURPOSE: Approximately 5-10% of long bone fractures lead to nonunion, requiring the patient undergo additional treatment. Currently, nonunion can be diagnosed radiographically after 3 to 6 months. Serum biomarkers have potential to prospectively identify patients predisposed to fracture nonunion, facilitating early detection and treatment. This study examines temporal shifts in systemic proteomic expression during fracture healing and nonunion in a rat model.

METHODS: Mid-shaft femoral osteotomy, stabilized with an intramedullary wire, was created in 48 female rats. The bone was allowed to heal in 24 rats (Healing Group). In the remaining 24 rats, a nonunion was induced (Nonunion Group) by cauterizing the periosteum circumferentially near the osteotomy. An additional 24 rats received K-wire fixation without osteotomy (Control Group). Rats from each group were sacrificed at 3, 7, 14, and 28 days postoperatively at which point blood was drawn and the femur excised. SELDI-TOF mass spectrometry (MS) was used to identify serum biomarker expression. Histology and micro-CT were used to characterize and quantify bone mineralization and density. These parameters were then related to biomarker expression.

RESULTS: Histology confirmed temporal increase in mineralization in the Healing Group and minimal bone remodeling in the Nonunion Group. Micro-CT showed significantly higher callus bone density in the Healing Group compared to the Nonunion Group at 28 days post-osteotomy ($P = 0.0016$), indicating thwarted mineralization in the Nonunion Group. Mass spectrometry demonstrated 141 differentially expressed serum biomarkers in the Healing Group vs. Control Group throughout the course of healing ($P < 0.05$). There were 2, 10, 43, and 21 differentially expressed, previously identified proteins at postoperative day 3, 7, 14, and 28 respectively. Several proteins related to osteogenesis were found to express temporal increases in expression in the Healing Group (CXCR2, IGF-I, IL-21, PTHrP, OGP, IGF-II, VEGFR-1, and GHR).

CONCLUSION: This study demonstrates fluctuation in the systemic proteome during bone healing following osteotomy. Nonunion Group protein expression is currently being analyzed. Significant differences in Healing Group protein expression were measured as early as postoperative day 3, with dramatic increase at day 14. Several of these proteins are related to bone healing. Histological and tomographic analyses assert increased mineralization and

Elution Profiles of Two Methods of Antibiotic Nail Preparations

Abstract ID: Paper 044

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PURPOSE: Antibiotic-coated intramedullary (IM) nails have been deemed good treatment options for infected long bone nonunions. However, antibiotic-coated guidewires may provide greater antibacterial activity given the thicker coating. This study was designed to compare the 2 constructs by determining the amount and bactericidal activity of antibiotics eluted over the course of 6 weeks. We also sought to determine the role of curing temperature and cement porosity in the elution patterns observed.

METHODS: Two-centimeter segments of antibiotic cement-coated 8 mm IM nails and antibiotic cement-coated 3.5 mm guidewires were used. The four groups (n=7) included: (1) IM nail with 1.0 g tobramycin, (2) guidewire with 1.0 g tobramycin, (3) IM nail with 1 g vancomycin and 2.2 g tobramycin, and (4) guidewire with 1 g vancomycin and 2.2 g tobramycin. Both types were coated with Simplex Cement with tobramycin using 40 French chest tubes as a mold. Segments were soaked in sterile phosphate-buffered saline and entire aliquots were exchanged at scheduled time intervals over a 6-week period. Tobramycin and vancomycin concentrations were measured in our clinical laboratory. We also measured cement curing temperatures, porosity of our samples, and bactericidal activity of the eluted antibiotics.

RESULTS: Regardless of construct, the majority of antibiotics eluted in the first 48 hours. More tobramycin (Figure 1) and vancomycin (Figure 2) were released from the coated IM nails as opposed to the coated guidewires. This released antibiotic continued to be bactericidal up to 6 weeks. Micro CT scan results found the only significant difference between the four groups was the high dose antibiotic guidewire compared to the other three. In general, the amount of antibiotic and construct did not relate to porosity. The cement's curing temperature averaged 93° and 86°F for IM nails which was less than those for guidewires (148° and 158°F) with and without vancomycin, respectively.

CONCLUSIONS: Our data demonstrate that antibiotic cement-coated IM nails can provide greater levels of antibiotics to infected long bone nonunions as compared to cement-coated guidewires. After concentrations, the tobramycin and vancomycin got to150 ug/mL and 75 ug/mL it became maximally effective with around 70-80% bacterial inhibition. Keeping a mantle of cement thin may allow greater elution, possibly due to larger pore size and cooler exothermic reactions. An antibiotic nail sitting in an IM canal for up to 6 weeks may continue to elute effective bactericidal antibiotics.

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Health Related Quality of Life Outcomes After Surgical Treatment of Bisphosphonate-Associated Femur Fractures

Abstract ID: Paper 045

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(Presented by Shane J. Kibbe, M.D., Louisville, KY)

INTRODUCTION: A variant of femur fractures associated with bisphosphonate therapy has recently been described, but few reports are available regarding clinical outcomes after surgical treatment. The objective of this study was to examine the health related quality of life outcomes (HRQOL) for bisphosphonate-associated femur fractures (BAFF) compared to Non-BAFFs, particularly with regard to mid-term follow-up after surgical interventions.

METHODS: After IRB approval, a large trauma center database was queried retrospectively for surgically treated fractures of the femur. Medical records were reviewed for use of bisphosphonates in the time preceding the fracture. Fractures were grouped into BAFFs, and a matching control group of Non-BAFFs were identified from the remaining series. Patients were prospectively contacted for administration of the Short Form-36v2 Health Survey.

RESULTS: A total of 29 patients were available to complete the SF-36v2 Health Survey. Surveys were completed an average of 20 months (range 6-39 months) postoperatively and 22 months (range 6-48 months) postoperatively for the BAFF and non-BAFF control groups, respectively. All patients were female, with 12 in the BAFF group sustaining 16 femur fractures at an average age of 69.1 years, and 17 in the Non-BAFF group with an average age of 66.5 years ($p=0.247$). All BAFF patients used bisphosphonates continuously for an average of 8.2 years prior to their fractures. The mechanisms of injury differed between the two groups, with the BAFF group generally sustaining fractures after lower energy mechanisms. Fractures healed at an average of 32 and 31 weeks, and 1.8 and 1.3 procedures per fracture in the BAFF and non BAFF groups, respectively. The average physical composite scores were 43.7 and 36.2 for the BAFF and non-BAFF groups, respectively ($p=0.039$). The average mental composite scores were 52.6 and 49.7 for the BAFF and non-BAFF group, respectively ($p=0.244$). All patients who were working before their BAFF subsequently returned to work, while only 2 of 7 working non-BAFF patients returned to work at the time of final survey.

CONCLUSIONS: The authors present, to our knowledge, the first measurements available in the literature of standardized HRQOL outcomes for patients treated surgically after Bisphosphonate-Associated Femur Fractures. Patients sustaining BAFFs rated their mid-term postoperative physical health significantly higher compared to patients with similar Non-BAFFs, as measured by the SF-36v2 Health Survey. Both groups rated similar levels of mental health at a minimum of 6 months postoperatively.

The Effect of Education on Orthopedic Surgery Residents' Ability to Objectively Evaluate a Simulated Compartment Syndrome

Abstract ID: Paper 046

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INTRODUCTION: Acute compartment syndrome is an orthopedic emergency. Proper diagnosis and treatment is of paramount importance. Orthopedic surgery residents often implement an objective intra-compartmental measuring device in evaluation of compartment syndrome. We investigated the technical skill and measurement accuracy in use of a Stryker STIC kit in evaluating a simulated compartment syndrome, and the impact of formal teaching didactics on its usage.

METHODS: 24 orthopedic surgery residents were given a Stryker STIC kit to assess a simulated compartment syndrome in a porcine model. They were evaluated on their technical skill and measurement accuracy. A formal didactic session of proper usage was then given, and the residents were re-evaluated. Retention of skill was evaluated in human cadaveric models nine months later.

RESULTS: Evaluation of technical skill demonstrated a significant change after education in all steps of proper assembly and usage from pre- to post-education and pre-education to nine month post-education ($p<0.05$). Assessment of measurement error within a tolerance range (10 mm Hg) also demonstrated a significant decrease after formal didactics from pre- to post-education ($p<0.001$) and pre-education to nine month post-education ($p<0.001$). The odds of having a measurement error out of an acceptable range was decreased 6-fold immediately after education, and 7-fold at the nine month interval. Finally, technical errors were found to significantly affect measurement errors ($p<0.05$).

CONCLUSIONS: This study is the first to demonstrate the number of technical and measurement errors made by residents when objectively evaluating compartment pressures, sustained improvement in technique and measurement accuracy before and after formal education, and that technical errors lead to increased measurement errors when evaluating compartment syndrome using this device.

MAOA BREAKOUT SESSION #4
REVISION HIP
April 24, 2014

Is There a Role for Routine Intraoperative Cultures to Diagnose Subclinical Periprosthetic Joint Infection During Revision Total Hip and Knee Arthroplasty?

Abstract ID: Paper 047

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Periprosthetic joint infections (PJI) continue to be a diagnostic challenge for orthopedic surgeons. Chronic PJI are sometimes difficult to diagnose and occasionally present in a subclinical fashion with normal CRP/ESR and/or normal joint aspiration. Some institutions advocate for routine use of intraoperative culture swabs at the time of all revision surgeries to definitively rule out infection. The purpose of this study is to determine whether routine intraoperative cultures is an appropriate and cost effective method of diagnosing subclinical chronic PJI in revision joint replacement patients with a low clinical suspicion for infection.

We performed a retrospective chart review and identified 33 patients that underwent revision hip or knee replacement from a single surgeon over a five-month period. The AAOS guidelines for preoperative PJI workup were followed. 13 patients were diagnosed preoperatively with infection and excluded from the study. 20 patients underwent revision joint replacement and three separate cultures swabs were taken for each patient to help in determining true-positive cultures. Infectious Disease was consulted for all patients with any positive culture. Culture results were reviewed. At our hospital, the cost billed to insurance for a single culture is $1,458.58. We did not calculate the cost of the consultant fee.

Three (15%) of the 20 revision arthroplasty patients had a single positive culture. Infectious Disease consultants diagnosed all three of these positive cultures as contaminants. None of the patients had a true-positive intraoperative culture. The total cost billed by the hospital to obtain these cultures in all 20 patients was $87,514.80.

In our study, obtaining a set of three intraoperative cultures for those patients with a negative preoperative infection workup was not only cost prohibitive, but did not diagnose a single subclinical infection. Studies to find other more reliable, accurate, and cost effective alternatives to diagnose PJI are warranted.

In patients undergoing revision hip or knee arthroplasty with a low preoperative clinical suspicion for infection, it does not seem that routine intraoperative culture swabs are necessary or cost-effective method for diagnosing subclinical periprosthetic joint infection.

Radiographic Identification of Pelvic Discontinuity in Revision THA

Abstract ID: Paper 048

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INTRODUCTION: Pelvic discontinuity (PD) is a rare but devastating mechanism of failure in total hip replacement. Radiographic findings have been described for the identification of pelvic discontinuity. However, no study has specifically examined radiographic parameters and the utility of specific views in the preoperative identification of pelvic discontinuity.

METHODS: We retrospectively identified 133 hips with an intraoperative diagnosis of pelvic discontinuity. All preoperative films were reviewed including AP pelvis, true lateral hip films, Judet, False Profile, and CT scans. The selection of radiographic views available for each patient was variable. All radiographs were read by the senior authors to identify the following parameters suggestive of PD: visible fracture line, medial migration of the inferior hemipelvis, and obturator ring asymmetry. The change in sensitivity for PD with the addition of specialized radiographic views was recorded. Radiographs were evaluated simultaneously for parameters of bone loss, and cup and stem stability.

RESULTS: The available preoperative radiographs for 133 hips with intraoperatively confirmed pelvic discontinuity were reviewed. All 133 hips were surveyed with AP pelvis views, 132 with a true lateral hip view, 47 with Judet views, 8 with a false profile view, and 14 with a CT scan of the pelvis. Utilizing only the AP view, the fracture line was visible in 116 (87%), medial migration of the inferior hemipelvis was present in 126 (94%), and obturator ring asymmetry was present in 114 (86%). 93 out of 133 (70%) met diagnostic criteria for pelvic discontinuity, defined here as the coincidence of all three radiographic parameters. A fracture line was visualized in 65 of 132 hips (49%) evaluated on lateral hip radiographs, 36 of 46 hips (78%) evaluated with Judet views, 3 of 4 (75%) evaluated with a false profile view, and 10 of 14 (71%) evaluated with CT. Of the 16 hips without evidence of fracture line on AP radiograph, inclusion of a lateral view detected fracture in 5 samples, Judet views an additional 8 (out of 10 evaluated) and CT an additional 2 (out of 3 evaluated). Judet films significantly enhanced fracture detection with only two fractures missed among the 47 hips evaluated with a combination of AP and Judet views.

DISCUSSION: Pelvic discontinuity can be diagnosed reliably by the presence of three radiographic parameters: a visible fracture line, medial migration of the inferior hemipelvis, and obturator ring symmetry. AP radiographs are critical to assess all three parameters and have good sensitivity (85%) for the detection of PD. Additional views are useful for visualization of fracture lines and are especially helpful when fractures are obscured by hardware on the AP view. CT scans suffered from significant metal artifact and were at best of equal utility to the addition of Judet views in visualization of the discontinuity.

Is There a Benefit to Modularity in "Simpler" Femoral Revision Surgery?

Abstract ID: Paper 049

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INTRODUCTION: It has been suggested that modular stems are superior to monoblock revision stems as they allow the surgeon to fine tune anteversion reducing the risk of dislocation. The purpose of this study was to compare the outcomes of femoral revision using a modular as opposed to a monoblock femoral stem for Paprosky Types 1 to 3A femoral defects.

METHODS: We reviewed the results of 343 consecutive femoral revisions at a minimum of two years (mean 51 months; range 24 to 139 months) that included a Paprosky type 1-3A femoral defect. 193 cases utilized a cylindrical fully porous coated stem at one site and 150 included a modular bibody revision femoral component performed at three sites (including the one site that performed the monoblock revisions). The bibody stems included 101 with a cylindrical distal geometry (67%) and 49 with a tapered distal geometry (33%). We determined the overall risk of complications and compared them between groups using Pearson chi-square testing.

RESULTS: Mean age (64 vs. 68), percentage of females (53% vs. 47%), and BMI (31 vs. 30) were similar between the two groups ($p>0.05$). However, there was a trend toward greater case complexity among the modular stems (55% vs. 65% type 3a femoral defects; $p=0.06$). The rate of dislocation for the monoblock vs. modular stems (7.3 vs. 9.3%; $p=0.48$), intra-operative fractures (4.1% vs. 8%; $p=0.13$), and aseptic loosening (4.7% vs. 2%; $p=0.18$) were no different between the two groups with the number of hips available for study.

CONCLUSIONS: The risks and costs of using a modular stem for more straight-forward femoral defects (Paprosky Types 1-3A) may not be warranted as with the numbers available for study we were not able to demonstrate a lower risk of complications when a modular stem was utilized.

Structural Allograft Supporting a Trabecular Metal Cup Provides Durable Results in Complex Revision Arthroplasty

Abstract ID: Paper 050

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BACKGROUND: The use of a highly porous revision shell supported by either metal augments or allograft bone has become a commonly used reconstruction technique. Structural bulk allograft has the advantages of providing structural support and coverage to the acetabular component, while simultaneously providing potential bone stock restoration. Potential disadvantage is graft resorption. The use of allograft bone in the presence of highly porous TM shell to reconstruct acetabular defects has not been reported and is the aim of this study.

MATERIALS AND METHODS: Between 2000 and 2010, 51 patients (53 hips) underwent acetabular reconstruction with a structural bulk allograft used to support a TM revision metal shell. Patients were followed for an average to 5.5 years (range 2 to 12 years). There were 10 males and 41 females with an average age of 62 years (range 34 to 86). Peri-operative data were obtained from medical records and radiographs were reviewed to assess preoperative acetabular bone deficiency, postoperative cup fixation, amount of graft coverage, and union to host bone.

RESULTS: Preoperatively, acetabular bone defects were classified as Paprosky 2A in 5 hips (9.3%), 2B in 9 hips (17%), 2C in 13 hips (24.5%), 3A in 11 hips (20.7%), and 3B in 15 hips (28.3%). The configuration of the structural allografts was classified as Type 1 (Flying Buttress) in 12 hips, Type 2 (Support Dome) in 25 hips, and Type 3 (Footings) 16 hips. All cases showed evidence of union between the graft and host bone at latest follow-up. 14 cases (25%) had partial bone graft resorption without affecting cup stability. One acetabular component was revised at 4 months postoperative for early loosening. At final follow-up, 2 components had radiographic evidence of loosening but were unrevised. Survivorship-free from radiographic acetabular loosening was 92% at 5 and 10 years. The 5 and 10-year survivorship-free with revision for any reason was 87% and 83%, respectively. The most common reason for reoperation was instability in 5 cases.

CONCLUSION: TM shells combined with allograft structural bone graft in patients with acetabular bone deficiency resulted in excellent mid-term follow-up. 94% of acetabular components obtained stable union onto host bone. Allograft bone restored bone stock with minimal graft resorption and when it occurred did not alter the survivorship of the acetabular component. The reconstruction compares favorably to the use of allograft bone with older generation acetabular components, but longer term follow-up is needed.

Construct Rigidity: Keystone for Reconstructing Pelvic Discontinuity

Abstract ID: Paper 051

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INTRODUCTION: Pelvic discontinuity is rare and presents the surgeon with a complex reconstructive challenge. The rarity of the condition has limited the evaluation of results of differing forms of surgical treatment. The objective of this study is to report results of current treatment strategies for pelvic discontinuity treatment with emphasis on revision rates, radiographic healing of the discontinuity, and mid-term clinical results.

METHODS: We retrospectively reviewed 113 revision THAs performed for unilateral pelvic discontinuity between 1997 and 2011. Surgeries were performed on 19 men and 95 women (average age 63 years). Patients were followed a minimum of 2 years or to failure of reconstruction (average 5 years [2 to 15 years]). Charts were reviewed for preoperative demographic data, surgical reports for details of the reconstruction, and postoperative notes to collect data regarding complications and clinical status (Harris Hip Score) at last follow-up. Patients were followed clinically and radiographically at three months, and one, two, five, and every five years thereafter. The preoperative, immediate postoperative, and last follow-up radiographs were reviewed to assess discontinuity healing and implant stability.

RESULTS: According to the Paprosky classification: 3 hips were (2.7%) type IIB, 21 (18.6%) type IIC, 22 (19.5%) type IIIA, and 67 (59.0%) type IIIB. The four most common treatment modalities included: uncemented cup with posterior plate N=50 (44.2%), cup-cage construct N=24 (21.2%), antiprotrusio cage with or without posterior plate and allograft bone N=22 (19.5%), and an uncemented cup alone N=12 (10.6%). The average follow-up time for each of the four types of surgical reconstruction was similar (range 4 to 6.5 years). Both five year revision-free survivorship and healing of the pelvic discontinuity increased with increasing construct rigidity; cup only 50% and 49%, posterior plate and uncemented cup 77% and 49%, cup cage constructs 73% and 75%, and in cage constructs 87% and 76%. Healing was highest in the cage construct with structural allograft and or posterior plating (85%) vs. without either (75%). Additionally, increasing construct rigidity enhanced fixation into the ischium with radiolucent lines in zone 3 decreasing from 69% in uncemented cups only to 19% in cage constructs. Overall, the average preoperative HHS improved from 49.95 to 66.65 (p=0.017).

CONCLUSION: Improved survivorship and healing rates were seen in this series when reconstruction cages were used as an adjunct to an uncemented cup (cup/cage) or in combination with bulk allograft bone that bridged the discontinuity. Uncemented cups with or without a posterior plate often demonstrated cup osteointegration to the ilium (zone 1), but less than half of the discontinuities healed when these constructs were used. Based on this review, we recommend either using a cup/cage or cage, plate, and allograft construct in the treatment of patients with pelvic discontinuity.

Porous Tantalum Acetabular Augments in Complex Revision THA: Results at 5-12 Years Post Surgery

Abstract ID: Paper 052

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INTRODUCTION: Revision hip arthroplasty for extensive segmental or irregular acetabular bone defects using porous tantalum augments to help provide mechanical stability of the cup until ingrowth occurs has shown very good short-term results. We report minimum 5-year radiographic and clinical results of such constructs.

METHODS: 89 patients whose surgery was performed 5 or more years ago were identified. 17 (19%) expired before 5-year follow-up, 6 (7%) had a medical condition precluding them from returning for follow-up or sending films, and 5 (5%) were lost to follow-up. Of the 72 patients alive for possible 5-year follow-up, radiographic and clinical results were available for 61 (85%).

RESULTS: The majority of patients undergoing revision had Paprosky type 3A (28/61, 46%) or 3B (20/61, 33%) acetabular defects. 8/61 patients (13%) had preoperative pelvic discontinuities. Radiographically, this technique allowed initial restoration of the anatomic femoral head center within 1 cm, and this optimization of hip mechanics was maintained at latest follow-up. 2/61 constructs (3%) failed due to aseptic loosening and required revision surgery. 5/61 patients (8%) demonstrated radiographic separation in Zone 3 at most recent follow-up and may be at risk for future revision. In the 7 patients revised or identified as at risk for revision, 6 had pelvic dissociation.

DISCUSSION AND CONCLUSION: With failure defined as aseptic loosening requiring revision surgery, this cohort demonstrated 97% survivorship at minimum 5-year follow-up. Clinically, patients were improved 5 years after surgery. Restoration of hip center to a more anatomic position was achieved. 8% of patients demonstrated progressive radiographic separation in zone 3. Porous Tantalum Augments are convenient, off-the-shelf reconstructive devices which provide the opportunity to restore hip mechanics during total hip revision surgery with large bone defects and provide durable fixation and improved clinical outcomes at 5 years.

Ideal Component Positioning Prevents Excessive Metal Ion Levels in SRA, but not Metal-on-Metal THA

Abstract ID: Paper 053

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INTRODUCTION: Large metal-on-metal total hip arthroplasty (MOM-THA) and surface replacement arthroplasty (SRA) have been utilized to address joint instability and polyethylene wear. While they have limited dislocation, some designs have still had early clinical failure. Elevated serum metal ions have been attributed to acetabular component malposition. This study was performed to determine whether serum ions remain within acceptable levels in young, active patients receiving MOM-THA or SRA with ideal component placement.

METHODS: We prospectively monitored metal ions at 2 years postoperative for 82 hips (62 SRA, 20 MOM-THA). Radiographs were reviewed to determine whether an ideal zone had been achieved for both acetabular inclination (30°-50°), anteversion (5°-30°), and combined version (<45°) targets. Serum metal ions including cobalt and chromium were reviewed to determine whether metal levels exceeded the recommended threshold of 7 µg/L.

RESULTS: Fifty-three hips (65%) were placed within the ideal zone (44 SRA, 9 MOM-THA). No SRA placed within the ideal zone had serum ion levels > 7 µg/L compared with 2 MOM-THAs (22%). Mean serum ion levels were elevated when comparing SRA placed outside vs. inside the ideal zone for both chromium (3.55 vs. 1.59 µg/L, p=0.002) and cobalt (3.88 vs. 1.61, p<0.001). In contrast, mean serum ion levels were not clinically or statistically elevated for either chromium (1.985 vs. 1.965 µg/L, P=0.98) or cobalt (3.69 vs. 2.98 µg/L, p=0.72) for MOM-THA constructs placed within or outside of ideal zone parameters.

CONCLUSION: Ideal component placement is protective of elevation metal ion levels following SRA but not MOM-THA. Increased metal ions with well-aligned MOM-THA implicate bearing surface wear and additional factors in metal ion production.

MRI Findings Associated with Recalled Modular Neck Femoral Implants

Abstract ID: Paper 054

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INTRODUCTION: Femoral stems with modular necks were designed to provide necks for anatomic hip reconstruction. Increased revision rates associated with the modular neck stems suggested underlying adverse local tissue reactions related to the implant and led to a voluntary recall. The purpose of this study was to present the MRI findings associated with a large cohort of patients who have received these implants at a major medical center.

METHODS: A retrospective review of prospectively collected data was performed on all patients who received a modular neck hip implant between October 2007 and February 2012. Demographic data, implant characteristics, metal ion levels, and metal artifact reduction sequence (MARS) magnetic resonance imaging (MRI) data were collected, and descriptive statistics were performed.

RESULTS: There were 361 hips (268 Stem #1, 93 Stem #2) in 350 patients (222 male, 139 female); follow-up ranged from 1-5.5 years. The mean age was 61.9 years (range 15-87 years) and mean BMI was 30.3 (range, 15-52). All hip replacement surgeries utilized navigation; most were performed with a dual incision (73%) or Smith-Peterson (16%) approach. Neck angles (125° to 135°) were as follows: 37:125°, 229:127°, 33:130°, 39:132°, and 23:135°. Neck length ranged from 28 mm to 42 mm. A retroverted modular neck was used in 72 hips (-7° to -16°), anteverted neck in 19 hips (-7° to -16°), and neutral neck in the remaining 270 hips. A ceramic head was used for 293 hips and cobalt-chromium in 68 hips. 179 hips received a mobile-bearing hip and 182 a fixed-bearing construct. Cobalt (mean: 6.1 μg/L, range <0.1 – 28.0 μg/L) and chromium (mean: 1.3 μg/L, range: <0.1-14.6 μg/L) levels were evaluated in patients at a mean of 26.1 months after index procedure.

MARS-MRI was performed on 312 hips. Osteolysis (5.4%) and synovitis (54%) were noted. Of the 194 intra-articular effusions detected, they were classified as small (46%), moderate (18%), or large (28%), and 27% contained debris. In 35% of hips, an extra-capsular effusion was present. Tendinopathy and disruption were present in several tendons: gluteus medius (58%/12%), hamstring (56%/12%), gluteus minimus (38%/7.7%) and iliopsoas (7.1%/4.8%).

CONCLUSION: Abnormal MARS-MRI findings and elevated metal ion levels were common in this series of modular neck stems. There were high rates of synovitis, effusion (27% with debris), and tendinopathy with and without tendon disruption. Abnormal MRI findings, even subtle, should be considered seriously when associated with modular neck femoral components.

18.5% Failure Rate of Metal-on-Metal Hip Implants at 3.5 Years Follow-Up: The Case for Yearly Surveillance

Abstract ID: Paper 055

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INTRODUCTION: Adverse reaction to metal debris (ARMD) produced a higher than expected revision rate with Articular Surface Replacement (ASR) DePuy hip implants and led to its recall in August 2010. The objective of this study is to report the experience of the ASR total hip replacement implants in a large U.S. medical center with special emphasis on patient symptomatology, results of metal-on-metal (MoM) evaluations, and revision rates.

METHODS: 119 ASR total hip arthroplasties (THA) were performed in 104 patients (91 males and 13 females) between June 2006 and February 2010 by three surgeons. The average age at the time of surgery was 50.4 years (range, 31-77 years). 103 hips (86.5%) were evaluated at a minimum of 2 years (average 3.5 years). Clinical records and radiographs at follow-up visits were reviewed with special attention to blood tests (e.g., cobalt-chromium blood levels, inflammatory markers) and additional imaging studies. Complication rates and reasons for revision were documented and analyzed.

RESULTS: Of the 103 hips with minimum 2 years follow-up, 46.6% (n=48) complained of pain at some point during their evaluation. Four hips were diagnosed with infection through elevated blood markers and aspiration. A total of 53 hips have had MoM screening with average cobalt and chromium levels of 7.9 ppb (range, 0.8-33) and 4.8 ppb (range, 0.8-16.2), respectively. MRI or US was performed in 39 hips and was positive for fluid collections resembling pseudotumor in 7, all of which have been revised for this finding. A total of 22 hip revisions have been performed at an average of 3.3 years: 16 ARMD (13.4%), 4 infections (3.4%), 1 pain/impingement (0.8%), and 1 for acetabular cup loosening (0.8%).

DISCUSSION AND CONCLUSION: In our experience, the revision rates of ASR THA at an average follow-up of 3.5 years was 18.5%, which is higher than the five-year revision rate of 13% published by the National Joint Registry of England and Wales in 2010. These patients have been contacted at routine follow-up periods (3 months, 1 year, 2 years) through our joint registry what could account for our higher revision rates. Patients with MoM bearings, especially the ASR THA, should be followed on an annual basis and appropriate workup for ARMD should be performed.

Risk Factors for Dislocation After Revision Total Hip Arthroplasty

Abstract ID: Paper 056

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INTRODUCTION: Dislocation is the most common reason leading to revision total hip arthroplasty (THA), and is even more common after revision THA. The purpose of this study was to analyze risk factors for dislocation following revision THA.

METHODS: 283 revision THAs over an 8-year time period were prospectively entered into a database and retrospectively reviewed. Patients were categorized based on the reason for dislocation, components revised, head size, use of a constrained liner, and use of a postoperative abduction brace. Statistical analysis was performed with Fisher's exact test.

RESULTS: The mean patient age was 60.0 years with a mean BMI of 28.8 kg/m^2. The mean follow-up was 35.8 months. Thirty-four patients (12.0%) sustained dislocations after revision THA. Patients that underwent revision THA for instability were more likely to sustain dislocations than patients revised for other reasons (OR 2.3, $p<0.01$). Patients that underwent revision of both components (stem and cup) were less likely to dislocate than patients that underwent revision of cup only (OR 3.7, $p<0.02$), or the stem only (OR 5.0, $p=0.002$). There was no difference in the dislocation rate for revision of the stem only compared to the cup only ($p=0.35$). Patients with femoral head sizes of 32 mm or smaller after revision THA were more likely to sustain dislocation than patients with larger heads (OR 2.4, $p<0.003$).

DISCUSSION: Risk factors that increase the risk of dislocation after revision THA include: revision THA for instability, revision of only one component, and a femoral head size of 32 mm or less. Dislocation after revision THA is a common complication, and a better understanding of risk factors for dislocation in these patients is essential to minimize the risk of dislocation.

Management of Polyethylene Wear and Osteolysis After Hip Replacement

Abstract ID: Paper 057

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INTRODUCTION: Polyethylene wear and osteolysis are a late complication of hip replacement. Two possibilities for treatment exist: exchange of the liner and prosthetic head, only possible if the components are well fixed, and acetabular revision. Bone grafting of the osteolytic defects can be done with both alternatives. The purpose of this study was to analyze the results and complications of both methods of treatment in a single surgeon practice.

METHODS: A retrospective analysis of a single surgeon's practice of revision hip arthroplasty was done. Between January 1, 1999, and December 31, 2004, 400 revision hip arthroplasties of all types were done by the same surgeon. Of these, 56 were done for polyethylene wear, pelvic osteolysis, or both. Revision surgery entailed either prosthetic head and liner exchange or acetabular revision. Survivorship and complications of both procedures were assessed.

RESULTS: Fifty-six patients were evaluated. Of these, 36 were female and 20 were male with an average age of 55.8 years (± 14.34), and the average BMI was 27.3 (± 5.1). Average time to revision surgery was 11.1 years (± 4.6) and average follow-up after revision was 7.8 years (± 2.85). Twenty-three patients underwent head and liner exchange and 33 underwent acetabular revision. Eight patients underwent a second operation, 5 because of instability, 1 for aseptic loosening, 1 for pathologic fracture, and 1 for heterotopic ossification. There was no difference in survival free of reoperation rates between those with acetabular revision and head liner exchange (Figure 1, $p>0.05$). Six patients (26%) with a head and liner exchange and 3 (9%) with an acetabular revision dislocated postoperatively (OR 3.6, $p=0.09$). At the time of the study, 50 patients had stable hips, 4 had died with stable hips, and 2 had died with unstable hips.

CONCLUSION: In this single surgeon retrospective study, postoperative instability occurred more frequently after head and liner exchange than after acetabular revision performed for polyethylene wear and osteolysis. The difference was only weakly statistically significant, but corroborates with previous reports. This knowledge is useful for choosing treatment for polyethylene wear and osteolysis.

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Biomechanical Evaluation of Different Periprosthetic Femoral Fracture Fixations Using a Variable Angle Locked Periprosthetic Femur Plate System

Abstract ID: Paper 058

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INTRODUCTION: According to the American Academy of Orthopaedic Surgeons (AAOS), more than 193,000 total hip replacements are performed each year in the United States. Femoral fractures are not common, but occur in 0.1% to 6% of all patients who have a total hip arthroplasty. Therefore, approximately 10,000 periprosthetic femur fractures need treatment annually. The majority (75%) of periprosthetic fractures following total hip arthroplasty occur at the tip of the stem (Vancouver type B110, Cooke type III). Most recently, the introduction of periprosthetic plates that allow for angling of the screws around the implant shaft proximally have been introduced. The purpose of this study was to test these plates biomechanically for stability and compare several different screw constructs in an effort to identify the most desirable construct.

METHODS: Fifteen large adult synthetic left femora were used. Each femur was implanted with a cementless hip prosthesis and osteotomized 45° to the shaft axis at the level of the implant tip to simulate a periprosthetic fracture, Vancouver type B1, OTA 32A2. A gap of 5 mm was created and fracture fixation was performed using a 12-hole periprosthetic proximal femur plate. Bone samples were randomly assigned to one of the following Groups: (1) proximal six 4 mm bicortical locked screws full contact, (2) proximal 3 cerclages (Cable Assembly Cerclage, 1.8 mm), or (3) proximal cerclage (1+1 NCB Locking Plate Cable Button)/four unicortical 5 mm screw. Distally, all groups had three 4 mm bicortical screws. Testing was performed using an axial-torsional universal testing machine in three different loading modalities (axial compression to 500 N, lateral bending to 250 N, torsion to 200 N). After testing the samples for stiffness in all three modalities, cyclic loading was performed in axial compression with a maximum load of 500 N at three Hz for 10,000 cycles. After cyclic loading, the femurs were again tested in all three modalities. The specimens were finally loaded to failure in torsional loading. The failed samples were visually inspected for mode of failure.

RESULTS: None of the constructs failed during cyclic testing. No significant differences in stiffness were found in axial loading before and after the cyclic loading between the 3 groups. Flexural stiffness after cyclic loading was higher in group 1 (5.4 N/mm) compared to group 2 (4.5 N/mm) ($p<0.01$). Torsional stiffness for cable only constructs (group 3; 13.1 N/mm) was significantly lower compared with group 1 (17.2 N/mm) and 2 (15.7 N/mm) ($p=0.01$, $p=0.03$, respectively). Load to failure was comparable in group 1 and 3 (806 N, 818 N respectively), but significantly lower in group 2 (606 N, $p=0.03$). Differences were found in the type of failure. Constructs in groups 1 and 2 failed by trochanteric region fractures and loosening of the hip stem. One construct in group 1 fractured along two screw holes. In group 3, lateral displacement at the fractures occurred. Load to failure resulted in rupture of the proximal cables.

CONCLUSIONS: Modern periprosthetic plates offer a wide variety of fixation techniques. All fixation methods demonstrated stable fixation for axial loading. Differences were noted for

flexion and torsion. Where bicortical screw fixation is not achievable, cable fixation is recommended. Additional unicortical screws improve torsional stiffness for cable fixation.

One-Stage Periprosthetic Hip Infection Revision Using a Prosthesis of Antibiotic Loaded Acrylic Cement (PROSTALAC)

Abstract ID: Paper 059

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INTRODUCTION: The gold standard treatment for periprosthetic infections of the hip is two-stage revision with antibiotic spacer, IV antibiotics, and revision total hip arthroplasty (rTHA) after laboratory and clinical evidence showing eradication of infection. Some institutions use a non-articulating antibiotic cement hip spacer while others advocate for articulating PROSTALAC devices. The final rTHA stage can often be financially challenging and physically demanding for the patient. The purpose of our study was to determine if one-stage revision using PROSTALAC reduces the number of required operations, as well as determine the re-infection/continued infection rate and complication rate in patients undergoing this surgical technique for periprosthetic hip infection.

METHODS: A retrospective review of all patients who meet the inclusion criteria for one-stage PROSTALAC for periprosthetic hip infection was performed. Inclusion criteria were good quality bone with significant remaining bone stock after joint resection and no prior two-stage procedure. A single surgeon performed surgical technique consisting of hand packed cementing of a femoral stem with cementing of an all polyethylene cup was performed on all patients. Medical records were reviewed for each patient from the date of their infection to present. Outcome measures were identified as the need for revision surgery and persistent infection.

RESULTS: Forty-three patients underwent one-stage PROSTALAC for periprosthetic hip infection. Eleven patients (26%) had revision surgery to remove the PROSTALAC. Four patients (9%) were revised because of persistent infection or re-infection with PROSTALAC in place. Recurrent dislocations forced rTHA in four patients (9%). Three patients (7%) underwent rTHA because of persistent pain or patient preference to have second stage performed. Follow-up time for our patients was an average of 12 months (range 1-77 months).

DISCUSSION: Using the gold standard two-stage technique, every patient would receive rTHA after PROSTALAC placement making minimum of 43 additional surgeries in our patient population. This technique allowed our group of patients to have only 11 revision operations. One-stage periprosthetic hip infection treatment by this technique may be beneficial both physically and financially for the patient. Using this technique to treat periprosthetic hip infections could offer a significant savings in healthcare while also providing appropriate treatment for our patients.

MAOA BREAKOUT SESSION #5
PRIMARY KNEE ARTHROPLASTY
April 24, 2014

Extreme Variability in Posterior Slope of Proximal Tibia: Are We Accounting for Patients' Normal Anatomy in UKA?

Abstract ID: Paper 060

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PURPOSE: Unicompartmental knee arthroplasty (UKA) is becoming more commonly performed and is more technically challenging than total knee replacement. Retention of the anterior and posterior cruciate ligaments requires more accurate re-creation of the patient's normal anatomic posterior slope with UKA. Purpose of this study was to accurately determine the posterior tibial slope in patients having medial or lateral UKA performed.

METHODS: Retrospective review was performed of 2,395 CT scans performed for a customized UKA implant. Standard CT technique was used and the posterior slope was measured on the involved side of the proximal tibia.

RESULTS: CT measurements from 2,031 knees undergoing medial UKAs had an average preoperative posterior slope of 6.8° (SD 3.3); in these patients, the posterior slope was between: 0-4° in 430 knees (21.2%), 4-7° in 696 knees (34.3%), 7-10° in 545 knees (26.8%), >10° in 360 knees (17.7%), and 13 knees (0.6%) had a reversed (anterior) tibial slope. Measurements from the 364 knees undergoing lateral UKAs showed an average preoperative posterior slope of 8.0° (SD 3.3), in these patients the posterior slope was between: 0-4° in 43 knees (11.8%), 4-7° in 100 knees (27.5%), 7-10° in 118 knees (32.4%), >10° in 103 knees (28.3%), and 1 knee (0.3%) had a reversed (anterior) tibial slope.

CONCLUSION: There is marked variability in the posterior slope of the proximal tibial with 44.5% of medial plateaus and 60.7% of lateral plateaus having more than 7° of posterior slope preoperatively. This is the first large CT based review of posterior slope variation of the proximal tibia. If attempting to match the patient's proximal slope during UKA, a routine setting of 5° posterior slope will produce a posterior slope less than the patient's native anatomy in more than 50% of patients.

Results of Oxford Phase III Mobile Bearing Unicompartmental Knee Arthroplasty from an Independent Center: 467 Knees at a Mean Six-Year Follow-Up: Analysis of Predictors of Failure

Abstract ID: Paper 061

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INTRODUCTION: Previous studies from Oxford have reported a revision rate of 2.9% and a bearing dislocation rate of 0.6% for the Oxford phase III medial UKA implant. However, other independent centers and registries have demonstrated inferior results with revision rates ranging from 2.9% to 14.9%, and dislocation rates ranging from 0.5% to 6.5%. Thus, there continues to be debates about this implant. No previous reports have assessed independent predictors of failure. Our purpose is to report revision, bearing dislocation, and assess multiple independent predictors of failure from a single independent center.

METHODS: A retrospective clinical and radiographic review of 467 consecutive UKA for isolated medial OA was performed. Oxford Knee Score, KSCRS, WOMAC, SF-12, and analysis of multiple independent predictors of revision (gender, BMI, age, number of previous surgeries, implant sizes, polyethylene thickness, surgeon experience, cement type and technique, MIS vs. standard incision) using univariate odds ratio was performed. Radiographic analysis included preoperative and postoperative long-leg alignment films. Radiographic measurements included: mechanical axis and position, tibiofemoral angle, AP femoral alignment, AP tibial alignment, lateral femoral flexion, lateral tibial slope, radiolucency, loosening, and OA grade in the lateral and patellofemoral compartments. No industry bias or implant company funding was received for this study. The mean follow-up was 5.2 years (range, 2-10 years).

RESULTS: There were improvements in KSCRS and Oxford Knee Scores ($p<.05$). At most recent follow-up, SF-12 and WOMAC was 42 and 80. Thirty-four knees (7.3%) were revised or pending revision to TKA (at a mean 47 months) most commonly for lateral compartment OA. Six knees (19%) required revision augments (5 tibial, 1 femoral), with a maximum size of 10 mm. One short cemented tibial and 6 short stubby tibial stems were utilized. The patella was resurfaced in 22 knees (71%). Twelve CR (39%) knees, 14 PS (45%), 4 cruciate substituting/dished (13%), and 1 (3%) constrained polyethylene were used. The dislocation rate was 0.86% (n=4). Over-correction of the mechanical axis beyond neutral on immediate postoperative radiographs was a predictor of revision. Surgeon experience and volume, non-MIS exposure, Simplex cement, and separate cement mixing for tibia and femur trended towards more favorable outcomes, but did not reach significance.

CONCLUSIONS: This is a large independent review with revision results not as favorable as from Oxford. Lateral compartment OA was the most common reason for revision. We could not find any statistically independent predictors of failure, but trends for surgeon experience and surgical technique were clinically significant. A valgus alignment on immediate postoperative radiograph was predictive of failure. Revisions were not "simple", and failure rates may be

higher as time progresses to 10 years. This is of concern, considering the lower revision rates associated with TKA surgery.

Differences in Short-Term Complications Between Unicompartmental and Total Knee Arthroplasty: A Propensity Score Matched Analysis

Abstract ID: Paper 062

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INTRODUCTION: Knee arthroplasty has emerged as an effective treatment for end stage gonarthrosis. While total knee arthroplasty (TKA) remains the gold standard, unicompartmental knee arthroplasty (UKA) is an appropriate alternative for select patients. We sought to identify differences in 30-day complication rates between TKA and UKA, and to identify risk factors for complication using a large, heterogeneous national database provided by the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP).

METHODS: Patients undergoing TKA and UKA between 2005 and 2011 were identified from the ACS NSQIP database. CPT codes were used to select cases of elective primary knee arthroplasty. Statistical models employing both univariate and multivariate logistic regression identified risk factors for short-term 30-day incidence of morbidity and mortality following TKA and UKA. Propensity score matching addressed demographic differences between the TKA and UKA cohorts.

RESULTS: In total, 29,333 patients were identified; 27,745 (94.6%) had TKA, and 1,588 (5.41%) had UKA. Prior to matching, females comprised 63.7 and 55.3% of the TKA and UKA cohorts while average BMI was 32.7 ± 7.3 and 31.5 ± 6.5 kg/m^2 ($p < 0.0001$) and average age was 67.2 ± 10.1 and 64.0 ± 10.7 years, respectively ($p < 0.0001$). A propensity score-matching algorithm was used to address demographic differences between the two cohorts. After matching, no significant difference in total complications between the TKA and UKA cohorts existed (5.29% vs. 4.16%; $p = 0.3454$), while DVT (1.5% vs. 0.50%; $p < 0.02$), and length of hospital stay (LOS) (3.4 vs. 2.2 days; $p < 0.0001$) were significantly higher in the TKA cohort.

CONCLUSIONS: In comparing TKA and UKA, there is no difference in overall short-term, 30-day morbidity and mortality. While this study does not address long-term subjective outcomes or implant survival, these findings should provide helpful information for surgeons counseling patients considering TKA and/or UKA.

The Effect of Payer Type on Clinical Outcomes in Total Knee Arthroplasty

Abstract ID: Paper 063

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INTRODUCTION: Medicaid recipients face increased barriers to receiving healthcare services. It was hypothesized that this may result in diminished outcomes after elective procedures such as total knee arthroplasty (TKA). The purpose of this study was to compare baseline demographics and outcome measures of TKA between Medicaid beneficiaries and patients of other payer types.

METHODS: This was a retrospective cohort analysis of 112 patients undergoing primary total knee arthroplasty, wherein baseline demographics and clinical outcomes were compared by insurance type: Medicaid, Medicare, or private.

RESULTS: At the time of surgery, Medicaid patients were younger ($p<.0001$) and had lower preoperative Knee Society Scores than Medicare and private patients ($p=.0125$). Medicaid postoperative scores were lower than those of private patients ($p=.0223$). The magnitude of benefit received by Medicaid patients was similar to Medicare and private patients. Medicaid patients had a higher number of cancelled ($p=.01$) and missed ($p=.0022$) appointments relative to Medicare and private patients. Medicaid patients also had shorter average follow-up periods compared to private patients ($p=.0003$).

CONCLUSIONS: When compared with patients of other payer types, Medicaid beneficiaries present earlier and with poorer functioning knees prior to total knee arthroplasty, but they stand to gain a similar magnitude of benefit from the procedure. Medicaid patients pose a unique challenge to healthcare providers due to their poor follow-up, increased appointment cancellation rate, and increased appointment skipping rate. Access to care and socioeconomic factors may be responsible for these findings.

The Influence of Comorbidities on Hospital Costs and Length of Stay Following Total Knee Arthroplasty

Abstract ID: Paper 064

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INTRODUCTION: Total knee arthroplasty (TKA) is one of most common orthopedic procedures performed. Rising arthroplasty costs and utilization have piqued national attention and ushered new regulation. The purpose of this study was to examine the influence individual patient characteristics has on hospital charges and length of stay (LOS).

METHODS: The 2009 National Inpatient Sample (HCUP-NIS) dataset was queried using ICD-9-CM codes to identify patients between ages 40 and 95 and undergoing elective TKA. We used weighted estimates of national procedure volume and patient comorbidities defined by the Agency for Healthcare Research and Quality (AHRQ) and identified them using standard methods described by Elixhauser. Generalized linear models, based on Poisson regression analysis, were used to estimate the influence of individual patient characteristics on hospital charges and (LOS).

RESULTS: In 2009, 621,029 patients underwent TKA. Of these, 12.7% of TKA patients had no comorbidities while 32.5% had three or more. The most common conditions included hypertension (67.6%), diabetes (20.0%), and obesity (19.9%). Mean hospital costs were $47,370 and mean hospital LOS was 3.4 days. With incremental comorbidities, both hospital charges and length of stay increased ($p < 0.01$). Both marginal charges and LOS rose with inpatient mortality (+$29,876, 1.9 days), patients with metastatic disease (+$20,526, 1.8 days), minority race (+$10,958, 0.3 days), pulmonary-circulatory disorders (+$10,665, 1.4 days), electrolyte disturbances (+$6,014, 0.7 days), and more. Patients treated in the Midwest had lower hospital charges and LOS (-$498, -0.04 days).

DISCUSSION: With incremental comorbidities, both hospital charges and length of stay increased. Hospital charges and length of stay after TKA rise dramatically with the multiply-comorbid patient. Most current reimbursement schemes fail to adequately adjust for these patient characteristics. As the payments for arthroplasty continue to decline, policy makers must focus on providing fair compensation and quality metrics to hospitals and surgeons treating the comorbid; otherwise, significant restrictions in access to care may occur.

Level of Evidence: Level III: Prognostic

Effect of Psychopathology and Obesity on Outcomes of Total Knee Arthroplasty

Abstract ID: Paper 065

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INTRODUCTION: Psychopathology has been demonstrated to result in worse patient-perceived outcomes after total knee arthroplasty (TKA). The association of obesity with outcomes after TKA is less clear. The purpose of this study was to analyze the effects of psychopathology on the outcome after TKA in obese patients.

METHODS: 266 consecutive patients undergoing primary TKA were enrolled in this prospective cohort study. Patients were divided into three groups based on BMI: non-obese (<30), obese (30-40), and morbidly obese (40+). The presence of Axis-I psychopathology was evaluated with the Patient Health Questionnaire. Each group was then subdivided based on the presence or absence of any Axis-I psychopathology. Outcomes were assessed preoperatively and at 1 year postoperatively using the WOMAC and KSS. Statistical analysis was completed with ANOVA.

RESULTS: There were 104 (39.1%) non-obese patients, 127 (47.7%) obese patients, and 35 (13.2%) morbidly obese patients. 26.3% of non-obese patients, 33.3% of obese patients, and 38.7% of morbidly obese patients were diagnosed with at least one Axis-I psychological diagnosis. In patients with no psychopathology, the final mean WOMAC score was worse in morbidly obese patients (35.5) compared to non-obese patients (19.7) (p=0.008). In patients with psychopathology, the final WOMAC score was worse in morbidly obese patients (47.6) than obese patients (26.6) (p=0.025). The final mean KSS was lower in obese (144.3) and morbidly obese (137.7) patients without psychopathology, than non-obese patients (159.2) without psychopathology (p=0.016). Morbidly obese patients with psychopathology had the lowest final KSS (113.5) and the worst WOMAC (47.6) of any group.

DISCUSSION: Psychopathology results in worse patient-perceived outcomes after TKA regardless of BMI and may be a confounding factor when analyzing the outcomes after TKA. Morbidly obese patients are at risk for a higher prevalence of Axis-I psychopathology and worse outcomes after TKA than non-obese patients.

Aseptic Protocol Decreases Surgical Site Infections Following Knee Arthroplasty

Abstract ID: Paper 066

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INTRODUCTION: Surgical-site infection (SSI) is a devastating complication after knee arthroplasty, is associated with long-term impacts on patient health, and is fiscally burdensome to the healthcare system. There is a critical need to optimize perioperative protocols to help minimize SSI risk. We report significant reduction in SSI rate utilizing a comprehensive aseptic protocol in a high-risk population undergoing knee arthroplasty.

METHODS: In a single-center prospective cohort study, a database of all primary and revision knee arthroplasty patients (2005 – 2011) was reviewed. SSI was defined as superficial and/or deep using CDC criteria. No patients other than those undergoing revision for sepsis were excluded. Data collected included medical comorbidities, known preoperative risk factors for SSI, and postoperative complications occurring within 12 months of surgery. Patients were stratified into low (no risk factors), moderate (1 risk factor), high (2 risk factors), or very high (> 3 risk factors) for SSI. All patients were treated with the same aseptic protocol: preoperative 2% mupirocin nasal ointment and surgical-site 0.4% chlorhexidine wipes, modified instrument care, perioperative prophylactic vancomycin and cefazolin, and surgical site-skin preparation with chlorhexidine, alcohol, and iodophor. Chi-squared tests, odds ratios, and number needed to treat (NNT) analysis were performed to compare our protocol SSI rate to our institutional historical knee arthroplasty SSI rate (2001-2004) as well as to contemporary comparable literature (Table 1). Odds ratios with 95% CI were used to compare incidence of independent risk factors for SSI amongst the groups (Table 2).

RESULTS: In the protocol group of 1,350 patients, 71% were ASA > 2, 64% were BMI > 30, and 61% were considered high risk (≥ 2 independent risk factors) for SSI. Having two or more independent risk factors was significantly related to incidence of SSI ($p<0.001$). All eight patients with SSI had ASA > 2 ($p < 0.001$). Patients classified as immunosuppressed (94 patients, 7.0%) were more likely to have SSI (OR 8.28, $p < 0.001$). Patients undergoing revision arthroplasty (126 patients, 9.3%) were more likely to have SSI than those undergoing primary operations (OR 3.6, $p < 0.001$). We found an overall 0.59% (8/1350) infection rate which is among the lowest in the literature; is significantly lower than our institutional historical SSI rate (0.39% vs. 2.24%, $p=0.004$, OR 0.26, NNT 145) and significantly lower than five recently published reports ($p < 0.001$-0.022, OR 0.13-0.36, NNT 44-120). Compared to recent reports, significantly more of our patients underwent revision arthroplasty (OR 1.4-2.9, $p < 0.001$-0.034), were ASA > 2 (OR 3.1-37.8, $p < 0.001$), were BMI > 30 (OR 2.0-14.7, $p < 0.001$), were immunosuppressed (OR 5.75, $p < 0.001$), or had rheumatoid arthritis (OR 1.4-4.5 $p < 0.001$-0.015). Our implant retention rate after SSI was 75%.

CONCLUSION: Our comprehensive aseptic protocol decreases SSI in a high risk population undergoing knee arthroplasty.

Click here to view Table 1
Click here to view Table 2
Click here to view Table 2 (continued)

Predictors of Pain Following Total Knee Arthroplasty

Abstract ID: Paper 067

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PURPOSE: Many investigators are studying variables that may predict the excessive postoperative pain and dissatisfaction reported in 15-20% of patients following TKA in the hopes of better defining indications for surgery or preoperative and postoperative modalities that may decrease the number of patients with pain and dissatisfaction. The authors have performed a prospective study and continue to monitor a series of patients with extensive preoperative and postoperative pain, function, and patient-reported outcome tools. The purpose of this study was to evaluate a simple range of motion test that could predict postoperative pain following TKR.

METHODS: Demographic information, analgesic intake, anxiety, depression, pain catastrophizing, resting pain, pain with simple active knee range-of-motion, and quantitative sensory tests, were performed preoperatively on 215 subjects scheduled for a TKA. On postoperative day 2 (POD#2), analgesic intake, resting pain, and pain with range-of-motion were again assessed. Composite scores were created for pain with active range-of-motion on POD#2 and coded as low, moderate, or severe pain.

RESULTS: Fifty-eight subjects experienced low pain (27%), 98 moderate pain (46%), and 59 severe pain (27%). Significant predictors of severe postoperative pain with range-of-motion were high preoperative pain with simple range-of-motion (higher than 15 out of 20), von Frey pain intensity score, and heat pain threshold. People with range-of-motion pain > 15/20 preoperatively were 20 times more likely to have severe pain with range-of-motion postoperatively. When the influence of preoperative pain was eliminated, depression was also a high predictor of postoperative pain.

CONCLUSION: TKA patients with high levels of preoperative pain with simple active range-of-motion, increased pain sensitivity, and depression are more likely to have severe range-of-motion pain early after surgery. Very high knee range-of-motion pain (>15/20) prior to TKA may be a predictive factor for worse or prolonged postoperative pain, and possibly for ultimately unsatisfactory results or imperfect knees. More aggressive management of preoperative range-of-motion pain with NSAIDs, PT, or other modalities, along with depression assessment and management prior to surgery, may be helpful in reducing these high pain levels and improving overall TKA results.

SIGNIFICANCE: All knee replacement surgeons are looking for preoperative indicators that can predict excessive pain and dissatisfaction following TKA. We have demonstrated a single test to predict postoperative pain following TKA. If this predictive test continues to predict long-term pain and dissatisfaction, surgeons should reconsider indications for surgery as well as pre- and postoperative pain and depression management.

Intravenous vs. Topical Tranexamic Acid in Total Knee Arthroplasty: A Prospective Randomized Study

Abstract ID: Paper 068

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INTRODUCTION: Intravenous (IV) administration of Tranexamic Acid (TXA) has been shown to reduce blood loss and transfusion rates following Total Knee Arthroplasty (TKA). Many common medical conditions constitute contraindications to IV TXA. We hypothesized that topical administration of TXA would exhibit similar efficacy and safety profiles as IV TXA for patients undergoing TKA.

METHODS: IRB approval was obtained, and patients who were candidates for TKA were recruited and randomized prospectively. Patients were excluded if they had a history of cardiovascular, cerebrovascular, or thromboembolic disorders, or an allergy to TXA. In the IV group, TXA was administered by a single 10mg/kg dose, 5 minutes prior to tourniquet release. In the topical group, 2g of TXA in 100ml saline solution was placed directly into the surgical site.

RESULTS: A total of 32 patients were enrolled in the study, 15 in the IV group and 17 in the topical group. There were no differences between the two groups with regard to age, gender, BMI, ASA classification, or tourniquet times. The mean preoperative, postoperative, and change in hemoglobin levels were 13.4 ± 1.1, 10.5 ± 1.2, and 3.0 ± 1.1 respectively in the IV group, and 13.5 ± 1.3, 10.2 ± 1.0, and 3.3 ± 1.2 in the topical group, with no statistical differences given the numbers available for study. Mean postoperative drain outputs were 343mL in the IV group and 599mL in the topical TXA group, ($p=0.05$). There were no transfusions, DVTs, PEs, or wound infections in either group.

CONCLUSION: Topical TXA administration appears to have an equivalent efficacy profile to IV TXA in reducing blood loss and transfusion rates following TKA, supporting our hypothesis. Our preliminary data appears favorable for the use of topical TXA in place of IV administration.

Does Implant Design Influence the Accuracy of Patient Specific Instrumentation in Total Knee Arthroplasty?

Abstract ID: Paper 069

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INTRODUCTION: Patient specific instrumentation (PSI) software must be able to accommodate differences in implant design. The purpose of this study was to identify any differences in the accuracy of limb alignment, component alignment, component sizing, or bony resection in patients undergoing PSI total knee arthroplasty (TKA) with identical software and one of two different implant systems.

METHODS: In this case-control study, two different implant systems were evaluated in 44 consecutive PSI TKA (Group 1) and 123 consecutive PSI TKA (Group 2) performed by a single surgeon. A third group (Group 3) consisted of 13 consecutive TKA performed with manual instrumentation and the same implant system as Group 1. Identical software was used to generate a preoperative plan from which planned limb alignment, component alignment, component sizes, and bony resection were determined. Intraoperatively, actual component sizes, bony resection, and recut frequency were determined. Long-standing and lateral radiographs were obtained preoperatively and 4 weeks postoperatively to evaluate limb and component alignment.

RESULTS: Groups were similar with regard to age, gender, BMI, and preoperative alignment. No differences in the accuracy of limb alignment, component alignment, component sizing, or PSI-planned vs. actual resection were found between Groups 1 and 2. The rate of recuts required was lower in Group 1 than Group 2 for the proximal tibia (7.8% vs. 35.8%;$p<0.05$). No differences were found in limb or component alignment between Groups 1 and 3. Resection depth in the posterior femur was closer to implant thickness in Group 1 compared to Group 3 (12.1 mm vs. 13.4 mm; $p<0.05$). Group 1 showed less variation than Group 3 in resection depth of the posterior femur (SD 1.4 mm vs. 2.1 mm) and proximal tibia (SD 1.8 mm vs. 2.5 mm).

DISCUSSION: No differences in the accuracy of limb alignment, component alignment, and component sizing were found between Groups 1 and 2. Group 1 required fewer recuts than Group 2 for the proximal tibia. There may be characteristics of implant design, e.g., the slope of the tibial plateau, that may influence PSI's ability to accurately determine cut thickness. Resection depth was closer to implant thickness and showed less variation in Group 1 compared to Group 3. This study suggests that PSI can be equally accurate for different implant systems. For a given implant system, PSI more accurately establishes a cut that is closer to implant thickness when compared to manual instrumentation.

Perceived Leg Length Discrepancy Following Primary Total Knee Arthroplasty

Abstract ID: Paper 070

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INTRODUCTION: Little is known about perceived leg length discrepancy (LLD) after total knee arthroplasty (TKA). The purpose of this study was to determine the incidence of perceived LLD before and after primary TKA and the timeframe for resolution of perceived LLD.

METHODS: 73 patients undergoing primary TKA were prospectively studied. Inclusion criteria included a normal ipsilateral hip and contralateral hip and knee. Patients were asked preoperatively and 3-to-6 weeks postoperatively if they perceived a LLD and had a standing mechanical axis radiograph taken from which the mechanical axis of their operative side was measured. Patients were followed until they did not perceive a LLD or 1 year postoperatively. Mechanical alignment was compared between patients with and without a perceived LLD using Student's t-test.

RESULTS: Preoperatively, 19 patients (26%) perceived a LLD with mean mechanical alignment of 6.5°; 15 had valgus alignment (79%). In contrast, the 53 who denied perceiving LLD preoperatively had a mean mechanical alignment of 7.8° (p=0.345); 12 had valgus alignment (23%). At 3.9 weeks mean follow-up, only 7 patients (10%) perceived a LLD with mean mechanical alignment of 3.8°, of which 5 had valgus alignment (71%). In contrast, 66 did not perceive a LLD with mean mechanical alignment of 3.2°; 43 had valgus alignment (65%). Only one patient who perceived LLD preoperatively perceived one postoperatively. At mean follow-up of 9 weeks, all perceived LLDs had resolved.

CONCLUSION: Perceived LLD is common prior to primary TKA, but is corrected in most cases during surgery. LLD is also commonly perceived postoperatively in patients who did not perceive one preoperatively, although the relationship between perceived LLD and mechanical alignment is unclear. Patients should be counseled that although approximately 10% of patients perceive a LLD after primary TKA, the vast majority resolve within 3 months.

No Increased Risk of TKA Failure in Metal Hypersensitive Patients: A Matched Cohort Study

Abstract ID: Paper 071

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INTRODUCTION: The purpose of this study is to investigate the effects of skin metal hypersensitivity on TKA function and survivorship.

METHODS: Between 1997 and 2009, 127 patients underwent 161 TKA after skin patch allergy testing (SPT). Cases were matched by age, sex, BMI, ASA score, and implant manufacturer to 161 controls without metal allergy. The 322 TKAs were subsequently divided into 3 groups after review of patch testing: Group 1: positive SPT for metals (n=59), Group 2: negative SPT for metals (n=102), and Group 3 controls (n=161). Within the first group, 17 knees had a so-called hypoallergenic TKA (Group 1a) while 42 cases did not (group 1b). Median follow-up was 5.3 years, and 79.5% were female. Revision, re-operation, and complications (including: arthrofibrosis, instability, and infection) were assessed using the Kaplan Meier method and Cox models.

RESULTS: Survivorship free of revision at 5 years was 98.2% (94.7-100; 95% CI) for group 1 and did not differ statistically from that of controls (97.8% [93.6-100 95% CI] [HR=1.5, p=0.62]). For group 1a, the 5-year rate of survivorship free of revision was 100%, while the corresponding rate for group 1b was 97.2% (92-100 95% CI). There was no significant difference in survivorship free of revision between groups 1 and 2 (98.2%; 94.7-100 95% CI vs. 100% HR=2.67, p=0.29). The most common complications seen were arthrofibrosis and instability seen in 34 knees (group 1: n=5, group 2: n=18 and group 3: n=11) and in 11 knees (group 1: n=2, group 2: n=4, and group 3: n=5), respectively. The only significant difference was survivorship free of arthrofibrosis that was significantly worse in patients who were skin patch negative compared to controls. HR=3.4, p=0.01.

CONCLUSION: Patients with a positive SPT have similar clinical outcomes with respect to implant survival, and complication rate compared to non-hypersensitive patients. To our knowledge, this is the first study that negates a causal relationship between metal hypersensitivity and TKA failure.

MAOA SECOND PLENARY SESSION
April 25, 2014

Shoulder Arthroplasty in Patients Less than 50 Years: Minimum 20-Year Follow-Up

Abstract ID: Paper 072

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INTRODUCTION: Currently, there is little information available on the long-term outcome of shoulder arthroplasty in young patients. Therefore, the purpose of this study was to determine the results, complications, and rate of revision of patients less than 50 years old who underwent shoulder arthroplasty with a minimum 20-year follow-up.

METHODS: Seventy-six Neer hemiarthroplasties (HA) and 35 Neer total shoulder arthroplasties (TSA) were performed in patients age 50 years or younger between 1976 and 1985 by a single surgeon. All 111 shoulders were included in survival analysis. Fifty-seven HAs and 19 TSAs with a minimum 20-year follow-up or follow-up until reoperation were included in the analysis of clinical results.

RESULTS: Both HA and TSA showed significant improvements in pain scores ($p<0.001$), abduction ($p <0.01$), and external rotation ($p=0.02$). Eighty-one percent of patients rated their shoulder as much better or better than preoperatively. There were a total of 14 excellent, 26 satisfactory, and 71 unsatisfactory results based on modified Neer ratings. No difference was identified between groups ($p=0.63$). Twenty-five HAs and 6 TSAs required reoperation. Estimated 20-year survival of HAs was 75.6% (CI 65.9-86.5) and 83.2% (CI 70.5-97.8) for TSAs. HAs were shown to have a higher risk of revision (HR 1.75), but this did not reach significance ($p=0.21$). Radiographically, 12 humeral stems were noted to be at risk (3 HA, 9 TSA). Eight glenoid components in the TSA group were noted to be at risk at the time of most recent follow-up.

DISCUSSION: At long-term follow-up, both HA and TSA continue to provide lasting pain relief and improved range of motion. However, in this young population, over 60% of patients had unsatisfactory Neer ratings secondary to pain and restricted motion. While both groups have survivorship in excess of 75% at 20 years, surgeons should remain cautious in performing shoulder arthroplasty in the young patient.

Cervical Radiculopathy Presenting as Shoulder Pain: Incidence and Results of Multidisciplinary Care

Abstract ID: Paper 073

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INTRODUCTION: Recently, reports in the literature have correlated the specific anatomic and clinical distributions of pain associated with cervical radiculopathy. However, scant literature exists to characterize patients presenting with shoulder pain caused by cervical spine pathology. The current study proposed to investigate the identification and multi-disciplinary treatment of patients where shoulder pain is the chief complaint of cervical radiculopathy.

METHODS: All new patients presenting to a single shoulder and elbow fellowship-trained orthopedic surgeon at a tertiary referral center from 2009-2012 were analyzed. Those with the chief complaint of shoulder pain were identified. From these patients, those with an isolated diagnosis of cervical radiculopathy were included in the study population.

Diagnosis of cervical radiculopathy was based on clinical symptoms of radicular pain radiating down the arm or medial scapula in conjunction with positive Spurling's and/or Lhermitte's signs. Confirmatory magnetic resonance imaging was obtained in patients that failed conservative treatment (directed physical therapy, oral corticosteroids, and oral muscle relaxers). Those patients were then treated with cervical epidural corticosteroid injection by a physiatrist. Patients failing injection were then referred for surgical evaluation by an orthopedic spine surgeon. Visual analog pain scores (VAS) were recorded at the initial visit, and VAS and National Disability Index Questionnaire (NDIQ) scores were obtained at a minimum of one year. Student's t-test was performed for statistical analysis with $p<0.05$ considered significant.

RESULTS: 1,169 initial visit patients were identified in the study period with a chief complaint of shoulder pain. Of these, 60 were diagnosed with isolated cervical radiculopathy (4%). Forty-eight patients (80%) were available for follow-up evaluation. Thirty-four patients (71%) were treated conservatively, 11 (23%) underwent cervical epidural injection, and 3 (6%) went on to anterior cervical discectomy and fusion (ACDF). At a mean follow-up of 27 months (range 12-44), the average overall pain score was 2 compared to 5.2 at the initial visit ($p<0.0001$). The differences between initial and follow-up VAS scores for conservative management (4.4 vs. 1.8, $p<0.0001$), cervical epidural injection (6.7 vs. 2.8, $p<0.0001$), and surgical intervention (7.3 vs. 1.0, $p=0.09$) demonstrate improvements with all three treatments.

The overall mean NDIQ score was 16% at follow-up, indicating minimal disability. Fifteen patients (31%) reported NDIQ scores of zero with 32 (67%) demonstrating minimal disability (<20%). Of 18 patients with NDIQ scores obtained prior to treatment, mean disability scores decreased from 21% to 9% ($p=0.0002$). The differences in NDIQ scores for conservative management, cervical injection, and surgical intervention were 18 vs. 8 ($p=0.01$), 30 vs. 10 ($p=0.002$), and 22 vs. 6 (one patient).

CONCLUSIONS: Approximately 4% of patients presenting to a shoulder and elbow specialist with a chief complaint of shoulder pain were identified to have an isolated cervical radiculopathy in this study. While most resolved with non-operative treatment, 23% went on to a cervical epidural corticosteroid injection and 6% required surgical intervention. These findings suggest patients may expect a significant reduction in pain and disability at greater than one year after this diagnosis utilizing a step-wise multi-disciplinary treatment strategy. Additional prospective studies may be helpful to further investigate these findings.

Early vs. Late Culture Growth Characteristics in P. acnes Positive Periprosthetic Shoulder Infections

Abstract ID: Paper 074

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INTRODUCTION: Propionibacterium acnes (P. acnes) is the most common pathogen in periprosthetic shoulder infection. Due to its indolent clinic course and variable incubation period, the presence of false-positive cultures makes it difficult to distinguish true infections from contaminants. The goal of this study was to determine if a relationship exists between the time to P. acnes culture growth and the likelihood of having a true periprosthetic shoulder infection as opposed to a culture contaminant in revision shoulder arthroplasty.

METHODS: We retrospectively reviewed the charts of 34 patients who underwent first stage revision shoulder arthroplasty between May 2010 and March 2012, and who had positive intraoperative cultures for P. acnes. Infection likelihood was categorized into 3 groups (definite, possible, probable) based on preoperative evaluation (gross examination, radiography, aspirate cell count and culture, serum inflammatory markers), intraoperative findings (frozen section, gross purulence), and postoperative cultures. The time to P. acnes culture growth was obtained, and patients were categorized into early culture growth (< 7 days) or late culture growth (≥ 7 days). Independent t-test was used for continuous variables and chi-square test for categorical variables.

RESULTS: Mean time to culture growth for P. acnes was significantly lower in the definite infection group (4.2 days ± 1.7) compared with possible infection group (8.2 days ± 5.8; $p = 0.037$). When comparing cases with early culture growth for P. acnes (< 7 days) and cases with late culture growth (≥ 7 days), no significant differences were found with regards to age, gender, type of prosthesis, and preoperative or intraoperative signs of infection ($p = 0.112 – 0.780$). However, laboratory and culture data showed a significantly higher serum C-reactive protein levels in the early growth group (1.2 mg/dL ± 1.4) compared with late growth group (0.4 mg/dL ± 0.6; $p = 0.019$). Furthermore, patients whose cultures grew P. acnes earlier often had ≥ 2 separate positive cultures (67% in early growth group and 22% in late growth group; $p = 0.024$).

CONCLUSION: In revision shoulder arthroplasty, the early growth of P. acnes in intraoperative cultures (< 7 days) is more likely to represent a true infection as opposed to a false-positive result. This study provides an evaluation adjunct for treating patients without clinical symptoms, equivocal perioperative testing, and who present with positive postoperative cultures.

Exercise Antagonizes Local and Systemic Inflammation vs. Suppression of NF- κ B Activation

Abstract ID: Paper 075

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PURPOSE: Inflammation is integral in cartilage damage and bone erosion. Physiologic levels of exercise are anti-inflammatory and suppress local inflammation of joints. The abrogation of pro-inflammatory signals by exercise is mediated by suppression of NF- κ B activity. Here we examined whether the observed effects of physiologic levels of exercise are mediated via its local or systemic actions on inflammation.

METHODS: All protocols were preapproved by the IACUC at Ohio State. Transgenic BALBc female mice (12-14 weeks) containing firefly luciferase cDNA in NF- κ B response elements were used to study transcriptional regulation of the NF- κ B gene to examine the effects of exercise (treadmill walking, 8M/min) on inflammation. Inflammation was elicited by injection of LPS (1 µg/gm body weight) in the right ankle. Mice received the following treatments: (1) no treatment, (2) exercise alone, (3) LPS injection alone, (4) pre-exercised 7 days prior to LPS, (5) exercised only post-LPS, or (6) exercised pre and post LPS injection. Activation of NF- κ B was assessed 2 hours, 24 hours, 48 hours, or 5 days post-LPS by examining luciferase activity by digital imaging. Induction of pro-inflammatory cytokines in serum was assessed by Multiplex ELISA assays.

RESULTS: Control mice and those exposed to exercise alone did not exhibit significant NF- κ B activation. LPS injection provoked a systemic and local inflammatory response 6-8 fold greater within 2 hours. Pre-exercised mice showed significant systemic inhibition of LPS-induced NF- κ B activation, while mice exposed to exercise following LPS showed more than 90% suppression of NF- κ B activation. LPS activated NF- κ B primarily in axillary and inguinal lymph nodes, spleen, and mesentery. Exercise was effective in suppressing LPS-induced NF- κ B activation in lymph nodes and at the site of injection. Immunofluorescence analysis in tissue confirmed that exercise inhibited NF- κ B nuclear translocation and its synthesis. Assessment of major pro-inflammatory cytokines all showed up-regulation by LPS, whereas pre-exercise and post-exercise effectively suppressed pro-inflammatory cytokine induction. Importantly, the effects of post-exercise were more dramatic than pre-exercise. We next examined whether the anti-inflammatory effects of exercise are sustained and for how long. In these experiments, mice were either exercised daily or for only one-day post LPS administration. Mice exposed to exercise daily maintained suppression of NF- κ B. However, the effects of exercise were transient in suppressing NF- κ B activation and lasted only 24 hours following exercise.

CONCLUSIONS: The findings suggest that exercise may not only suppress local inflammation of the joints, but its effects may also be systemic by inhibiting NF-κB activation post acute inflammation.

Rivaroxaban vs. Enoxaparin for Venous Thromboembolism Prophylaxis After Hip and Knee Arthroplasty

Abstract ID: Paper 076

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The oral Factor Xa inhibitor rivaroxaban (Xarelto) has been the routine pharmacologic agent used for venous thromboembolism (VTE) prophylaxis after primary hip and knee arthroplasty at our institution since February 2012. The purpose of our study was to compare rates of VTE and major bleeding between rivaroxaban to our previous protocol of enoxaparin after primary total hip and knee arthroplasty (THA and TKA, respectively). A retrospective cohort study was performed including 2406 consecutive patients who underwent primary THA or TKA at our institution between 1/1/11 and 9/30/13. Patients were excluded who did not have unilateral primary THA or TKA or if they required treatment with other anticoagulants for medical reasons. Of the 1762 patients ultimately included in the study, 1113 patients (63.2%) received enoxaparin and 649 patients (36.8%) received rivaroxaban. There were no demonstrable differences between these two anticoagulants in rates of deep venous thrombosis (DVT), pulmonary embolus (PE), transfusion, superficial infection, deep infection, reoperation, or hemorrhagic cerebrovascular events. In what we believe to be the largest non-industry-funded study evaluating rivaroxaban to date, there were no differences in rates of VTE or bleeding complications between rivaroxaban and enoxaparin.

Click here to view Table 1
Click here to view Table 2

BMI as a Continuous Variable in Long-Term Survival of Total Hip Arthroplasty

Abstract ID: Paper 077

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INTRODUCTION: Body Mass Index (BMI) has been associated with increased rates of complications in total hip arthroplasty (THA). There has been no study translating risk of revision with respect to BMI as a continuous variable. Our purpose was to characterize the survival after THA across a continuous range of BMIs.

METHODS: 21,406 consecutive THA patients from 1985-2012 were analyzed from a single-institution prospective total joint registry. The average BMI was 28.7 (range, 15-68). 7,661 patients (35%) had a BMI >30, and 997 (4%) >40. The average age was 65 years (range, 11-98); 53% of patients were female. Average follow-up after surgery was 7.5 years +/-5.5. The risk of revision surgery associated with BMI was analyzed using the Kaplan-Meier survival method. Comparisons were made using the log-rank test and multivariate regression analysis model. Statistical significance was set at a p-value <0.05.

RESULTS: 1,781 revision surgeries were performed. Five-year survivorship rate was 96%; 10-year rate was 90%; and 15-year rate was 79%. The risk of revision surgery was the lowest for BMI 27-32. However, the risks significantly increased (in sigmoidal fashion) for BMIs <27 ($p<0.001$; hazard ratio 1.04) and >32 (<0.002; hazard ration 1.03) (Figure 1). When referencing the normal BMI range (20-25), BMIs from 25-30 had a significantly decreased revision rate ($p<0.04$), while BMIs >45 had a significantly increased failure rate ($p<0.05$). Furthermore, when compared to non-obese patients (BMI <30), although obese (BMI 30-40) patients did not have a difference in implant ($p=0.32$), morbidly obese patients had a significant increase in risk of revision surgery ($p<0.003$) (Table 1). Other variables that worsened overall implant survival included younger age ($p<0.001$), inflammatory arthritis ($p<0.05$), post-traumatic arthritis ($p<0.001$), and osteonecrosis ($p<0.001$).

CONCLUSION: The rate of revision surgery after THA is associated with BMI. However, the effect of BMI on failure rate increases in a sigmoidal fashion for BMIs <27 and >32. Further study may examine etiologies for this relationship. This study informs the continued debate of impact of BMI on the outcomes after primary THA.

Click here to view Figure
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Effects of Local Delivery of D-Amino Acids from Biofilm-Dispersive Scaffolds on Infection in Contaminated Rat Segmental Defect Model

Abstract ID: Paper 078

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INTRODUCTION: Biofilms form within open fractures and contaminated wounds within hours after injury. Biofilms thwart the immune response and the quiescent persister cells are resistant to antibiotics, leading to postoperative infections and decreased osseous union rates. Thus, anti-biofilm agents have recently gained considerable interest. This study investigates the spectrum and activity of the biofilm dispersal activity of D-amino acids (D-AAs) on clinical bacteria isolates and the effectiveness of local delivery of D-AAs in preventing infection within a contaminated segmental defect model.

METHODS: Human fibroblasts and osteoblasts were exposed to individual D-AAs in vitro to assess toxicity. The ability of D-AAs, individually and as a mixture, to disrupt and prevent biofilm formation in a collection of clinical wound isolates was evaluated using the conventional 96-well plate microtiter model. D-AAs most effective at preventing biofilm formation (D- Met, D- Pro and D-Trp) were then embedded into polyurethane scaffolds in a 1:1:1 ratio. The embedded scaffolds were then tested in vivo against UAMS-1 (high-biofilm producer, recovered from an osteomyelitis patient) in a previously characterized contaminated, critical-size rat femur defect that utilized systemic, post-operative antibiotics (Cefazolin, BID for 3 days).

RESULTS: D-AAs were observed to have minimal toxicity on human osteoblasts and fibroblasts while being very effective against the clinical bacteria strains. Combining D-Pro, D-Met and D-Trp enhanced these effects and the addition of D-AAs decreased the minimum biofilm eliminating concentration (MBEC) of the S. aureus to cefazolin by 16-fold. The D-AA embedded scaffolds decreased the number of infected bone samples from 40% to 0% and greatly reduced biofilm formation on the scaffolds (Figure 1). The D-AA embedded scaffolds also significantly ($p<0.05$) reduced the microbial burden within the contaminated, critical-size defects in a does-dependent response when compared to controls (Figure 2).

DISCUSSION: Our results suggest that D-AAs have broad-spectrum activity, are not harmful to cells at therapeutic levels, and their local delivery significantly reduces biofilm after bacterial contamination and appear to work synergistically with systemic antibiotics. Traditional bone grafts provide bacteria with a surface to adhere and grow whereas the biofilm-dispersive graft is protected from colonization and enhances the host immune system and antibiotic therapy. This adjunctive therapy appears to work in concert with current clinical infection prevention practices to decrease potential bone and hardware related infections.

Click here to view Figures

Factors Affecting Readmission Rates Following Primary Total Hip Arthroplasty

Abstract ID: Paper 079

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BACKGROUND: Hospital readmission rate following total hip arthroplasty (THA) is a focus of interest given the contemporary environment and looming financial penalties anticipated in 2015. A relationship between high comorbidity burden and increased complication rate has been previously reported. The current study investigates a similar relationship between preoperative comorbidity, postoperative complication, and the risk of hospital readmission following THA.

METHODS: Using the American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) data for the year 2011, a study population was generated using the CPT code for primary THA (27130). Univariate statistics compared unplanned readmitted and non-readmitted cohorts with regard to demographics, preoperative medical comorbidities, and surgical outcomes. Categorical variables were assessed using Pearson's chi-square (and Fisher's Exact test when appropriate) whereas continuous variables were assessed using Mann-Whitney U tests. Significance considered $p<0.05$ and Odds ratios report 95% confidence intervals. A multivariate logistic regression model was created using readmission as the outcome of interest and Hosmer-Lemeshow and C-stats were computed to assess fit and predictive ability of the model.

RESULTS: Study population: 9,441 patients with 345 unplanned 30 day readmissions (3.65%). Preoperative comorbidities that increased readmission risk included: diabetes (<0.001), COPD ($p<0.001$), bleeding disorder/anticoagulant use ($p<0.001$), preoperative transfusion ($p=0.035$), chronic steroid use ($p<0.001$), dyspnea ($p=0.001$), previous cardiac surgery ($p=0.002$), and hypertension ($p<0.001$). Additionally, the majority of readmitted patients were ASA class 3 (59.13%; $p<0.001$), while the majority of the non-readmitted patients were ASA class 2 (55.35%; $p<0.001$). A multivariate regression model controlling for confounders showed BMI>40 (Odds Ratio [OR] = 1.941, Confidence Interval [CI] = 1.019 - 3.696; $p=0.044$) and chronic steroid use (OR 2.928, CI 1.731 – 4.953; $p<0.001$) were independently associated with a higher likelihood of readmission. A high preoperative serum albumin (OR 0.688; CI 0.477 – 0.992, $p=0.045$) was independently associated with a lower risk for readmission. Postoperative complications including: superficial surgical site infection, pulmonary embolism, deep venous thrombosis, and sepsis ($p<0.001$) were all independent risk factors for readmission following THA. An increasing trend was seen between the number of complications and readmission rates. Cochrane-Armitage trend test revealed that this trend was significant ($p<0.001$).

CONCLUSIONS: BMI>40, history of chronic steroid use, and low preoperative serum albumin are independent preoperative risk factors of readmission following THA. Furthermore, postoperative complications including superficial surgical site infection, thromboembolic event, and sepsis increase risk of readmission after THA.

MAOA BREAKOUT SESSION #6
SHOULDER
April 25, 2014

Irrigation and Debridement for the Management of Infected Shoulder Arthroplasty

Abstract ID: Paper 080

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INTRODUCTION: Irrigation and debridement (I&D) with component retention for infected shoulder arthroplasty is appealing to both patients and surgeons. However, results of this form of treatment are poorly documented in the current literature. The aim of this study is to define the outcomes, complications, and patient factors related to I&D with component retention.

METHODS: All patients diagnosed with deep periprosthetic infection of the shoulder at our institution from 1980-2010 were identified with the use of our prospective joint registry. Of the 5,466 primary and revision shoulder arthroplasties during the study period, there were 100 deep periprosthetic infections, 12 of which were treated with irrigation and debridement. All were followed for a minimum of 2 years or until the time of death. Outcome data including further revision, pain, range of motion (ROM), and eradication of infection were reported.

RESULTS: Nine of the 12 shoulders treated with I&D had acute onset of symptoms lasting less than a month before presentation. All patients were treated with a course of intravenous antibiotics (average 4.8 weeks) followed by oral suppressive treatment. Four shoulders (33%) went on to require resection arthroplasty for ongoing pain and/or failure to eradicate infection. Among those with retained components there were 1 excellent, 2 satisfactory, and 5 unsatisfactory results according to the classification system developed by Neer. Pain was rated as moderate in five patients and mild in three. There were no patients who were described as pain free. Range of motion in the shoulders with retained components was greater than 90° in 6/9 patients and 90° or less in 3/9 patients. Notably in all patients with less than 90° of elevation, ROM was measured as less than 40°.

CONCLUSION: Treatment with I&D and component retention is an option for the treatment for periprosthetic infection of the shoulder. Up to this point however, little published data has been available on results of treatment. Our study represents the largest reported cohort of results of this treatment method. Overall, we found that a subset of patients may obtain an acceptable result with regard to function and adequate pain relief. However, there are substantial rates of reoperation, poor function, and ongoing disability despite the treatment.

A Comparison of Perioperative Outcomes Following Total Shoulder Arthroplasty in Patients with and without Diabetes

Abstract ID: Paper 081

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BACKGROUND: Studies have reported increased adverse events and higher costs associated with joint arthroplasty in patients with diabetes. Prior studies have primarily focused on total hip and knee arthroplasty, but data on the effect of diabetes on patients undergoing total shoulder arthroplasty is limited. We investigated the immediate perioperative outcomes and complications of patients with and without diabetes following total shoulder arthroplasty.

METHODS: We evaluated the Nationwide Inpatient Sample (NIS) database from 2005-2010 for patients who underwent a total shoulder arthroplasty. The NIS is a statistically representative sample of hospitals from across the nation and includes data on approximately 8 million inpatient admissions per year. We analyzed inpatient data in a total of 32,221 patients. We retrospectively divided our patients into three groups: those without diabetes (n=26,579), those with controlled diabetes (n=5439), and those with uncontrolled diabetes (n=179) based on ICD-9 diagnostic codes that reported diabetes associated complications.

RESULTS: We found that patients with controlled diabetes, as compared to patients without diabetes, had a small, but statistically significant, difference in cost of surgery ($48,178 vs. $46,568, $p<0.001$) and hospitalization length (2.5 vs. 2.3 days, $p<0.001$). When comparing patients with uncontrolled diabetes against patients without diabetes, this difference in ($59,794 vs. $46,568, $p<0.001$) and hospitalization length (3.7 vs. 2.3 days, $p<0.001$) was much greater. Patient with uncontrolled diabetes had a higher percentage of fractures ($p<0.001$), but lower percentage of osteoarthritis ($p<0.001$) and rheumatoid arthritis ($p<0.001$), than patients without diabetes. Patients with uncontrolled diabetes had increased rates of pneumonia (odds ratio [OR] =5.9, $p<0.001$), urinary tract infection (OR=2.5, $p<0.001$), and blood transfusions (OR=2.4, $p<0.001$). Patients with uncontrolled diabetes also had higher rates of comorbidities including congestive heart failure (OR=3.7, $p<0.001$), hypothyroidism (OR=1.6, $p<0.001$), hypertension (OR=2.6, $p<0.001$), obesity (OR=3.4, $p<0.001$), and renal failure (OR=7.8, $p<0.001$). After adjusting for these comorbidities in our multivariate analysis, uncontrolled diabetes was still a significant independent predictor of longer hospitalization ($p<0.001$) and higher cost of surgery ($p<0.001$) while controlled diabetes was only a significant predictor of longer hospitalization ($p=0.03$).

CONCLUSIONS: Patients with uncontrolled diabetes who underwent a total shoulder arthroplasty experienced increased complications, higher costs, and longer hospitalizations as compared to patients without diabetes or patients with controlled diabetes.

Accuracy Testing of Four Physical Examination Maneuvers for Detecting Lateral Epicondylitis

Abstract ID: Paper 082

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BACKGROUND: While lateral epicondylitis is a common disorder seen by most orthopedic surgeons, little data exists on the accuracy of the physical examination tests used to diagnose this condition. We sought to determine the accuracy of four commonly-used maneuvers in diagnosing lateral epicondylitis.

METHODS: Patients were recruited that presented with lateral elbow pain and positive findings for at least one of the following physical examination tests: (1) tenderness to palpation at the lateral epicondyle, (2) pain with resisted dorsiflexion of the wrist, (3) pain with resisted extension of the long finger, and (4) pain with resisted supination. After examination with all four tests, patients were then injected at the lateral epicondyle with 2 cc of lidocaine and 1 cc of methylprednisolone. After ten minutes to allow the lidocaine to anesthetize the lateral epicondyle, patients were then re-examined with each of the tests. Pre- and post-injection findings for the four tests were recorded and accuracy data was compiled.

RESULTS: Forty-six elbows in 44 patients were enrolled. There were 24 females and 20 males, with one male and one female affected bilaterally. The average age of patients was 50 years (range 35-69). All patients presented with lateral elbow pain and positive findings on at least one of the aforementioned physical examination findings. Following injection, all patients had relief of elbow pain and all physical examination maneuvers were negative upon re-examination. The sensitivities and accuracy of the tests in isolation (with 95% confidence intervals) were: lateral epicondyle tenderness test 0.8 (0.69-0.92), wrist extension test 0.74 (0.61-0.87), long finger extension test 0.54 (0.39-0.69), and resisted supination test 0.59 (0.44-0.73). The combination of the lateral epicondyle tenderness and wrist extension test produced a sensitivity and accuracy of 0.9 (0.79-1.01), and the combination of the lateral epicondyle tenderness test and resisted supination test produced a sensitivity and accuracy of 0.95 (0.85-1.05).

DISCUSSION: Both the lateral epicondyle tenderness test and wrist extension test have reasonable accuracy and sensitivity in evaluating lateral epicondylitis, but are not individually diagnostic. The combination of the two achieved 90% accuracy. But the combination of the lateral epicondyle tenderness test and resisted supination test was most accurate (95%) in this study. The long finger extension test and resisted supination test are individually less sensitive and accurate than the other tests.

A Comparison of Reverse Shoulder Arthroplasty Functional Outcomes with Two Different Glenosphere Sizes

Abstract ID: Paper 083

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INTRODUCTION: Studies have shown that RSAs successfully improve pain and functionality; however, variability in range of motion and high complication rates persist. As a result, consistent effort has been dedicated to optimizing the performance of RSAs by improving the biomechanics and design. Biomechanical and computer simulations studies have shown that increasing the glenosphere size and the diameter of the glenosphere improves shoulder range of motion. The purpose of this study was to evaluate the in vivo effect of glenosphere design on clinical outcomes for patients treated with a RSA.

METHODS: A matched cohort of 32 patients (>2 years follow-up) with 16 patients treated with a 36-size glenosphere and 16 patients treated with a 42-size glenosphere were included in this study. Radiographic and clinical outcomes were compared between groups.

RESULTS: There was a trend toward significant increased forward elevation for patients treated with a 42-size glenosphere ($p=0.07$); however, no significant difference in external rotation or strength was demonstrated between groups ($p=0.24$, $p=0.51$). The complication rates including scapular notching were similar for both size glenospheres.

DISCUSSION: Although theoretical advantages have been demonstrated for increased glenosphere size in previous studies, there was no significant difference in the prevention of notching, complications, or external rotation with an increased glenosphere size in this study. There may be a significant improvement in forward elevation which can be attributed to increased center of rotation offset, but further research is needed to validate true clinical improvements without increased complications for a larger glenosphere.

Patient Preoperative Confidence in Outcome Predicts Functionality After Total Shoulder Arthroplasty

Abstract ID: Paper 084

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INTRODUCTION: Patient satisfaction in the outcome of their medical treatment has become an increasingly important component of the evaluation of medical outcomes by governmental and patient advocate organizations. Satisfaction has also been recently tied to reimbursement rates. Patient co-morbidities have been identified as affecting potential outcomes, function, and, therefore, satisfaction. Patient's preoperative mental state may play an equally important role in a patient's functional outcome. This study sought to determine if a patient's confidence in their ability to return to the level of activity desired after total shoulder arthroplasty (TSA) would influence their postoperative functional scores.

METHODS: All patients undergoing a primary TSA at a single institution between January 1, 2008, and December 31, 2010, were required to complete a preoperative questionnaire that included their demographics, body mass index (BMI), Penn Shoulder Score, SF-12, and their confidence in reaching their level of desired functionality postoperatively (scored 0-10). Patients who did not complete the questionnaire within 6 months of their index surgery or underwent another surgery within 3 months of their index TSA were excluded. Patients then completed an identical postoperative questionnaire at their follow-up visits through April 30, 2013. Correlation of patient confidence in attaining treatment goals and the outcomes collected was established using multiple linear and logistic regression models that were adjusted for gender, age, BMI, baseline SF-12 mental component scores, college education, smoking status, baseline functional scores, and length of follow-up.

RESULTS: Of 499 patients eligible, questionnaires were completed by 347 patients at an average follow-up of 550 days. Cohort population average age was 66.4 years, females comprised 41.5%, and the average BMI was 30.3. Patients had a high level of confidence that their outcome would match their expectations, with an average score of 7.8 (standard deviation = 2.2, range 0-10). For every 1 point increase in confidence, patients experienced an average increase in their function score of 2.9 (95% confidence interval: 1.1, 4.7; p=0.001) and improvement in their pain score of 1.4 (95% CI: 0.2, 2.5; p=0.021) according to the Penn Shoulder Score. There was no significant association with the patient's SF-12 score postoperatively.

CONCLUSIONS: Patient's preoperative confidence in their ability to attain their desired postoperative functional outcomes is a significant predictor of the patient's outcome. Patients with greater preoperative confidence actually have better postoperative functional outcomes than their less confident peers.

A Quantitative Analysis of Baseplate and Glenosphere Position on Deltoid Tension in Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 085

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INTRODUCTION: Reverse total shoulder arthroplasty is typically associated with an elongation of the deltoid to assist in regaining forward elevation. This has prompted questions regarding the deltoid's ability to tolerate these increased stretch forces and may have implications for implant longevity. To date, no studies quantifying the effect of baseplate and glenosphere position on deltoid tension exist. The purpose of this study is to quantify deltoid elongation under physiologic loads for three baseplate-glenosphere configurations and compare those values to elongation at failure (yield displacement). We hypothesized that the increased deltoid tension caused by increasing the inferior offset of the construct would result in a lessened ability of the deltoid to further elongate under physiologic loads leading to decreased deltoid yield displacement.

MATERIALS AND METHODS: Twenty-four fresh frozen cadaver shoulders were divided into 3 groups of 8 specimens and then underwent superior rotator cuff resection followed by standard humeral component implantation and preparation of glenoid components in 10 degrees of inferior tilt. Group 1 baseplates were placed at the center point of the glenoid and the glenospheres placed in minimum offset (0.5 mm inferior offset). Group 2 baseplates were placed 2 mm inferior to the centering hole and glenospheres placed in minimum offset (2.5 mm inferior offset). Group 3 baseplates were placed in the same inferior position with glenospheres placed in maximum inferior offset (4.5 mm inferior offset).

The shoulders were then mounted on an electro-mechanical test (EMT) machine and physiologic tension was placed on the deltoid (30N), latissimus dorsi (15N), and pectoralis major (15N) tendons. Deltoid elongation was measured at the time of initial loading and again after 5 minutes. This allowed calculation of deltoid displacement and percent elongation. Following this, the deltoid was pulled in tension to failure. Average yield strength and deltoid displacement at failure were calculated and the mode of failure was also evaluated.

One way analysis of variance with a Neuman Keuls comparison was used to detect differences among the three configurations. Differences with $p<0.05$ were considered statistically significant.

RESULTS: Deltoid displacement after loading (1.3 mm, 1.3 mm, 0.7 mm) decreased with increasing inferior offset across the three groups. Percent elongation of the deltoid also decreased significantly between groups 2 and 3 (20% vs. 10%, $p=0.007$). The average load to failure for the 24 specimens was 583N. The yield displacement decreased significantly between groups 2 and 3 (33.3 mm vs. 17.3 mm, $p=0.007$). Sixteen of 24 specimens (67%) failed by anterior deltoid detachment from the acromion.

CONCLUSION: Increasing inferior baseplate and/or glenosphere offset intuitively increases stretch forces on the deltoid. This results in a diminished ability of the deltoid to further elongate under physiologic loads. And the percentage of deltoid elongation decreases significantly when the baseplate and glenosphere are maximally offset inferiorly. Further, this configuration also significantly decreases the yield displacement of the construct. This suggests that with maximally inferior offset configurations, the deltoid may not tolerate additional lengthening to the same extent as other constructs. However, this potential limitation should be balanced by the ability to minimize scapular notching with inferiorly offset configurations. The most common mode of deltoid failure in these non-pathologic specimens was detachment of the anterior deltoid from the acromion.

An Analysis of Perioperative Outcomes in Patients Following Total Shoulder Arthroplasty and Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 086

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BACKGROUND: Multiple studies have reported the outcomes and complications after different shoulder arthroplasty procedures. However, the comparison of the perioperative complication rates between total shoulder and reverse total shoulder arthroplasty has not been as well established.

METHODS: We evaluated the Nationwide Inpatient Sample (NIS) database for the 2010 year and used ICD-9 procedure coding to differentiate between patients who received a total shoulder arthroplasty (81.80) and those who received a reverse total shoulder arthroplasty (81.88). The NIS is a statistically representative sample of hospitals from across the nation that includes data on approximately 8 million inpatient admissions per year. Our retrospective analysis included a total of 8,855 patients that was divided into a total shoulder arthroplasty group (N=7901) and a reverse total shoulder arthroplasty group (N=954).

RESULTS: Our group of patients who underwent reverse total arthroplasty were older (71.9 vs. 69.0 years, p=0.02), had a higher proportion of females (64.3% vs. 56.7%, p<0.001), and lower proportion of elective surgeries (89.4% vs. 93.5%, p<0.001). In terms of indications for surgery, reverse total shoulder patients had significantly decreased rates of osteoarthritis (69.5% vs. 86.0%, p<0.001), but had significantly increased rates of fracture (28.2% vs. 14.9%, p<0.001). They also had significantly increased perioperative rates of pneumonia (Odds ratio [OR]=2.5, p=0.02), acute mental status changes (OR=7.1, p=0.001), urinary tract infection (OR=1.7, p=0.01), and blood transfusion (OR=1.6, p=0.001). In addition, these patients had longer hospital stays (2.6 vs. 2.2 days, p<0.001) and higher surgical costs ($64,677 vs. $52,585, p<0.001). Patients who underwent reverse total shoulder arthroplasty also had higher rates of comorbidities including diabetes (OR=1.2, p=0.03), hypertension (OR=1.2, p=0.03), peripheral vascular disease (OR=1.6, p=0.01), and renal failure (OR=1.4, p=0.04). After adjusting for these comorbidities with our multivariate analysis, a reverse total shoulder arthroplasty was still an independent predictor of increased cost (p<0.001), length of stay (p=0.003), non-routine hospital discharge (p<0.001), and higher rates of pneumonia (p=0.04) and acute mental status changes (p=0.001).

CONCLUSION: We found that patients who underwent reverse total shoulder arthroplasty, as compared to total shoulder arthroplasty, experienced higher hospital costs that is not completely attributable to increased implant costs alone. Reverse total shoulder arthroplasty patients also had significantly increased hospital length of stay and perioperative complications.

The Effect of Axillary Hair on Surgical Antisepsis Around the

Abstract ID: Paper 087

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(Presented by Hasham M. Alvi, M.D., Chicago, IL)

INTRODUCTION: Infection after shoulder surgery can have devastating consequences. Recent literature has focused on Propionibacterium acnes as a causative agent for postoperative shoulder infections. Although axillary hair removal has been suggested as a method for infection prevention, there is no data to quantify its effect on the bacterial load around the shoulder.

METHODS: We removed the hair from one randomly selected axilla in 40 healthy male volunteers using commercially available surgical clippers. Aerobic and anaerobic cultures were taken from the shaved and unshaved axillae. Each shoulder was then administered a surgical prep using 2% chlorhexidine gluconate and 70% isopropyl alcohol. Repeat cultures were then taken from both axillae. Cultures were held for 14 days, and recorded with a semi-quantitative system (0 – 4 points). Results were compared using the sign test.

RESULTS: There was no difference in the burden of P. acnes between the unshaved and shaved axillae before or after surgical prep ($p = 0.67$, $p > 0.999$ respectively, Table 1). There was no difference in the total bacterial burden between the shaved and unshaved axillae before or after surgical prep ($p = 0.34$, $p = 0.68$, Table 2). There was a significant reduction in total bacterial load and P. acnes load for both axillae after surgical prep ($p = 0.001$ for all).

CONCLUSIONS: Removal of axillary hair has no effect on the burden of P. acnes or total bacterial burden around the shoulder. A 2% chlorhexidine gluconate surgical prep is effective at removing all bacteria, and specifically P. acnes from the axilla.

	shaved	unshaved	
pre-prep	1.32 (1.06)	1.33 (1.15)	p = 0.67
post-prep	0.08 (0.14)	0.05 (0.09)	p > 0.999

Table 1: Burden of Propionibacterium acnes in volunteers' axillae.
Values expressed as mean (SD).

	shaved	unshaved	
pre-prep	3.80 (2.26)	3.71 (2.10)	p = 0.34
post-prep	0.20 (0.35)	0.13 (0.23)	p= 0.0.68

Table 2: Total bacterial burden in volunteers' axillae.
Values expressed as mean (SD).

Wear Characteristics of Vitamin E-Infused Polyethylene in a Reverse Shoulder Arthroplasty Model

Abstract ID: Paper 088

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INTRODUCTION: Little is known of polyethylene wear in reverse total shoulder arthroplasty (RTSA). However, complications related to wear debris are a potential concern as use of the prosthesis expands and follow-up periods extend into the mid- and late-term. We proposed to compare the wear rates of vitamin E-infused highly cross-linked polyethylene with standard highly cross-linked polyethylene in a wear simulation model. We hypothesized that vitamin E-infused polyethylene would demonstrate improved wear characteristics compared with standard polyethylene.

MATERIALS AND METHODS: Six RTSA articulations were configured with vitamin E-infused highly cross-linked polyethylene and six with standard highly cross-linked polyethylene. Thirty-six millimeter glenospheres were used for all articulations. A 12-station ATMI hip simulator was adapted for this study. The shoulder constructs were aligned with custom fixtures to allow the machine's vertical compressive force to mimic the magnitude and direction of shoulder forces. The maximum ranges of cyclic shoulder motion achieved with the constraints of the simulator were 38°-79° of forward elevation repeated between 15°-45° of external rotation to introduce cross shear. Each elevation rise (twice per cycle) was accompanied by a rising and falling sinusoidal compressive load in the range 50N–1700N. Wear was gravimetrically measured at 100,000, 500,000, and 1 million cycles. Single-tailed t-tests were used to calculate differences in wear volume. Differences with $p<0.05$ were considered statistically significant.

RESULTS: Wear volume with standard deviations (SD) for standard highly-cross linked polyethylene was 3.4 mm^3 (SD 2.5-4.3) at 100,000 cycles, 16.7 mm^3 (SD 14.6-18.7) at 500,000 cycles, and 29.4 mm^3 (SD 26-32.9) at 1 million cycles. Wear volume with standard deviations for vitamin E-infused highly cross-linked polyethylene was 0.7 mm^3 (SD 0.4-1.1) at 100,000 cycles, 3.1 mm^3 (SD 2.7-3.5) at 500,000 cycles and 4.3 mm^3 (SD 3.8-4.9) at 1 million cycles. The differences in wear volume between groups were significant at all times points ($p=0.02$, $p=0.0006$, $p=0.0004$).

DISCUSSION: Vitamin E-infused highly cross-linked polyethylene demonstrates improved in vitro wear characteristics compared to standard highly cross-linked polyethylene, even at early time points. This suggests vitamin E-infused polyethylene is a promising alternative bearing surface in reverse shoulder arthroplasty. However, clinical studies to examine the in vivo effectiveness of vitamin E-infused polyethylene are warranted.

The Rising Incidence of Operative Fixation of Acute Mid-Shaft Clavicle Fractures

Abstract ID: Paper 089

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INTRODUCTION: Traditionally, acute mid-shaft clavicle fractures have been treated non-operatively. Over the past decade, new evidence has expanded the indications for operative fixation. Recent data suggests that nonunion rates may be higher than previously reported, and patients may experience more dysfunction with non-operative treatment than operative treatment. The purpose of this study is to evaluate whether the incidence of operative treatment of mid-shaft clavicle fractures has increased in recent years.

METHODS: A search of all licensed ambulatory surgery centers and emergency departments in the states of California and New York was conducted from 2005 to 2010 utilizing the Healthcare Cost and Utilization Project (HCUP) databases. Patients diagnosed with a mid-shaft clavicle fracture and subsequently underwent operative fixation were identified each year during that period using International Classification of Diseases 9 (ICD-9) as well as Current Procedural Terminology (CPT) codes. Demographic data including sex, age, and insurance status were collected on all patients identified in each database.

RESULTS: Operative fixation of mid-shaft clavicle fractures increased by 356% and by 337% from 2005 to 2010 in all licensed ambulatory surgery centers in New York and California, respectively. The number of patients with clavicle fractures presenting to all licensed emergency departments in New York and California increased by 0.4% and by 15% during that same period, respectively. Mid-shaft clavicle fractures occurred more frequently in men than women by a ratio of 3:1, but operative fixation was performed more frequently in men than women by a ratio of 5:1 in both states. The median age of patients presenting to emergency departments in New York and California with mid-shaft clavicle fractures remained stable at 16 years over that time period. The median age of those undergoing operative fixation decreased from 28.5 to 24 and from 33 to 27 years over that period in New York and California, respectively. Patients that underwent operative fixation were more likely to carry private insurance (4:1) than those who presented to emergency departments with mid-shaft clavicle fractures (2-2.5:1).

CONCLUSIONS: The rate of operative fixation of mid-shaft clavicle fractures has increased dramatically over the past few years, possibly in response to high level evidence demonstrating better patient outcomes and improved surgical techniques. The majority of patients who underwent operative fixation in ambulatory surgery centers were young males with private insurance.

Functional Outcomes of Floating Shoulder Injuries After Clavicular Fixation Only

Abstract ID: Paper 091

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INTRODUCTION: Although 'floating shoulder' injuries are relatively rare, many have debated the proper surgical management for years. Some have theorized that reduction and fixation of the displaced clavicular fracture will restore proper anatomical relationships of the shoulder girdle and displaced scapular fracture with lateralization of the medialized glenoid component and extension of the flexion angulation. The purpose of this study was to evaluate clinical outcomes of patients with a floating shoulder injury who underwent fixation of the clavicular fracture only.

METHODS: Twelve patients (8 males, 4 females), average age 46 (range 18-60), with 'floating shoulder' injuries were identified using Current Procedural Terminology codes. Fractures were classified according to AO/OTA classification. Patients were evaluated at 2, 6, and 12 week follow-up, as well as ongoing clinical necessity. Clavicular reduction and union was evaluated with caudal and cephalad radiographs. Pain was evaluated using the visual analog scale. Forward flexion and abduction were assessed using basic clinical measurements. Return to function and work was determined with last follow-up.

RESULTS: Mean follow-up was 11 months. Clavicle fractures were classified 15B1 (4, 33%), 15B2 (7, 58%), and 15B3 (1, 8%). Scapular fractures were classified 14A3.1 (7, 53.8%), 14A3.2 (4, 33%), and 14C1.1 (1, 8%). All mechanisms of injury were high energy. None of the fractures were open. Two unplanned secondary surgeries consisting of plate removal secondary to irritation occurred. Eleven (92%) patients reported minimal pain (1-3 VAS), and one (8%) patient reported moderate pain (4-6 VAS) at final follow-up. Average forward flexion and abduction at last follow-up was 170º (range 140°-180°) and 159º (range 90°-180°) respectively. Eleven (92%) patients returned to full, unlimited function and work activities.

CONCLUSION: The majority of patients with floating shoulder injuries treated with clavicular plating returned to function despite minimal residual pain and permanent scapular deformity. Clavicular hardware irritation can be relieved with plate removal.

30-Day Morbidity and Mortality Following Elective Shoulder Arthroscopy: A Review of 9,410 Cases

Abstract ID: Paper 092

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INTRODUCTION: Few studies have reported incidence or risk factors for morbidity and mortality after elective shoulder arthroscopy.

METHODS: We used current procedural terminology (CPT) billing codes to query the National Surgical Quality Improvement Program database and identified 9,410 cases of elective shoulder arthroscopy. Univariate and multivariate analyses were used to identify risk factors for complication.

RESULTS: 109 complications occurred in 93 (0.99%) of 9,410 patients. Major morbidity was 0.54% (51 patients) which included four patients (0.04%) with a mortality, and minor morbidity was 0.44% (42 patients). The most common complication was a return to the operating room (29 cases, 0.31%). Superficial surgical site infections occurred in 15 cases (0.16%), deep infections in 1 (0.01%), deep venous thrombosis or thrombophlebitis in 8 (0.09%), peripheral nerve injury in 1 (0.01%), and pulmonary embolism in 6 (0.06%) (Table 1). The multivariate analysis showed smoking history (OR of 1.91, 95% CI 1.12 – 3.27), a history of chronic obstructive pulmonary disease (COPD) (OR of 3.25, 94% CI of 1.38-7.66), operative time of greater than 1.5 hours (OR of 2.1, 95% CI of 1.32-3.36), and an American Society of Anaesthesia (ASA) class of 3 or 4 as compared to 1 or 2 (OR of 1.82, 95% CI of 1.03-3.21), as risk factors for complication (Table 2).

CONCLUSIONS: Morbidity and mortality are rare events after elective shoulder arthroscopy and the procedure should generally be considered safe. Surgeons should offer smoking cessation to active users of tobacco and should be efficient with operative time whenever possible.

Click here to view Table 1
Click here to view Table 2

MAOA BREAKOUT SESSION #7
TUMOR/BASIC SCIENCE/RESIDENT EDUCATION
April 25, 2014

Has Best Available Evidence Changed the Treatment of Femoral Neck Fractures? A Look at ABOS Part 2 Examinees

Abstract ID: Paper 093

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INTRODUCTION: A substantial number of recent trials and reviews have suggested an advantage of arthroplasty over internal fixation and of total hip arthroplasty over hemiarthroplasty in the treatment of femoral neck fractures in some patients. Our goal was to investigate the trends in operative management by orthopedic surgeons applying for board certification.

METHODS: We queried the American Board of Orthopaedic Surgery (ABOS) database to determine all femoral neck fractures reported by candidates taking Part 2 of the licensing examination from 1999-2011 to determine the utilization of internal fixation, hemiarthroplasty, and total hip arthroplasty. The longitudinal trends were then stratified by patient age (<65, 65-79, ≥80) and declared subspecialty of the candidate (adult reconstruction, trauma, other). We used bivariate methods for statistical analysis.

RESULTS: There were 19,541 cases (13,081 hemiarthroplasty, 5,990 internal fixation, and 470 total hip arthroplasty) treated by 4,450 candidates available for review. The use of total hip arthroplasty increased tenfold over time (0.7% in 1999, 7.7% in 2011 [p<0.001]) while hemiarthroplasty (67.1% in 1999, 63.1% in 2011 [p=0.020]) and internal fixation (32.2% in 1999, 29.2% in 2011 [p=0.064]) demonstrated changes of less significance. The proportion of patients <65 years managed with total hip arthroplasty increased from 1.4% to 13.1% (p<0.001) and with hemiarthroplasty decreased from 35.9% to 27.5% (p<0.001) from 1999-2002 to 2009-11 (Fig 1). The use of internal fixation was generally stable in all age groups and was the dominant form of fixation in patients <65 years. Candidates with a declared subspecialty of adult reconstruction showed a strong trend toward the use of total hip arthroplasty (4.3% in 1999-2002, 21.1% in 2009-11 [p<0.001]) (Fig 2), while trauma examinees demonstrated decreasing utilization of internal fixation (40.9% in 1999-2002, 32.9% in 2009-11 [p=0.012]) (Fig 3). The percent of candidates treating at least one femoral neck fracture decreased from 54.8% in 1999-2002 to 46.3% in 2009-2001 (p<0.001).

DISCUSSION AND CONCLUSION: The most substantial changes in treatment of femoral neck fractures were seen in younger patients, with hemiarthroplasty remaining the treatment of choice in the elderly. Longitudinal trend variations of adult reconstruction and trauma examinees suggest that recent literature has had a measurable effect on clinical practice. Fewer candidates

today are treating femoral neck fractures than in the past, possibly reflecting a trend toward specialty care in these patients.

Click here to view Figure 1(A)
Click here to view Figure 1(B)
Click here to view Figure 1(C)
Click here to view Figure 2(A)
Click here to view Figure 2(B)
Click here to view Figure 2(C)

The Validity of a Rat Model for Analyzing miRNA in Chondrosarcoma

Abstract ID: Paper 094

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INTRODUCTION: MicroRNA (miRNAs) expression has been previously shown to be linked to tumor growth and progression. Analysis of miRNA expression has also provided biomarkers that define tumor type and stage. Several studies have looked at miRNA expression in human sarcomas, but no studies have reported the use of miRNAs signatures to define chondrosarcoma stage or to distinguish enchondroma from chondrosarcoma. The Swarm rat chondrosarcoma has for many years provided a resource for studying cartilage biochemistry and chondrosarcoma development. In our institution, we have established a widely used chondrosarcoma cell line derived from the original Swarm rat chondrosarcoma that produces a highly reproducible tumor when injected subcutaneously in rats. To validate the use of the rat chondrosarcoma for studies miRNA function in the development of the chondrosarcoma, we have compared the expression of miRNAs in the rat chondrosarcoma relative to normal rat cartilage with miRNA expression in human chondrosarcoma relative to normal human cartilage.

METHODS: Twenty healthy Sprague-Dawley rats age 10-15 weeks were sacrificed, sterna and rib cartilage were collected and RNA extracted. 380 miRNAs were analyzed by Taqman low-density arrays from the rib and the sternum samples. The results were then directly compared to an array analysis of chondrosarcoma dissected from a tumor in a rat swarm chondrosarcoma cell line. Normal human tissue was similarly compared with human chondrosarcoma tissue. CT values of miRNA in each sample were normalized by the loess method. MiRNAs were then selected that showed differences between normal human cartilage and fresh chondrosarcoma, and between normal rat cartilage and rat chondrosarcoma.

RESULTS: Several miRNA that showed a difference between normal human cartilage and fresh chondrosarcoma showed similar difference between normal rat cartilage and rat chondrosarcoma. Of particular interest during preliminary analysis were: miR-181a, miR-145, miR-143, miR-21, miR-138, miR-489, and miR-320. More extensive analysis is currently underway in human tissues and the rat model, but at present time it appears that miRNA expression in the rat chondrosarcoma closely resembles that human chondrosarcomas.

CONCLUSIONS: At present time, the similarities in miRNA between normal human and rat samples, and human and rat chondrosarcoma samples suggest that the rat model is a viable model for further study of chondrosarcoma and will enable us to determine the role of miRNAs in chondrosarcoma development and progression. We anticipate that these studies will provide rational new targets for the development of much needed therapeutic intervention.

Desmoid Tumors of the Upper Extremity

Abstract ID: Paper 095

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INTRODUCTION: Desmoid tumors are rare, locally aggressive fibroblastic tumors. The clinical presentation of these lesions varies, from a slowly growing, painless mass, to a rapidly growing painful mass. The treatment algorithm for the lesions has not been established, with local control achieved through surgery, chemotherapy, or radiation therapy alone or in combination; however, recurrence remains a common complication. The purpose of this study was to evaluate the clinical outcomes of surgically treated desmoid tumors of the upper extremity.

MATERIALS AND METHODS: Through a retrospective chart review, we identified 57 patients who were surgically treated for a desmoid tumor of the upper extremity over a 42-year period (1970-2012). All patients had at least 1 year of clinical follow-up. Pertinent demographic information as well as treatment, surgical margin status, location of tumor, recurrence, and complications of the procedure were obtained from the medical records of patients with a pathologically confirmed desmoid tumor. Statistical analysis was performed using Student t-test, Fischer Exact test, and odds-ratio, with significance set a P value of 0.05.

RESULTS: There were 30 females and 27 males, with an average age of 38.3 years in the cohort. The most common location was the shoulder (n=31), and the least common location was the hand (n=4) (Table 1). The most common presenting complaint was a painful mass (n=34). All patients were treated with surgical excision either alone or in combination with adjuvant radiation or chemotherapy (Table 1). At the time of surgical excision, 84% (n=48) of patients had negative surgical margins. At last clinical follow-up, on average 8.9 years (range 1-30 years), local recurrence occurred in 44% (n=25) of patients, on average 2 years (range 0.17-5.3 years) following surgery.

A greater local recurrence was noted in younger patients (32.6 vs. 42.8 years); however, there was no difference between the sex of the patient and size of tumor (Table 2). Patients with a desmoid tumor with a positive surgical margin, or was in intimate contact with a neurovascular bundle or underwent a reexicision for a positive margin, had an increased likelihood of recurrence (Table 2). There was no difference or increased likelihood of recurrence in patients who underwent adjuvant therapy or had a desmoid tumor which invaded the periosteum. There was no difference in the overall disease-free survival for surgery alone and surgery with addition of adjuvant therapy (54% vs. 58%, P=0.70).

DISCUSSION: Recurrence following surgical excision of a desmoid tumor in the upper extremity is common. Younger patients should be educated on the increased rate of recurrence following treatment. The addition of chemo or radiation therapy may increase disease free survival.

Click here to view Table 1
Click here to view Table 2

Factors Affecting Outcomes in Patients Treated Surgically for Upper Extremity Tumors and Tumor-Like Lesions

Abstract ID: Paper 096

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BACKGROUND: There is little data available regarding outcomes of patients who have undergone surgery for tumors of the upper extremity. Functional data after surgery for upper extremity tumors will aid in guiding patient expectations in the peri-operative period.

PURPOSE: To identify which patient, tumor, and surgery-related characteristics are associated with patient-reported physical and emotional function before and after surgery for tumors of the upper extremity.

METHODS: At the authors' institution, patient reported Short Form 36 (SF36) physical and mental component scores are collected preoperatively and at follow-up of musculoskeletal tumor related procedures. Although the majority of patients did not complete functional data at every time point, as a study group we were able to evaluate 79 patients with benign and malignant neoplasms of the upper extremity who underwent surgery at our institution between 2000 and 2010 and had complete data both pre- and postoperatively. A retrospective chart review was performed to ascertain whether tumor behavior, type, location, patient sex, age, surgical specimen size, or type of surgery correlated with differing outcomes. Our outcome measure was patient-reported physical and mental score (SF-36) at less than one year, one to two years, and greater than two years postoperatively.

RESULTS: Patients with tumors proximal to the elbow and patients with right-sided tumors had lower postoperative SF-36 physical component scores at minimum two-year follow-up ($p=0.02$). Lower physical component scores were associated with age greater than 50 ($p=0.03$) and tumor resection rather than curettage ($p=0.01$). The subset of patients with hereditary multiple exostoses had significantly lower postoperative physical scores than other patient sub-populations. There was no difference in physical function after surgery between patients with benign and malignant tumors, patients with tumors larger than 5 cm and less than 5 cm in greatest dimension, and patients with bone vs. soft tissue tumors. Remarkably, there was no difference in mental function scores between any comparisons.

CONCLUSION: Our results suggest that patient age, tumor location, and type of surgery are correlated with patient-reported physical function following surgery. These findings are helpful in counseling patients undergoing surgery for tumors and tumor-like lesions of the upper extremity.

The Effect of Suture Technique on Cutaneous Blood Flow and Immediate Wound Repair Strength

Abstract ID: Paper 097

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PURPOSE: Traumatized skin provides a challenge to the orthopedic surgeon seeking to minimize the effects of closure on cutaneous blood flow and wound healing. Five suture techniques were examined on two parameters important to wound healing; cutaneous blood flow (CBF) and immediate wound repair strength (IWRS). We hypothesized that knotless suture techniques would have less effect on CBF at skin edges and provide comparable IWRS.

METHODS: The 28 incisions, each 3 cm in length, were marked out on the dorsal skin of two anesthetized, 50 kg pigs. The baseline CBF was measured using a laser Doppler flowmeter (LDFM) at each incision. The incisions were then made and immediately closed with a randomized pattern consisting of 5 different suture techniques; barbed knotless suture; Allgöwer-Donati, Horizontal Mattress, Vertical Mattress and Simple knotted sutures. All knotted sutures were 3-0 Nylon and all knotless sutures were 3-0 in size. All knots were tied in a consistent fashion by a single surgeon. The CBF was measured at each closed incision at three sites along their length with the LDFM and averaged together. Subcutaneous fat was extirpated, dermal edges secured with cryogrips, and ultimate load to failure assessed by Instron tensiometry. Statistical analysis was performed using a single factor ANOVA.

RESULTS: Before incision, all sites did not differ demonstrably in cutaneous blood flow (p-value 0.075). All CBF are reported in arbitrary perfusion units (PU). The Allgöwer-Donati stitch (82.5 PU) had the least effect on cutaneous blood flow followed by knotless suture (76.1 PU), then Vertical Mattress (68.5 PU), Horizontal Mattress (63.2 PU) and then Simple Interrupted (49.0PU). None of the intersuture comparisons reached significance except Allgöwer-Donati vs. Simple Interrupted (p-value 0.0156) and Barbed Suture vs. Simple Interrupted (p-value 0.019). There was not a significant difference between Allgöwer-Donati and Barbed Suture (p-value 0.591). Compared to all other techniques, simple interrupted stitches incited the greatest decrease in cutaneous blood flow. Biomechanical testing showed a significant decrease in IWRS between the knotless sutures and all nylon suture patterns (p-values <0.05 range 0.002 to .019). There were no significant differences between the 4 nylon suture patterns in IWRS (p-values >0.05 range 0.11 to 0.71).

CONCLUSIONS: Knotless barbed suture has statistically similar effects on cutaneous blood flow at the skin edges as the traditional Allgöwer-Donati technique. Our data suggest that knotless sutures are a viable alternative to traditional suture techniques in traumatized skin with questionable blood flow and need for a biomechanically strong repair.

Nonoperative Hip Fracture Management in the Elderly: Patient Characteristics and Predictors of Mortality

Abstract ID: Paper 098

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PURPOSE: Most studies of hip fracture care focus on operative treatment. As a result, there is little available data regarding the patient factors and characteristics that influence the rare decision to pursue non-operative management of these fractures. However, the rapid increase in the frail elderly population makes consideration of non-operative treatment more relevant. Given the paucity of information, it is difficult to determine when to counsel active non-operative treatment (early mobilization) or palliative non-operative treatment (pain control and comfort care).

The purpose of the present study is to evaluate the characteristics of elderly, non-operatively managed hip fracture patients and to determine their 30-day and one-year mortality.

METHODS: We retrospectively reviewed 1,444 consecutive hip fracture patients > 50 years of age treated at a busy level one trauma center from 2005-2010. All patients managed non-operatively were further evaluated for injury characteristics, patient comorbidities, and mortality.

RESULTS: Non-operative management occurred in 5.7% (82/1,444) of hip fracture patients treated between January 1, 2005, and December 31, 2010. Forty-one percent were male and 59% female, with an average age of 80 (range, 50-98). Prior to hip fracture, 50% of patients lived at home, 25% lived in assisted living facilities, 19% in nursing homes, and 6% were on hospice. Intertrochanteric fractures comprised 58% of the study population, followed by 34% femoral neck, 5% subtrochanteric, and 3% with a subtrochanteric/intertrochanteric fracture. Forty-two percent of the femoral neck fractures were type I, 3% type II, 29% type III, and 26% Type IV. Fifty-five patients (67%) were seen by the palliative care service and 36 patients (44%) received palliative treatment (pain control, comfort care) during index admission. Forty-two patients (51%) received active treatment (early mobilization). Eleven patients expired prior to planned treatment. The overall 30 day and 1 year mortality rates were 45% (37/82) and 54% (44/82) respectfully for the cohort. There was a statistically significant difference in 30 day and 1 year mortality rates between the palliative and active non-operative groups of ($p<.001$ and $p=.021$), respectively.

The Charlson Co-Morbidity index was found to be a statistically significant predictor of 30-day mortality in the group ($p=.045$, OR=1.63, 95% CI [1.01-2.63]). Active non-operative treatment (early mobilization) when compared to palliative non-operative treatment (pain control, comfort care) was also statistically significant ($P<.0001$) in predicting 30-day mortality. Interestingly, dementia (seen in 40% of the patient population), pre-fracture living situation (home, nursing home, assisted living center), pre-fracture ambulatory status, and fracture type (Garden classification) did not reach statistical significance as predictors of mortality.

CONCLUSION: Few hip fracture patients are managed non-operatively. In a retrospective review of hip fracture patients treated over a 5-year period, 82 patients with hip fractures did not

undergo surgical treatment. We found 2 groups of non-operative patients: those treated actively (early mobilization) and those treated palliatively (pain control and comfort care). There were different characteristics and outcomes of patients in each group.

Does Immediately Following a Dirty Case with a Clean Case Predict Infection?

Abstract ID: Paper 99

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INTRODUCTION: Recent use of operating room for a contaminated or infected case is routinely cited as a reason to avoid performing a subsequent clean case in the same room. The purpose of this study was to evaluate the rate of infection in clean cases performed immediately subsequent to contaminated cases.

METHODS: We retrospectively reviewed all patients in the Department of Orthopedic Surgery between 2003 and 2010 with a type I surgical wound whose case had been performed immediately following at type IV wound on the same day in the same operating room. Demographic characteristics and case details were abstracted and surgical-site-specific cultures were followed for one year after the procedure. These data were compared to the overall rate of surgical site infection for orthopedic type I wounds over the same time period. Culture characteristics between associated type IV wounds and infected type I wounds were compared.

RESULTS: There were 69,037 type I surgical wounds between 2003 and 2010. 973 of these developed a surgical site infection, a rate of 1.4%. 674 pairs of type IV wounds immediately followed by type I wounds were identified for study. 3.3% of the type I wounds subsequently developed surgical site infection, a difference of 1.9% ($p = 0.007$, 95% CI 0.48 – 3.2). The bacterial profile of the infections in type I cases was not identical to the associated type IV cases in any instance. There was a similar bacterium in 5 of 22 cases (3 staphylococcus aureus, 2 coagulase negative staphylococcus); however, the antibacterial susceptibility profile was different in each of these cases.

CONCLUSION: While the rate of infection in the clean cases following dirty cases was higher than the overall rate of infection in type I wounds, the culture data and antibiotic susceptibility profile were different in all cases. This finding suggests that direct cross-contamination is not a reason for infection in clean cases that are performed immediately subsequent to dirty cases.

The Impact of Resident Education on Short-Term Outcomes Following Orthopedic Surgery

Abstract ID: Paper 100

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INTRODUCTION: The effect of resident involvement in orthopedic procedures is largely unknown. In the era of an evolving resident educational environment, this information is needed to guide the development of surgical skills outside the operating room. The purpose of this study was to examine the impact of resident involvement has on short-term morbidity and mortality across orthopedic surgery using the NSQIP database.

METHODS: The 2005-2011 ACS NSQIP dataset was queried using CPT codes for cases across six orthopedic procedural domains of varying complexity: primary total joint arthroplasty (TJA), revision TJA, basic (BA) and advanced arthroscopy (AA), lower extremity (LE) trauma, and spine arthrodesis (SA). We analyzed resident involvement dichotomously, reported operative times, hospital length of stay (LOS), re-operation rates, morbidity, and mortality. Bivariate, multivariate logistic regression, and propensity scores were used to build models of risk-adjustment, for each aforementioned domain. Crude and risk-adjusted morbidity and mortality were reported. Outcomes were further sub-stratified and analyzed by resident level. All domains were analyzed separately.

RESULTS: In total, 59,347 patients were included: 28,686 primary TJA, 2,735 revision TJA, 16,832 BA, 5,916 AA, 8,320 LE trauma, and 5,178 SA. Resident participation was associated with no differences in mortality, both before and after propensity score risk-adjustment. Before adjustment, in resident cases, morbidity was higher after revision TJA (OR 1.63, 95% CI: 1.37-1.94), LE trauma (1.42, 95% CI: 1.27-1.59), and SA (2.16, 95% CI: 1.88-2.50). After statistical adjustment, the odds of morbidity was lower with resident cases, but still remained significant in revision TJA (1.44, 95% CI: 1.21-1.73), LE trauma (1.40, 95% CI: 1.23-1.60), and SA (1.71, 95% CI 1.46-2.00). Operative time was significantly higher ($p < 0.001$) with resident involvement in all procedural domains: primary TJA (93 vs. 109 mins), revision TJA (160 vs. 137 mins), basic arthroscopy (51 vs. 44 mins), advanced arthroscopy (106 vs. 96 mins), LE trauma (93 vs. 65 mins), and SA (201 vs. 151 mins). Hospital LOS and re-operation rates were not significantly associated with resident participation. Level of resident training did not consistently influence surgical outcomes.

DISCUSSION: Resident involvement within the surgical setting is associated with an increase in short-term morbidity after select cases in orthopedic surgery, without an increased mortality. Longer resident operative times were also found across all disciplines. Residency programs must optimize resident education to include surgical skills development and education of efficiency outside the operating room environment to minimize these discrepancies.

Patient Attitudes Towards Resident and Fellow Participation in Orthopedic Surgery

Abstract ID: Paper 101

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INTRODUCTION: Residents and fellows' participation in orthopedic surgery is a potential source of anxiety and concern for patients. The purpose of this study was to determine patients' attitudes towards residents and fellows assisting an attending orthopedic surgeon during surgery.

METHODS: We prospectively surveyed 167 consecutive patients at a single academic center using an anonymous, self-administered written questionnaire. The questionnaire was developed in consultation with an expert in survey design using cognitive interviewing to ensure question clarity and patient comprehension. Potential resident or fellow involvement in performing a total knee arthroplasty at various levels of training was presented and attitudes towards these scenarios were assessed. Differences between patient attitudes towards involvement of residents and fellows at different levels of training were compared using Fisher's Exact Test.

RESULTS: 101 patients completed the questionnaire (response rate 61%). While only 50% of patients were willing to have a PGY-2 perform some or most of their surgery, 75% would allow a PGY-5 ($p < 0.001$) and 84% a fellow ($p < 0.0001$). A minority of patients was willing to postpone their surgery by > 1 month if it meant that no resident (37%) or fellow (26%) would assist. Interestingly, > 90% of patients believed that it is important for patients to help in the education of future surgeons. Patients almost universally agreed that resident or fellow involvement should be disclosed to patients (99% for both). Attitudes towards orthopedic surgeons who teach residents and fellows were favorable, with 80% agreeing that such surgeons are more likely to stay up-to-date on the latest techniques.

CONCLUSIONS: Patients desire disclosure of resident/fellow involvement in surgery and have a favorable view of surgeons who teach. While over 90% of patients believed that training residents and fellows was important, only half were comfortable having junior residents participate in their own surgical procedure, but were more amenable to more experienced trainees.

Pilot Study for the Design and Implementation of an Orthopedic Surgical Training Laboratory for Basic Motor Skills

Abstract ID: Paper 102

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OBJECTIVE: Our goal was to create a surgical skills training session to educate junior-level orthopedic residents in four core areas: comfort with basic power equipment, casting/splinting, suturing, and surgical instrument identification. We also evaluated residents through pre- and post-written examinations and a novel pre- and post-ankle fracture model after completing skills sessions.

DESIGN: Prospective, uncontrolled, observational.

SETTING: A major Midwestern tertiary referral center and academic medical center.

PARTICIPANTS: Eleven of 15 PGY 1-3 orthopedic residents completed the skills lab.

RESULTS: For the 11 residents (PGY 1-3) who completed the written examination, the pre-test percentile mean for the group was 87.3 + 10.4. The post-test percentile mean was 92 + 8.4, the median 96, and the mode 96. There was a significant difference noted in pre- and post-testing among all test takers, regardless of level of training ($p = 0.019$). In the ankle fracture model, the overall pre-test percentile mean for the entire group was 68.6 + 13.9. The overall post-test percentile mean for the group was 95.2 + 5.2. There was a significant difference noted in pre- and post- among all test takers, regardless of level of training ($p = 3.27E-20$).

CONCLUSION: Orthopedic training sessions may be our next best option in teaching residents. While we documented improvement in objective outcomes, we acknowledge little is known or published regarding what the average resident skills are and what is acceptable for graduation. More work is needed to determine what baseline proficiency should be.

An Analysis of References Used for the Orthopedic In-Training Examination

Abstract ID: Paper 103

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INTRODUCTION: The Orthopaedic In-Training Examination (OITE) is one of the primary methods used to evaluate orthopedic surgery residents' knowledge. To aid in preparation for the examination, previous OITE questions are available along with recommended references. However, these references have never been evaluated for their level of evidence (LOE) or the impact factor (IF) of their respective journals. The purpose of this study was to determine the most commonly cited journals in previous OITE questions, as well as the LOE of the article and the IF of the journal in which they are published. This information may be useful for resident preparation as well as residency program directors charged with developing educational curriculae.

METHODS: All OITE questions administered from 2010 to 2012 were reviewed for the recommended references and compiled into a database along with their pre-assigned subject area. LOE was assigned to each recommended reference according to American Academy of Orthopaedic Surgeon guidelines. The IF of each journal referenced was determined using the Thomson Reuters calculation for IF. ANOVA and post-hoc Tukey HSD analyses were used to determine differences in LOE and IF between the three years of OITE administration and different subject areas; statistical significance was defined as $p<0.05$.

RESULTS: A total of 1,815 references were recommended during the three OITE administrations, including 1,337 journal articles (73.6%), 464 book chapters (25.6%), and 14 multimedia references (e.g., websites; 0.8%). The 12 most commonly utilized references included 8 journals (JBJS American, JAAOS, CORR, JOT, AJSM, Spine, JHS, and JBJS British), 3 textbooks (Orthopaedic Basic Science: foundations of clinical practice and the Orthopaedic Knowledge Updates – both the general and subspecialty volumes), and the AAOS Instructional Course Lectures. Of the 1,337 articles identified, 40 (3.0%) were level 1, 107 (8.0%) were level 2, 154 (11.5%) were level 3, 337 (25.2%) were level 4, and 699 (52.3%) were level 5 studies. Neither the average LOE nor the IF differed ($p>0.05$) between 2010 (LOE: 4.10, IF: 3.74), 2011 (LOE: 4.22, IF: 2.94), and 2012 (LOE: 4.14, IF: 3.10) test administrations. Spine surgery questions exhibited a higher LOE than other subject areas (LOE: 3.74; $p<0.001$). Basic science and spine questions were more likely to be published in journals with a higher impact factor compared to other subject areas (Basic Science IF: 7.16, Spine IF: 5.73; $p<0.001$).

CONCLUSIONS: Overall, the LOE of references recommended for OITE preparation was poor, with the majority of studies being level 4 or 5. Interestingly, the references selected for spine surgery questions were of higher quality evidence compared to the other subject areas. Given the prevalent role previous OITE questions and their respective recommended references play in resident education and OITE preparation, this study is important as it sheds light on the most commonly cited journals, types of studies referenced, and the most recommended texts. As a larger emphasis is being placed on standardized examinations in residency education, this data

may help residents and program directors tailor their program's core curriculum and OITE preparation in order to maximize learning.

MAOA BREAKOUT SESSION #8
PEDIATRIC SPINE/ADULT SPINE
April 25, 2014

Static and Dynamic Anterior Cervical Plates: A Retrieval Analysis of Damage and Clinical Data

Abstract ID: Paper 104

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INTRODUCTION: Metallic anterior cervical plates (ACPs) are frequently employed in the setting of cervical fusion to prevent graft extrusion and provide mechanical support to the anterior column. Due to the range of motion of the cervical spine, as well as the probability of interbody graft subsidence, ACPs experience a high degree of biomechanical loading, particularly at the screw-plate interface. The purpose of this retrieval study was to characterize the material-level damage of ACPs and analyze patient and surgical factors to elucidate trends in clinical implant failure.

METHODS: Fourteen two-level ACPs of two different designs, 7 static and 7 dynamic, were retrieved from 14 patients at our institution from 2005 to 2010, under an IRB-approved protocol. Retrieved components were examined microscopically for damage modes, including burnishing, scratching, and pitting. Additionally, each plate was inspected with scanning electron microscopy (SEM)/energy dispersive x-ray spectroscopy (EDX) in three regions: (1) potential corrosion (e.g., crevices, near screw-plate interface), (2) scratched, and (3) bulk/undamaged, as a control. Chart reviews were performed to collect patient and surgical data. Correlation coefficients of 0.20-0.40, 0.40-0.60, 0.60-0.80, and 0.80-1.00 were considered weak, moderate, strong, and very strong, respectively.

RESULTS: The patient population included five males and nine females, with average ages at implant and revision of 51 (range 31-76) and 56 (range, 41-78), respectively, and average body mass index of 28 (range, 21-39). Terms of implantation in the static and dynamic groups were 89 (range, 34-139) and 42 (range, 23-72) months, respectively. Indications for revision included disc herniation (n=7), cervical spondylotic radiculopathy (n=6), adjacent level degenerative changes (n=3), pseudoarthrosis (n=3), and cervical stenosis (n=1). At revision, there were no reported infections, no observed wear debris, and one case of implant loosening (static group; screw back out). All dynamic plates showed evidence of pitting and scratching damage, while these damage modes were demonstrated in 86% and 57% of static plates, respectively. Burnishing damage was observed in 29% of both the static and dynamic plates.

SEM/EDX showed no significant differences between the static and dynamic systems, in terms of average weight percent of the elemental constituents. Additionally, there were no significant differences when the compositions of the potential corrosion and scratched regions were compared with the bulk/undamaged regions, within each plate group; however, iron was located in the scratched regions of the plates, indicating possible iatrogenic damage and material transfer from surgical instruments.

DISCUSSION AND CONCLUSION: Although no significant compositional differences were shown between various locations on the plates via EDX, damage on dynamic plates covered a larger surface area than damage observed on the static plates, perhaps due to the variability in plate thickness near the screw holes, allowing for stress concentrations and the collection of biologic fluid. Future work is ongoing to analyze additional plate systems as well as characterize damage and corrosion within screw holes. Data will also be correlated to radiographic analysis of plate alignment.

At What Levels Are Free Hand Pedicle Screws More Frequently Positioned?
Abstract ID: Paper 105

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SUMMARY: Pedicle screws placed by the freehand technique were found to have the highest rate of malposition from T3 to T8 (19% vs. 6%, p=0.0001). Medial breaches and pedicle screw malposition > 2 mm were more frequent in pediatric patients with deformity.

INTRODUCTION: On CT evaluation, pedicle screws placed by freehand technique in pediatric deformity surgery have up to a 9% rate of malposition. We sought to determine which region of the spine is associated with the greatest risk for screw malposition in pediatric patients with and without deformity.

METHODS: Incidental postoperative CT exams were available in 85 pediatric patients (605 screws) treated with posterior spinal fusion using freehand pedicle screw technique. Of the screws imaged, 355 were in patients without deformity (fracture, tumor), and 250 screws in patients with deformity (scoliosis, any type). Malposition/breaches were categorized as mild (< 2 mm), moderate (2-4 mm), or severe (> 4 mm). We hypothesized that screws at the apical concavity would have a higher rate of malposition.

RESULTS: Screws in pediatric patients with deformity had a higher rate of moderate/severe malposition compared to pediatric patients without deformity (19% vs. 27%, p=0.02). For severe malposition (> 4 mm), no difference was found between patients without deformity and patients with deformity (9.6% vs. 8.6%, p=0.40). Overall, the highest rates of severe screw malposition were at T3 through T8 (Figure 1), which is also the region of smallest pedicle diameter in children. In patients with deformity, no higher rate of screw malposition was detected at the apical levels, or at the apical concavity. Severe medial breaches were more common in patients with deformity (8 of 19) compared to patients without deformity (6 of 34, p=0.005).

CONCLUSION: The clinical significance and acceptable rate of asymptomatic pedicle screw breaches in children has not yet been determined. There does not appear to be a higher rate of malposition in the apical concavity, although medial breaches were more frequent in patients with deformity. Efforts to reduce the rate of pedicle screw malposition would likely be most effective at T3 to T8, where screw malposition using the freehand technique is most frequent.

Click here to view Figure

Allograft and Polyetheretherketone (PEEK) Cage in Anterior Cervical Discectomy and Fusion (ACDF)

Abstract ID: Paper 106

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SUMMARY: In a retrospective radiographic review of 67 cases (117 levels) comparing subsidence rates of PEEK and allograft in ACDF, it seems that use of either interbody fusion device does not affect subsidence rates of cervical fusion segments.

INTRODUCTION: Structural allografts and PEEK cages are commonly used as interbody fusion devices in ACDF. The subsidence rates of these two spacers have not yet been directly compared. The primary aim of this study was to compare the subsidence rate of allograft and PEEK cage in ACDF. The secondary aim was to determine if the presence of subsidence affects the clinical outcome.

METHODS: We reviewed 67 cases (117 levels) of ACDF with either structural allograft or PEEK cages. There were 85 levels (48 cases) with PEEK and 32 levels (19 cases) with allograft spacers. All surgeries were performed by a fellowship-trained spine surgeon from November 2005 to September 2012. Immediate postoperative and 6-month lateral cervical radiographs were evaluated for subsidence by measuring the anterior disc height and posterior disc height at each operative level. Subsidence was defined as a decrease in anterior or posterior disc heights >1 mm. The subsidence rate between the two groups was compared using the chi-square to test for significance (α =0.05). NDI was recorded to evaluate clinical outcome of the subsidence (SG) and non-subsidence group (NSG). T-test was used to test for difference between the two groups (α =0.05).

RESULTS: There was no statistically significant difference between subsidence rate of the PEEK group (54%; 46/685) and the allograft group (59%; 19/32) (p=0.69). Overall mean subsidence was 1.0 ± 1.3 mm anteriorly and 1.2 ± 1.2 mm posteriorly. The mean NDI improvement was 11.7 (from 47.1 to 35.4; average follow-up: 12 months) for the SG and 14.0 (from 45.8 to 31.8; average follow-up: 13 months) for the NSG (p=0.74).

CONCLUSION: The subsidence rate does not seem to be affected by the use of either PEEK or allograft as spacers in ACDF. Furthermore, subsidence alone does not seem to be predictive of clinical outcomes of ACDF.

Lumbar Spine Posterior Subcutaneous Fat Thickness is a Risk Factor for Surgical Site Infection

Abstract ID: Paper 107

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INTRODUCTION: Obesity (BMI≥30) is a risk factor for surgical site infections (SSI) in spine procedures. However, BMI does not account for body mass distribution. Subcutaneous fat thickness has been shown to be a risk factor for SSIs in other areas of the body. The purpose of this study was to test the hypothesis that subcutaneous fat thickness in the lumbar spine is a stronger risk factor for SSI than is BMI.

METHODS: A retrospective review of 149 adult patients treated at our institution who underwent posterior lumbar surgeries involving midline approaches between 2003-2011 who had CT scans which included the spine and posterior skin. The development of an SSI and previously identified risk factors for SSI (age, diabetes, tobacco use, BMI, anesthesia time, number of levels, prior procedure) were identified using hospital records. Using novel standardized semi-automated analytic morphomic techniques with MATLAB software, the distance from the spinous process to back skin was obtained at the T12-L5 vertebral levels from CT scans.

RESULTS: Data presented as mean (± standard deviation). The overall rate of SSIs was 9.9% (n=15). Patients with an SSI had an average age of 51.3 (±17.5) years, BMI of 32.7 (±8.0), fat thickness of 59.3 (±21.3) mm, 33.3% had tobacco use, 26.7% diabetes, and 26.7% underwent prior operations. Patients without an SSI had an average age of 53.7 (±15.6) years, BMI of 27.9 (±6.4), fat thickness of 41.5 (±16.3) mm, 30.6% had tobacco use, 14.9% diabetes, and 9.7% underwent prior operations. Among factors previously identified to be associated with SSI, univariate analysis showed BMI (p=0.014), obesity (p=0.015), and fat thickness (p=0.001) to be significant. In multivariate logistic regression analysis, BMI and obesity lost their significance and fat thickness was determined to be the only significant risk factor (p=0.042). For every millimeter of fat thickness, there was a 5.5% (OR = 1.055, 95%CI 1.002- 1.111) increase in the odds of developing an SSI. When broken down by fat thickness tertiles, those in the highest tertile (>51 mm) had an 8-fold increased risk for SSI than the lower tertiles (p=0.009). Fat thickness and BMI were moderately correlated (r^2=0.4783).

CONCLUSION: The thickness of subcutaneous fat is a risk factor for SSI in lumbar spine procedures in our model while BMI/obesity are not. Identifying patients with a critical threshold of fat thickness and targeting treatments for this risk factor may be more economical than identifying patients at risk using BMI.

Epidural Steroid Paste in Posterior Lumbar Surgery: Surgical Site Complications in a Retrospective Case-Control Cohort Study

Abstract ID: Paper 108

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INTRODUCTION: Various epidural agents have been used to reduce postoperative pain and inflammation following lumbar surgery. These agents are typically administered as steroid and/or analgesic-laced paste, sponges, or foams. Studies have shown reduced pain and narcotic usage acutely with few adverse effects. However, a few small studies have suggested that the steroid component may not be entirely safe, and that infection and wound complications may be more common when these pain-pastes are used. We tested the hypothesis that a steroid -containing epidural pain paste, applied after laminotomy, does not elevate risk of acute surgical site infection (SSI).

METHODS: A case-controlled retrospective review of patients treated by lumbar decompression, either with or without analgesic steroid paste, was done. Demographic characteristics including age, gender, BMI, smoking and alcohol status, and type of operation were analyzed. Acute SSIs were defined as any infection within the first six weeks postoperatively. Late infections were not encountered. SSIs were coded as superficial, deep-suprafascial, or deep-subfascial.

RESULTS: We analyzed 62 consecutive patients with no paste, and 61 patients receiving pain paste. Male patients represented 57.4% in the paste group and 66.1% in the no paste group (p=0.32). The average age of patients in the two groups was 49.8 and 46.1 respectively (p=0.15). There were four suspected or documented infections, (6.7%) in the paste group, and one (1.67% [0.03%, 8.7%]) in the no paste group (p=0.21). One additional patient in the paste group had a slow healing wound. There were no wound complications in the no paste group.

DISCUSSION: A previous study found a nearly 8-fold increase in surgical site infections after laminectomy when a morphine-prednisolone nerve paste was used. Our data does not demonstrate a statistical difference in the rates of infection with epidural steroid paste, but the observed three-fold increase in the rate is concerning. A larger cohort, allowing stratification of co-morbid risk factors improved statistical power is indicated. This larger review is currently ongoing, and will allow better statistical certainty. For the moment, we suggest that surgeons use caution when considering the application of steroids-paste in at-risk patients.

The Utility of Inpatient Spine Surgery Consults in Patients Over the Age of 65 for Pain and Radiculopathy

Abstract ID: Paper 109

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PURPOSE/OBJECTIVE: Axial back pain and radiculopathy are common causes of inpatient hospital admission in patients over the age of 65. The pathology is often self-limited and usually resolves with non-operative treatment. However, inpatient spine surgery consults are often ordered by hospitalists in primary care. Rarely do these consults result in acute surgical intervention, and often provide minimal therapeutic value. The hypothesis of this study is that inpatient spine surgery consults in patients over the age of 65 has a low therapeutic yield as treatment strategies are not changed after the consultation.

METHODS: A retrospective chart review was performed for inpatient orthopedic spine surgery consults from January 2010 to June 2012 at Summa Health Systems. Inclusion criteria consisted of patients over 65 years old, inpatient admission to a regular nursing floor, and consult for neck or back pain ordered by the primary care physician. Exclusion criteria included patients admitted to the intensive care unit, consult ordered by an emergency room physician, patients admitted to the trauma service, consults for fractures, consults for infections, and consults for prior surgery within 1 year of admission. Inpatient consults that resulted in operative intervention on the same admission were noted. The percentage of consults that resulted in surgical intervention, epidural steroid injection, physical therapy, and a routine outpatient follow-up was calculated.

RESULTS: 186 out of the 372 inpatient spine consults met the inclusion criteria. Average age was 80 years old, back pain consults consisted of 86%, neck pain was 15%. In terms of treatment, 25% received oral steroids, 19% received epidural steroid injections, and 3.2 % received both. Most importantly, only 3/160 back pain patients received surgery during the same admission. Two of the patients who received surgery had previous back surgeries and were established patients who were failing conservative therapy. The third operative patient was someone who already had surgery scheduled in the next few weeks.

CONCLUSIONS: Inpatient spine surgery consults in patients over the age of 65 for axial back pain and radiculopathy rarely resulted in operative intervention or significant therapeutic utility. In the majority of these patients, an algorithm that includes physical therapy, pain management, and appropriate outpatient follow-up with a spine surgeon would be appropriate.

Do Preoperative Hospital Tours Alleviate Anxiety in Posterior Spinal Fusion Patients? A Prospective, Randomized Study

Abstract ID: Paper 110

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INTRODUCTION: A prospective, randomized study examined the effect of an interventional preoperative hospital tour and orientation on anxiety levels of patients undergoing posterior spinal fusion (PSF). Secondary outcomes analyzed were caregiver anxiety, length of stay, morphine equivalent usage, and patient/caregiver satisfaction.

METHODS: Patients undergoing PSF were randomly distributed into a control group (N= 39) or interventional group (N=26). All subjects and caregivers completed the State-Trait Anxiety Inventory (STAI) at different intervals: preoperative appointment, preoperative holding area, postoperative orthopedic unit, and discharge. At discharge, patients and caregivers completed a satisfaction survey. State anxiety measures how the respondent feels at that exact moment in time and trait anxiety measures how the respondent feels in general.

RESULTS: Both patient groups demonstrated significantly higher state anxiety scores than trait anxiety scores at all intervals (control p= 0.003) (interventional p= 0.010). The only significant difference was in postoperative scores: the orientation group scored higher on state anxiety than the control group (p= 0.024). There were no significant differences in the caregiver state anxiety scores. Linear correlation and regression analysis found that caregiver anxiety was most strongly correlated with patient age of ≤ 14 years old at the postoperative interval (r=0.520) and at discharge (r=0.636), in the orientation group. In the control group, anxiety was strongly correlated between caregiver and patients ≥15 years old at the preoperative appointment (r=0.709), postoperatively (r=0.469), and at discharge (r=0.544). Trait anxiety scores for both groups remained stable over time. No significant differences were found in length of stay or morphine equivalent use. Patient satisfaction scores were higher in the intervention group than in the control group (p=0.0005).

CONCLUSIONS: Preoperative tour and orientation before PSF was associated with increased anxiety in adolescents in the immediate postoperative period. Despite the increase in anxiety, patient satisfaction was higher in the group receiving a hospital orientation tour. It is likely that patients need information correlated with their age and developmental level using different interventional strategies for both the caregiver and the patient.

Level I Study

Hybrid Fixation with Sublaminar Polyester Bands in the Treatment of Neuromuscular Scoliosis: A Comparative Analysis

Abstract ID: Paper 111

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SUMMARY: The polyester band technique using a hybrid construct in the treatment of neuromuscular scoliosis provides another tool for the spinal deformity surgeon. This technique is a superior sublaminar implant with low risk of neural damage and infection, along with easier and safer removal than wires. It is superb in correction of neuromuscular scoliosis and kyphosis and is an excellent choice in osteoporotic bone, achieving equivalent corrections to all pedicle screw constructs, and avoiding the potential complications associated with transpedicular fixation.

INTRODUCTION: Segmental spinal instrumentation in the treatment of scoliosis has evolved since Eduardo Luque first described his technique more than three decades ago. Despite the initial advantages, Luque wiring was associated with frequent complications including implant failure and neurologic complications, particularly in patients with neuromuscular disorders. More recently, all pedicle screw constructs have emerged as the most widely utilized method of posterior spinal fixation. Despite several advantages, high rates of implant malposition in the thoracic spine have been reported. The adequacy of fixation in osteoporotic bone, found in many patients with neuromuscular conditions, has also been called into question by several clinical and biomechanical studies. We report the use of polyester bands as an alternative method of posterior spinal instrumentation in the treatment of neuromuscular scoliosis.

METHODS: A retrospective review was conducted of 115 pediatric spinal deformity cases between 2008 and 2010 at a single center performed by a single surgeon. Intraoperative and postoperative complications were recorded. Radiographs were reviewed preoperatively, immediate postoperatively, and at the latest follow-up visit to determine both coronal and sagittal corrections. A review of the literature was performed and includes all identified studies of patients with neuromuscular scoliosis treated with either sublaminar fixation techniques used in isolation or all-pedicle screw constructs. Studies utilizing hybrid constructs in the treatment of neuromuscular scoliosis were excluded given the variability of constructs reported. Pooled data from the two reference groups where then used in a comparative analysis with the present study.

RESULTS: Twenty-nine patients were identified who underwent hybrid fixation with a combination pedicle screw and sublaminar band construct for neuromuscular scoliosis. There was minimum follow-up of two years (range 24 to 52 months). The postoperative correction of coronal balance was 69% (71˚ to 24˚). Sagittal balance was corrected to within 2 cm of the C7 plumbline in 97% of patients. The loss of coronal and sagittal correction at latest follow was 0% and 2%, respectively. There were two intraoperative clamp failures out of 398 implants (0.5%). No postoperative implant failures were observed. There were two major (7%) and seven minor (24%) complications in eight patients (27% overall). A systematic review of the literature identified 12 articles that met our inclusion criteria (7 sublaminar and 5 all-pedicle). There were 150 complications in 397 patients (38%) treated with sublaminar wires, cables, or hook constructs. Coronal correction was on average 49%. Of papers reporting outcomes of all pedicle screw fixation, 71% coronal correction was achieved on average, with an overall complication

rate of 29%. Implant failure in the sublaminar group and pedicle groups occurred in 8% and 3% of cases, respectively.

CONCLUSION: The polyester band technique utilized in a hybrid posterior fixation construct is an excellent adjunct in the correction of spinal deformity in patients with neuromuscular scoliosis and is particularly useful with osteoporotic bone. Sublaminar bands appear to be safer than previously described sublaminar fixation methods, achieves corrections equivalent to all pedicle screw constructs, and avoids the potential complications associated with transpedicular fixation.

Venous Thromboembolism Following Pediatric Spinal Surgery

Abstract ID: Paper 112

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Christina K. Hardesty, M.D.
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PURPOSE: With a recognized increase in the incidence of (DVT) in young patients, especially in those with complex chronic conditions, it is important for patient safety and risk management to identify subgroups that would benefit from prophylactic treatment. The aim of our study was to assess whether spine surgery in children and adolescents was associated with an increased incidence of DVT, and, thus, if prophylaxis is warranted.

METHODS: An Institutional Review Board approved, prospectively collected, Pediatric Orthopedic Spine database (1992-2012) was reviewed to identify patients who had a clinical DVT postoperatively. Demographics including age, sex, diagnosis and medical comorbidities, curve size, spinal procedure, and time to documented DVT were collected. In-patient notes were reviewed to identify known risk factors, such as previous DVT and presence of central venous catheters.

RESULTS: 1,264 patients (856 female, 408 male) with a mean age at surgery of 12 ± 3.54 years (range 0.75 – 18 years) who underwent spinal surgery (2,062 procedures) were reviewed. Four patients had lower limb DVTs (0.3%) within 10 weeks of surgery (range 31 to 76 days). There were no upper limb thromboses or pulmonary emboli. The affected children were 9 to17 years old; 3 with a neuromuscular scoliosis (1 post-polio and 2 with myelomeningocoele) who underwent posterior spinal fusion with segmental spinal instrumentation, and one who had in-situ fusion of a grade 3 spondylolisthesis. Two of these patients had peri-operative central venous lines, a known risk factor for thromboembolism, and one had a prior history of a popliteal thrombus. All were treated with injectable anticoagulants until oral Coumadin had reached a therapeutic dose.

CONCLUSION: We performed a 20-year retrospective review from our Pediatric Orthopedic Spine database to evaluate the incidence of deep venous thromboembolism (DVT) in those who had spine surgery, including growing rods and VEPTRs. There was a 0.3% incidence among 1,264 patients, corresponding to a 0.19% incidence in 2062 procedures. Despite extensive surgical procedures, our spinal surgery patients have a low rate of clinical DVT, which has diminished over time, with no events since 2005. The decrease in use of sub-clavian/internal jugular or femoral lines, secondary to the increase of peripherally inserted central catheters (PICCs) may be one contributing factor, as is earlier mobilization and implementation of a strict 2 hour turning and leg-exercise protocol in the immediate postoperative period. We conclude that there is no evidence to routinely treat pediatric patients undergoing spinal surgery with thromboproplylaxis.

The Effect of Sagittal Alignment on Standing Balance: Correlation with Sway Path Length and Sway Velocity

Abstract ID: Paper 113

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BACKGROUND: Spinal imbalance in the sagittal plane has been shown to correlate with impaired physical function and increasing pain. Sagittal balance is traditionally described using a plumb line from C7 measured on lateral full spine radiographs which include the pelvis and femoral heads. More recently, the concept of static measurements using an orthogonal line drawn from the center of pressure as measured on a force plate ("gravity line") has been explored. These are both static measurements of what is well known to be a dynamic process. To the best of our knowledge, dynamic measurement of the gravity line has never been described in a population of adults with and without spinal deformity.

PURPOSE: Dynamically examine standing balance using a novel consumer-level force plate in patients with scoliosis and varying degrees of sagittal alignment.

METHODS: Prospective case-control (Type II): 92 patients with spinal deformity (age=59±1; BMI=28±7) were divided into 3 groups -- I: SVA (spinal vertebral angle)=0-4 cm; II: SVA=5-9 cm; III: SVA≥10 cm; and compared with 23 non-scoliotic individuals "controls" (age=28±3; BMI=23±5). Subjects were asked to stand on a Wii Balance Board for 30 seconds with their knees locked in extension, arms resting on the sides of the body. The COG was measured and the sway path length, velocity, and 95% sway area were calculated using MATLAB. Statistical measures including Turkey's HSD and Games-Howell multiple-comparison's tests were performed with values expressed as mean and 95% CI.

RESULTS: Group III patients had a significantly longer sway path length than groups II and I (65.6 cm [47.2 to 84.1] vs. 40.4 [34.3 to 46.4] and 35.4 cm [30.3 to 40.6], p=0.001), as well as controls (figure 1). Similarly, group III had a significantly faster sway velocity (65.6 cm/s [47.2 to 84.1] vs. 40.4 cm/s [34.3 to 46.4] and 35.4 cm/s [30.3 to 40.6], p=0.001).

CONCLUSIONS: The sway path length and velocity is significantly increased in patients with sagittal imbalance (SVA ≥10 cm), reflecting increased difficulty in standing balance with spinal deformity.

Click here to view Figure

Use of Bipolar Sealer Device Reduces Blood Loss and Transfusions in Posterior Spinal Fusion for Neuromuscular Scoliosis

Abstract ID: Paper 114

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PURPOSE: Reducing peri-operative blood loss and the need for transfusions in patients undergoing spinal surgery is especially important for those with neuromuscular disorders. These patients require extensive spino-pelvic exposure and are often medically fragile. We have used Amicar to decrease blood loss since 2001. As an effort to further reduce blood loss and transfusions, we use a bipolar sealer device (Aquamantys, Salient Surgical Technologies) as an adjunct to electrocautery. We present the results of our first 64 neuromuscular patients to show the efficacy of the device.

METHODS: Using a prospectively maintained database, we reviewed the operative time, estimated perioperative blood loss, cell saver use, and intraoperative and postoperative transfusion rate in patients who underwent posterior spinal fusion for neuromuscular scoliosis. Sixty-four patients were identified who fit these criteria since the use of the bipolar sealer device was instituted. We compared these patients to a control group of the preceding 65 patients in whom this device was not used for hemostasis. All patients, including those in the study group, received Amicar (infusion of 100 mg/kg over 15 to 20 minutes, then 10 mg/kg per hour throughout the remainder of the procedure). The surgical technique did not differ between the two groups.

RESULTS: Baseline characteristics between the two groups were similar except for the number of patients having an all-screw construct which was larger in the investigational group (31% vs. 12%, p=0.011). There were no significant differences in operative time or duration of hospital stay. Intraoperative blood loss was lower in the investigational group (871 ml) as compared to the control group (588 mL) (p=0.003). Total perioperative blood loss, however, showed no significant difference. Thirty-four (53%) patients in the study group and 49 (75%) patients in the control group required additional intraoperative or postoperative transfusions (p=0.01). The number of packed red cell units transfused per patient was 0.81 in the study group and 1.57 in the control group (p=0.001). Though the intraoperative cell saver transfusion was same, the total blood volume transfused, which includes cell saver and any other transfusions, was significantly lower in the study group, 425 mL vs. 671 mL (p=0.002).

CONCLUSION: Use of a bipolar sealer device in posterior spinal fusion for neuromuscular scoliosis significantly reduced intraoperative blood loss and transfusion rate when compared to a control group in this retrospective review.

SIGNIFICANCE: Use of a bipolar sealer device significantly reduces intraoperative blood loss and transfusion requirements in posterior spinal surgery for neuromuscular scoliosis.

Success of Risser Casting in the Treatment of Scheurmann's Kyphosis

Abstract ID: Paper 115

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PURPOSE: Assess demographic differences between patients who were treated with Risser casting for Scheuermann's kyphosis and those treated surgically. We also sought to demonstrate that Risser casting successfully decreased and maintained kyphosis.

METHODS: We reviewed our pediatric spinal deformity database from 1992 to 2012 for patients with Scheuermann's kyphosis treated with surgery, casting, or bracing. We collected demographic data, measurements of thoracic kyphosis and lumbar lordosis before treatment, during treatment, and at final follow-up.

RESULTS: The casting group (treated with Risser casting alone or followed by bracing or surgery) included 18 patients compared to 17 patients who were initially treated with surgery. The casting group had a pretreatment mean Risser sign of 2.3 ± 1.6 (range 0-4) and mean age of 13.4 (range 11-15), while the surgery group had 4.88 ± 0.34 (range 4-5) and 16.6 (range 15-21), respectively. The mean pretreatment kyphosis was 79.3 ± 10.6 (range 60-100) in the casting group and 91.0 ± 13.5 (range 70-118) for the surgery group. Casting reduced the mean kyphosis to 48 ± 11.3 (range 40-56) while surgery decreased it to 51.3 ± 6.7 (range 42-65). At final follow-up, the mean thoracic kyphosis of casted patients was 59.1 ± 9.1 (range 43-71) and 60.7 ± 9.1 (range 44-77) for surgery patients. Surgical procedures and complications were higher in the surgery group.

CONCLUSIONS: Risser casting is an effective method to decrease thoracic kyphosis in patients with Scheuermann's kyphosis, which can be maintained with continued casting or bracing as successfully as surgery. Patients who were treated with surgery initially had higher Risser signs and were generally older. Patients treated with surgery underwent more procedures and had more complications.

SIGNIFICANCE: Risser casting is an effective way to manage Scheuermann's kyphosis in a younger population with a lower Risser sign.

Comparison of Uniplanar vs. Fixed Pedicle Screws in the Restoration of Thoracic Kyphosis in the Treatment of Adolescent Idiopathic Scoliosis (AIS)

Abstract ID: Paper 116

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INTRODUCTION: The aim of surgical treatment of scoliosis is to obtain a fusion of the spinal column, balanced in the coronal and sagittal planes. Presently, the use of posterior segmental vertebral anchors linked by rods remains the standard method. Great success has been attained with coronal correction; however, the sagittal profile has received less attention, often resulting in little restoration of sagittal plane alignment. The purpose of this study was to compare Uniplanar and Fixed pedicle screws in the restoration of the thoracic alignment in the sagittal plane in the treatment of Adolescent idiopathic scoliosis (AIS).

METHODS: The sagittal profile of two groups of patients that underwent posterior fusion for AIS was compared. One group had Uniplanar screws (n=16) as bone anchors, and the second group had Fixed screws (n=20). Consecutive patients with AIS treated by posterior spinal fusion in the years 2004-06 with Fixed screws; and those treated in 2008 with Uniplanar screws were included in the study. Data included patient demographics (age, gender, height, weight), medical conditions, curve type, Risser stage, curve magnitude in the coronal and sagittal plane, curve flexibility, fusion levels, type and location of instrumentation, initial postoperative curve magnitude in the coronal and sagittal plane, and curve magnitude at final follow-up. A p-value < 0.05 was considered significant.

RESULTS: Both groups were comparable demographically, medically, in relation to the curve characteristics and the surgical treatment. Higher curvatures preoperatively were related to higher curvatures postoperatively and at follow-up. The average T2-T12 measurement at follow-up was about 4° higher than the immediate postoperative values. The post-correction T2-T12 curvature measurements were on average higher by 10° using the Uniplanar than the Fixed screws. This difference was seen by the model as steady, both across levels of preoperative T2-T12 measurement and the time of measurement.

CONCLUSION: In patients undergoing posterior spinal fusion for AIS, uniplanar screws achieved superior restoration of the sagittal alignment of the thoracic spine than fixed screws. This advantage was maintained in the postoperative follow-up period. The ability of the Uniplanar screws to adapt to variable sagittal orientation appears to contribute to the better outcome. The mild increase in the kyphosis measurements at the follow-up, in both the groups, could be attributed to the ‘settling of the curve’ with time.

MAOA BREAKOUT SESSION #9
REVISION KNEE
April 25, 2014

The Evaluation of the Efficacy of a Dilute Povidone-Iodine Lavage in Preventing Deep Postoperative Infection Before Wound Closure in Primary Total Knee Arthroplasty

Abstract ID: Paper 117

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This study evaluated the efficacy of a dilute povidone-iodine lavage in preventing early deep postoperative infection after total knee arthroplasty (TKA). A dilute povidone-iodine lavage (0.35%) for 3 minutes was introduced prior to closure of the senior author in March 2012. A total of 160 of consecutive primary TKA cases performed before this lavage were compared with 221 consecutive TKA cases after initiation of the povidone-iodine lavage for the occurrence of periprosthetic infections within 90 days postoperatively. One infection was identified before the use of the dilute povidone-iodine lavage and zero since (0.62% and 0.00%, respectively; $P < 0.01$). Thus, our findings showed that a dilute povidone-iodine lavage is an effective means of reducing acute postoperative infections after total knee arthroplasty.

Key Words: povidone-iodine lavage, betadine, TKA, periprosthetic joint infection

Does Operative Time Affect Infection Rate Following Primary Total Knee Arthroplasty?

Abstract ID: Paper 118

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BACKGROUND: Prolonged operative time may increase the risk of infection after total knee arthroplasty (TKA). Both surgeon-related and patient-related factors can contribute to increased operative times.

QUESTIONS/PURPOSES: The purpose of this study was to determine (1) whether increased operative time is an independent risk factor for revision resulting from infection after TKA; (2) whether increasing body mass index (BMI) increased operative time; and (3) whether increasing experience substantially decreased operative time.

METHODS: We retrospectively evaluated primary TKAs from our joint registry between March 2000 and August 2012. Cox proportional hazard models were used to assess the relationship between operative time and revision resulting from infection after accounting for age, sex, BMI, and Agency for Healthcare Research and Quality comorbidity score. Of 9,973 instances of primary TKA, 73 underwent revision surgery for infection (0.73%).

RESULTS: After accounting for the confounders of age and sex, operative time was not found to have a significant effect; a 15-minute increase in operative time increased the hazard of revision resulting from infection by only 15.6% ($p = 0.053$; 95% confidence interval, 0.0%–34.0%). In addition, a five-unit increase in BMI was found to increase mean operative time by 1.9 minutes, on average, regardless of sex ($p = 0.0001$). Operative time decreases with increasing experience, but appears to plateau at approximately 300 surgeries.

CONCLUSIONS: Operative time is only one of many factors that may increase infection risk and may be influenced by numerous confounders. Increasing BMI increased operative time, but the effect was modest. The effect of increasing experience on operative duration of this common procedure was surprisingly limited among our surgeons.

Is Malnutrition a Risk Factor for Septic Failure and Acute Postoperative Infection Following Revision Total Joint Arthroplasty?

Abstract ID: Paper 119

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INTRODUCTION: Malnutrition has been hypothesized to increase the risk of periprosthetic joint infection (PJI); however, strong evidence linking the two is lacking. The purpose of this study was to assess the prevalence of malnutrition in patients undergoing revision knee and hip arthroplasty. We hypothesized that (1) patients undergoing revision for chronic PJI would have a higher rate of malnutrition than revisions performed for other causes and (2) malnutrition would increase the risk of acute postoperative infection in those patients undergoing aseptic revision.

METHODS: A consecutive series of 501 revisions (375 aseptic, 126 septic) were screened for malnutrition (defined as total lymphocyte count < 1500/mm^3, serum albumin < 3.5 g/dL, or serum transferrin less than 200 mg/dL). Age, sex, insurance type, race, Charlson Comorbidity Index (CCI), and body mass index (BMI) were compared between aseptic and septic groups using Fisher's Exact Test and Student's t-test, as appropriate. The 375 aseptic revision cases were then assessed for the incidence of acute postoperative infection (within the first 90 days postoperatively). Multivariate regression analysis was performed to identify independent risk factors for (1) septic as opposed to an aseptic mode of failure and (2) acute postoperative infection following an aseptic revision.

RESULTS: A total of 67 of 126 patients (53.2%) undergoing revision for PJI were malnourished compared to 123 of 375 (32.8%) undergoing revision for a non-infectious etiology ($p<0.0001$). Patients undergoing septic revision were also significantly more likely to be male (65% vs. 53%, $p=0.03$) and to have non-private insurance (81.4% vs. 65.6%, $p=0.03$). Normal weight patients had the highest prevalence of malnutrition (50.6%), although malnutrition was common in obese patients (31.9%). Of the 375 aseptic revisions, 12 developed an acute postoperative infection (3.2%). The prevalence of infection was 9 of 123 in the malnourished group and 3 of 252 in the adequately nourished group (7.3% vs. 1.2%; $p=0.003$). Multivariate regression revealed that malnutrition is both an independent risk factor for septic revision ($p=0.0030$, Odds Ratio = 2.1) and for acute postoperative infection after aseptic revision arthroplasty ($p=0.02$, Odds Ratio=5.9).

CONCLUSION: Preoperative malnutrition is extremely common among patients undergoing revision arthroplasty and is an independent risk factor for both chronic septic failure and acute postoperative infection following revisions performed for a non-infectious etiology. Malnutrition was paradoxically more common in normal weight patients. Surgeons should consider screening patients preoperatively for malnutrition, even if they appear to be of normal weight.

Morbidly Obese Patients Have a Significantly Higher Risk of Failure Following Revision Total Knee Arthroplasty for Infection

Abstract ID: Paper 120

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INTRODUCTION: Obese patients are known to have a higher risk of complications following primary total knee arthroplasty (TKA), including prosthetic joint infection (PJI). However, there is a paucity of data on the effects of obesity in the setting of revision for infection. We compared the results of two-stage revision TKA for PJI in a group of morbidly obese (BMI ≥40) patients with a matched cohort of non-obese (BMI ≤30) patients.

METHODS: We analyzed all patients undergoing a two-stage revision TKA for PJI at a single institution over a 20-year period (1987-2007) with minimum follow-up of 5 years. All patients with a BMI ≥40 were identified (n=37), and compared to a 2:1 cohort of non-obese (BMI ≤30) patients (n=74) matched by sex, age, and date of surgery. Medical records were examined for reinfection, reoperation, and removal of components. Clinical outcomes were measured using the Knee Society pain and function scores. Statistical analysis was performed using Student T-test, Fisher Exact test, and Kaplan-Meier Survival Curve with statistical significance set at a p-value <0.05.

RESULTS: There were 26 (70%) females, with an average age of 60 ± 9 years, and average BMI of 43.7 ± 4 in the morbidly obese group, compared to 52 (70%) females, 62 ± 8 years of age, and 25.1 ± 3 average BMI in the non-obese group. There was no statistically significant difference between the groups with respect to certain medical comorbidities, including rheumatoid arthritis (8% obese vs. 16% non-obese, p=.38), diabetes mellitus (38% obese vs. 20% non-obese, p=.07), and current tobacco use (13% obese vs. 8% non-obese, p=.50).

Overall, the morbidly obese patients had a statistically significant increased risk for revision surgery (35% vs. 9%, p<0.01), reinfection (24% vs. 5%, p<0.01), and reoperation (51% vs. 16%, p<0.01) (Figure 1, Table 2). Implant survival rates were 80% and 97% at 5 years, and 48% and 82% at 10 years for the morbidly obese and non-obese groups, respectively. There was no difference in patient mortality during the follow-up period (11% vs. 13%, p=0.83).

At an average follow-up of 6.8 years in the obese group and 7.9 years in the non-obese group, patients in both groups experienced significant postoperative improvement in Knee Society pain and function scores. However, patients in the non-obese group had significantly better scores at 2-, 5-, and 10-year follow-up (p<0.01). Furthermore, at most recent follow-up, 92% of patients in the non-obese group reported no or mild pain compared to 59% in the obese group (p<0.01).

CONCLUSION: Morbid obesity significantly increases the rates of subsequent revision, reoperation, and reinfection following two-stage revision TKA for infection. In addition, these patients have worse pain relief and overall function at mid-term clinical follow-up. While two-stage revision should remain a standard treatment for chronic PJI, the poorer outcomes in

morbidly obese patients should be seriously considered in regards to patient education, healthcare policy, and outcome-based incentives moving forward.

Click here to view Figure
Click here to view Table

Sonication for the Enhanced Diagnosis of Prosthetic Joint Infection

Abstract ID: Paper 121

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INTRODUCTION: Culture negative prosthetic joint infections present a therapeutic dilemma, and recent efforts have focused on improving the accuracy of periprosthetic cultures. Sonication has been shown to enhance the yield of standard clinical cultures in patients with prosthetic joint infection (PJI), but this has not been consistently validated. The purpose of this study was to determine if the addition of sonication improves the diagnostic accuracy of clinical cultures in patients with a PJI.

METHODS: We performed a prospective trial comparing conventional microbiologic culture techniques to cultures obtained from sonication. Explanted prostheses from revision hip and knee arthroplasties were treated with an established sonication procedure and cultures were obtained from the supernatant. Multiple tissue cultures were obtained at the time of surgery and cultured in the clinical microbiology laboratory using conventional techniques.

RESULTS: A total of 198 patients undergoing revision or resection arthroplasty participated in the study. Of these, 60 patients met MSIS Work Group criteria for PJI. The sensitivities of conventional periprosthetic tissue cultures performed in the clinical microbiology laboratory and sonication fluid cultures were 85% and 78%, respectively (p= 0.30). The specificities of conventional periprosthetic tissue cultures performed in the clinical microbiology laboratory and sonication fluid cultures were 96% and 89%, respectively. Three cases of PJI were detected by the sonication fluid cultures, but not by the clinical microbiology laboratory.

DISCUSSION: Our study did not demonstrate an improved sensitivity of sonication cultures compared to conventional periprosthetic tissue cultures. Enhanced microbiologic techniques (utilization of pediatric blood culture bottles and prolonged incubation times) may contribute to the improved yield of cultures performed in our clinical microbiology laboratory. Our data do not support the additional expense and effort needed to perform the sonication culture procedure.

Mortality of Elderly Patients After Two-Stage Reimplantation for Total Joint Infection: A Case Control Study

Abstract ID: Paper 122

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INTRODUCTION: Two-stage reimplantation has previously been shown to be the standard of care for periprosthetic total joint infection. As the number of elderly patients with total hips and total knees rises, so do the number of periprosthetic infections. The mortality of two-stage reimplantation in patients over the age of 80 has not previously been studied.

METHODS: We utilized our institution's total joint registry to retrospectively review the mortality of elderly patients over the age of 80 undergoing two-stage reimplantation for periprosthetic total joint infection between 1995 and 2010. We compared this group to a matched cohort of patients who underwent single stage total joint revision for aseptic causes. The two groups were matched by age, gender, joint, and American Society of Anesthesiologist (ASA) score. Preoperative co-morbidities were compared between the groups using chi-square tests. Mortality and the rate of postoperative complications were estimated using the Kaplan-Meier method, and these outcomes were compared between the groups using Cox proportional hazards regression. Mortality estimates were reported at 90 days, 1 year, and 5 years.

RESULTS: We reviewed a total of 268 patients with at least two-year postoperative follow-up; 134 in both the two-stage reimplantation and the aseptic revision groups. Females represented 53.7% and males 46.3% of patients. Each cohort consisted of 54.5% total knee and 45.5% total hip patients. The mean age at surgery was 83 years. There was no significant difference in preoperative co-morbidities between the two groups. Coagulase-negative Staphylococcus was the most commonly identified bacteria (36.6%) in the two-stage reimplantation group. The mortality rate at 1 and 5 years for the two-stage group was 3.1% and 39.9% respectively, compared to 4.6% and 34.1% for the aseptic group. There was no significant difference in mortality between the groups at 90 days, 1 year, or 5 years postoperatively (HR 1.30, CI 0.94, 1.81, p=0.11). There was a significantly higher rate of postoperative myocardial infarction (p=0.04), reinfection (p=0.004), and a trend towards higher wound complications (p=0.06) in the two-stage reimplantation group.

DISCUSSION: Two-stage reimplantation surgery for periprosthetic total joint infection does not significantly increase the mortality of patients over the age of 80 when compared to an age and ASA score matched cohort of patients undergoing aseptic total joint revision. Five-year mortality rates are similar to previous studies that evaluated total joint surgery in this age group. Postoperative myocardial infarction and reinfection were significantly higher in the two-stage reimplantation group.

Are the Results of Two-Stage Reimplantation of a Prosthetic Joint Durable Over the Patient's Lifetime?

Abstract ID: Paper 123

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INTRODUCTION: Two-stage reimplantation has consistently yielded high rates of success for patients with a chronic prosthetic joint infection. The purpose of this study is to determine if the success of two-stage reimplantation is durable over the patient's lifetime.

METHODS: We treated 111 patients (116 joints) who had a prosthetic joint infection. Of the 111 patients, 17 had incision, debridement, and component retention, 16 prosthetic joint resection without reimplantation and 2 a one-stage reimplantation, leaving 76 patients (81 joints) treated with a two-stage reimplantation. Patients were followed for a minimum of 2 years or until infection or death. Forty-five joints were infected with Staphylococcal organisms including 20 resistant to methicillin (3 MRSA, 17 MRSE).

RESULTS: Eight patients (8 joints) (10.5%) developed a recurrence of their prosthetic joint infection. Three occurred within 2 years and all 3 were methicillin-resistant pathogens (MRSA or MRSE). Five infections were late hematogenous (5-10 years) after reimplantation and none of the pathogens were resistant (Streptococcus viridans, Serratia marcescens, Group G Streptococcus, Staphylococcus aureus). Early infections were more often caused by a resistant pathogen and late infections by a sensitive pathogen (p=0.018). One of the late infections was the same pathogen as treated for the original infection.

DISCUSSION: This study provides important information about the long-term sequela of a prosthetic joint infection. The early success of two-stage reimplantation is not durable over the patient's lifetime. In our experience, 63% (5 of 8) of the infections occurred more than 5 years after reimplantation. These findings emphasize the need for research that may improve the host's ability to prevent infection.

Risk Factors for Manipulation After Total Knee Arthroplasty: A Pooled Electronic Health Record Database Study

Abstract ID: Paper 124

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INTRODUCTION: Total knee arthroplasty (TKA) is a reliable surgical procedure for relieving pain, restoring mobility, and improving quality of life in patients with degenerative knee pathology. Stiffness following TKA is a relatively common complication (termed arthrofibrosis), and generally is initially treated with a manipulation under anesthesia when severe. However, the risk factors for postoperative arthrofibrosis are not well understood. The purpose of this study is to identify risk factors for postoperative stiffness requiring a manipulation under anesthesia after TKA between groups stratified by race, sex, nicotine dependence, or depressive disorders.

METHODS: A commercially available software platform, Explorys, was used to query a multicenter electronic healthcare database consisting of the medical records of over 24 million patients. The incidence of manipulation under anesthesia within 90 days of total knee arthroplasty was determined, and the relative risks with 95% confidence intervals (CI) were then calculated for defined risk factors including race, sex, nicotine dependence, and depressive disorders. A subgroup analysis of African American females was also performed. The Pearson's Chi Squared statistical instrument was used to determine significance ($p<0.05$).

RESULTS: Of the 184,580 patients that had undergone a total knee arthroplasty, 2,810 (1.5%) had undergone manipulation under anesthesia within 90 days of total knee arthroplasty. Female sex, African American race, and nicotine dependence demonstrated a relative risk of 1.27 (CI: 1.17-1.362), 2.51 (CI: 2.32-2.73), and 1.34 (CI: 1.26-1.52) respectively, when compared to the group without the defined risk factor. A statistically significant difference was found between all three groups ($p<0.001$). African American females had the highest relative risk of manipulation under anesthesia (2.77, CI: 2.52-3.01) compared to non-African American females ($p<.001$). Depressive disorders were not found to be a significant risk factor ($p=0.26$).

CONCLUSION: African American race, female sex, and nicotine dependence are statistically significant risk factors for manipulation under anesthesia after TKA. African American females had the highest risk. Defining patient risk factors for postoperative arthrofibrosis will allow physicians to counsel patients on their individual risks factors preoperatively and closely monitor patients postoperatively.

Level of Evidence: Prognostic Level II

Results of Patients Undergoing a Second Manipulation Under Anesthesia for Stiffness After Total Knee Arthroplasty

Abstract ID: Paper 125

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INTRODUCTION: Limited range of motion (ROM) after total knee arthroplasty (TKA) decreases patients' ability to participate in activities of daily living. Manipulation under anesthesia (MUA) has been demonstrated to achieve improvements in ROM after TKA. However, there is conflicting evidence whether the gains in ROM from MUA are sustained and some patients continue to have poor ROM after a MUA. To our knowledge, there has been no study evaluating the benefit of a second MUA in patients with poor ROM despite an initial MUA after TKA.

METHODS: Surgical records over a 30-month period of two fellowship-trained joint surgeons were reviewed. Over the studied period, 1,331 primary TKAs were performed. We identified 226 knees in 209 patients who underwent an initial MUA for stiffness and poor ROM after TKA. A subset of this group was identified which included 17 patients who underwent a second MUA.

RESULTS: Early follow-up information was available for 177 knees in 161 patients (mean age 65). Mean preoperative extension and flexion were 8.42º and 94.07º, respectively. At early follow-up after MUA (mean 37 days), mean extension improved to 3.21º and mean flexion improved to 109.85º. At latest follow-up after MUA (mean 527 days), mean extension and flexion were 0.87º ($p<0.0001$) and 112.61º ($p<0.0001$), respectively. Mean Knee Society Score was 16.75; mean SF-12 score was 35.02.

Follow-up information was available for 16 patients, average age 62 years, who subsequently underwent a second MUA. Regarding the 1st MUA, mean preoperative extension was 10.50º and mean flexion was 87.50º. At early follow-up after 1st MUA (mean 76 days), mean extension was 8.69º ($p=0.285$) and mean flexion was 97.38º ($p=0.084$). Prior to the 2nd MUA, mean extension and flexion were 9.31º and 94.94º, respectively. At latest follow-up after 2nd MUA (mean 539 days), mean extension was 2.50º ($p=0.010$) and mean flexion was 112.69º ($p<0.0004$). Mean Knee Society Score was 21.09; mean SF-12 scores was 34.42. Complications included revision arthroplasty (3), deep infection (1), late supracondylar femur fracture (1), late patellar tendon rupture (1), and deep venous thrombosis (1).

CONCLUSIONS: A second MUA can achieve an improvement in ROM that is sustained through long-term follow-up in patients with poor ROM despite initial MUA after TKA.

Revision Total Knee Arthroplasty in a Veteran Population

Abstract ID: Paper 126

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INTRODUCTION: This study describes a population of U.S. military veterans undergoing revision total knee arthroplasty (TKA), and identifies the reasons for primary and revision TKA failure at a single Veterans Affairs Medical Center.

METHODS: In this retrospective chart review, we identified patients undergoing revision of primary TKA during a 14-year period. Patient demographics, medical comorbidities, and the Charlson Comorbidity Index (CCI) were recorded for each revision. Failures were grouped as early (<2 years) and late (>2 years). The causes of TKA failure were classified into: aseptic loosening, septic loosening, polyethylene wear, and other. Subsequent failures of the revision TKAs were examined for causes and timing of failure. Failures of primary TKA performed at our institution were compared with those from outside institutions, and single revisions were compared with revision failures.

RESULTS: Eighty-four primary TKA revisions were identified. Mean follow-up was 7.76 years. Patients were 95.2% male. Mean age at revision surgery was 63.98 years, mean BMI was 31.56, mean number of medical comorbidities was 6.32, and the mean CCI was 1.70. Reasons for failure of primary TKA were aseptic loosening (61.9%), polyethylene wear (27.4%), septic loosening (11.9%), and other causes (25%). Less than half (45.7%) of primary TKAs failed early. Patients whose primary TKA was performed at our facility had significantly more medical comorbidities (7.94 vs. 5.27, $p=0.011$) and higher CCIs (2.18 vs. 1.39, $p=0.046$) than those from outside centers. They also had increased incidences of smoking, gastroesophageal reflux disease, and cerebrovascular accident ($p< 0.05$). Seventeen revision TKAs failed (20.2%). The leading cause of failure in revision TKA was septic failure at 58.8%. The majority of revision failures occurred early (58.8%). Revisions for septic TKA showed a higher rate of failure than those revised for all other causes (50% vs. 16.2%, $p=0.013$), and demonstrated a higher rate of revision failure due to sepsis (100% vs. 41.7%, $p=0.044$).

DISCUSSION AND CONCLUSION: Aseptic loosening was the most common reason for primary TKA failure in this series. Patients presenting for revision TKA from our institution had significantly more comorbidities, and higher CCIs than patients presenting from other institutions. Revision TKAs failed 20.2% of the time in this study. Septic loosening was the leading mode of revision failure. We recommend that all patients with failed TKA revisions undergo a thorough infection work-up prior to re-revision given the high prevalence of septic failure in this setting.

Comparison of Arthroscopic and Nonoperative Treatment of Patellofemoral Soft Tissue Impingement Following Total Knee Arthroplasty: Minimum Two-Year Follow-Up

Abstract ID: Paper 127

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BACKGROUND: The purpose of this study is to evaluate functional results of arthroscopic vs. conservative treatment of peripatellar fibrosis following TKA at a minimum 2-year follow-up.

METHODS: A retrospective case series of 40 patients (47 knees) diagnosed with patellofemoral fibrosis and crepitance following TKA were evaluated. Seventeen patients (19 knees) underwent arthroscopic debridement. Patients were followed for a minimum of 2 years. Clinical evaluation included need for re-revision and Knee Society Scores at time of diagnosis and final follow-up, as well as final follow-up WOMAC and SF-36 scores, and radiographic evaluation of patella height and subluxation on Merchant views.

RESULTS: Of the 1,488 TKAs performed over an 11-year period, 47 cases of peripatellar fibrosis were diagnosed (prevalence = 3.17%). Following diagnosis, 19 knees with peripatellar fibrosis underwent arthroscopic debridement an average of 11 months after TKA. 4 knees in the arthroscopic group had recurrence after treatment, but resolved with a second operation. 28 knees underwent conservative management. Mean WOMAC for the arthroscopic and conservative groups were 81.4 (range 56-97) and 88.1 (range 60-100), respectively. Mean SF-36 scores for the two groups were 62.3 (range 27-80) and 66.3 (range 40-85) for the PCS, and 79.2 (range 53-94) and 76.2 (range 31-96) for the MCS, respectively.

CONCLUSION: Arthroscopic debridement is the treatment for peripatellar fibrosis with crepitance and was effective in this series. However, many patients were treated non-operatively and still were satisfied with their results.

The Effect of Obesity on the Revision Rate of Totak Knee Arthroplasty: A Population Based Validation Study of a Pooled Electronic Healthcare Database

Abstract ID: Paper 128

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INTRODUCTION: The aim of this study is to validate the use of a novel pooled electronic medical records database of over 16 million patients from 13 major United States healthcare systems for orthopedic research. Our hypothesis is that, consistent with prior reports in the literature, obese patients possess a greater risk of revision total knee arthroplasty (TKA) when compared to a non-obese cohort within this database.

METHODS: A novel software platform (Explorys) was utilized for this retrospective cohort study to query the database. The risk of revision TKA was determined in cohorts of varying body mass indices (BMI) relative to patients who were normal/overweight (BMI 18 – 30). The effect of increasing BMI within men and women was also assessed. Relative risk of revision increased as a function of BMI. The Pearson's Chi Square test was used for statistical analysis ($p<0.05$).

RESULTS: 70,070 patients were identified within that database that had undergone a TKA. Relative risk was significantly increased in the group of all patients with a BMI greater than 30 ($p=0.013$), the subgroup of all patients with a BMI greater than 40 ($p=0.006$), all men with a BMI greater than 30, and the subgroup of men with a BMI greater than 40 compared to normal/overweight patients ($p=0.005$). Relative risks were significantly greater in men than in women ($p<0.05$).

CONCLUSION: Consistent with prior reports, the results of this study support our hypothesis that obese patients possess a statistically significant greater risk of revision total knee arthroplasty. Patients with a BMI > 40 have the greatest risk of revision TKA. Using the Explorys software platform to investigate pooled electronic medical data is a useful instrument to investigate associations across large populations.

Surgical Measures to Correct Flexion Instability Associated with Well-Fixed Components

Abstract ID: Paper 129

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IINTRODUCTION: Flexion instability occurs in total knee arthroplasty (TKA) due to mismatched flexion-extension spacing. There is minimal literature on the multiple surgical maneuvers required to gain control of the flexion gap during revisions. The goals of this consecutive series were to identify the surgical measures deemed necessary to correct flexion instability.

METHODS: Between January 2000 and 2010, the senior author performed 661 revision TKAs. Of these, 60 patients (60 knees) underwent revision for flexion instability associated with well-fixed components (9%). The mean age was 65 years (range, 43 – 82 years), with 69% having a cruciate-retaining design. No patients had infection. Mean follow-up was 3.6 years (range, 2 – 3.6 years).

Surgical maneuvers included additional distal femoral resection, upsizing the femoral anteroposterior (AP) dimension, reduction of tibial slope, correction of axial malalignment, and correction of component malrotation. Digital radiographic measurements were epicondylar axis to distal femur height, condylar offset, tibial slope, component coronal alignment, and Insall-Salvati ratios. Intraoperative measurements included component malrotation. Knee Society Scores (KSS) were used to assess clinical outcomes.

RESULTS: Pre-revision under-resection of distal femoral bone was common with a mean medial epicondylar distance of 24 mm (range, 17 – 34 mm). Preoperative tibial slope averaged 7º (range, -9º – 22º). Internal component malrotation occurred in 63% of femoral components averaging 8º (range, 5º – 12º), and 38% of tibial components averaging 13º (range, 5º – 20º). Of the 60 patients, 92% required AP upsizing of the femoral component and 57% required additional distal femoral resection. The mean correction with increased condylar offset and decreased epicondylar distance was 9.5 mm. There was a statistically significant improvement in the KSS pain (34 to 82 points; $p = 0.0001$) and function (37 to 84 points; $p = 0.0001$) scores.

DISCUSSION: The etiology of symptomatic flexion instability is often multifactorial and includes inadequate distal femoral resection, an undersized femoral component, excessive tibial slope, and component malrotation.

MAOA BREAKOUT SESSION #10
HIP
April 25, 2014

Fixation and Wear with Contemporary Acetabular Components and Cross-Linked Polyethylene at 10 Years in Patients Age 50 and Under

Abstract ID: Paper 130

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INTRODUCTION: Bearing surface wear was reported as the major long-term problem in patients undergoing total hip arthroplasty (THA) age 50 and under. Moderately cross-linked polyethylene was developed to reduce bearing surface wear and, thus, help alleviate this long-term problem. The purpose of this study was to evaluate the minimum 10-year results of a third generation cementless modular acetabular component using moderately cross-linked polyethylene liners in patients age 50 and under.

METHODS: We prospectively followed 100 THAs in 86 patients age 50 and younger at the time of surgery who underwent primary THA using a third generation cementless modular acetabular component with moderately cross-linked polyethylene liners (5 Megarad re-melted). Average age at surgery was 41.9 years with surgeries being performed at two institutions. Hips were evaluated clinically for revision and by SF-36, WOMAC, Tegner, and UCLA questionnaires. In addition, patients wore accelerometers to assess functional activity. Radiographs were evaluated for wear, loosening, and osteolysis. These results were compared to a group of 115 hips performed in patients 50 and under by the same surgeons with gamma in air or gas plasma sterilized polyethylene that were also followed for 10 years with the same methodology.

RESULTS: At minimum 10-year-old follow-up, six patients (6 hips) were deceased, two patients (2 hips) withdrew from the study, and five patients (5 hips) were lost to follow-up. No hips were revised for loosening at minimum 10 years. All acetabular and femoral components were bone ingrown and there were no cases of osteolysis. Average UCLA score was 5.5 and average Tegner score was 3.9 (moderate to heavy labor). Calculated mean steps per year was 1.90 million (range: 0.33 to 4.36 million). Mean linear and volumetric head penetration rates were 0.05 mm/year and 15.24 mm^3/year in this active population. These results were significantly better ($p<0.001$) than the results with polyethylene that was not moderately crosslinked where the average linear wear rate was 0.252 mm/year, the volumetric wear averaged 80 mm^3/year, and 10% of cases were revised for linear wear.

DISCUSSION: THA using a third generation cementless modular acetabular component with moderately cross-linked polyethylene liners in a younger population proved durable at minimum 10 years. Bearing surface wear in this younger cohort was similar to an older cohort even with their increased activity and was far superior to this age group in patients with polyethylene that was not moderately crosslinked. These results support the use of a third generation cementless acetabular component and moderately cross-linked polyethylene in THA for patients age 50 and under.

Excellent Results at an Average 10 Years for Primary Uncemented Acetabular Components in THA for Protrusio Acetabuli

Abstract ID: Paper 131

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(Presented by Amy L. McIntosh, M.D., Rochester, MN)

BACKGROUND: Protrusio acetabuli is an uncommon radiographic finding in patients undergoing primary THA for end stage arthritis. The long-term outcome of patients undergoing primary THA with a concomitant diagnosis of acetabular protrusio is not well described. The objectives of this study are to evaluate the survivorship of uncemented acetabular component for THA performed for arthritis associated with protrusio acetabuli and describe its clinical and radiographic results at the long-term.

METHODS: We reviewed medical records for 53 patients (65 hips) undergoing primary THA for protrusio between 1983 to 2001 and having potential minimum ten years follow-up period. The mean follow-up was 10 years (range, 2 – 20 years). The mean age at THA was 66 years (range; 37 – 85 years). There were 47 women (54 hips) and 6 men (11 hips). The femoral head protruded medial to ilioischial line (Kohler's line) by mean of 6 ± 4 mm (standard deviation). Fifty-seven hips (88%) required autologous femur head bone graft for the acetabular floor reconstruction. The THA survivorship using any revision or acetabular component revision as end points was estimated with Kaplan-Meier method. Clinical results were reported using Harris hip scoring tool (HHS).

Latest RESULTS: During the study follow-up duration, six acetabular components and ten femoral components were revised. The THA survival from acetabular revision was 94% (95% confidence interval [CI]; 84% - 98%) at 10 years and 85% (95% CI; 70% – 94%) at 15 years. The THA survivorship from any revision was 82% (95% CI; 70%–90%) at 10 years and 70% (95% CI; 54%–82%) at 15 years. The HHS improved from 50 ± 12 to 76 ± 16 points at latest evaluation ($p < 0.001$). Another 14 acetabular components had radiolucent line on most recent radiographs including one involving the three zones.

CONCLUSION: Uncemented fixation using a hemispherical shell with bone graft of the acetabular floor when needed was associated with 85% survivorship at 15 years. Uncemented acetabular reconstruction can be a standard of care in these patients with acetabular protrusio at the time of THA as it provides a stable, durable reconstruction in these patients with satisfactory clinical results the long-term.

True Sizing of the Acetabulum in Total Hip Arthroplasty: Off-the-Shelf vs. Factory-New Reamers

Abstract ID: Paper 132

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W. Trevor North, M.D.
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INTRODUCTION: The purpose of this study was to compare the actual size cavity reamed by off-the-shelf reamers, compared to factory-new reamers. Both conventional and minimally invasive reamers were utilized. Additionally, reamer extension handles were tested for excessive run-out.

METHODS: Both off-the-shelf and factory-new hemispherical and minimally invasive (cut-off) acetabular reamers were tested on a CNC-machine to create cavities in special, machinable wax blocks. A total of 32 acetabular reamers were studied, in sizes 48 mm through 55 mm. All bundled reamer handles were tested for run-out.

RESULTS: Three sets of off-the-shelf, conventional acetabular reamers were compared to their factory-new counterparts, with an average ream undersize of 1.24 mm. Three sets of off-the-shelf, minimally invasive acetabular reamers were compared to their factory-new counterparts, with an average ream undersize of 0.828 mm. Of the off-the-shelf reamer extension handles tested, approximately 30% showed a run-out exceeding 0.5 mm.

CONCLUSION: Compared to their factory-new counterparts, off-the-shelf modular hemispherical cutting shells tend to undersize the cavity created of both conventional and minimally invasive systems. Furthermore, the reamer extension handles have both excessive and variable run-out. Off-the-shelf acetabular reamer systems may negatively affect the sizing of prepared acetabular beds. This inaccuracy should be considered when performing total hip arthroplasty.

Results of Cementless Femoral Reconstruction in Primary THA for Treatment of DDH

Abstract ID: Paper 133

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INTRODUCTION: Though there is a predictable spectrum of femoral and acetabular abnormalities encountered during total hip arthroplasty (THA) in patients with developmental dysplasia of the hip (DDH), reconstruction can present a challenge. Modular cementless reconstruction facilitates management of the dysplastic femur by allowing the surgeon to accommodate for variations in anteversion, coxa valga, and the metaphyseal-diaphyseal mismatch often present. The purpose of this study was to evaluate the clinical and radiographic results of primary THA for DDH using a modular, uncemented femoral prosthesis.

METHODS: We utilized the total joint registry at our institution to identify all patients with DDH undergoing a primary THA using a modular uncemented femoral component between 1997 and 2010. 112 hips in 101 patients (average age 48) were retrospectively reviewed and followed for an average of 5 years. Our primary outcome measures were rates of re-operation, femoral component loosening, and overall complication rate. Clinical outcomes were assessed with a Harris Hip Score.

RESULTS: The mean Harris hip score improved from 45 points preoperatively to 89 points at the time of last follow-up, with 89% of patients having good to excellent outcomes (HHS > 80). All femoral components were well fixed at last radiographic follow-up. Four patients underwent a subsequent re-operation: one hip resection for infection, one head and liner exchange, one ORIF of a Vancouver B1 femur fracture, and one acetabular component revision (for aseptic loosening). 13 hips (11%) experienced either an intraoperative or a late complication including 7 calcar fractures treated with intraoperative cerclage cabling, one late Vancouver B1 periprosthetic fracture, two greater trochanteric fracture treated non-operatively, two late dislocations which did not require operative intervention, and one transient femoral nerve neuropraxia.

DISCUSSION/CONCLUSION: Despite an 11% overall complication rate, femoral reconstruction in patients with DDH using uncemented modular femoral components provides excellent clinical outcomes, consistent stable implant fixation, and a low rate of re-operation.

Early Subsidence is Minimized in a Modern Taper-Wedge Femoral Component Compared to a Traditional Fit-and-Fill Design

Abstract ID: Paper 134

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INTRODUCTION: Although cementless total hip arthroplasty (THA) is well accepted, the optimal femoral component design remains unknown. Among early complications, loosening and periprosthetic fracture persist and are related to implant design. The purpose of this study is to compare the anatomic fit and early subsidence of two different stem designs: a modern, short taper-wedge design and a traditional fit-and-fill design.

METHODS: A retrospective cohort study of 129 consecutive cementless THAs using two different femoral stems was performed. A modern taper-wedge stem was used in 65 hips and a traditional proximal fit-and-fill stem was used in 64 hips. Radiographic analysis was performed at preoperative, immediate postoperative, and 1-month postoperative intervals. The radiographic parameters of bone morphology via the canal-flare index, implant subsidence at 1 month, sagittal alignment, and the “anatomic fit” metrics of canal fill and associated gaps were measured and recorded.

RESULTS: There were no differences between groups in patient demographics ($p>0.4$), and in bone morphology via the canal-flare index ($p=0.6$) with numbers available. The mean subsidence was less in the taper-wedge design at 0.27 mm compared to 1.1 mm in the fit-and-fill stem ($p<0.0001$). Subsidence greater than 2 mm occurred in 26 of 64 fit-and-fill stems (41%) compared to 1 of 65 taper-wedge implants (1.5%). The percentage fill at all levels measured was greater in the taper-wedge design ($p<0.0001$). The taper-wedge design was inserted a mean of 2.7º sagittal extension compared to 0.4º in the fit-and-fill design ($p<0.0001$).

CONCLUSION: Despite being shorter in length, the taper-wedge design demonstrates greater axial stability and less subsidence compared to a traditional fit-and-fill stem. The optimized proximal femoral fit inherent in this anatomic-based taper-wedge design is likely responsible for the minimal subsidence. The clinical implication of greater extension in the sagittal plane is unknown and longer-term clinical follow-up is warranted.

Cerclage Fixation for Cementless Total Hip Arthroplasty Complicated by Intraoperative Vancouver B1 Periprosthetic Fractures: A Biomechanical Analysis

Abstract ID: Paper 135

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INTRODUCTION: Demand for total hip arthroplasty (THA) continues to rise and, as such, there is a concurrent presumed increase in the incidence of periprosthetic femoral fractures. Several studies have previously demonstrated differences in fixation technique and biomechanical advantages of various cerclage constructs in fixation of femoral periprosthetic fractures. The purpose of this study is to determine the most effective combination of cerclage materials and technique in fixation of periprosthetic fractures during cementless THA.

METHODS: Thirty-fourth generation synthetic femora were tested in axial compression and torsion. Femurs were placed in a standardized mount and a cementless hip prosthesis was implanted by one senior surgeon. After broaching, but prior to implant placement, a band saw was used to create a Vancouver B1 fracture below the level of the lesser trochanter. The implant was then placed in the femur. Four different cerclage constructs were then created using two of the following: (1) hose clamp, (2) metallic cable, (3) synthetic cable, and (4) monofilament wire. All cables were placed using tensioning devices to standardize final cerclage tension. Additional constructs were created increasing the number of cerclage cables/wires to three and then four, evenly spaced across the implant. Axial compression and torsion were assessed to failure for all constructs using standard Instrom testing criteria. Cost analysis was performed for each construct.

RESULTS: Data suggests that Construct 1 demonstrated superior results in both axial compression and torsion in all trials, increasing with the number of clamps used. Construct 4 demonstrated inferior results in both axial compression and torsion, although increasing the number of wires significantly increased the strength of the construct. Construct 2 and 3 were equivalent.

CONCLUSION: Increasing the number of cerclage cables/wires significantly increases the strength of the construct in both axial compression and torsion. Overall strength in order of strongest to weakest is as follows: hose clamp, metallic cable, synthetic cable, and monofilament wire. It is reasonable to consider monofilament wires as a viable fixation option given lower cost and overall strength at physiologic loads.

Are Large Heads an Unqualified Benefit for Metal-on-Metal Total Hip Replacement? Stability vs. "Trunnionosis" Wear

Abstract ID: Paper 137

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INTRODUCTION: A number of recent reports have indicated an unacceptably high rate of wear-associated failure with large diameter bearings, possibly due in part to increased wear at the trunnion interface ("trunnionosis"). We evaluated the potential tradeoff between implant stability and trunnion wear using a modular total hip arthroplasty finite element model.

METHODS: Computational simulations were executed using a previously developed and physically-validated non-linear contact finite element model. The head/neck interface consisted of the tapered trunnion and head bore. When assembled on the trunnion, a moment arm exists between the center of rotation of the head and the trunion contact pressure centroid. Stability was determined at 36 cup orientations, for five distinct dislocation challenges, for five distinct femoral head diameters (32, 36, 40, 44, and 48 mm) resulting in a total of 900 FE simulations. Seven head diameters were investigated from 32 mm to 56 mm, in 4 mm increments to evaluate trunion wear.

RESULTS: Stability (measured in terms of femoral head subluxation) improved with increased diameter, although diminishing benefit was seen for size increases beyond 40 mm. By contrast, at the trunnion interface unabated increase in stress was observed for femoral heads exceeding 40 mm, with the greatest effect seen for larger values of head diameter. Linear wear at the trunnion interface demonstrated a similar dependence upon head size, accelerated wear observed for femoral head diameters exceeding 40 mm for both gait and sit-to-stand motions.

CONCLUSIONS: The current parametric finite element results corroborate recent clinical evidence that large-diameter heads for MoM THA have a tendency to undergo deleterious wear generation at the head/trunnion interface. Although there were marginal additional improvements in construct stability, the propensity for trunnionosis-inducing wear increased substantially for head diameters greater than about 40 mm.

Radiographic Outcomes After Direct Anterior With Fluoroscopy vs. Mini-Posterior THA Without: Reliable, Reproducible, and Similar

Abstract ID: Paper 138

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PURPOSE: One proposed advantage of direct anterior total hip arthroplasty (THA) is that intraoperative radiographic imaging is easily obtained which might make leg-length, hip offset, acetabular cup, and femoral stem positioning more reliable. Others suggest that careful, systematic preoperative planning produces reliable and reproducible radiographic outcomes. We sought to determine if there was systematic benefit to the intraoperative imaging. We compared 2 THA cohorts: direct anterior (DA) with imaging and mini-posterior (MP) with preoperative planning, but no intraoperative imaging.

METHODS: From July 2011-February 2012, we compared 126 consecutive DA THA with fluoroscopy to 96 consecutive MP procedures performed. Groups were similar in age (64+/-12), sex (50% female), and BMI (30+/-5.7). Two fellowship-trained surgeons performed all cases using the same uncemented implants. Postoperative measurements of leg length, offset, acetabular abduction, and anteversion were done with validated techniques. Independent reviewers used calibrated eight-week postoperative x-rays and digital templating software for analysis.

RESULTS: The DA group had mean leg length increase 1.0 mm (SD 4.1), while MP had a decrease 0.9 mm (SD 5.6) (p=0.009). Femoral offset increased more in the MP group (3.0 mm; SD 5.6) than DA (0.6 mm; SD 4.4) (p=0.0009). Acetabular anteversion was higher in DA using two measurements: 35.8º (SD 6.9) vs. 32.5º (SD 7.4) Woo and Morrey (p=0.0009); and 52.7º (SD 9.0) vs. 50.2º (SD 9.5) ischio-lateral method (p=0.049). No differences in cup abduction (39.1º [SD 5.0] for DA vs. 40.2º [SD 5.7] for the MP) or varus/valgus stem position. More stems were flexed in the DA (38.4% vs. 12.5% for MP; p=0.0001). No components failed for subsidence or fracture.

CONCLUSION: Reliable, reproducible, and similar radiographic outcomes were obtained with THA via a direct anterior/fluoroscopy and mini-posterior/no-fluoroscopy technique. Having a well-defined preoperative and intraoperative plan appears more important than the specific surgical techniques in obtaining tight radiographic outcomes after hip arthroplasty.

Wear Analysis of Three Different Bearing Combinations in THA

Abstract ID: Paper 139

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INTRODUCTION: The early and mid-term clinical outcomes of total hip arthroplasty using highly crosslinked polyethylene (HXLPE) have been outstanding. Reported wear rates with HXLPE have been very low. Alternative hard bearings (monolithic ceramics, and oxidized zirconium) are commonly used to further improve the wear of HXLPE, although published results with these combinations are rare. The purpose of this study was to analyze the wear rates of three different bearing combinations in THA.

METHODS: We evaluated 198 THAs with a minimum follow-up of 5 years (range 60-122 months) and a mean follow-up of 75.4 months. Hips were assigned to three groups based on the bearing couple. The bearing couple used in Group 1 was CoCr on HXLPE, Group 2 was CoCr on standard polyethylene, and Group 3 was oxidized zirconium on HXLPE. We measured the linear wear for each group using the Martell Method. Median wear rates for Groups 1 and 2 and Groups 1 and 3 were compared using the Mann-Whitney test for statistical significance.

RESULTS: The median true linear wear rate for Group 1 was 7.5 µm/year (± 75 µm/year), Group 2 was 52 µm/year (± 98 µm/year), and Group 3 was 24 µm/year (± 98 µm/year). The wear rate for group 1 was significantly less than the wear rate for group 2 ($p=0.001$). The wear rate for group 1 was not significantly different than the wear rate for group 3 ($p=0.144$). The Harris Hip scores improved from 51 (range 26-75) preoperatively to 97 (range 66-100) at follow-up. There was no radiographic evidence of implant loosening or osteolysis.

DISCUSSION: We found the wear rate of HXLPE was significantly less than the wear rate of standard polyethylene at an average follow-up of 6 years. The use of oxidized zirconium did not improve wear rates of HXLPE when compared to CoCr. Our data would suggest that any benefit to alternative head material is dwarfed by the significant effect of crosslinking polyethylene.

MAOA THIRD PLENARY SESSION
April 26, 2014

Are Clinical Results of Periacetabular Osteotomy Generalizable? A Large, Prospective, Multicenter Cohort Study

Abstract ID: Paper 140

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INTRODUCTION: The majority of reports on the clinical outcomes of the periacetabular osteotomy (PAO) have been single surgeon, retrospective case series. There is a need for large prospective cohort studies to better define the clinical outcomes, predictors of treatment results, and generalizability of the procedure. The purpose of this prospective, multicenter, longitudinal cohort study was to analyze the early clinical and radiographic results obtained with the Bernese periacetabular osteotomy in the treatment of acetabular dysplasia in adolescent and young adult patients.

METHODS: 473 hips (in 441 patients) were enrolled in this prospective PAO cohort between January 2008 and December 2010 and were analyzed at an average 27 months follow-up. Preoperatively, all patients had hip pain and sufficient hip joint congruency for the PAO. Prospective clinical data including patient demographics, radiographic measurements, and patient-rated outcome scores (Harris Hip, HOOS, WOMAC, and UCLA scores) were collected.

RESULTS: The average age at the time of surgery was 24.8 years (range, 10-54). There were 358 females (76%) and 115 males (24%) with an average BMI of 25 kg/m^2. Comparison of preoperative and follow-up radiographs demonstrated an average improvement of 20.5° (from 8.7° to 29.2°, $p < 0.001$) in the lateral center-edge angle, an average improvement of 23.7° (from 6.2° to 29.9°, $p<0.001$) in the anterior center-edge angle, and an average improvement of 16.2° (from 22.2° to 6.0°, $p<0.001$) in Tönnis angle. The Harris Hip score improved 23.1 points (from 61.4 to 84.4, $p<0.001$). The UCLA score improved 1 point (from 6.7 to 7.3, $p<0.001$). The HOOS Pain score improved 27.8 points (from 56.5 to 84.3, $p<0.001$). The HOOS Symptoms score improved 20.4 points (from 58.8 to 79.2, $p<0.001$). The WOMAC Total score improved 21.6 points (from 66.5 to 88.1, $p<0.001$). At the time of the most recent follow-up, five (1.1%) of the hips had required conversion to total hip arthroplasty.

DISCUSSION AND CONCLUSION: These prospective, multicenter data indicate that at early follow-up, the PAO provides reliable pain relief and improved function in the treatment of

symptomatic acetabular dysplasia. The procedure has a low early conversion rate to total hip replacement and achieves generalizable results in the hands of trained surgeons.

Intermediate Term Results of the Bernese Periacetabular Osteotomy for the Treatment of Acetabular Dysplasia

Abstract ID: Paper 141

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INTRODUCTION: In patients with symptomatic acetabular dysplasia, the Bernese periacetabular osteotomy (PAO) is an effective procedure for deformity correction and early relief of pain and hip dysfunction. There is a paucity of data regarding the intermediate term results of this procedure. The purpose of this study was to analyze the intermediate term clinical and radiographic results obtained with the Bernese periacetabular osteotomy for the treatment of symptomatic acetabular dysplasia in adolescent and young adult patients.

METHODS: Retrospective review of the institution's hip preservation database for patients who underwent PAO for symptomatic acetabular dysplasia was performed. The 246 hips (in 210 patients) that were treated with periacetabular osteotomy from July 1994 through December 2008 with acetabular dysplasia had an average follow-up of 65.5 months (2.4 to 215.3 months). Preoperatively, all patients had hip pain and sufficient hip joint congruency to be considered candidates for the osteotomy. Clinical data including patient demographics, radiographic measurements, and patient-rated outcome scores (Harris Hip score, UCLA) were collected.

RESULTS: The average age of the patient at the time of surgery was 25 years (range, 10-60). There were 162 females (77%) and 48 males (23%) with an average BMI of 25 kg/m^2. Comparison of preoperative and follow-up radiographs demonstrated an average improvement of 19.2° (from 9.9° to 29.1°, $p<0.001$) in the lateral center-edge angle, an average improvement of 25.5° (from 5.0° to 30.5°, $p<0.001$) in the anterior center-edge angle, and an average improvement of 20.3° (from 24.2° to 3.9°, $p<0.001$) in Tönnis angle. The Harris Hip score improved 18.5 points (from 64.2 to 82.7, $p<0.001$) and the UCLA score improved from 6.7 to 7.1 points, $p=0.04$. At the time of the most recent follow-up, nine (3.7%) of the hips had required conversion to total hip arthroplasty, and one hip required revision in the early postoperative period for overcorrection of the deformity and loss of hip flexion.

DISCUSSION AND CONCLUSION: The periacetabular osteotomy is an effective technique for surgical correction of a dysplastic acetabulum in adolescents and young adults. In this series, the intermediate term results were very good with a low conversion rate to total hip arthroplasty.

Rivaroxaban Use for Thrombosis Prophylaxis is an Independent Risk Factor for Periprosthetic Joint Infection

Abstract ID: Paper 142

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INTRODUCTION: Periprosthetic joint infection (PJI) is a disastrous complication after total hip (THA) and total knee arthroplasty (TKA) adding significant morbidity to the patient and cost to the healthcare system. Eliminating risk factors that predispose patients to PJI is therefore critically important. The use of certain agents to prevent deep vein thrombosis (DVT) after arthroplasty has been linked to increased risk of adverse effects including wound bleeding and infection. Rivaroxaban was recently introduced to the alternatives for DVT prophylaxis. Its adverse effects, including infection, were studied in a single community hospital.

METHODS: A retrospective case control study was used for the analysis. An administrative database was used to review all primary THA and TKAs performed at one large volume community hospital during the timeframe for which Rivaroxaban had been used for DVT prophylaxis using ICD-9 codes 81.51 and 81.54 (January 2012 to December 2012). Patients were divided in two groups: study group received Rivaroxaban while the control group received other form of chemical DVT prophylaxis depending of surgeon's preference for at least 2 weeks after surgery. Demographics including age, gender and race, and illness severity score were collected for each group. The primary measured outcome was the incidence of surgical site infection (SSI) within 90 days from the index operation. Student t-test was used to compare continuous variables and a Pearson's chi-square analysis was used for categorical variables.

RESULTS: A total of 779 patients underwent primary TKA or THA during the study timeframe. 163 patients received Rivaroxaban and 616 received other form of chemical prophylaxis. There were no significant differences between groups regarding age, gender, race, or illness severity scores. Incidence of SSI in the Rivaroxaban group was three times higher than the incidence in the control group (n=5 [3.1%] vs. n=2 [0.3%]) ($p<0.001$).

CONCLUSION: The use of Rivaroxaban for DVT prophylaxis led to an increased incidence of SSI in a continuous series of patients undergoing primary THA and TKA procedures in a single institution. This difference was significant, even when controlling for other variables including severity of illness. These findings are different to the ones reported by industry-sponsored studies. As a result of these findings, the use of Rivaroxaban for DVT prophylaxis after arthroplasty was discontinued at this hospital. This medication should be used with caution in the settings mentioned above.

Does Psychotropic Medication Use Affect the Results of Hip Arthroscopy?

Abstract ID: Paper 143

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BACKGROUND: Over the past decade, the use of psychotropic medications (PTMs) by American adults has tripled, and currently, 20% of adult males and 25% of adult females are taking one or more of these antidepressant, antipsychotic, and anti-anxiety drugs. However, to the authors' knowledge, the percentage of hip arthroscopy patients that are using these medications, and the results of hip arthroscopy in these patients have not been reported. Thus, the goals of this study were to determine the prevalence of PTM use in hip arthroscopy patients and to compare their outcomes to those of patients who were not taking PTMs.

METHODS: The medical records of 880 consecutive patients that had hip arthroscopy performed by the senior author were reviewed and data collection included age, gender, arthroscopic findings, arthroscopic procedures performed, and the number and type of psychotropic medications (e.g., antidepressant, antipsychotic, anti-anxiety medications, or mood stabilizers) that a patient was taking at the time of their hip arthroscopy. All of the hips were assessed with Byrd's 100-point modified Harris hip scoring system preoperatively, and at 3, 6, and 12 months after surgery. The pre- and postoperative Modified Harris Hip Scores (MHHS) of the patients using psychotropic medications (PTM patients) were compared to those of patients that were not taking psychotropic medications (NPTM patients). Two sample t-tests were used for data analysis with $p = <0.05$ defined as significant.

RESULTS: 48% of the 880 patients reviewed were taking at least one psychotropic medication (PTM), and 280 patients (32%) were taking two or more PTMs at the time of their hip arthroscopy. Average age of the PTM patients was significantly higher (48 vs. 35 years) than the NPTM patients ($p=0.02$), but average preoperative MHHS for the PTM and NPTM patients (43 and 35 points) did not significantly differ ($p=0.46$). Postoperatively, the PTM and NPTM patients had similar 3-month scores (75 vs. 83 points, $p=0.08$), but the PTM patients had significantly lower 6-month (72 vs. 89 points, $p=0.001$) and one-year scores (77 vs. 91 points, $p=0.001$).

CONCLUSIONS: The incidence of PTM use in hip arthroscopy patients was much higher (48% vs. 20%) than that reported for U.S. adults, and the one-year MHHS of these patients were significantly lower (77 vs. 91 points) than those observed in patients who were not taking PTMs. We believe that it's imperative that each patient's use of PTMs is identified and addressed before proceeding with hip arthroscopy.

Diagnosis of Periprosthetic Joint Infection in Revision Hip Arthroplasty with a Metal-on-Metal Bearing or Corrosion

Abstract ID: Paper 144

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INTRODUCTION: Failed metal on metal (MOM) bearings and corrosion reactions are being increasingly encountered with little to guide evaluation for periprosthetic joint infection (PJI). Our purpose was to determine the utility of the erythrocyte sedimentation rate (ESR), C-Reactive Protein (CRP), synovial fluid white blood cell count (WBC), and differential (%PMN) in diagnosing PJI in failed hips with a MOM bearing or corrosion.

METHODS: We identified 150 revision THA that included a MOM bearing (92, 61%), hip resurfacing (19, 13%) a metal-on-polyethylene bearing with corrosion (30, 20%), or full thickness polyethylene wear with metallosis (9, 6%). 19 Patients (13%) were diagnosed as infected using MSIS criteria. Mean laboratory values were compared between groups and receiver operating curves (ROC) generated with an area under the curve (AUC) to determine test performance and optimal cutoffs. Only synovial fluid samples with both a WBC and differential were included to ensure accuracy of the samples.

RESULTS: The synovial fluid WBC was deemed inaccurate secondary to cellular debris in 47 patients (31.3%); 41 of these were not infected and initially reported with a mean synovial WBC of 16,157 cells/μL before being deemed inaccurate. Infected patients had significantly higher mean serum ESR (50 vs.18 mm/hr), CRP (65 vs. 13 mg/L), synovial fluid WBC (25,547 vs. 1720 cells/μL), and differential (89% vs. 52% PMN) ($p < 0.0001$, all). The best tests for diagnosis of PJI were the synovial fluid WBC (AUC=98%, optimal cutoff 4,350 WBC/μL), and differential (AUC = 90%, optimal cutoff 85%PMN). The ESR and CRP both had good sensitivity.

CONCLUSIONS: The diagnosis of PJI is extremely difficult in patients with metallic bearings or corrosion, and the synovial fluid WBC can frequently be falsely positive. It should only be relied upon if a manual count is done or if a differential can be performed on the sample.

Cigarette Smoking Increases Complication Rate in Forefoot Surgery

Abstract ID: Paper 145

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INTRODUCTION: Cigarette smokers were found to have a significantly higher complication rate (36.4%) in forefoot surgery than patients who previously (16.5%) or never (8.5%) smoked in this retrospective review.

METHODS: Retrospective medical record review on all patients whom underwent forefoot surgical procedures at our institution between years 2008-2010. Patients were classified into three groups. Group I patients had no history of cigarette smoking. Group II patients smoked cigarettes in the past, but stopped prior to date of surgery. Group III patients continued to smoke in the perioperative period. Outcome measures including nonunion, infection, delayed wound healing, delayed union, and persistent pain were recorded while total complications and complication rate were calculated. Chi-Square analysis was performed to determine statistical significance.

RESULTS: 633 patients underwent forefoot procedures in years 2008-2010. Cigarette use could be determined from medical records in 602 patients (95%). Group I contained 457 patients with average follow-up of 15.3 months. Group II and III had 79 patients with 18.4 month follow-up, and 66 patients with 11.6 month follow-up, respectively. The percent of patients with diabetes, rheumatoid arthritis, peripheral vascular disease, and steroid use were similar among all groups. Power analysis confirmed adequate sample size to detect significance. The number of patients with a complication occurring in each group were: Group I – 39 (8.5%), Group II – 13 (16.5%), and Group III – 24 (36.4%). There is a statistically significant ($p<0.0001$) increase in complication rate associated with cigarette smoking. The rate of nonunion, infection, delayed wound healing, delayed union, and persistent pain each showed statistically significant variation among each group. Those patients that continued to smoke in the perioperative period had the highest percentage of delayed union (3.0%), infection (9.1%), delayed wound healing (10.6%), and persistent pain (15.2%).

CONCLUSION: This is the first study to examine complication rate associated with cigarette smoking in forefoot surgery. Cigarette smoking significantly increases complications in those patients undergoing forefoot procedures with 36.4% of current cigarette users suffering a complication. Surgeons should educate patients who smoke cigarettes on the increased incidence of complications prior to forefoot surgery and support those patients through smoking cessation.

Association Between Diabetes, Obesity, and Short-Term Outcomes Among Patients Surgically Treated for Ankle Fractures

Abstract ID: Paper 146

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BACKGROUND: Obesity is now recognized by the American Medical Association as a disease. While obesity is widely accepted as a risk factor for surgical complications following orthopedic surgery, there are mixed results in the literature with regard to the effect of obesity on ankle fracture surgery, particularly in relation to competing risks from diabetes. We hypothesized that obesity would be independently associated with more frequent complications, longer length of stay, and higher costs of care in patients with and without diabetes.

METHODS: Using the 2001-2010 Nationwide Inpatient Sample, we identified all adult patients who underwent surgical treatment for a primary diagnosis of isolated ankle fracture or dislocation. We then divided patients into four groups based on the presence or absence of diabetes or obesity: (a) neither diagnosis, (b) obesity alone, (c) diabetes alone, or (d) both diagnoses. Multivariable regression models were constructed to determine the association between each diagnostic group and in-hospital complications, hospital length of stay, and costs of care while controlling for other conditions.

RESULTS: The final sample included148,483 patients (a=78.4%, b=5.0%, c=13.6%, d=3.0%). The average age was 53.0 years and most patients were female (62.2%) and had a closed-bi-malleolar or tri-malleolar fracture (62.2%). In the unadjusted analysis, in-hospital complications (2.6 vs. 4.2 vs. 5.3 vs. 6.5%, p <0.001), length of stay (3.0 vs. 3.6 vs. 4.4 vs. 4.8 days, p <0.001), and costs of care ($9,686 vs. $10,555 vs. $11,616 vs. $12,804, p <0.001) increased across groups. This trend was also seen for increasing length of stay and costs of care across groups in the adjusted analysis. Similarly, patients with diabetes alone (odds ratio=1.1, 95% confidence=1.0-1.2), obesity alone (1.4, 1.3-1.6), and both diagnoses (1.4, 1.2-1.5) had more frequent in-hospital complications than those without either diagnosis.

CONCLUSIONS: Patients with diagnoses of diabetes and obesity have higher health care utilization and costs in the perioperative period following surgical treatment for ankle fractures than those without. Further study is warranted to identify ways to mitigate the impact of these diagnoses on their perioperative care.

Indirect Shoulder Magnetic Resonance Arthrography: A Novel Technique for Identifying Labral Pathology in Young Patients

Abstract ID: Paper 147

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INTRODUCTION: Direct magnetic resonance arthrography (D-MRI) is the preferred imaging technique for detecting shoulder labral pathology. Indirect magnetic resonance arthrography (I-MRI) has been presented in the adult literature as an alternative to D-MRI, but its use in a pediatric population has not been widely reported. The purpose of this study is to compare the sensitivity of I-MRI to historical D-MRI for detecting shoulder labral pathology in young patients.

METHODS: An IRB approved retrospective review identified 68 cases of shoulder I-MRI preformed at a single pediatric institution from 2010 to 2011, 37 of which had subsequent shoulder arthroscopy findings available for review. A specific I-MRI protocol was consistently followed which included a pre-contrast routine MRI and a post-contrast MRI performed 15 minutes after intravenous contrast administration and mild exercise. Labral pathology was defined as a labral tear or fraying. The images or reports reviewed for labral pathology included the original I-MRI reports generated by the in-house pediatric radiologist, I-MRI images reviewed by a second pediatric radiologist with an interest in musculoskeletal conditions blinded to surgical findings, and operative images and reports. Statistics were used to determine the sensitivity, false negative percentage, and exact binomial 95% lower bound for detecting shoulder labral pathology.

RESULTS: Of the 37 cases included in the study, 32 had labral pathology on arthroscopic examination. Compared to arthroscopic findings, the sensitivity of I-MRI for detecting labral pathology in young patients was 94% (100% for the second radiologist) with a 6% false negative percentage (0% for the second radiologist). The exact binomial lower bound was calculated at 82%.

CONCLUSION: I-MRI is a novel imaging technique for detecting labral pathology in young patients. In this series, the sensitivity of I-MRI for detecting labral pathology of 94% (100% for a second radiologist) was comparable to the historical range reported for D-MRI of 88-100%, the current gold standard. The advantages of I-MRI in a pediatric population include no direct injection in the joint, no radiation exposure, and decreased cost. Clinicians need to be aware that there is an increased risk of false positive radiographic reads for rotator cuff pathology with I-MRI due to enhancement of vascular structures. However, it appears that I-MRI may be a reasonable and less invasive alternative to D-MRI for detecting labral pathology in young patients.

MAOA BREAKOUT SESSION #11
HIP PRESERVATION AND ARTHROPLASTY
April 26, 2014

Does Relief from Intra-Articular Anesthetic Injection Predict Outcome After Hip Arthroscopy?

Abstract ID: Paper 148

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OBJECTIVE: Prior to surgery for femoroacetabular impingement (FAI), intra-articular anesthetic injection is commonly performed as a diagnostic test to localize the source of pain. Currently, there is a paucity of data correlating post-injection pain relief and functional outcomes after hip arthroscopy for FAI. The purpose of this study is to determine whether the amount of pain relief after preoperative intra-articular anesthetic injection predicts clinical and functional outcomes following hip arthroscopy with minimum 1-year follow-up.

METHODS: The records of patients undergoing hip arthroscopy for FAI at our institution between April 2007 and April 2012 were reviewed. Inclusion criteria were: ultrasound or fluoroscopic guided intra-articular anesthetic injection performed at our institution, documented pre- and post-injection Numerical Rating Scale (NRS) pain scores, no prior ipsilateral hip surgery, and minimum 1-year follow-up. Preoperative radiographs were reviewed and degree of osteoarthritis was determined using the Tonnis classification system. Outcomes were assessed with Modified Harris Hip Score (MHHS) and Hip Outcome Score (HOS). Univariate and multivariate models were performed to assess whether percent pain relief correlated with outcome scores.

RESULTS: 57 hips in 55 patients met our inclusion criteria and included 37 females (67%) and 18 males (33%) with a mean age of 42.6 ± 14.7 (range 15-68) years. 8 patients had Tonnis grade 0, 35 had Tonnis grade 1, and 14 had Tonnis grade 2. Mean pain relief after intra-articular injection was 74.4 ± 31.9 (range 0-100) percent. Outcome scores were obtained at a mean 25.5 (range 12- 60) months. Mean MHHS, HOS-ADL, and HOS-Sport scores were 82.1 ± 17.4 (range 42.9-100), 85.0 ± 16.6 (range 39.7-100), and 71.8 ± 28.1 (range 11.1-100), respectively. There was no correlation between percent pain relief and MHHS, HOS-ADL, or HOS-Sport scores. There was no significant difference in outcome scores between those with ≤ 50% and > 50% pain relief. When adjusting for Tonnis grade, there was no correlation between percent relief and any of the outcome scores measured.

CONCLUSIONS: In patients undergoing hip arthroscopy for FAI, our data indicates that the amount of pain relief from intra-articular anesthetic injection does not correlate with minimum 1 year clinical and functional outcomes even when adjusting for Tonnis grade. Although pain relief did not predict outcomes in our study, we still believe it is a useful diagnostic tool to localize the source of pain in patients considering hip arthroscopy.

The Effect of an Acetabular Labral Tear, Repair, Resection, and Reconstruction on the Hip Fluid Seal

Abstract ID: Paper 149

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BACKGROUND: The acetabular labrum is theorized to have an important role in the normal function of the hip by creating intra-articular fluid pressurization and by providing stability to distraction forces through the suction effect through the hip fluid seal. However, the effect of a labral tear or partial labral resection, and interventions including labral repair and labral reconstruction, on the hip fluid seal remain to be defined.

PURPOSE: Our purpose was to characterize the intra-articular fluid pressurization and maximal distractive strength of the hip fluid seal in six different labral conditions: (1) intact, (2) labral tear, (3) labral repair (looped vs. through), (4) partial resection, (5) labral reconstruction with iliotibial band, and (6) complete resection. Additionally, our purpose was to determine the relative contributions of hip capsule and labrum to the distractive stability of the hip.

STUDY DESIGN: Controlled laboratory study.

METHODS: Eight cadaveric hips with a mean age of 47.8 years were included in the study. For each labral condition, the hip was compressed with a force of 2.7 times body weight (2118 N) while intra-articular pressure was continuously measured with 1.0 x 0.3 mm pressure transducers. The hip seal was then broken by distracting the hip at a rate of 0.33 mm/second while the required force, energy, and negative intra-articular pressure were measured. All parameters were normalized relative to the intact state of each hip. Statistical analyses were performed utilizing linear mixed–effects models with repeated measures analysis and several pairwise, predetermined comparisons of labral conditions.

RESULTS: Intra-articular fluid pressurization of the intact state varied from 78 to 422 kPa. Labral tear, partial resection, and complete resection resulted in average pressurization of 75%, 53%, and 24%, respectively compared to the intact state. Through type labral suture repair resulted in significantly greater increases in pressurization from the labral tear state, compared to the looped type repair (median increase; +46.0% vs. -12.1%, p=0.029). Labral reconstruction resulted in a mean pressurization of 110% relative to intact state, with a significant 56% improvement in pressurization compared to partial labral resection (p=0.009). The maximal distraction force required to break the hip seal in the intact labral state (capsule removed) varied from 124 to 150 N. Labral tear, partial resection, and complete resection resulted in average maximal distraction forces of 75.6%, 29.2%, and 26.9%, respectively compared to the intact state. Through type labral repairs resulted in significantly greater improvements in maximal negative pressure generated, compared to looped type repairs (+32.2% vs. -9.4%, p=0.029). Labral reconstruction resulted in a mean maximal distraction force of 66.0%, with a significant improvement of 36.8% compared to partial labral resection (p<0.001).

The relative contribution of the labrum to distractive stability was greatest at 1 and 2 mm of displacement, where it was significantly greater than the role of the capsule and accounted for 80.9% ($p=0.006$) and 77.3% ($p=0.009$) of total distractive stability, respectively. The relative contribution of the capsule to distractive stability increased with progressive displacement, providing 43.6% and 43.8% of distractive stability at 3 mm and 5 mm of distraction.

CONCLUSION: Our study demonstrates that an acetabular labral tear results in variable changes in the hip fluid seal, while partial labral resection consistently causes significant decreases in both intra-articular fluid pressurization and stability to distraction forces. Through type labral repair restores the hip fluid seal function better than looped type repairs at time zero. Labral reconstruction significantly improves pressurization and stability to distraction, compared to partial labral resection.

2-14 Year Clinical and Functional Outcomes After Isolated Arthroscopic Hip Labral Debridement

Abstract ID: Paper 150

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OBJECTIVE: The purpose of this study is to (1) report the rate of failure of labral debridement as defined by subsequent surgery, (2) report clinical and functional outcomes after labral debridement with a minimum two-year follow-up, and (3) to identify risk factors for worse clinical and functional outcomes.

METHODS: The records of patients undergoing arthroscopic labral debridement for the treatment of a labral tear at our institution between March 1996 and October 2010 were reviewed. Inclusion criteria were: age 18 or older, no concomitant surgical procedure other than chondroplasty, and no prior hip surgery. Age, gender, coxa profunda, Tonnis grade, presence of FAI and subchondral cysts or edema on MRI, and treatment of chondral lesions were documented. Kaplan Meier estimate of failure (defined as subsequent surgery) was performed for all patients. Patients with minimum 2-year follow-up were assessed with Modified Harris Hip Score (MHHS) and Hip Outcome Score (HOS). Univariate analysis was then performed to assess which factors were associated with worse clinical and functional outcomes.

RESULTS: 59 hips in 57 patients met our inclusion criteria and included 39 females (68%) and 18 males (32%) with a mean age of 46.2 ± 13.6 (range 18-73) years. 12 hips (20%) failed at a mean 23 (range 6-60) months (7 total hip arthroplasties, 2 open revisions, 3 arthroscopic revisions). Kaplan-Meier 2 and 3 year survival estimates were 88% (95% CI 79%-97%) and 84% (95% CI 75%-94%), respectively (Figure 1). The 3-year estimates for survival free of failure showed no significant association between any analyzed risk factor and the risk of failure.

Of the remaining 47 hips, 44 had minimum 2 year outcome scores with a mean follow-up of 5 (range 2-14) years. Mean MHHS score was 83.4 ± 19.7 with 29 of 44 (66%) reporting good or excellent outcomes (score ≥ 80). Mean HOS ADL score was 83.8 ± 21.3, and mean HOS sport score was 70.6 ± 32.9 with 33 of 41 (75%) reporting normal or nearly normal current level of function. Univariate analysis revealed no significant association of any analyzed factor with worse outcome scores.

CONCLUSIONS: Arthroscopic labral debridement for hip labral tears had positive clinical and functional outcomes for the majority of patients. No analyzed factors were associated with increased risk of failure or worse outcomes.

Figure 1: 5-year Kaplan-Meier survival plot

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Comparison of the Amount of Iliopsoas Tendon Lengthening that Occurs After Arthroscopic Labral-Level and Lesser Trochanteric Tenotomies

Abstract ID: Paper 151

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BACKGROUND: The success of arthroscopic iliopsoas tenotomies (AITs) performed at the level of the lesser trochanter for treatment of a painful snapping tendon is well documented. Currently, iliopsoas labral-level tenotomies have been advocated for treatment of this problem. However, a recent study reported a high incidence (~50%) of recurrent snapping after iliopsoas tendon (IT) releases at this level (1). The purpose of this study was to determine if there is a difference in the amount of tendon separation/lengthening following AITs at the labral and lesser trochanteric levels. To date, the amount of tendon separation that occurs after releases at these two sites has not been reported.

METHODS: From the senior author's data base of 1,000 hip arthroscopies, 80 patients who had arthroscopic iliopsoas tenotomies performed: (1) at the level of the labrum [40 patients], or (2) at the lesser trochanter [40 patients] were identified. The amount of tendon separation/lengthening in these 80 patients was determined either from direct intraoperative measurements (40 patients) or from measurements made off of the intraoperative photographs. Image magnification on the intraoperative photographs was controlled for by basing the measurements of tendon separation on the known dimensions of the radiofrequency probe or 5 mm cannula that was present in each iliopsoas release picture. Two sample t-tests were used for data analysis with $p = <0.05$ defined as significant.

RESULTS: Average age of the 40 patients with labral-level (LL) tenotomies was 36 years (range 16-58 years), and there were 9 males and 31 females and 19 left and 21 right hips in this group. Average age of the 40 patients with lesser trochanteric (LT) tenotomies was 32 years (range 17-55 years), and there were 8 males and 32 females, and 11 left and 29 right hips in this group. In the LL tenotomy group, the average tendon separation was 8.3 ± 2.04 mm. In the LT tenotomy group, the average tendon separation was 13.3 ± 3.01 mm. The 0.5 cm difference in the amount of tendon separation between the two groups was statistically significant at the $p<0.001$ level.

CONCLUSIONS: An arthroscopic, lesser trochanteric iliopsoas tenotomy produces significantly greater (0.5 cm) tendon separation than tenotomies performed at the level of the labrum. The difference in the amount of tendon separation that occurs at these two sites may explain the high rates of recurrent snapping (~50%) that have been reported with arthroscopic and open labral-level releases.

Figure 1: Measurements of iliopsoas tendon separation were made at the level of the labrum (upper photos), and at the insertion of the tendon on the lesser trochanter (lower photos). Image magnification was controlled for by basing the measurements of tendon separation on the known dimensions of the radiofrequency probe that was present in each iliopsoas release picture.

HYPOTHESIS: Release of the iliopsoas tendon at the lesser trochanter will result in greater tendon separation/lengthening than a release performed at the level of the labrum.

Keywords: Iliopsoas, hip, arthroscopy, coxa saltans

This study comparing arthroscopic labral level and lesser trochanteric iliopsoas tenotomies found that there is significantly greater tendon separation (0.5 cm) with lesser trochanteric tenotomies. The difference in tendon separation that occurs at these two sites may explain the high rates of recurrent snapping (~50%) that have been reported with arthroscopic and open proximal releases.

An arthroscopic, lesser trochanteric iliopsoas tenotomy produces significantly greater (0.5 cm) tendon separation than tenotomies performed at the level of the labrum. The difference in the amount of tendon separation that occurs at these two sites may explain the high rates of recurrent snapping (~50%) that have been reported with arthroscopic and open proximal releases.

Click here to view Figure

Treatment of Femoral Acetabular Impingement with Reverse Periacetabular Osteotomy

Abstract ID: Paper 152

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BACKGROUND: Retroversion of the acetabulum has been associated with femoral acetabular impingement (FAI) in the young patient. In the setting of relative posterior acetabular under coverage, a reverse periacetabular osteotomy (RPAO) has been recommended as a treatment option for managing this patient group. The goal of this paper is to report the clinical and radiographic results of RPAO in patients with FAI secondary to pure acetabular retroversion.

METHODS: A retrospective review of 27 patients (34 hips) (26 females and 8 males, average age 22 (12-47) undergoing reverse PAO for pure acetabular retroversion at 2 institutions was conducted. Dysplastic hips (LCE < 20), and those hips done for iatrogenic retroversion were excluded. Acetabular retroversion was diagnosed clinically and with the following radiographic findings: (+) cross over, (+) ischial and (+) posterior wall signs on a standardized AP pelvic radiograph. Preoperatively, 21 patients were Tonnis 0 and 13 were Tonnis 1. The average follow-up was 3.3 years (1-10). At the time of PAO, an arthrotomy was concomitantly performed in 33 hips with 19 osteochondroplasties and 3 with labral work. Pre- and postoperative Harris hip scores were recorded along with radiographic evaluation at last follow-up.

RESULTS: At an average of 3.3 years (range 1 to 10), Harris hip scores improved from 64.6 (24.8-71) preoperatively to 91.3 (44-99) postoperatively. One patient required a THA and 1 hip underwent hip arthroscopy for a labral tear. Complications included 1 DVT, 1 superficial wound infection and variable concerns with LFCN symptoms, none that required treatment. On postoperative radiographs, all osteotomies healed with the exception of the pubis in 2/34, the cross-over sign was present in 4/34, the posterior wall sign was negative in 31/34, and there was no change in LCE Angle (preoperatively 30.9 (21.3-57.5) and postoperatively is 30.5 (21.5-35.8). Only one patient progressed to Tonnis 2 at latest follow-up and required THA.

CONCLUSION: To the authors' knowledge, this is the largest series of reverse PAO performed for pure acetabular retroversion. It provides a safe and clinical effective way of treating the structural problem that leads to FAI in the presence of posterior undercoverage, without compromising hip stability.

Transfusion Rate After Periacetabular Osteotomy in the Absence of Mandatory Autologous Blood Donation

Abstract ID: Paper 153

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INTRODUCTION: The Bernese periacetabular osteotomy (PAO) has gained favor as treatment for symptomatic adolescent and young adult hip dysplasia in the absence of arthritic changes. Blood loss remains a risk during the operation, and several reports have cited average blood losses ranging from 350 to 2000 milliliters. Postoperative allograft blood transfusion rates have been reported as high as 20%. In an attempt to prevent allograft transfusions, some institutions encourage autologous blood donation prior to the scheduled surgical date. This may incur undo costs if the autologous blood remains unused. The purpose of this study was to investigate the rate of allograft blood transfusion after PAO at an institution that does not require preoperative donation of autologous blood.

METHODS: Medical records of patients who underwent PAO by a single surgeon at a single institution from March 2011-February 2013 were retrospectively reviewed. Parameters recorded included sex, age, weight, BMI, length of procedure, average intraoperative systolic and diastolic blood pressures, intraoperative fluids, estimated blood loss, intraoperative cell saver administered, preoperative hemoglobin, postoperative hemoglobin levels within four days of surgery, number of units of allograft blood transfused in the acute postoperative period, and any concurrent or prior procedures to the affected hip. Transfusion criteria included symptomatic anemia (hemoglobin less than 8.0 g/dL).

RESULTS: There were 156 consecutive patients at an average age of 22 years. Average length of procedure was 2 hours 56 minutes. Average estimated blood loss was 332 mL. All procedures utilized cell saver and 84% of the patients received autologous blood recovered from cell saver at an average yield of 161 mL. Average intraoperative fluid administered, excluding blood products, was 2266 mL. Average preoperative hemoglobin was 13.7 g/dL. Nine patients received intraoperative or postoperative allograft blood transfusions. Thus, the transfusion rate was 5.8%. The lowest average hemoglobin in the acute postoperative period was 9.7 g/dL. There were no complications related to blood loss anemia. By not requiring autologous blood donation preoperatively, this institution saves an average of $174 per patient.

CONCLUSIONS: The low rate of allograft blood transfusion after PAO observed at this institution may be due to less blood loss, the routine use of cell saver, and stricter criteria for transfusing allograft blood. The low rate of allograft transfusion provides argument against routine preoperative donation of autologous blood, which may help to decrease costs.

A Comparison of Radiographic Acetabular Measurements in Elderly Patients with and without Osteoarthritis

Abstract ID: Paper 154

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INTRODUCTION: To our knowledge, there is limited or no data available pertaining to normal values for measuring CEA, AI, and D:W ratio in elderly patients or in comparison to patients with OA. The purpose of this article is to analyze the anatomical similarities and differences of the acetabulum between elderly patients with hip OA scheduled for total hip arthroplasty and without OA who presented with a femoral neck fracture to our institution who had no OA, and to compare these parameters to previously identified normal reference ranges.

METHODS: An IRB-approved retrospective review was done on 285 AP pelvic radiographs, 142 patients who had a femoral neck fractures (patients with OA were excluded) and 143 patients with OA of the hip scheduled for THA. Two independent observers measured CE angle, acetabular index, and acetabular depth:width ratio between the 2 groups. The non-OA group consisted of 50 male and 92 female patients average age 73. The OA group was 68 male, 75 female patients average age 58 range (33-85). The effect of diagnosis (OA or fracture) and gender was evaluated with a two-way ANOVA, with post-hoc Fisher's LSD test.

RESULTS: There was no difference in AI (34.955 F vs. 38.952 OA) ($p=0.764$) or CE angle (36.082 F vs. 31.304 OA) between the 2 groups. ($p=0.302$). Non OA patients (0.278 vs. 0.314 OA) had a significantly higher DW ratio than did OA patients (0.278 F vs. 0.314 OA) ($p<0.001$). Depth:Width CE angle ratio increased significantly with age in both the entire sample, and in the female-only subgroup ($p<0.008$); in neither case did the adjusted r^2 for the regression exceed 0.039 (see figure).

DISCUSSION AND CONCLUSION: The values obtained in this study for both groups are within the normal reference range of CE angle and AI for by Fowkes et al. The average measurements for CE angle Acetabular Index were not distinguishable between the osteoarthritic and non-osteoarthritic hips. However, DW ratio was significantly different and may be a factor in the development or result from the development of osteoarthritis.

Click here to view Table

Prevalence of Femoroacetabular Impingement Imaging Findings in Asymptomatic Volunteers: A Systematic Review

Abstract ID: Paper 155

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PURPOSE: To determine the prevalence of radiographic findings suggestive of femoroacetabular impingement (FAI) in asymptomatic volunteers.

METHODS: A systematic review was performed using PRISMA guidelines. Studies reporting x-ray, computed tomography (CT), and/or magnetic resonance imaging (MRI) findings suggestive of FAI in asymptomatic volunteers were included. Cam, pincer, and combined pathologies were investigated.

RESULTS: We identified 26 studies for inclusion, comprising 2,114 asymptomatic hips (57.2% male; 42.8% female). The mean alpha angle in asymptomatic hips was 54.1º. The prevalence of an asymptomatic cam deformity was 37% (range 7-100% between studies). Of the 17 studies that measured alpha angles, 9 used MRI and 9 used x-ray (1 study used both). The mean lateral and anterior center-edge angles (CEA) were 31.2º and 30º, respectively. The prevalence of asymptomatic hips with pincer lesions was 67% (range 61-76% between studies). Pincer deformity was poorly defined (4 studies; 15%) (focal anterior undercoverage, acetabular retroversion, abnormal CEA or acetabular index, coxa profunda, acetabular protrusio, ischial spine sign, crossover sign, and posterior wall sign). Labral injury was found on MRI in 68.1% of hips.

CONCLUSIONS: The prevalence of radiographic abnormalities suggestive of FAI in asymptomatic patients was 37% for cam deformities and 67% for pincer deformities. Labral injury was determined to be 68.1% on MRI. Cam and pincer morphology is common in asymptomatic patients, but FAI is a clinical diagnosis. Patient history and physical examination must be used in addition to imaging studies to meet the criteria of FAI.

Recent National Trends and Outcomes for Hip Resurfacing in the United States

Abstract ID: Paper 156

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INTRODUCTION: Hip resurfacing (HR) is an alternative to total hip arthroplasty (THA) for treating hip arthritis in select patient populations. Controversy exists though regarding its results and clinical benefits, particularly given the recent well-publicized problems with other metal-on-metal implants. The purpose of this study was to assess recent national trends in HR in the United States (US) and to evaluate patient outcomes for this treatment group.

METHODS: International Classification of Disease - 9th Revision (ICD-9) procedure codes were used to search the National Hospital Discharge Survey (NHDS) for patients admitted to surveyed U.S. hospitals after HR or primary THA for each year from 2007-2010. Data regarding patient demographics, hospitalization length, discharge disposition, blood transfusions, lower extremity deep venous thrombosis (DVT), pulmonary embolism (PE), mortality, and hospital size/location were gathered from the NHDS. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test and the z-test for proportions with alpha=0.05.

RESULTS: 153 patients admitted for HR were identified. 6,216 patients were admitted for THA during the same 4-year interval. The use of HR demonstrated a strong negative correlation with time (r=0.94), accounting for an average 3.1% of primary hip arthroplasty cases between 2007-2008, but significantly decreasing to an 1.7% between 2009-2010 ($p<0.01$). Hospital size was found to significantly impact the utilization of HR ($p<0.01$), with the lowest rate in hospitals under 100 beds (1.1%) and the highest rate in those with 200-299 beds (4.6%). No significant difference in HR use was found based on the hospital's region of the country (p=0.76). The mean age of HR patients was 49.6 years (range 28-70). This group included 113 men and 40 women. The THA group had a mean patient age that was significantly higher at 64.9 years ($p<0.01$) and included 2,805 men and 3,411 women. Gender was significantly different ($p<0.01$) between the HR and THA groups. The average hospitalization length for HR was 3.2 days (range 2-8), which was significantly shorter than the average length for the THA group (3.6 days, range 1-68, p=0.04). The rate of blood transfusion was significantly lower in the HR group (10.5%) vs. the THA group (22.4%, $p<0.01$). There were significantly fewer DVT in the HR group (0%) vs. THA (0.29%, $p<0.01$), but no difference in PE (0.65% vs. 0.24%, p=0.53) was seen. Mortality was significantly less for HR (0%) vs. THA (0.18%, $p<0.01$) as well. Discharge disposition significantly varied based on surgical status, with 89.4% of HR patients able to go directly home after their inpatient stay, compared to only 66.0% of THA patients ($p<0.01$).

DISCUSSION AND CONCLUSION: This study demonstrates that HR in relatively young male patients is associated with short hospital stays, few perioperative complications, and minimal postoperative rehabilitation requirements. Despite these favorable results, the use of HR appears to be declining in the U.S., decreasing nearly 45% over the past 4 years. Interestingly, the utilization of HR demonstrated variability based on hospital size. The reasons for this are not immediately clear, but may be related to differences in availability of joint reconstruction sub-specialists.

Total Hip Arthroplasty in the Pediatric Population

Abstract ID: Paper 157

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INTRODUCTION: Historically, the most common indication for total hip arthroplasty (THA) in young patients was inflammatory arthritis. However, disease-modifying anti-rheumatic drugs, have dramatically improved the clinical course of these patients. The purpose of this study was to examine the etiologies of end-stage hip pathology in pediatric patients undergoing THAs, and how these indications have changed over time.

METHODS: This is an IRB approved retrospective analysis of all patients referred to and treated at our institution with hip pathology between 1983 and 2012. All patients who underwent THA prior to age 20 were included for the purposes of this analysis. Patients were categorized into three groups based on the year of their THA (Group 1: 1984-1993, Group 2: 1994-2003, Group 3: 2004-2012). The principle diagnoses, and re-operation for any reason at final follow-up were recorded. Statistical analysis was performed using the t-test and Fisher's exact test.

RESULTS: Forty-six (32 female, 14 male) patients underwent 55 THAs. The mean age at surgery was 16.4 years (11-19 years). There were 9 THAs in Group 1, 13 THAs in Group 2, and 33 THAs in Group 3. All patients in Group 1 underwent THA for inflammatory arthritis. In Group 3, 7 patients (21%) underwent THA for inflammatory arthritis, which was lower than Group 1 (100%, $p=0.0001$) and Group 2 (69.2%, $p<0.01$). The most common reason for THA in Group 3 was developmental dysplasia of the hip (30.3%). Five patients (15.2%) in Group 3, and 3 patients (23.1%) in Group 2 underwent THAs for osteonecrosis. Other etiologies of end-stage arthrosis included septic arthritis, Legg-Calve-Perthes disease, slipped capital femoral epiphysis, post-traumatic arthritis, and idiopathic chondrolysis.

DISCUSSION: Although the most common indication for THA in pediatric patients has historically been inflammatory arthritis, that has changed significantly over the past 30 years. The number of pediatric patients undergoing THA has not decreased; however, the etiologies of end-stage arthrosis leading to THA have changed over this time period.

MAOA BREAKOUT SESSION #12
PEDIATRIC AND ADULT TRAUMA
April 26, 2014

Complications Following Operative Treatment in Pediatric Both Bone Forearm Fractures

Abstract ID: Paper 158

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INTRODUCTION: Pediatric ulnar and radial shaft fractures are common injuries. Even though most fractures can be treated conservatively, they are also the most common reason for operative treatment. Elastic stable intramedullary nailing (ESIN) is the preferred method in the pediatric population, but also plate fixation methods are applied, if a more anatomic and stable correction of malrotation or malangulation is needed. The purpose of this study was to determine complications after operative treatment of pediatric both bone forearm fractures.

METHODS: Between 2003 and 2012, 83 consecutive children with operatively treated both bone diaphyseal forearm fractures were retrospectively analyzed at a Level I trauma center and followed in a large orthopedic practice. Included fractures had either follow-up >2 months or had a union by x-ray with removed hardware. 79 consecutive patients with 80 diaphyseal both bone forearm fractures were included. Age averaged 11.8 years (range 5-15 years) in 50 (63%) males and 29 (37%) females. 19 (24%) fractures were open. 59 (74%) fractures in children with mean age 11 years (range 5-15) were treated using an ESIN. 17 (21%) fractures in children with mean age of 14 years (12-15) were treated with open reduction and internal plate fixation. 4 (5%) fractures were stabilized with both techniques. Follow-up averaged 6.6 months (range 1-54).

RESULTS: Three (4%) children had neurologic complications due to the injury. Nine (15%) fractures treated with ESIN had complications: 3 (5%) superficial wound infections, 3 (5%) refractures, 2 (3%) malunion, 1 (2%) extensor pollicis longus tendon rupture, and 1 (2%) compartment syndrome. One (6%) compartment syndrome was observed in one fracture treated with internal plate fixation (ORIF). No complications occurred in the four fractures, which were treated with both techniques. Hardware removal was performed in 59 (100%) ESIN and 3 (18%) ORIF at 4.5 months (range 1-52). Refractures occurred at 4.8 months (range 4-6). The average time to hardware removal in these patients was 2.6 months (range 2.5-2.8). Malunion occurred in 2 children, age 12 and 13 years, treated with ESIN. Six (10%) children treated with ESIN and 2 (12%) treated with plates, had limited range of motion on their final follow-up.

CONCLUSION: Both bone forearm fractures are common injuries in children. The majority of operatively treated fractures are successfully treated using ESIN. In older children, in whom the remodeling potential is limited and plates allow a more stable fixation, fractures were successfully treated with open reduction and internal plate fixation. ESIN had three refractures, which might be avoided by a later hardware removal after the 3 months interval.

Functional Outcomes After Adolescent Clavicle Fractures

Abstract ID: Paper 159

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PURPOSE: Adolescent clavicle fractures have traditionally been treated nonsurgically. Recent evidence suggests that displaced mid-shaft clavicle fractures in adults may benefit from surgical treatment. Little literature exists concerning outcomes after treatment of similar fractures in adolescents. The purpose of this study is to evaluate the subjective and objective outcomes following unilateral displaced clavicle fractures in adolescents and compare these results to radiographic findings at time of injury.

METHODS: Patients between 10-17 years old who sustained displaced mid-shaft clavicle fractures 1-5 years ago were identified and measurements from clavicle radiographs at time of injury were made including shortening, displacement, and length. Subjects completed the Nottingham Clavicle Score (NCS) to determine subjective function and a custom questionnaire was used to obtain demographic and sports-related information. Fracture and non-fracture side Constant Murley Shoulder scores (CMSS) were obtained by a single blinded PT and compared using a non-parametric Wilcoxon Signed Rank Test (WSRP). Pearson product moment correlations were used to determine the relationship significance between the NCS, CMSS, and radiographic measurements. Alpha value $P < 0.05$ was selected to indicate statistical significance.

RESULTS: 29 subjects completed the NCS (23:6 male:female). Of these, 17/29 (13:4 male:female) underwent clinical examination. 3/29 underwent ORIF, and 1/17 underwent ORIF. Average age at time of clavicle fracture was 14.0 ± 1.9 years. Time since fracture was 27.8 ± 10.8 (range = 12.5-58.3) months. Average shortening of fracture was 1.1 ± 0.6 (range = 0-2.4) cm, and average percent shortened was 7.6% ± 3.4% (range 0 - 13%). CMS scores were lower on the side of clavicle fracture (86.5 ± 12.6 vs. 92.1 ± 4.3, WSRP $P = 0.03$). The NCS revealed a moderately strong inverse relationship with clavicle shortening ($r = -0.65$) and displacement ($r = -0.67$) measurements. CMSS did not display statistically significant relationships with NCS or radiographic measurements.

CONCLUSIONS: Radiographic measurements of clavicle shortening and displacement were found to have strong relationships with the NCS; increasing fracture severity (shortened or displaced) was associated with worse subjective outcomes. However, increased shortening or displacement was not associated with worse scores on the more objective CMSS. This study reveals that some adolescent clavicle fractures may cause long-term subjective sequelae especially in those with more shortening or displacement. The effect of clavicle fractures on objective outcomes was not significant. Data collection continues in order to increase samples size and to discern between surgical and nonsurgical treatment using statistical methods.

Excision of Partial Physeal Arrest Followed to Skeletal Maturity

Abstract ID: Paper 160

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BACKGROUND: Partial physeal arrest resection has been performed since 1967 to successfully restore growth to the injured physis in skeletally immature patients. However, there are no previous publications reporting the results of a series of patients undergoing partial physeal arrest resection followed to skeletal maturity. It is our hypothesis that in patients followed to skeletal maturity, there will be a significant number of patients in whom physeal growth occurs at a rate slower than the contralateral normal physis, a significant number of patients in whom the physeal arrest recurs, and a significant number of patients who require additional surgery.

METHODS: A prospective study of 98 patients followed to skeletal maturity following partial physeal arrest resection was performed. Partial arrest occurred in the distal femur in 43 patients, proximal tibia in 18, and distal tibia in 37 patients. Surgical excision and interposition of polymethylmethacrylate (Cranioplast) were performed in all cases. Sex, age, etiology, limb length, angular deformity, growth, and percent physeal involvement were recorded.

RESULTS: Compared to the normal contralateral physis, average physeal growth following physeal arrest resection was 78% in the femur, 88% in the proximal tibia, and 93% in the distal tibia. Area of physeal arrest was greater than 45% in 17 patients, greater than 30% in 20, and less than 30% in 61 patients. Additional operations included epiphyseodesis in 43, osteotomies in 38, lengthening in 16, and repeat physeal arrest excision in 21 patients, for an average of 1.2 additional surgeries per patient. Two patients fractured through resection sites.

CONCLUSIONS: Following partial physeal arrest resection, the affected physis grows at a slower rate and matures earlier than the normal physis. Virtually all patients will require additional surgery to correct length or alignment.

Does the Pediatric Pelvic Fracture Pattern Affect the Presence of Associated Injuries?

Abstract ID: Paper 161

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INTRODUCTION: Pediatric pelvis fractures are serious high impact injuries. Severe associated injuries are often present, and multidisciplinary trauma treatment is required. Associated injuries are often more life-threatening than the fracture of the pelvis itself. The purpose of this study was to determine whether the pelvis fracture pattern in children affected the presence of associated injuries.

METHODS: 133 consecutive pediatric pelvic fractures from 2002 through 2011 were retrospectively analyzed at a Level 1 teaching trauma center and followed in a large orthopedic private practice. Exclusion criteria were age >16 years, isolated coccygeal (1), and acetabular fractures (13). The study sample consisted of 119 children, age 11.5 years (2-16). Fractures were classified according to AO/OTA classification as 29 A1, 23 A2, 1 A3, 4 B1, 44 B2, 16 B3, and 2 C2 fractures. 29 avulsion fractures (AO/OTA A1) were analyzed separately. OTA B and C fractures were further classified as 26 LC1 (lateral-compression), 20 LC2, 10 LC3, 4 APC1 (anterior-posterior-compression), 5 APC2, and 1 VS (vertical-shear) injuries according to Young and Burgess. Mechanism of injury, Injury Severity Score (ISS), Glasgow Coma Score (GCS), length of hospital stay, transfusion requirement, deaths and, associated injuries were analyzed.

RESULTS: 71 (79%) injuries were caused by traffic accidents. Four (4%) fractures were open. Averaged ISS was 22 (1-66). 88 (98%) children were admitted to the hospital with an average length of stay of six days (1-39). Eighteen (20.0%) children required blood transfusion. Two (2%) died secondary to their associated injuries. 73 (81%) had associated injuries of the head 49% (44), thorax 46% (41), abdomen 38% (34), urinary tract 16% (14), extremities 30% (27), acetabulum 23% (21), and spine 8% (7). Additional surgery for associated injuries was required in 39 (43%). Two (2%) children required an interventional embolization and one (1.1%) operative treatment for an intrapelvic arterial injury. AO/OTA B and C fractures had a significantly higher ISS than OTA A fractures (24 vs. 15, p=0.013). AO/OTA B fractures had higher rates of injuries of the head (55% vs. 33%), abdomen (42% vs. 25%), urinary tract (19% vs. 8%), and extremities (8% vs. 17%) than OTA A fractures. 32 (57%) of children with LC fractures and 4 (44%) with APC fractures sustained injuries of the head. APC fractures were more likely to sustain thorax trauma (67% vs. 43%), urinary tract (33% vs. 16%), genital (11% vs. 4%), and lower extremity injuries (44% vs. 16%) compared to LC fractures.

CONCLUSION: The majority of pediatric pelvis fractures are caused by traffic accidents. Treatment for associated injuries was required in over 40% with polytrauma. The complexity of the pelvis fracture is concomitant with associated injuries. APC fractures demonstrated higher rates of injuries to the lower body than LC fractures.

Distal Femoral Physeal Fractures: Radiographic Features that Influence Outcome

Abstract ID: Paper 162

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INTRODUCTION: Distal femoral physeal injuries pose unique challenges to treating physicians. The distal femoral physis is responsible for the largest proportion of longitudinal growth of the lower extremity and injuries resulting in growth arrest can result in substantial leg length discrepancy and/or angular deformity. Several studies have identified factors that contribute to poor outcomes in these injuries including the presence of displacement; however, little data exist which correlates the degree and direction of fracture displacement to growth arrest. The goal of our study was to identify radiographic factors associated with growth arrest after traumatic insult to the distal femoral physis.

METHODS: A retrospective review of clinical and radiographic data was conducted on patients with distal femoral physeal fractures treated at our facility from May 2001 to October 2011. Using CPT and ICD-9 codes from billing records, skeletally immature patients with distal femoral physeal fractures were identified. In addition, clinical records were retrieved for each patient included in the study. Patients that were skeletally mature did not have distal femoral physeal fractures, and those without adequate clinical follow-up were excluded from the study. For patients included in the study, a detailed analysis and measurement of radiographic parameters including gross displacement and percentage displacement relative to physeal length in the coronal and sagittal planes was undertaken in order to identify features associated with growth disturbances.

RESULTS:119 distal femur fractures identified. 36 patients (37 fractures) met the inclusion criteria. 14/37 (37.8%) of distal femoral physeal fractures developed growth disturbance. Physeal growth arrest was seen 6/12 (50%) SH1 fractures, 7/20 (35%) SH2 fractures, 0/1 (0%) SH3 fractures, and ¼ (25%) of SH4 fractures. The average age of patients with and without growth disturbance was 10.5 and 12 respectively. Coronal displacement showed direct correlation to physeal growth disturbance. Average initial displacement and displacement relative to physeal length in the coronal plane was higher in the growth arrest group. Sagittal displacement showed no correlation to physeal growth arrest. Average sagittal displacement and percentage displacement in the sagittal plane were both higher in the non-arrest group.

CONCLUSION: Identifying risk factors for poor outcomes in these injuries is an important task for treating physicians. Displacement in the coronal plane showed higher incidence of growth arrest which can have profound prognostic implications.

Pediatric Talar Fractures

Abstract ID: Paper 163

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INTRODUCTION: Little is reported about pediatric talar fractures. Because of the remodeling potential in the growing foot, treatment is usually based on the severity of the fracture and the age of the child. Due to higher activity levels and high intensity sports, more complex fractures of the foot, including the talus with coexisting injuries, are seen. Even though severe long-time complications are less likely in pediatrics than in adults, avascular necrosis as well as arthrosis of the surrounding joints occurs. Resulting pain syndromes and decreased mobility may need further treatment such as arthrodesis. The purpose of this study was to determine the clinical and radiographic outcomes following pediatric talar fractures.

METHODS: From 2002 to 2010, 52 consecutive children with 54 talar fractures were retrospectively evaluated. The data of 26 children with 28 fractures was available for follow-up > 6 months (mean follow-up 32 months, range 6-95). Patients (6) who had follow-up 6-12 months had no signs of avascular necrosis (Hawkins sign on a radiograph) on their final follow-up. Associated injuries, conservative and operative treatment, and complications were recorded. Nonunion, infection, and avascular necrosis (AVN), as well as final clinical and radiographic outcome concerning arthrosis signs, arthrodesis, range of motion (ROM), pain, and pain medication were determined.

RESULTS: Age averaged 14.2 years (4–18). 64% (18) fractures were caused by high-energy trauma. Two (7.1%) fractures were open. 19 (73.1%) children had associated injuries. Fractures were classified according to Marti-Weber as 12 (42.9%) Type 1, 6 (21.4%) Type 2, 3 (10.7%) Type 3, and 7 (25.0%) Type 4 fractures. Neck fractures were classified according to Hawkins as 6 (21.4%) Type 1, 3 (10.7%) Type 2, and 5 (17.9%) Type 3 fractures. Five fractures (17.9%) were treated conservative and 23 (82.1%) operative. Nonunion occurred in three fractures (10.7%), one talar neck, and two talar dome fractures, which resulted in ostechondrosis dissecans (OD). Nonunion was treated with repeat open reduction and internal fixation. ODs were either treated with subchondral drilling or osteochondral allograft transplantation. AVN of the talus occurred in three fractures (10.7%), one Hawkins Type 1, and two Type 3 fractures. One AVN had no further treatment, one subtalar and ankle fusion, and one talar dome excision with allograft reconstruction were performed. 42.9% (12) showed arthrosis in at least one of the surrounding joints. One ankle fusion and one talar with ankle fusion occurred. Ankle ROM averaged 19.5° (0-35) dorsiflexion and 37.1° (0-45) plantarflexion. 10 subtalar joints had < 50% ROM. 12 children (46.2%) had persistent pain on their final follow-up, of whom four (15.4%) used pain medication regularly (3 NSAIDs, 1 narcotics).

CONCLUSION: Pediatric talar fractures are severe injuries of the foot. Although potential remodeling of the foot is present, severe long-term complications occur and may require joint arthrodesis even in pediatric populations. Anatomic reduction and fixation is necessary to reduce the rate of long-term complications.

Is the Axillary Nerve at Risk During a Deltoid-Splitting Approach for Proximal Humerus Fractures?

Abstract ID: Paper 164

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INTRODUCTION: A paucity of literature exists describing the specific risks placed upon the axillary nerve by the deltoid-splitting approach utilized for proximal humerus fractures. While the nerve may be identified to avoid iatrogenic injury, the strain and micro-trauma to the nerve could increase risk of a neuropraxia. The purpose of this study is to evaluate the change in length and strain of the axillary nerve during the deltoid-splitting approach. Histologic analysis of the nerve was also performed.

METHODS: Ten fresh-frozen cadaver specimens were secured onto a shoulder jig and maintained in the beach chair position. An incision was made and the axillary nerve identified. Two suture tags were placed along the nerve edges. The distance between the two tags was measured and recorded after each expansion click of a Kolbel retractor until fully expanded (6 clicks). The retractor was then released in 30-minute intervals and subsequently fully expanded again for a total time of 2 hours. The section of the nerve crossing the field of exposure and a more proximal control section was excised for histologic. Specimens were embedded in paraffin and plastic, then stained with H&E and toluidine blue. The strain at each interval measurement was calculated as change in length over initial starting distance.

RESULTS: The location of the nerve was 6.32 cm (range 5.20-7.6) from the anterolateral aspect of the acromion. The specimens demonstrated a mean change in length of 8.42 mm (range 6.43- 12.26). After the retractor was released at the first 30-minute interval, the strain initially decreased to a mean of 29% (range 14 -52%) while distance between the two tags decreased by 3.25 mm (range 1.46-6.41). This represented 19% of the distance measured prior to release. On each subsequent measurement, strain continued to increase until a final mean of 51% (range:28-99%). Thus, the final length of the nerve accompanied by the increasing strain demonstrated the nerve never recovered to original length. Pathologic analysis confirmed the presence of myelin sheath disruption and axonal retraction compared to control specimens.

CONCLUSION: This study showed that with increasing retractor expansion, the amount of strain placed across the axillary nerve increases, as does the microscopic damage to the neuronal structure. Although the deltoid-splitting approach places fewer structures at risk for iatrogenic injury, care must be taken to avoid over-retraction and soft-tissue injury using this exposure.

Percutaneous Reduction and Fixation with Screws Alone in Displaced Intra-Articular Fractures of the Calcaneus

Abstract ID: Paper 165

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INTRODUCTION: Between 2000 and 2011,153 patients with 182 intra-articular fractures of the calcaneus were reduced and fixed with screws alone using percutaneous techniques (JBJS Essential Surgical Techniques 2011; 01(02):e9 1-12). We reported a retrospective study of these patients.

METHODS: All patients were assessed for early postoperative complications at a minimum of three months from injury. Patient pain (VAS score), late complications, and secondary procedures were assessed for patients seen at a minimum of 1 year (90 patients, 106 feet).

Bohler's angle, Gissane angle, talocalcaneal angle, calcaneal width, height, and length were measured by a non-treating surgeon on preoperative, immediate postoperative, and 3 months postoperative radiographs. In patients who had both preoperative and postoperative CT scans (50 patients, 60 feet), the articular reduction was quantitatively measured. The widest gap or step in anterior-talocalcaneal joint, posterior-talocalcaneal joint, and calcaneocuboid joint were measured in sagittal, horizontal, and coronal planes. A composite score was derived from these three measurements.

RESULTS: All patients were classified according to Sander classification (type 2a 6.7%, type 2b 10%, type 3ab 26.7%, type 3ac 33.2%, type 3bc 6.7%, and type 4 16.7%). At 1-year follow-up (90 patients, 106 feet), the VAS score was 0 in 35 patients (23%), VAS 1-3 in 39 patients (25%), VAS 4-7 in 58 patients (38%), and VAS score 8-10 in 21 patients (14%). Among the 182 fractures treated, there were 2 infections, 1 broken screw, 1 sural nerve irritation, and 1 Achilles tendinopathy. Repeat surgery was in 17 fractures (9.3%) for hardware removal, 4 (2.2%) for subtalar arthrodesis, and the 2 infected fractures (1.1%) were debrided.

Bohler's angle, calcaneal height, and width were significantly improved at immediate postoperative measurement (all $p<0.0001$). However, at 3 months follow-up, Bohler's angle was significantly decreased compared with immediate postoperative ($p=0.0002$) while the other parameters showed well maintenance. The CT composite score showed significantly improvement in joint reduction at posterior talocalcaneal joint ($p<0.0001$) and calcaneocuboid joint ($p=0.0303$).

DISCUSSION: These data suggest that the shape of the calcaneus (height, width, and Bohler's angle) can be substantially improved using percutaneous techniques and the improvements are maintained with screw fixation alone (average 4.3 screws/foot). The complication rate is low compared to other reported techniques. The articular reduction on postoperative CT was substantially compared with preoperative CT. However, residual articular displacement is still present. The clinical significance of this residual displacement is uncertain.

Postoperative Complications of Olecranon Fractures: Locked vs. Non-Locked Plates, a Comparison of Outcomes

Abstract ID: Paper 166

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INTRODUCTION: The purpose of this study was to compare the incidence of postoperative complications and unplanned secondary surgeries in patients with olecranon fractures who underwent definitive fixation with non-locked (NLP) vs. locked plates (LP). We hypothesize there will be no significant difference in frequency of postoperative complications or rates of secondary surgeries between groups. Our secondary hypothesis is that overall total cost of the newer, pre-contoured LP construct would be more than traditional NLP constructs.

METHODS: A retrospective chart review was performed to identify eligible patients with olecranon fractures treated with plate fixation between January 2004 and January 2012. Medical records were reviewed to determine demographic information, mechanism, Mayo and AO/OTA classification, follow-up, and postoperative complications. Postoperative complications included symptomatic hardware, hardware failure, superficial infection, deep infection, nonunion, or loss of reduction. Minimum follow-up was set at 5 months. The incidence of unplanned secondary surgeries was also evaluated. Cost of plate and screw constructs were collected. Statistical analysis was performed using a two-way ANOVA, student t-test, and Chi-Square.

RESULTS: 220 patients with olecranon fractures were identified from the orthopedic trauma registry at a Level I trauma center. Thirty patients were treated with LP and 21 were treated with NLP and had adequate follow-up. The mean age of NLP patients was 42 years (range: 19-68) and LP patients was 49 years (range: 19-89). Mean follow-up was 24 months (range: 5-94) for NLP group and mean of 15 months (range: 5-39) for LP group. The number of patients with symptomatic hardware in the NLP was 8 (38%) vs. LP groups 7 (23.3%). 12/30 (40%) of LP patients and 7/31 (33%) NL patients required unplanned secondary surgeries, including hardware removal. There was one failure of fixation requiring revision in each group. The average cost for similar plate and screw constructs (4 proximal, 3 distal screws) was $980.13 for NLP and $1,831.58 for LP.

CONCLUSION: Patients with olecranon fractures who have undergone surgical fixation with either non-locked or locked plating constructs have similar rates of symptomatic hardware requiring secondary surgery. Our study also determined that the total cost to the patient for a LP construct was almost twice that of NL construct. Although the newer pre-contoured locked plating constructs are available, this study demonstrates no additional clinical benefit to the patient.

Designing and Implementing a Bone Health and Fragility Fracture Service: Early Experience at a University Hospital

Abstract ID: Paper 167

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INTRODUCTION: Despite increased awareness of fragility fractures, bone health treatment for high-risk patients remains low. The purpose of our project is to define the process by which a fragility fracture service is created and present our preliminary data.

METHODS: All patients with a fragility fracture were identified upon their presentation through either the emergency department or the orthopedic clinic and referred to our Fragility Fracture Service. The initial workup included history, physical examination, laboratory values, and radiographic assessment. Diagnostic imaging included a dual-energy x-ray absorptiometry (DEXA) scan. A fracture risk assessment tool (FRAX) was calculated on osteopenic patients.

RESULTS: While the major focus will be outlining the process of initiating a fragility fracture service, we will also present our preliminary data. Our service has enrolled 73 patients (55 female / 18 male) with an average age of 74 years. Ninety-two percent of patients were Caucasian, 4% Asian, 3% Black, and 1% Hispanic. The most common fractures encountered were femoral neck (58%), pelvic (12%), and humeral (10%). Forty-one patients (44%) had a previous fracture. Twenty-eight percent of patients were osteoporotic and 62% of patients were osteopenic. Twenty-two percent of patients were vitamin D deficient and 37% had vitamin D insufficiency. Bone turnover marker P1NP was abnormal in 29% and bone turnover marker CTX was abnormal in 12%. Thirty-eight percent have a 20% or greater risk of major osteoporotic fracture and 71% have a 3% or greater risk of a hip fracture in the next decade based on FRAX score. Treatment was initiated by our Fragility Fracture Service in 76% of enrolled patients while the remainder had treatment initiated by their primary care physicians. Management has consisted of vitamin D, calcium, secondary hyperparathyroidism correction in 100% of patients and Teriparatide in 42%, Bisphosphonates in 25%, and Denosumab in 13%. Early follow-up rate is 94% compared to 30% prior to initiation of the Fragility Fracture Service.

CONCLUSIONS: The objective of this submission is to serve as an educational guideline to reference when initiating fragility fracture care. In addition, our preliminary data suggest that employment of a fragility fracture service is a comprehensive strategy for treating this patient population. At the time of the meeting, we will also present 3- and 6- month follow-up data which will include response to treatment with laboratory parameters of calcium, PTH, vitamin D, bone turnover markers, and clinical data including repeat fracture rates.

Effectiveness of Vitamin D Therapy in Orthopedic Trauma Patients

Abstract ID: Paper 168

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PURPOSE: 77% of our orthopedic trauma patients have been shown to have either Vitamin D deficiency or insufficiency. The purpose of this study was to determine the effectiveness of our Vitamin D treatment protocol in orthopedic trauma patients. Our hypothesis was that Vitamin D therapy normalized serum vitamin D levels.

METHODS: A retrospective review was done of all orthopedic trauma patients at university level 1 trauma center from January 1, 2009, to September 30, 2010. Patients were selected if they had an initial and repeat vitamin D-25 serum levels. The standard regimen for all patients was over-the-counter vitamin D 1000 IU and 1500 mg of calcium daily. For patients with vitamin D deficiency or insufficiency, they also received 50000 IU of ergocalciferol weekly until their vitamin D level normalized or their fracture healed. No compliance monitoring was performed except for questioning at each clinic visit.

RESULTS: 201 patients had initial and repeat Vitamin D-25 levels. 84% of patients with a normal initial vitamin D-25 level remained normal and 16% became insufficient or deficient. 48% of the patients initially in the insufficient group improved to normal and 8% became deficient. Of the patients with vitamin D deficiency, 26% remained deficient and 74% became insufficient. See Table 1.

CONCLUSIONS: Although Vitamin D therapy did improve the majority of the patients' Vitamin D-25 level, it wasn't as successful as was hoped. Patients with initial deficiency had the largest improvement, but still didn't normalize. This study indicates that continued vigilance is required to adequately treat a low vitamin D-25 level. Future studies will prospectively evaluate treatment regimens and the effect of low vitamin D on complications of orthopedic trauma.

Click here to view Table

Outcomes of Displaced Femoral Neck Fractures Treated with Hemiarthroplasty Utilizing the Direct Anterior Approach

Abstract ID: Paper 169

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INTRODUCTION: The treatment of displaced intracapsular femoral neck fractures in the elderly is generally limited to arthroplasty due to the high rates of fixation failure, nonunion, and avascular necrosis associated with internal fixation. Hemiarthroplasty is the treatment of choice in older patients with low functional demands. Although the direct anterior approach has been shown to result in early return to ambulation and decreased dislocation rates compared to other approaches in patients undergoing elective THA, there is limited data reporting outcomes in patients undergoing hemiarthroplasty through the direct anterior approach for displaced femoral neck fractures. The purpose of this study was to report the outcomes of patients undergoing hemiarthroplasty for displaced intracapsular femoral neck factures utilizing the direct anterior approach. We hypothesized that patients undergoing hemiarthroplasty utilizing the anterior approach would have improved postoperative ambulation and decreased complication/dislocation rates compared to those undergoing other surgical approaches.

METHODS: A retrospective chart review was conducted from June 2011 – February 2013 to identify patients undergoing hemiarthroplasty for displaced intracapsular femoral neck fractures. Patients were grouped into one of two groups based on whether the direct anterior approach (Group 1) or any other surgical approach (Group 2) was utilized. Statistical analysis was conducted to compare baseline demographics and clinical outcomes including operative time, estimated blood loss, length of stay, feet ambulated postoperatively, and overall complication rate.

RESULTS: A total of 101 patients underwent hemiarthroplasty for displaced femoral neck fractures. The direct anterior approach was utilized in 31 patients (Group 1), and an anterolateral, direct lateral, or posterior approach utilized in 70 patients (Group 2). The mean age of all patients at the time of surgery was 80.8 years old. No difference in age, ASA class, or pre-injury ambulatory status was identified between groups. Patients in Group 1 (direct anterior approach) possessed similar operative times, estimated blood loss, and length of stay compared to patients in Group 2 (other surgical approaches). The overall complication rate was 55.4% with no significant difference between groups (Group 1: 17/30 patients, 56.7%, Group 2: 39/70, 55.7%).

CONCLUSIONS: Patients undergoing hemiarthroplasty for displaced femoral neck fractures utilizing the direct anterior approach possess similar operative times, blood loss, and length of stay compared to those undergoing the same procedure utilizing other surgical approaches. No decrease in complication or dislocation rate among those undergoing the anterior approach could be identified. This evidence suggests the use of the direct anterior approach in patients undergoing hemiarthroplasty for displaced femoral neck fractures can achieve comparable clinical outcomes to other surgical approaches.

Mobile Outreach: An Integral and Innovative Part of Comprehensive Elder Fracture Care

Abstract ID: Paper 170

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INTRODUCTION: To describe the integral Mobile Outreach (MO) component of a Geriatric Fracture Program (GFP).

METHODS: Design--Descriptive QA/QI study of an intervention in a prospective cohort of patients. Setting--Level 1 Trauma Center and 138 affiliated nursing care facilities.

The hospital GFP focuses on enhancing care for older fracture patients in the perioperative period; working with vulnerable populations of elders with musculoskeletal problems, and preventing subsequent fractures in elderly fracture patients. The GFP accomplishes this by focusing on three main components: (1) Mobile Outreach (MO), (2) in-hospital elder fracture care, and (3) bone health evaluation - osteoporosis treatment and secondary fracture prevention. This study focuses on the MO component of the GFP. Through MO, frail elder patients with orthopedic concerns who reside in nursing care facilities are seen and treated in their nursing care facility. Mobile Outreach includes 24 hour per day, seven day per week, GFP phone consultation service for geriatricians and nurse practitioners who provide care through partnering nursing homes. It also includes on-site injury assessments (portable x-rays, admission/preoperative workup, etc.), on-site postoperative visits, and procedural visits (cortisone injections for arthritis, splint or cast management for fractures, etc.).

RESULTS: The Mobile Outreach component of the hospital GFP has been successfully implemented throughout the hospital and the surrounding affiliated nursing care facilities. Between January 1, 2012, and March 31, 2013, MO was utilized 1,488 times: 224 nursing care facility postoperative visits, 145 closed fracture follow-up visits (78 from ED/Clinic, 67 from direct Geri Consult), 166 injections, 36 pain consults to rule out fracture (non-fracture), and 917 phone consult/film reviews.

CONCLUSION: The number of frail elderly orthopedic patients is large and increasing. The current heath care model is not effective and does not provide the best standard of care for the frail elderly across the care continuum. The frail elderly patient can be well cared for in their own home with Mobile Outreach.

MAOA BREAKOUT SESSION #13
PERIOPERATIVE MANAGEMENT IN TOTAL JOINT ARTHROPLASTY
April 26, 2014

Mobile vs. Fixed-Bearing Medial Unicompartmental Knee Arthroplasty: A Series of 375 Patients

Abstract ID: Paper 171

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(Presented by Michael G. Azzam, M.D., Memphis, TN)

INTRODUCTION: Amongst surgeons, considerable debate still exists as to the superiority of mobile vs. fixed bearing unicompartmental knee arthroplasty (UKA) for the treatment of medial compartment knee arthritis. We sought to compare outcomes between mobile and fixed bearing UKA in a multi-specialty clinic setting to establish any trends in survivorship between the different implant designs.

METHODS: Medical records of all patients who underwent a medial unicompartmental knee arthroplasty at a large multi-surgeon group were queried between March 2003 and August 2012. Variables investigated included final postoperative range of motion (ROM), type and cause of complication, time to revision surgery. and overall survivorship.

RESULTS: 375 medial UKAs performed by 12 surgeons met inclusion criteria and were used in final analysis (308 mobile bearing and 67 fixed bearing). Average time to follow-up was 47 months. Final knee ROM between the two groups was comparable (mobile: 1-122°, fixed: 1-120°, p=0.34). Complications occurred in 20/308 (6.6%) mobile bearing UKA and 5/67 (7.5%) fixed bearing UKA (p=0.77). The most common complications in mobile bearing implants were progression of lateral compartment disease (7/20), component loosening (4/20), and dislocated bearing (3/20). The complications in fixed bearing implants were arthrofibrosis (3/5) and tibial plateau fracture (2/5). Overall survivorship between implants differed, but not significantly (mobile bearing: 94.8%, fixed bearing: 96.9%, p=0.44). There was no significant difference in time to revision between the two cohorts as well. (7.5 months for fixed bearing vs. 18.1 months for mobile bearing with p=0.17).

CONCLUSIONS: In this largest recorded single cohort series comparing mobile vs. fixed bearing UKA, we found no significant difference in final clinical knee range of motion, rates of complications, and survivorship between the two bearing types. In mobile bearing designs, the most common complications were progression of lateral compartment disease and loosening, while failure of fixed bearing designs was associated with arthrofibrosis and tibial plateau fracture. In this series, fixed bearing implants required revision much earlier than mobile bearing implants, but the difference was a statistical trend that was not significant.

A Novel Predictor for 30-Day Readmission Following Total Hip and Knee Arthroplasty

Abstract ID: Paper 172

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INTRODUCTION: We attempted to identify demographic or care process variables associated with increased 30-day readmission within a heterogeneous adult population that underwent an orthopedic procedure. Using this information, we generated the primary goal of this study, which was to develop a model to predict 30-day readmission risk following total hip and knee arthroplasty procedures.

METHODS: A retrospective review of patients that underwent orthopedic procedures, including total joint arthroplasty, at a major tertiary care medical center was performed over a 12-month period (May 1, 2010 – April 30, 2011). Demographics, comorbidities, and other care process variables within preceding index admission leading up to readmission were collected. Readmission and non-readmission patients were compared, and using univariate and multivariate analysis, the risk factors associated with readmission were identified. Using these risk factors, a predictive nomogram for 30-day readmissions after total hip and knee arthroplasty was developed using a logistic regression model. This was internally validated using bootstrapping.

RESULTS: From a total of 2,368 orthopedic procedures, 159 (6.7%) required an unplanned readmission within a 30-day period. In this cohort, receiving a blood transfusion was the single variable to show a significant risk for readmission (OR=2.77, 95% CI [1.82, 4.15]). Within this cohort, 1,236 patients (1,291 episodes) underwent a primary total hip or total knee procedure, and from these, 44 patients (46 episodes, 3.6%) required unplanned readmission. Longer index length of stay, discharge disposition, blood transfusion, general anesthesia, anemia, anticoagulation prior to index admission, and Charlson Comorbidity Index greater than 2 were identified as independent risk factors for readmission. The predictive nomogram for primary total joint readmission had a bootstrap-corrected concordance statistic of 0.76.

CONCLUSIONS: Care process factors during the hospital stay appear to have a significant predictive value for 30-day readmission. Specific comorbidities and patient demographic factors showed less significance. This nomogram can be used to identify patients at risk for readmission after total hip and knee arthroplasty. Further multi-institution collaboration is needed to understand the generalizable nature of this model.

Level of Evidence: Prognostic Level III.

Decreased Hospital Length of Stay After Total Hip Arthroplasty is Not Associated with Increased Readmission Rates

Abstract ID: Paper 173

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INTRODUCTION: In an era of healthcare reform, reimbursements for total joint arthroplasty will be intimately linked to patient outcome measures, namely hospital length of stay and readmission rates. There has been a series of perioperative changes at our institution to decrease the length of hospital stay associated with primary total hip arthroplasty (THA). Incremental changes over the past 12 years have included the adoption of preferred spinal anesthesia and multi-modality pain management in 2005 and early postoperative mobilization protocols with streamlined therapy services introduced in 2009. The purpose of our study is to investigate changes in hospital length of stay and readmission rates for primary THAs associated with incremental introduction of these rapid recovery protocols.

METHODS: We performed a retrospective review of one surgeon's primary total hip replacement surgeries from 2000-2012 (2,182 THAs). The patient sample was divided into one of three cohorts: 2000-2004 (Group 1; 480 subjects), 2005-2008 (Group 2; 772 subjects), and 2009-2012 (Group 3; 930 subjects). Cohort determination was decided by the year that major protocol advancements were initiated. Average length of stay, 30-day all-cause readmission, demographic, and co-morbidity data were collected.

RESULTS: The average length of stay for groups 1, 2, and 3 were 3.94 days, 2.66 days, and 1.84, respectively. Results of regression analysis demonstrated a significant decrease in readmissions for decreasing hospital lengths of stay (R^2 = -.29, t(12) = 2.49, p = .02). Moreover, there was a significant decrease in the proportion of readmissions compared to all cases between the three groups over time (χ^2= 14.56, p=0.0006). For individual groups, there was a significant decrease in readmission rates between groups 1 and 3 (χ^2= 13.71, p=0.0002) and 2 and 3 (χ^2= 4.71, p=0.0297), but not between groups 1 and 2 (χ^2= 2.24, p=0.1348).

DISCUSSION AND CONCLUSION: The results from our study indicate that the incremental introduction of rapid recovery perioperative protocols for primary THA can be associated with shorter hospital stays without increasing the risk of readmission.

Effect of Day of Surgery on Length of Stay and Charges in Total Hip and Knee Arthroplasty Patients

Abstract ID: Paper 174

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INTRODUCTION: Length of stay (LOS) for primary total hip (THA) and knee arthroplasty (TKA) is a significant driver of cost and quality metrics. Identifying patients at risk for longer LOS may help guide strategies to reduce the THA and TKA economic burden. The purpose of this study was to examine the effect of surgery day on LOS and charges at a large U.S. healthcare system.

METHODS: An administrative database was retrospectively reviewed for all primary THA and TKA admissions (ICD-9-CM, 81.51 and 81.54) in 2010-2012 (n=15,237). Exclusion criteria included: age <18 years, simultaneous bilateral procedures, non-elective diagnoses (malignancy, fractures, etc.), Saturday/Sunday operations, non-orthopedic service line (n=437). The cohort was additionally divided into early (Monday-Tuesday; n=8,457) and late week (Thursday-Friday; n=3,508) admissions. Demographic data (age, gender, and race) and severity of illness were collected and analyzed as univariate risk factors for longer LOS. Continuous and categorical variables were compared using Student's t-test, ANOVA, and Pearson's chi-square.

RESULTS: Among the 14,800 admissions, there was a significant increase in mean LOS based on day of surgery (Monday, 3.48; Tuesday, 3.60; Wednesday, 3.69; Thursday, 3.89; Friday, 3.93; $p<0.0001$). Older age, female gender, black race, increased illness severity, and TKA procedure were associated with increased LOS ($p<0.05$). Early and late week admissions were similar with respect to demographic variables. Overall mean LOS and charges were significantly greater for late week admissions (3.9 vs. 3.5 days, $p<0.0001$; \$44,319 vs. \$43,522, $p<0.003$). While mean charges were greater for late week TKA cases ($p<0.0001$), they did not differ among early and late week THA cases ($p=0.40$).

CONCLUSIONS: Primary THA and TKA done late in the week had longer LOS. Total charges were elevated among late week primary TKA cases. Older age, female gender, black race, increased illness severity, and TKA procedure were associated with longer overall LOS.

Effect of Tranexamic Acid on Blood Utilization and Thromboembolic Events After Hip and Knee Surgery

Abstract ID: Paper 175

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INTRODUCTION: The effectiveness of tranexamic acid (TXA) in reducing blood loss and minimizing transfusions has been documented in many surgical subspecialties. The purpose of this study is to determine any changes in transfusion rates or incidence of venous thromboembolic events (VTE) following the institution of routine use of TXA in hip and knee arthroplasty.

METHODS: A retrospective review of a prospectively collected database was performed to include all patients undergoing primary or revision joint replacement or resurfacing over 2 years with patients prior to and after the institution of the routine use of TXA. All patients were stratified into low, intermediate, and high-risk groups for TXA dosing. A concurrent prospective study on our local anticoagulation protocol collected incidence of VTE.

RESULTS: Transfusion rates decreased significantly for hip and knee surgeries. In 1,320 hip cases, 29.52% of patients receiving no TXA vs. 10.73% patients receiving TXA were transfused at least one non-autologous unit ($p<0.001$). Transfusion rates dropped in primary THA (28.25% to 7.22%), revision THA (48.51% to 37.70%), and hip resurfacing (5.56% to 0%). In 886 knee cases, 18.85% of patients receiving no TXA vs. 3.64% of patients receiving TXA were transfused ($p<0.001$). Transfusion rates dropped in primary TKA (17.10% to 3.07%) and revision TKA (30.00% to 7.41%). Most importantly, from our prospective data collected on VTE, there was no significant difference in the incidence of thromboembolic events with TXA compared to no TXA at 4-6 weeks (2/690=0.3% vs. 6/1067=0.6%, $p=0.41$) or at 6 months (2/482=0.4% vs. 8/1181=0.7%, $p=0.53$) postoperatively.

CONCLUSION: Tranexamic acid aids in a decreased transfusion rate following primary and revision hip and knee arthroplasty and, for the first time, we have prospective data on VTE to show no increase in events with the addition of TXA.

Risk of Acute Kidney Injury After Primary and Revision THA and TKA Using a Multimodal Approach to Postoperative Pain Control Including Ketorolac and Celecoxib

Abstract ID: Paper 176

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INTRODUCTION: Pre-emptive pain management following THA and TKA has become a standard adjunct to the procedures. Safe and effective postoperative analgesia is now recognized as being instrumental to improving patient satisfaction and decreasing length of hospital stay. The purpose of the present study was to determine any deleterious effects from the use of a multimodal pain control regimen incorporating scheduled celecoxib and PRN ketorolac in both primary and revision total joint arthroplasty.

METHODS: The authors retrospectively reviewed 1,046 primary and revision THAs and TKAs performed by two senior surgeons between January 2011 and May 2013. A standard protocol had been initiated where patients were treated by one of two regimens. Patients with adequate preoperative renal function (defined as Cr < 1.2) received celecoxib and ketorolac in addition to narcotics and acetaminophen. While patients with chronic renal disease (defined as Cr >/= 1.2) received a standard narcotic and acetaminophen regimen. Acute kidney injury (AKI) was defined by a postoperative increase in Cr of >/= 0.3. We evaluated pre- and postoperative BUN/Cr and UOP to identify AKI and assess the safety of this protocol.

RESULTS: Of 1,046 procedures, 1,038 (99.2%) had appropriate documentation to be included in the study. 903 (87.0%) were found to have adequate preoperative renal function and received a pain regimen including celecoxib and ketorolac. 135 (13.0%) with chronic renal disease were treated with the standard narcotic and acetaminophen regimen. In the celecoxib/ketorolac protocol cohort, average age was 59.7, BMI was 32.7, and AKI was found in 43/903 (4.8%) of procedures. In the celecoxib/ketorolac protocol cohort, those who developed AKI had significantly increased length of stay (4.6d vs. 2.8d, $p<0.01$). In the narcotic/acetaminophen protocol cohort, average age was 66.6, BMI was 33.2, and AKI on chronic insufficiency developed in 16/135 (11.9%) of procedures.

CONCLUSION: Safety of THA and TKA postoperative analgesia protocols incorporating potentially nephrotoxic pain adjuncts has received little attention. Our experience demonstrates that with a protocol incorporating celecoxib and ketorolac in patients without evidence of significant preoperative renal impairment, there is a 4.8% rate of AKI. In addition, acute postoperative kidney injury was significantly correlated with increased length of stay. When using potentially nephrotoxic drugs in pain management protocols, close monitoring of renal function should be performed.

Preoperative Selection Criteria for Simultaneous Bilateral Total Knee Arthroplasty (TKA)

Abstract ID: Paper 177

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BACKGROUND: A large percentage of the patients who present for unilateral TKA have bilateral disease. Performing simultaneous, bilateral TKA has been debated and currently there is no consensus on the risks and benefit of this approach. In addition, specific selection criteria have not been defined to more accurately identify which patients are potentially appropriate candidates for this approach.

OBJECTIVES: The purpose of this study was to evaluate the clinical outcomes and perioperative complications in simultaneous, bilateral TKAs using preoperative patient selection criteria.

METHODS: A retrospective analysis of 117 consecutive patients, (234 knees), was performed between February 2008 and March 2012 who underwent simultaneous, bilateral TKA performed by one surgeon under a single anesthetic. Preoperative selection criteria were used for all patients to qualify for a simultaneous bilateral approach. This included the following: (1) BMI less than 34, (2) minimum arc of motion to 100° flexion, (3) flexion contracture less than 10°, (4) varus or valgus alignment less than 10°, (5) no prior history of cardiovascular disease, and (6) age less than 70 years old.

Clinical outcomes were assessed including anesthesia type, tourniquet time, length of stay, transfusion rate, preoperative hemoglobin, postoperative hemoglobin, preoperative range of motion, postoperative range of motion, DVT, and PE. Knee Society Score (KSS) and Functional KSS were assessed preoperatively and 1 year postoperatively. Anatomic and mechanical axis evaluation was also performed on all patients with long standing radiographs pre- and postoperatively. A control group of 573 consecutive patients undergoing unilateral total knee arthroplasty during this same time period were identified and matched for the year of surgery, and prosthesis type. The same selection criteria were used for the control group and the same data points were evaluated.

RESULTS: 117 consecutive patients, (234 knees), undergoing simultaneous, bilateral TKA were reviewed. There were no DVTs, or PEs. 19% required a transfusion for postoperative anemia. There were no cases of deep infection. Average preoperative KSS score was 49, with a postoperative KSS score of 89 at an average follow-up of 1 year. Average preoperative Functional KSS score was 52, with an average postoperative Functional KSS score of 91. Average ROM at one year postoperative was 0° of extension and 123° of flexion. Average anatomic axis was 6° valgus with a neutral mechanical axis restored in all patients. The clinical outcomes of the control group were comparable, with no statistically significant increase in the incidence of perioperative complications between the study group and the control group.

CONCLUSION: When the degenerative process involves both knees with comparable severity, the decision to perform total knee arthroplasty on one knee at a time with a staged approach, vs. a simultaneous bilateral approach, has been challenging for many surgeons. There have

been previous reports of increased perioperative complications associated with bilateral total knee arthroplasty, including increased risks of cardiovascular, neurological complications, as well as the increased demands on rehabilitation. Similarly, benefits of simultaneous bilateral total knee arthroplasty have also been identified such as, shortened rehabilitation, improved patient satisfaction, and decreased costs both to the patient and the hospital system. Using preoperative patient selection criteria, the decision process in determining which patients are appropriate candidates for a bilateral approach can be facilitated, with clinical outcomes comparable to unilateral total knee arthroplasty.

Successful outcomes for bilateral total knee arthroplasty (TKA) has been reported in the literature.

A patient selection criteria was used to more accurately define appropriate candidates.

Perioperative Outcomes of Bilateral Total Hip Arthroplasty

Abstract ID: Paper 178

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INTRODUCTION: Patients with bilateral hip arthritis may be candidates for bilateral total hip arthroplasty (THA), but controversy exists about the clinical benefits for this option. The purpose of this study was to assess recent national trends in unilateral and bilateral THA and to evaluate perioperative outcomes.

METHODS: The National Hospital Discharge Survey (NHDS) database was searched using International Classification of Diseases - Ninth Revision (ICD-9) codes for patients admitted for unilateral and bilateral THA between years 2001-2010. ICD-9 diagnosis and procedure codes were used to analyze patient demographics, hospital length of stay, adverse events (deep vein thrombosis [DVT], pulmonary embolus [PE], blood transfusion, mortality), and discharge disposition. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test, z-test for proportions with a significance level of 0.05.

RESULTS: 18,207 patients who underwent unilateral THA and 147 patients who underwent bilateral THA were identified. The rate of bilateral THA demonstrated a weak positive correlation with time ($r=0.09$), accounting for 4.991 per 100,000 hospital admissions between 2001-2005; insignificantly increasing to 4.995 per 100,000 between 2006-2010 ($p=0.996$).The unilateral THA group had a mean patient age of 65.2 years and included 7,884 men and 10,323 women. The bilateral THA group had a significantly lower mean patient age of 55.4 years ($p<0.001$) and included 86 men and 61 women. Men significantly, accounted for more bilateral THA (58.5% vs. 43.3%, $p<0.001$). The bilateral THA group had a significantly longer average hospitalization length (4.8 days vs. 4.0 days, $p=0.010$), significantly lower DVT rate (0.00% vs. 0.16%, $p<0.001$), significantly lower PE rate (0.00% vs. 0.25%, $p<0.001$), and significantly less mortality (0.00% vs. 0.23%, $p<0.001$). The bilateral THA group was significantly more likely to be discharged to a rehabilitation facility (38.0% vs. 29.6%, $p=0.040$). No significant difference was noted between unilateral and bilateral THA for the rate of blood transfusion (25.9% vs. 25.2%, $p=0.83$).

CONCLUSIONS: This study demonstrates that the rate of bilateral THA was staying constant and the patients undergoing bilateral THA were more likely to be men and younger. Bilateral THA patients had a longer length of stay in the hospital and were more likely to go to a rehabilitation facility. Interestingly, less DVTs, PEs, and mortality were seen in the bilateral THA group. This observation is potentially related to patient selection process, where only younger, healthier patients are getting bilateral THA.

Do Routine Radiographs Obtained at the Initial Outpatient Postoperative Visit Change Management?

Abstract ID: Paper 179

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INTRODUCTION: Despite a paucity of peer-reviewed evidence to support the practice, routine postoperative radiographs are commonly obtained by orthopedic surgeons at the initial postoperative visit. In addition to the dubious cost-utility of obtaining routine postoperative radiographs, the practice also exposes the patient to potentially harmful ionizing radiation. The purpose of our study was to demonstrate the clinical utility of routine postoperative radiographs and to quantify the unnecessary radiation exposure to the patient as well as the cost to the healthcare system.

METHODS: All orthopedic surgeries performed during 2007 at a single Level 1 trauma center were retrospectively analyzed. Surgical subjects that were likely to require follow-up radiographs were included. Excluded surgical subjects included those subjects who were seen by a provider who did not perform the surgery or those who underwent multi-plane external-fixation. Medical records were reviewed to include surgery and radiographs performed, postoperative events, reason for radiographs, and if the radiographs showed unexpected findings or changed patient management. Additionally, radiation exposure and cost of radiographs were determined.

RESULTS: This ongoing study has analyzed 451/1,240 orthopedic procedures. After further analysis, 94 of these 451 orthopedic procedures met exclusion criteria. 357 orthopedic procedures in 291 patients have been included to date. A total of 188 (52.7%) surgical procedures received postoperative radiographs at the initial outpatient visit. Routine radiographs were performed in 180 (95.7%) procedures with 2/180 (1.1%) triggering a change in management. Non-routine radiographs were performed in 8 (4.3%) procedures with 2/8 (25.0%) triggering a change in management. These non-routine radiographs were obtained due to increased pain and a known unstable fracture pattern. Of these four procedures that required a change in management, one procedure required additional advanced imaging and three procedures required additional orthopedic surgery. Subjects receiving radiographs at the initial postoperative visit underwent a mean 2.33 (2-8) radiographs per procedure with a mean exposure of 0.176 mSv (0.002-4.5) with a median cost of $32.73 in 2013 TRICARE reimbursement dollars. The most common surgeries included open reduction internal fixation (38.8%), arthroplasty (19.3%), and hardware removal (8.1%). Mean time to the first postoperative visit was 13.6 days.

DISCUSSION AND CONCLUSION: Initial findings demonstrate that routine radiographs at the first postoperative visit minimally impact patient management (1.1%), while exposing the patient to an average of 0.176 mSv of unnecessary radiation at a median cost of $32.73 per radiographic series. Necessity of postoperative radiographs should be based on a clinical rationale at a patient management transition point.

The Evaluation of Opioid Consumption, Hospitalization Costs, and Length of Stay Utilizing Surgical Site Infiltration of Liposomal Bupivacaine (Exparel) vs. Femoral Nerve Blocks with Patient-Controlled Analgesia in Patients Undergoing Primary Total Knee Arthroplasty

Abstract ID: Paper 180

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This study sought to evaluate opioid consumption, hospitalization costs, and length of stay utilizing surgical site infiltration of liposomal bupivacaine after total knee arthroplasty (TKA). A 266 mg liposomal bupivacaine cocktail was introduced to the practice of the senior author in March 2013. A total of 53 consecutive primary TKA cases performed before this were compared with 47 consecutive TKA cases after initiation of this liposomal bupivacaine cocktail for the length of hospital stay, total mg amount of opioids consumed, and total hospitalization costs. The average total hospitalization cost of the liposomal bupivacaine group was $26,350.07 vs. $27,260.22 in the femoral nerve block with PCA group ($P = 0.04$) and the median length of stay was 1.53 days vs. 2.02 days ($P \leq 0.00$), and mean total amount of post-surgical opioids consumed was 320 mg vs. 290 mg, respectively ($P = 0.57$). There were no significant demographic differences between the two groups. Liposomal bupivacaine before primary wound closure is an effective means in lowering hospitalization costs and decreasing length of stay, while providing an equivocal post-surgical amount of opioid consumption after total knee arthroplasty. Furthermore, it has the potential of saving approximately $3.13 billion (excluding inflation) and 4,800 hospital stay years in 2030.

Vasopressor Support During ICU Admission Results in Poor Survivorship After Primary Total Hip Arthroplasty (THA)

Abstract ID: Paper 181

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SUMMARY SENTENCE: 5% of elective primary total hip replacements required ICU admission; mortality rate for patients requiring vasopressors was 70% at final follow-up with a 30-day mortality rate of 40%.

INTRODUCTION: Rarely, patients undergoing elective hip replacement surgery will be admitted to the intensive care unit (ICU). The subset of primary THA patients who require ICU management has been poorly studied. We sought to characterize the risk factors for ICU admission, as well as outcomes associated with ICU care.

METHODS: From a single-institution registry (2002-2012), 9,602 consecutive primary total hip arthroplasties were reviewed. The average age was 63 years (range, 11-100). Those patients requiring ICU admission were compared to those who did not. Demographic data, perioperative complications, and in-hospital mortality were recorded. Particular attention was paid to use of vasopressor use during ICU management.

RESULTS: 482 patients required ICU admission, representing 5% of all primary THA patients. Twenty ICU patients (4.1% of all ICU admits) received vasopressor support for refractory hypotension. 70% of the patients requiring vasopressors were deceased at final follow-up. The 30-day and 1-year mortality rates were 40% and 45%, respectively. The mortality rate for those ICU patients who did not need vasopressors was 23.2% at final follow-up, with a 1.3% mortality rate at 30 days. The mortality rate at final follow-up for those patients who did not go to the ICU was 7.2%. Age, American Society of Anesthesiologists (ASA) classification, and operative time were significantly higher between patients admitted to the ICU and non-ICU patients. Length of stay was significantly longer for patients requiring vasopressors ($p<0.001$).

DISCUSSION AND CONCLUSION: 5% of primary THA patients required ICU admission, and those patients who required vasopressor treatment had a 70% mortality rate at final follow-up with a 30-day mortality of 40%. Strategies to further optimize this particularly sick subset of orthopedic patients is important.

Significant Differences Between Clinician-Derived and Patient-Reported Outcome Measures After TJA

Abstract ID: Paper 182

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INTRODUCTION: The ever-changing healthcare environment in the U.S. has placed increased responsibility on healthcare providers for improving care and controlling the costs of their interventions. Medicare and private payers may require reporting of long-term clinical outcome (i.e., registry) data by hospitals and surgeons as a way to measure quality and value of their interventions. Although ideal, routine clinical surveillance of THA and TKA is expensive and may be a barrier to its universal implementation. In lieu of clinical evaluation, many have advocated alternative ways of obtaining follow-up, such as the use of patient reported outcomes derived through electronic, phone, or mailed questionnaires. We aim to compare the accuracy of these indirect media with clinical evaluation.

METHODS: All patients who underwent TKA or THA from 2003-2013 were reviewed. Those patients returning for routine surveillance at 3 months, 2, 5, or 10 years and also answered a telephone or mailed survey within 6 months of the clinic visit were entered into the study. 995 patients (754 who answered a mailed questionnaire and 241 who answered a telephone questionnaire) composed the cohort. We chose to compare 5 routine questions: level of pain, overall activity level, distance walked, use of a support, and ability to do stairs.

RESULTS: Of the 754 that answered a mail questionnaire, 338 (45%) reported the same pain level, 464 (61%) reported the same level of activity, 382 (51%), reported the same distance walked, 564 (75%) reported the same use of support, and 490 (65%) reported the same ability to do stairs when compared to their assessment at the time of their clinic visit. Of the patients reporting different outcomes, 80% of patients reported lower pain levels and 71% higher activity levels during their clinic visit. These differences were statistically significant ($p<0.001$). Of the 241 patients who answered a phone questionnaire, 167 (69%) reported the same pain level, 144 (60%) reported the same distance walked, 193 (80%) reported the same use of support, and 176 (73%) reported the same ability to do stairs when compared to their clinic visit assessment. Of the patients reporting different outcomes, 61% of patients reported a lower pain level and 60% reported higher activity levels at the time of their clinical evaluation. Again, these differences were statistically significant ($p<0.05$).

DISCUSSION AND CONCLUSION: Administration of outcomes questionnaires using electronic or mailed media has the potential of convenience and decreased cost for both patient and surgeon. Nevertheless, this study demonstrates that there are significant differences in routine outcome measures when assessed through different modes of surveillance. A more reliable and validated method of obtaining accurate assessments of patient outcomes is clearly needed. Nevertheless, further study is needed to determine if the differences in these reported outcomes are clinically relevant.

SUMMARY: Though administration of outcomes questionnaires using electronic or mailed

media may be convenient and cost effective, a more reliable method of obtaining accurate assessments of patient outcomes is needed.

MAOA BREAKOUT SESSION #14
FOOT AND ANKLE
April 26, 2014

Foot and Ankle 30-Day Readmission Rate Data: Results from a Tertiary Care Center

Abstract ID: Paper 183

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INTRODUCTION: Recently, there has been significant focus on 30-day hospital readmission rate as a hospital quality measure. The advent of the CMS Hospital Readmission Reduction program penalizes hospitals for increased readmission rates. However, previous studies have shown that readmission rates may not be an appropriate quality measure as the program disproportionately penalizes academic, high volume, specialized, and safety-net centers. The purpose of our study was to analyze the 30-day readmission data to our Foot and Ankle service.

METHODS: An IRB-approved retrospective review was performed to identify patients who had readmission to the hospital following a Foot and Ankle procedure from 2003-2012. Information regarding age, sex, primary diagnosis, reason for readmission, distance from tertiary care center, and insurance payer were obtained from their medical records.

RESULTS: We identified 79 readmissions in 69 patients who had undergone readmission to the Foot and Ankle service within 30 days of a previous admission from 2003-2012. There were 49 male and 20 female with an average age of 50.4 years (range 9-84). The average time to readmission following a previous admission was 16.2 days (range 2-30). The most common reason for readmission was continued treatment of manifestations of chronic diabetes mellitus (60.75%). Nine patients underwent two or more readmissions and eight of them were due to chronic manifestations of diabetes mellitus. Only 5% of readmissions were related to surgical complications. The average distance the patients traveled was 139.78 miles (range 0-259.93). The majority of patients (53.6%) involved Medicare, Medicaid, or state health insurance as a payer.

CONCLUSIONS: The most common reason for readmission within 30 days of a previous admission to our Foot and Ankle Service was continued treatment of the chronic manifestations of diabetes mellitus. Although these readmissions may constitute a penalty, the majority of readmissions were continued quality care for chronic medical conditions. Physicians and healthcare law makers should be made aware of this data to revise the CMS Hospital Readmission Reduction program to avoid penalizing hospitals for treatment of chronic medical conditions.

Current Procedural Terminology Coding in Foot and Ankle Surgery

Abstract ID: Paper 184

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INTRODUCTION: Little is known on resident proficiency in Current Procedural Terminology (CPT) coding. The purpose of this study was to evaluate the correlation and inter-rater reliability between resident and attending CPT coding in orthopedic foot and ankle surgeries, as well as residents' opinions about the coding process.

METHODS: CPT codes from resident case logs were compared to those submitted by attending surgeons. An online survey was used to examine resident perceptions and habits regarding CPT codes and the coding process.

RESULTS: Twenty residents' (a total of 1,164) CPT codes were compared to those recorded by 3 attending Foot and Ankle Surgeons (a total of 1,259). Correlation between attending and resident codes was poor ($r = -0.015$). Inter-rater reliability demonstrated a kappa value of 0.04, indicating poor agreement. Compared to attending CPT coding, residents correctly coded 42% of the time, with an individual resident range from 2% to 65% correct. Additionally, 43% of residents were uncomfortable with Foot and Ankle CPT coding. They reported rarely discussing CPT codes with attending surgeons in the perioperative period.

DISCUSSION: Resident accuracy and reliability in CPT coding is poor, and is supported by a low level of resident comfort with coding. This is likely secondary to a lack of education and preparation in coding. Given the fact that accuracy in CPT coding is valued by the ACGME and has implications for evaluating and grading institutions, we believe that more attention is warranted in improving resident comfort and accuracy with CPT coding in order to improve overall resident education.

Foot and Ankle Radiographic Parameters: Validity and Reproducibility of Biplane Imaging System vs. Conventional Radiography

Abstract ID: Paper 185

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BACKGROUND: While considered a standard method for evaluation of foot and ankle deformity, conventional x-rays lack the ability to understand three-dimensional information, rotational deformities, and fraught with magnification errors. The biplane imaging system has emerged as a valuable method in deformity evaluation due to its capability of simultaneously capturing two orthogonal AP and lateral images of the whole body in standing weight-bearing position with substantially reduced radiation exposure. This study evaluates the validity and reproducibility of biplane imaging system for angular and distance measurements of commonly used foot and ankle radiographic parameters using conventional x-rays as gold standard.

MATERIAL AND METHODS: Fifty consecutive patients indicated for foot and ankle realignment surgeries were included. Radiographic studies included AP and lateral ankle weight-bearing conventional x-rays and long leg AP and lateral weight-bearing images using EOS^{TM} 2D imaging system in both staggered feet and non-staggered feet positions. Radiographic parameters included in the study were talocrural angle, talar tilt angle, tibiofibular clear space, medial clear space, lateral distal tibial angle, Hip Knee Shaft angle, Hip Knee Ankle angel, Femoral Neck Shaft Angle, femur length, tibia length, mechanical axis deviation, and limb length discrepancy measurement for AP views and calcaneal pitch, lateral talocacaneal angle, lateral talo-1stmetatarsal angle, medial cuneiform-5th metatarsal height, and anterior distal tibial angle for lateral views. Measurements were conducted by two blinded observers and one observer repeating all the measurements 6 weeks apart. Inter- and intraobserver reliability was assessed using Intraclass Correlation Coefficients. Between groups comparison was assessed using Pearson correlation coefficient, ANOVA, and paired t-test.

RESULTS: There was a strong correlation between the measurements from conventional radiographs and the biplane imaging system (Pearson correlation coefficient 0.662 to 0.999). There was no statistically significant difference in the mean of all parameters in staggered and non-staggered views (ANOVA p = 0.7919 to 0.9973 and Pair simple T-test p = 0.067 to 0.977) except limb length discrepancy (p = 0.000), femur length (p = 0.002), and tibia length (p = 0.049). Intra and inter-rater reliability of long leg views from the biplane imaging system were excellent in both staggered feet and non-staggered feet positions (ICC = 0.938 to 1.000).

CONCLUSION: The biplane imaging system was demonstrated to be valid and reliable in the measurement of commonly used foot and ankle radiographic parameters when compared to conventional radiographic method. Staggered feet positioning allowed simultaneous imaging of both feet in lateral view without affecting limb alignment except limb length discrepancy, femur, and tibial length measurement.

Level of Evidence: Level III, Retrospective Comparative Study

Key Words: Biplane imaging system (EOS^{TM} 2D system), Conventional x-ray, Radiographic parameters of foot and ankle, Lower limb alignment

Complications of the Tornier Salto Talaris Total Ankle Prosthesis: A Single-Surgeon Experience

Abstract ID: Paper 186

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PURPOSE: Since its introduction in the 1970's, total ankle arthroplasty (TAA) has struggled with lower survivorship (with reoperation and/or revision as endpoints) than total hip or knee arthroplasty, and persistent issues with complex biomechanics, poor soft tissue envelope, and soft tissue balancing.

The objective of this study was to retrospectively evaluate the postoperative complications encountered with the Tornier Salto Talaris total ankle arthroplasty system, using the Glazebrook classification system for assessing TAA complications.

METHODS: The surgeon's private office records were queried for all Salto Talaris TAA cases. All primary implantation cases were included in this data set, and fusion take-downs were excluded. Medical records were reviewed from the time of the index procedure (operative note) until most recent follow-up or revision.

Per the Glazebrook classification, complications were categorized as high-grade (deep infection, aseptic loosening, implant failure), medium-grade (technical error, subsidence, postoperative bone fracture), and low-grade (intraoperative bone fracture, wound healing problems), based on the likelihood of revision. Nonunions are included in the "aseptic loosening" category. The classification system was modified to include uncharacterized pain (high-grade), medial impingement (high-grade), and nerve palsy (low-grade). "Learning curve" (complication rate vs. surgeon experience), concurrent procedure, and "at risk" prosthesis data were also captured.

RESULTS: Since 2008, the senior author has implanted 104 Salto Talaris TAA prostheses, with an average follow-up of 29 months (range, 4-64). At the index procedure, 90 ankles (87%) underwent at least one concurrent procedure, including tendo-Achilles lengthening (n=77), prophylactic medial malleolus fixation, and prophylactic fibular plating.

The annual rate of all complications, normalized to number of cases per year, fluctuated between 0% (2013; partial data) and 39% (2012). In this data set, 27 complications (26%) were identified in 25 ankles. The most common complications were wound healing (9.6%), infection (2.9%), and nonunion (2.9%). There was an 11% reoperation rate in the study population, including one prosthesis (0.96%) revised due to unresolved pain; specifically, uncharacterized pain, subsidence, and medial impingement were classified as high-grade complications due to 100% reoperation rates. Aseptic loosening (including nonunion) (75%), infection (67%), and postoperative bone fracture (50%) were medium-grade complications requiring reoperation. Wound healing (10%) was the only low-grade complication that required reoperation.

Additionally, seven prostheses were identified as "at risk" due to subluxation of the talar component, periprosthetic radiolucencies, periprosthetic cysts, residual heel varus, or

reoperation (specifically, tibial osteotomy for limb alignment).

CONCLUSION: The most common complication was wound healing (n=10), followed by aseptic loosening/nonunion (n=3) and infection (n=3). Nearly 90% of the patients in this data set underwent a procedure concurrent with Salto Talaris prosthesis implantation, which may have affected the types and rates of complication; although, the overall rate of reoperation was 11%, including one revision. Further work is ongoing to further analyze radiographs, evaluate the effect of specific concurrent procedures on complication rate and stratify the onset/timing of specific complications in the postoperative period.

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Long-Term Clinical and Functional Outcomes Following Bilateral Ankle Arthrodesis

Abstract ID: Paper 187

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INTRODUCTION: Ankle arthrodesis is currently considered to be the standard of care for end-stage ankle arthritis. Although an ankle arthrodesis is a relatively common procedure, typically they are only performed unilaterally due to the concern for functional limitation and adjacent joint arthritis. The purpose of this study was to evaluate the outcomes of patients treated with bilateral ankle arthrodesis with attention to clinical and functional outcomes.

MATERIALS AND METHODS: The medical records of 31 patients were reviewed over a 30-year period (1977-2007). All patients had a least 1 year of clinical follow-up, with an average follow-up of 11.2 years following the initial arthrodesis. The medical records were reviewed for pertinent patient demographics, information pertaining to the surgical procedure, complications, and subsequent adjacent joint fusions. Radiographs were reviewed for time to fusion. Functional outcomes were measured using the Foot and Ankle Ability Measure (FAAM) and the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle and Hindfoot scale.

RESULTS: Ten females and 21 males underwent a bilateral ankle fusion, at an average age of 57 years at the time of their first fusion (Table 1). The contralateral fusion occurred on average 2.8 years following the initial fusion. On average, radiographic fusion occurred 12 weeks following the initial fusion and 14 weeks following the contralateral fusion. There was a statistically significant increase (P=0.0001) in the average AOFAS score from preoperative to the 2, 5, and 10-year follow-up for both ankles. The average FAAM score at last follow-up was 70. There were three (5%) nonunions treated with an additional procedure and seven (11%) subsequent subtalar fusions for symptomatic arthritis, which occurred on average 9.8 years following their tibiotalar fusion.

DISCUSSION: Bilateral ankle arthrodesis provides patients with effective technique for the treatment of bilateral, end-stage ankle arthritis. Arthrodesis results in good functional outcomes at long-term follow-up, and a low rate of failure. Although there is a concern for adjacent joint arthritis, it was symptomatic enough in a small amount of patients to warrant an arthrodesis.

Click here to view Table

Knotted vs. Knotless Suture Bridge Repair of the Achilles Tendon Insertion: A Biomechanical Study

Abstract ID: Paper 188

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BACKGROUND: Surgical treatment of insertional Achilles tendinopathy often involves detachment and debridement of the Achilles tendon insertion. A recent study has shown that knotted suture bridge fixation of the Achilles to the calcaneus is biomechanically superior to single row fixation, but there is an absence of literature on the use of a knotless suture bridge construct to repair the Achilles tendon in these instances.

HYPOTHESIS: There will be no significant difference in the load to failure, mode of failure, repair site gapping, or repaired footprint size when comparing knotted suture bridge repair to knotless suture bridge repair of the Achilles tendon after detachment for insertional Achilles tendinopathy.

STUDY DESIGN: Controlled Laboratory Study

METHODS: One specimen from each pair of ten cadaver heels was randomized to one of two Achilles insertion repair groups: knotted (n = 10) or knotless (n = 10) suture bridge repair. Repaired footprint size was measured, and then cyclic testing from 10-100 N for 2000 cycles was performed. This was followed by measurement of repair site displacement and load to failure. Mode of failure was also recorded.

RESULTS: The knotted suture bridge repair of the Achilles tendon had a significantly higher load to failure compared to the knotless suture bridge at 317.8 ± 93.6N and 196.1 ± 12.1N, respectively ($p = 0.001$). All constructs failed at the tendon-suture interface. Although not significantly different, there was a trend towards smaller repair site displacement after 2000 cycles in the traditional group (2.8 ± 1.2 mm) compared to the knotless group (3.6 ± 1.1 mm) ($p = 0.075$). Initial footprint size was not significantly different between the traditional and knotless suture bridge repairs ($p = 0.4$).

CONCLUSION: During suture bridge repair of the Achilles tendon after detachment, knots at the proximal suture anchors significantly improve the biomechanical strength of the repair.

CLINICAL RELEVANCE: Our study demonstrated that the knotless suture bridge repair had a significantly lower load to failure than the knotted suture bridge. Surgeons should be aware of these biomechanical differences, as they influence the postoperative rehabilitation protocol and may lead to higher surgical complication rates.

Outcomes Following Retrograde Intramedullary Nailing for Tibiotalocalcaneal Arthrodesis

Abstract ID: Paper 189

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INTRODUCTION: Pain and progressive malalignment of the ankle and subtalar joints secondary to trauma, ischemia, infection, neuropathy, bone loss, and failed prior ankle arthroplasty or arthrodesis present a challenge for orthopedic surgeons. Tibiotalocalcaneal (TTC) arthrodesis is an alternative to amputation in patients with severe ankle and subtalar arthropathy that is refractory to other forms of treatment. Fixation can be achieved by multiple methods, the most common being retrograde intramedullary nailing and crossed screws. When compared to the crossed screw method, retrograde intramedullary nailing maintains length, alignment, and stability with a significantly stiffer construct for TTC fusion. The objective of this study was to assess the efficacy of retrograde intramedullary nailing to maintain tibiotalocalcaneal fixation.

METHODS: Retrospective case review identified 16 patients who underwent TTC fusion with one of two unique intramedullary nails between 2008 and 2011. The final results are based on clinical and radiological outcomes.

RESULTS: 9 females and 7 males met inclusion criteria. The average age at TTC arthrodesis was 58.25 years (range 35-77 years). All patients except one had TTC fusion to revise a failed primary procedure; primary procedures included total ankle arthroplasty (4 patients), ankle, subtalar, or TTC fusion (8 patients), open reduction internal fixation (1 patient), and Charcot reconstruction (2 patients). The most common indication for surgery was pain/arthritis (50% patients). The mean length of follow-up was 26.4 months (range 9.96-57.6 months). Mean time to healing, defined as time to maximum benefit, was found to be 1.4 years. Following TTC fusion, 6 patients reported no complications. Seven patients developed infectious complications, 5 of which resulted in below knee amputation. A sixth patient requested an amputation for chronic swelling and neuropathic pain. In all, eight patients required at least one additional procedure following TTC fusion. All patients except the six who ultimately progressed to amputation reported increased ankle stability after TTC fusion. The average VAS pain score decreased from 5.719 preoperatively to 0.94 postoperatively. Of the 10 patients who did not require amputation, 9 reported postoperative satisfaction at last follow-up.

CONCLUSIONS: Tibiotalocalcaneal fusion is a viable alternative to primary below knee amputation for patients who have failed previous treatment of ankle and subtalar joint pain and deformity. Patients need to be counseled preoperatively that complications can be significant and amputation is not an extraordinary outcome. Despite complications, patients report high rate of postoperative improvement in pain.

Salvage Hindfoot Arthrodesis Using Internal and Ilizarov Fixation

Abstract ID: Paper 190

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OBJECTIVES: Success of hindfoot arthrodesis in patients with end-stage arthrosis and complicating factors including failed fusion attempts, previous infection, bone loss, soft tissue compromise, diabetes, and chronic tobacco use is challenging and may appear to preclude the treatment option of arthrodesis. We reviewed results of a standardized protocol combining simultaneous open reduction and internal fixation with Ilizarov compression frame application to achieve fusion in higher risk patients.

METHODS: With IRB approval, retrospective review of hindfoot patients treated with simultaneous open reduction and internal fixation and Ilizarov frame was undertaken. Records and x-rays allowed identification of co-morbidities and presence or absence of successful fusion. Complications were acknowledged and treated.

RESULTS: Fifteen patients underwent the procedure. Average follow-up was 27.9 months. Thirteen patients failed previous fusions. Post-traumatic arthrosis accounted for 80% of patients, 5 had open injuries. All patients had one co-morbidity and 67% had multiple, including rheumatoid arthritis, diabetes (types 1 and 2), and smoking. Four patients presented with deep infection requiring segmental bone debridement prior to fusion. Union was achieved in 73.3%, with 80% of patients experiencing post- operative pain relief. Seven patients required symptomatic hardware removal. Three patients received eventual below knee amputation for recalcitrant nonunion. Statistically significant correlations exist between smoking and wound infection/revision, as well as nonunion and amputation.

CONCLUSION: Our results indicate combined open reduction and internal fixation with Ilizarov compression frame application provides a surgical option for management of end-stage, hindfoot arthritis, and nonunion. Further study is planned to compare cohort outcomes and gait analysis in these fusion patients to patients who elect below knee amputation.

Analysis of Gradual Correction Techniques for the Treatment of Complex Midfoot and Hindfoot Deformities

Abstract ID: Paper 191

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PURPOSE: Complex midfoot and hindfoot deformities are challenging problems that are difficult to treat with conventional methods of acute correction and internal fixation, due to soft tissue and neurovascular issues. Amputation is often the only alternative to address refractory pain and/or recurrent ulceration; however, staged reconstruction with gradual deformity correction, followed by open fixation once the desired alignment has been obtained, may be a means to manage these complex deformities. The purpose of this study was to retrospectively review medical records of gradual correction cases by a single surgeon, in order to assess patient complications and outcomes.

METHODS: Under an IRB-approved protocol, seven cases of gradual correction using Taylor Spatial Frames (TSF) by a single surgeon (PTF) were retrospectively reviewed. Demographic, surgical, and postoperative complication data were collected for each case, including patient sex, body mass index, presence of ulceration, injury/condition treated, total time in frame and complications (e.g., pin tract infection, neurovascular complaints, fixation failure). Radiographic analysis (preoperative to postoperative/most recent follow-up) was performed.

RESULTS: Seven cases of gradual correction techniques were retrospectively evaluated. Six cases used a Butt TSF, with one case using both a Butt and Torpedo TSF during two separate treatment periods. The patient population consisted of five females and two males, with an average age (at first surgery) of 55 years (range, 32-74) and average BMI of 28 (range, 20-39). In this study population, the foot and ankle conditions included fracture malunion of the midfoot, severe midfoot arthritis, osteomyelitis, severe neuropathic arthopathy, and fibular hemimelia/planovagus, as well as midfoot and hindfoot malunion. The average time in frame was 113 days (range, 80-159).

Pin tract infections, neurovascular compromise, and fixation failure were the complications examined. Three pin tract infections (43%) occurred; subsequently, two resolved within one month of antibiotic therapy and one required irrigation and debridement. No neurovascular complaints or fixation failures occurred in the study group; thus, there was an overall complication rate of 43% in this population. Two patients presented with an ulceration at the time of surgery.

From pre- to postoperative, the talo first metatarsal angle decreased an average of 11.5° (preoperative=23.2°; postoperative=11.7°), talocalcaneal angle decreased an average of 6.9° (preoperative=24.6°; postoperative=17.8°), and calcaneal pitch angle increased an average of 4.6° (preoperative=11.8°; postoperative=16.4°).

CONCLUSION: Medical records of seven gradual correction cases, treating multiple complex midfoot and hindfoot deformities, were analyzed to determine demographic, treatment, and complication data, in this distinct patient population. Pin tract infection was the only complication

recorded in the population, with an occurrence rate of 42%.

Midfoot and hindfoot deformities remain as a challenging clinical scenario for orthopedic foot and ankle surgeons. Techniques, such as limited open osteotomies and TSF, offer the surgeon alternatives to amputation. Three dimensional visualization of the deformity and its associated forces are necessary components of successful, gradual correction of these anatomic deformities. Careful incision placement, osteotomy placement and morphology, as well as definitive fixation are important components of gradual correction techniques.

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Open vs. Posterior Arthroscopic Subtalar Arthrodesis: A Comparative Study

Abstract ID: Paper 192

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BACKGROUND: Open subtalar joint arthrodesis is an effective procedure for treating patients with subtalar joint arthritis after failure of nonsurgical treatment. Arthroscopic technique, especially through the posterior approach, has gained increasing popularity, with reports of high patient satisfaction, excellent fusion rate, and minimal postoperative morbidity. There is a lack of comparative research to demonstrate outcomes and complications between the two techniques.

MATERIAL AND METHODS: Retrospective chart review was performed evaluating 52 and 56 consecutive patients who underwent subtalar joint arthrodesis using open and arthroscopic technique between 2001 and 2012. The primary outcome was Foot Function Index (FFI) and secondary outcomes included Short Form-36 (SF-36) physical and mental component scores, Visual Analogue Scale, Angus and Cowell rating score, coronal plane hind foot alignment, tourniquet time, the length of hospital stay, fusion rate, time to return to work, sport activity, activity daily living, and complications.

RESULTS: Both groups showed significant improvement in the FFI, SF-36 physical and mental component score, Angus and Cowell rating score, and Visual Analogue Scale. There was significantly greater improvement in union rate, shorter union time, shorter hospital stay, lesser time to return to daily activities, lesser time to release to work, and lesser time to play sport activities in the arthroscopic arthrodesis group ($p<0.05$ all). However, tourniquet time, Visual Analogue Scale, Angus and Cowell rating score, and coronal plane hindfoot alignment were similar between two groups. Sural nerve complications and painful surgical scar were more frequent in the open arthrodesis group while hardware symptoms were more frequent in arthroscopic group.

CONCLUSION: Open and arthroscopic subtalar arthrodesis were associated with significant improvement in terms of pain and function as measured with the FFI and SF-36. Posterior subtalar arthroscopic arthrodesis resulted in a higher union rate, shorter hospital stay, and lesser time to return to activities, as well as lower overall complication rate.

Level of Evidence: Level III, Retrospective study

Key Word: Posterior Arthroscopic Subtalar Arthrodesis, Open Subtalar Arthrodesis, Comparative Study

Analysis of Failed Fresh Osteochondral Allografts of the Talus

Abstract ID: Paper 193

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PURPOSE: Fresh osteochondral allografting is an increasingly common option for the treatment of large chondral defects, with concomitant damage to subchondral bone. Despite encouraging early term results, failure rates of up to 35% are reported. A retrieval study was performed to characterize the clinical failure of talar allografts.

METHODS: A prospective collection of fresh osteochondral allografts of the talus was undertaken (IRB-approved). Cases of deep infection were excluded. At revision, the failed allograft tissues were explanted and placed in 10% buffered formalin. After tissue fixation, samples were decalcified and embedded in paraffin; subsequently, 5 mm thick sections were obtained from embedded tissue blocks and stained with Safranin-O/Fast Green and Hematoxylin and Eosin. Stained sections were analyzed via light microscopy. Analysis focused on proteoglycan content within the cartilage cap (directly proportional to Safranin-O staining intensity), qualitative viability of chondrocytes within the cartilaginous tissue, osteoblast viability and presence/absence of inflammatory infiltrate at the graft-host junction. Primary diagnosis, reason for revision, demographic factors as well as radiographic analysis (post-index to revision of post-index) were determined through medical record reviews.

RESULTS: To date, 8 grafts (6 patients) implanted for an average of 35 months (range, 12-96) were retrieved at the time of revision. All were revised due to graft collapse. Analysis of Safranin-O staining intensity within the cartilaginous tissue of retrieved specimens demonstrated a decreased amount of proteoglycans when compared with healthy osteochondral tissue. Cartilage tissue demonstrated microanatomic signs of poor tissue viability, including empty lacunae. Subchondral bone also displayed numerous empty lacunae at the periphery of the grafts. Of note, substantial osteoclast-mediated bone resorption was observed, as was the active formation of fused polykaryons indicative of the differentiation of monocytes to an osteoclastic lineage. Hypercellular regions were observed in proximity to the region where graft fixation (screw or bioabsorbable pin) was utilized. This inflammatory infiltrate may be a result of debris or degradation of the screws or pins and/or related to remodeling effect due to micromotion of the fixation system within the graft tissue.

From post-index procedure to revision of the post-index procedure, the graft decreased in height by an average of 25% and joint space decreased in height by an average of 21%. Prior to revision, 100% of grafts exhibited collapse and subchondral lucencies, interface was visible in 63% of grafts, and density was increased in 88% of cases.

CONCLUSION: Definitive conclusions regarding cellular and tissue-level mechanisms of failure of fresh osteochondral talar allografts cannot be made from an analysis of eight specimens; however, this study highlights data gleaned from histopathologic and radiographic analysis. Cartilage tissue within the failed graft displayed altered matrix composition and poor viability, which may preclude cartilaginous incorporation in vivo, and subchondral bone within the grafts

displayed elevated osteoclastic bone resorption. Increased bone resorption, especially at the periphery of the graft, may lead to weakening of the graft-host interface with subsequent mechanical collapse of the graft. No evidence of immune-mediated graft rejection was observed, suggesting osteoclastic bone resorption was independent of graft vs. host disease. Immunostaining (CD44, G-CSF and CD68) are underway.

Click here to view Figure

The Effect of Exercise and Glycemic Control on Diabetic (db/db) Mouse Achilles Tendons

Abstract ID: Paper 194

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IINTRODUCTION: It has been well documented that diabetics have stiffer joint tendons which make them more prone to capsular contracture, and as a result, have an increased risk of foot ulceration. It is not entirely clear why these changes occur. In this study, we examine the Achilles tendon biomechanical, proteinomic, and histological properties in diabetic mice and explore the effect of pharmacologic glycemic control and exercise in this model.

METHODS: Male diabetic mice (db/db) and age-matched non-diabetic lean control (lc) mice were used for this study and divided into a total of 8 groups (regular diet, no exercise, regular diet with exercise, Metformin diet without exercise, Metformin diet with exercise). For 10 weeks, mice in the exercise groups were run at 10 meters/minute for 1 hour 5 days per week. After 10 weeks, all mice were euthanized and the Achilles tendon complex was collected from each mouse and underwent histological, biomechanical, and proteinomic testing.

RESULTS: Histological analysis of the Achilles tendon was completed in five to six Achilles tendons from each of the eight groups. One lean control mouse treated with metformin and no exercise had tendon neutrophil infiltration. The remaining samples from all 8 groups showed normal histological findings. Biomechanical testing revealed a significant difference in maximum load to failure between the untreated diabetic and untreated lean control mice (6.09N vs. 3.93N). There were no significant differences between the treated and untreated diabetics. Proteinomic testing did not reveal any significant differences between the experimental and control groups.

CONCLUSIONS: There is limited data about the histological, proteinomic, and biomechanical effect of diabetes on the gastrocsoleus myotendondous complex, and almost no literature evaluating tendons with medication control of the diabetes. Our data show no significant gross histologic or proteinomic changes between the diabetic and lean control mice in both the treatment and non-treatment groups. This is in contrast to previous studies in the ob/ob diabetic mouse model which had insertional degenerative changes. Biomechanical testing revealed only an increased load to failure in the uncontrolled diabetic group compared to a lean control. It is our belief that a 10-week study period may not be long enough for the diabetic tendons to develop detectable histologic, proteinomic, and biomechanical changes and that a longer experimental period may reveal significant differences among the study and control groups.

The Minimal Screw Length for Tricortical Syndesmosis Fixation in Ankle Fracture: A Cadaveric Study

Abstract ID: Paper 195

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INTRODUCTION: The effects of the screw length for single tri-cortical syndesmosis fixation of a syndesmotic injury can be assessed by evaluating the three-dimensional kinematic behavior of the tibiofibular diastasis. To our knowledge, no study has shown the kinematic behavior using a biomechanical study of single tricortical screw fixation with varied lengths. The specific aim of this study was to determine the minimal tri-cortical syndesmosis screw length for tibiofibular syndesmosis reduction fixation.

METHODS: Fifteen fresh-frozen cadaveric lower extremities used for testing. A specially designed apparatus was used to stabilize the specimen and rotate the ankle joint in 25° of internal rotation and 35° of external rotation for 9 cycles in each direction. Three stages were tested: intact (Stage I), injury (Stage II), and fixation (Stage III). For Stage III, fixation was accomplished with a single 3.5 mm cortex metallic syndesmosis screw with 3 different predetermined screw lengths. Group I was fixed with threads less than 35% across the width of the metaphysis of the tibia after syndesmotic fixation 4 cm proximal to the plafond; Group II was fixed with the screw threads between 35% and 65% across the width of the metaphysis of the tibia after syndesmotic fixation; and Group III was with the screw threads juxtaposing the far cortex of the tibia after syndesmotic fixation. Axial loading, torque, and rotational angle were recorded.

RESULTS: Our torque results indicated that after the deltoid, anterior tibiofibular ligament, and interosseous ligaments were sectioned, the foot lost 74% and 61% torsional strength compared to intact specimen for the foot externally rotated 35° and internally rotated 25°, respectively. There was no statistically significant difference detected in foot torsional strength between the three groups of screw fixation specimen, and simulated injury specimen for either foot rotations. The torque of the three groups when externally rotated 50º was found not significantly different between each group (Group I: 9+5Nm; Group II: 8+3Nm; Group III: 13+5Nm). Fibula fractures were detected when foot external rotated 50º (Group I: 2; Group II: 3; and Group III: 4).

CONCLUSION: This study suggested that tricortical syndesmosis screw fixation of the distal tibiofibular syndesmosis with differing screw lengths did not provide a difference in torque applied to the syndesmosis. Fixation did not provide a difference in torque from sectioned ligaments to fixation in our study. Therefore, it is advised that patients should not bear weight in the period necessary for ligaments to heal.

MAOA BREAKOUT SESSION #15
SPORTS
April 26, 2014

Results of Revision Anterior Stabilization Surgery in Adolescent Contact and Overhead Athletes

Abstract ID: Paper 196

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INTRODUCTION: Adolescent athletes, particularly those involved in contact and overhead sports, are at high risk for recurrent subluxation or dislocation of the glenohumeral joint, even after anterior stabilization surgery. This often necessitates revision surgery, of which the outcomes are largely unknown. The purpose of this study was to determine (1) failure rates, (2) functional outcomes, and (3) risk factors for failure after revision stabilization surgery in high-risk adolescent athletes.

METHODS: Records of adolescent athletes (18 years old or younger) who underwent primary anterior stabilization surgery for recurrent instability after traumatic anterior dislocations at our institution between 1998 and 2009 were reviewed; patients undergoing subsequent revision stabilization surgery were identified. Failure rates after revision surgery were assessed using Kaplan-Meier analysis. Functional outcomes were assessed using the Marx Activity Score, the American Shoulder and Elbow Surgeons (ASES) Score, the UCLA Shoulder Rating Scale, and the Rowe Score for Instability at greater than 2 years follow-up (Marx and ASES) or at last clinical follow-up (UCLA and Rowe). Characteristics of patients who re-dislocated after revision surgery and required re-revision (RR group) were compared to those who required only a single revision (Rev group) to identify potential risk factors for failure.

RESULTS: Of 90 patients who underwent primary anterior stabilization surgery at our institution, 15 (17%) failed and underwent revision surgery (14 male, 1 female; 6 [40%] involving the dominant arm). Average follow-up was 5.5 (range 2-12) years.

Five of the 15 revision patients (33%) had recurrent dislocations and underwent repeat revision stabilization surgery at a mean of 50 (range 22-102) months after initial revision (RR group). Kaplan-Meier failure-free estimates are 86.7% (95% CI: 59.5, 96.6) at 24 months, and 75.8% (95% CI: 44.6, 92.4) at 48 months after revision surgery (Figure 1). A comparison of the Rev and RR groups is shown in Table 1. Failure-free estimates at 48 months for arthroscopic and open revision surgery are 64.3% (95% CI: 23.0, 91.6) and 87.5% (95% CI: 46.3, 98.3), respectively (Figure 2).

CONCLUSIONS: At 5.5 years' follow-up, adolescent athletes had a high failure rate of revision stabilization surgery and modest functional outcomes. We were unable to convincingly identify specific risk factors for failure of revision surgery due to the small numbers of involved patients. However, failure-free estimates at 48 months appear to be higher for open when compared to arthroscopic revision stabilization procedures.

Click here to view Table and Figures

Performance and Return-to-Sport After Tommy John Surgery in Major League Baseball Pitchers

Abstract ID: Paper 197

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BACKGROUND: Ulnar collateral ligament reconstruction (UCLR) is a common procedure performed in Major League Baseball (MLB) pitchers with symptomatic UCL deficiencies that have failed non-surgical treatment. The purpose of this study was to determine: (1) the rate of return to sport (RTS) in the MLB following UCLR, (2) timing of RTS, (3) performance after RTS, and (4) the difference in RTS and performance between pitchers who underwent UCLR and demographic-matched control pitchers who have not had UCLR.

METHODS: MLB pitchers with symptomatic UCL deficiency that underwent UCLR between 1986 and 2012 were evaluated. Players' data was extracted from MLB team websites, injury reports, player profiles/biographies, press releases, and cross-referenced with the MLB injury database (MLB411). All player, elbow, and surgical demographic data were analyzed. Age, body mass index (BMI), position, handedness, and MLB experience-matched controls were selected from the MLB during the same years as those undergoing UCLR. An 'index year' was designated for controls, analogous to UCLR year in cases. RTS and performance in MLB was compared between cases and controls. Student's t-tests were performed for analysis of within-group and between-group variables.

RESULTS: 148 pitchers (83%) were able to RTS in MLB. Of the 148 pitchers who RTS, 118 players (80%) were able to RTS the season following UCLR (mean 20.5 +/- 9.72 months). Length of career in MLB following UCLR was 3.9 +/- 2.84 years. Revision rate was 3.9%. In the year prior to UCLR (index year), controls pitched more innings, played more games, had more wins, and had greater winning percentage ($p<.05$ for all) while cases were not better in any parameter. Following UCLR, pitchers had significant ($p<.05$) improvements in losses, losing percentage, earned run average, hits, runs, home runs given up, walks, and WHIP. Comparisons between cases and controls for the timeframe following UCLR (cases) or index year (controls) demonstrated that cases were significantly better in losses per season, losing percentage, Earned Run Average, hits allowed, and walks plus hits per inning pitched (WHIP). Controls were not significantly improved over cases in any measures following index year.

CONCLUSION: There is a high rate of RTS in the MLB following UCLR. Nearly all players RTS by the second season following surgery. Performance declined prior to surgery and improved following surgery. When comparing to demographic-matched controls, UCLR had better performance in multiple outcome measures.

Biomechanical Evaluation of the Incline Horizontal Mattress Stitch

Abstract ID: Paper 198

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INTRODUCTION: Despite suture, suture anchor, and repair technique advances, clinical and biomechanical studies highlight the suture-tendon interface as the primary weak link in rotator cuff repair constructs. The incline horizontal mattress stitch is an antegrade stitch placed through the rotator cuff tissue at a 40º angle allowing the suture to engage a larger tissue area than a traditional antegrade stitch. It has been proposed as a simple and efficacious stitch for rotator cuff repairs, but has not been evaluated biomechanically. The purpose of this study is to evaluate the suture-tendon interface strength characteristics of the incline mattress stitch compared to a simple, horizontal mattress, modified Mason-Allen (MMA) and Massive Cuff (MAC) stitch using sheep infraspinatus tendons.

STUDY DESIGN: Controlled laboratory study.

METHODS: 75 sheep infraspinatus tendon grafts were randomized among five stiches (N=15) to include: simple, horizontal mattress, incline horizontal mattress, Massive Cuff (MAC), and modified Mason-Allen (MMA). Each graft was cyclically loaded on a mechanical testing system from 5 to 30 N for 20 cycles and then loaded to failure. Analysis of variance was used to compare the five types of stitches with respect to cyclic elongation, peak-to-peak displacement, and ultimate load.

RESULTS: Mean stitch load-to-failure values were: 81 +/- 42 N for the simple, 107 +/- 46 N for the mattress; 128 +/- 37 N for the incline mattress; 140 +/- 47 N for the MAC; and 170 +/- 50 N for the MMA. The incline mattress stitch had a higher load-to-failure value than the traditional horizontal mattress, but the differences were not significant (p=0.195). The incline horizontal mattress was not significantly weaker than the MAC stitch (p=0.489), but the traditional horizontal mattress stitch was significantly weaker (p=0.050). The only significant load-to-failure differences with the incline mattress stitch was comparison with the simple stitch (p=0.009) and the MMA stitch (p=0.013). Regarding peak-to-peak displacement and cyclic elongation, the incline mattress was less compared to other stitches with the differences being significant for all values except elongation of the simple stitch (p=0.649) and elongation of the MAC stitch (p= 0.074).

CONCLUSIONS: The incline horizontal mattress stitch had favorable testing parameters compared to other rotator cuff stitches.

Critical Neurovascular Structure Location for Posterior Portals in Knee Arthroscopy

Abstract ID: Paper 199

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INTRODUCTION: Injury to neurovascular structures is a rare complication of posterior portal placement during knee arthroscopy. Despite the risk, there is minimal data characterizing the anatomic course of the common peroneal nerve (CPN), saphenous nerve (SN), and popliteal artery (PA) in this area. The goal of this study was to define the location and variability of these structures.

PATIENTS AND METHODS: Magnetic resonance imaging (MRI) of the knee were reviewed for 100 adult patients. On axial images at the level of the joint, the location of SN, CPN, and PA were identified. The posteromedial portal tract was simulated by a line from the posterior edge of the medial collateral ligament (MCL) to the posterior cruciate ligament. The posterolateral portal tract was similarly defined from the lateral collateral ligament (LCL) to the PCL. The vector distances between the tracts and the SN, CPN, and PA were recorded. Distances between these neurovascular structures and fixed ligamentous landmarks (MCL, LCL, and PCL) were also recorded. Age, gender, height, weight, and race were gathered from each patient's medical record. Descriptive statistics were calculated using Student's t-test and ANOVA.

RESULTS: Mean height, weight and BMI were 1.69 m (range 1.31 -1.82), 84.4 kg (60.3-118.8), and 29.1 (20.5-49.0), respectively. Mean distance between SN and posteromedial tract was 13.1 mm (range 6.8-20). From the posterolateral tract, mean distance to CPN was 15.9 mm (11.2-20.9) and to PA was 9.2 mm (2.7-12.8). The vector, AP, and ML distances between the MCL and SN were 14.3 mm (range 6.8-20.4), 13.5 mm (6.1-19.4), and 2.8 mm (-0.6-9.2), respectively. The vector, AP, and ML distances between the LCL and CPN were 16.5 mm (range 11.2-22.1), 15.9 mm (8.3-21.0), and 2.7 mm (0.3-8.5), respectively. The vector, AP, and ML distances between the PCL and PA were 11.7 mm (range 5-16.9), 8.9 mm (3.3-13.1), and 6.1 mm (1.5-11.4), respectively.

A significant ($p<0.05$) decrease in distance between the posteromedial portal tract and SN was found in patients with BMI ≤ 25 (mean 11.6 mm vs. 13.9 mm). Significant decreases was also found between the posterolateral portal tract and CPN (mean 15 vs. 17) and between the PCL and PA vector (mean 8.3 vs. 10.3) for patients with a BMI of ≤ 30. No other significant differences in distance were noted.

DISCUSSION/CONCLUSION: The location of CPN, SN, and PA can dangerously approach posterior arthroscopy portals, with closest distances seen in relatively low-BMI patients. Caution needs to be taken when creating posterior portals.

Return to Activity Following Medial Patellofemoral Ligament Reconstruction: A Systematic Review

Abstract ID: Paper 200

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BACKGROUND: Recurrent patellar instability tends to affect a young, athletic population, often inhibiting athletic activities. Reconstruction or repair of the medial patellofemoral ligament (MPFL) has gained favor as increasing evidence shows this ligament as the primary soft tissue stabilizer to lateral patellar displacement. Despite the gaining popularity in MPFL reconstruction, there is limited data on returning to activities in the athletic population.

PURPOSE: This review sought to report the ability to return to activity following MPFL reconstruction described in the literature and assess the overall success rate of the procedure in an athletic population.

STUDY DESIGN: Meta-analysis.

METHODS: A systematic review was performed using multiple databases. Studies reporting outcomes with Tegner scores after repair or reconstruction of the MPFL were included. Surgical technique, Tegner scores, and episodes of recurrent patellar instability were recorded and organized into a database.

RESULTS: Ten articles with a total of 402 patients were included and reviewed. The mean preoperative Tegner score was 4.7 (2.9-7.5). The mean postoperative Tegner score was 5.8 (4.0-7.7). Forty-nine patients (12.2%) had a recurrent episode of instability, 11 of which required additional corrective procedures.

CONCLUSION: Medial patellofemoral ligament reconstruction has a success rate of 87.8% in an athletic population, with the majority of patients returning to pre-injury activities. The small increase in preoperative and postoperative Tegner scores was not statistically significant, establishing that most patients return to the same activity level prior to injury.

Biomechanical Comparison of Patellar Fixation Techniques in Medial Patellofemoral Ligament Reconstruction

Abstract ID: Paper 201

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BACKGROUND: Multiple techniques for reconstruction of the medial patellofemoral ligament (MPFL) have been described; however, little is known about the biomechanical properties of these techniques. Fixation of the graft to the patella has not been studied in a human cadaver model. The purpose of this study is to compare the ultimate load to failure and stiffness of two different MPFL patellar fixation techniques: suture anchor fixation and interference screw fixation. The ultimate load to failure of the native MPFL has been shown to be 208 N, providing an important benchmark for both methods of reconstruction. The hypothesis of this study is that the suture anchor group will show a similar ultimate load to failure and stiffness compared to the interference screw group.

METHODS: Semitendinosus autograft MPFL reconstructions were performed in 8 pairs (16 total) of fresh cadaver knees. The specimens were randomly assigned to two groups of 8 specimens based on the method used to fix the graft to the medial patella: suture anchor or interference screw fixation. Each reconstruction technique was performed on a knee from the same cadaver. The reconstructions were cyclically loaded for 10 cycles to 30 N and then tested to failure at a constant displacement rate of 6 mm/sec. Load to failure (N), stiffness (N/mm), and mode of failure were recorded for each specimen.

RESULTS: The suture anchor group had a significantly lower load to failure (201.54 [SD 63.14] N]) than the interference screw group (299.25 [SD 99.87] N) ($p<0.01$). The suture anchor group also had a significantly lower mean stiffness (20.60 [SD 6.78] N/mm) compared to the interference screw group (34.66 [SD 10.74] N/mm) ($p<0.01$).

CONCLUSIONS: Interference screw fixation to the medial patella was found to be significantly stronger than suture anchor fixation. The suture anchor group, however, was not different from the native MPFL, and may still be a valid choice for fixation on the patellar side in MPFL reconstruction surgery.

Incidence of Head and Neck Injuries in Extreme Sports

Abstract ID: Paper 202

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INTRODUCTION: Since their conception during the mid 1970s, international participation in extreme sports has rapidly grown. The recent death of extreme snowmobiler Caleb Moore at the 2013 Winter X games has demonstrated the serious risks associated with these sports. The purpose of this study was to examine the incidence and prevalence of head and neck injuries (HNI) in extreme sports.

METHODS: The 2000-2011 National Electronic Injury Surveillance System (NEISS) was used to acquire data for 7 sports that are included in the Winter and Summer X games. Data from the NEISS database was collected for each individual sport per year and type of HNI. Cumulative data for overall incidence and injuries over entire 11 year period was calculated. National estimates were based off NEISS weighted calculations using U.S. census data.

RESULTS: Over 4 million injuries were reported for extreme sports participants between 2000-2011 of which 11.3% were HNI. Of all HNI, 83% were head injuries and 17% neck injuries. The four sports with the highest total incidence of reported HNI were skateboarding (129,600), snowboarding (97,527), skiing (83,313), and motocross (78,236). Severe HNI (cervical or skull fracture) had a reported total incidence of 2.5% of extreme sports HNI. Of these, skateboarding had the highest percentage of severe head and neck injuries (Figure).

CONCLUSION: The number of serious injuries suffered in extreme sports has increased as participation in the sports continues to grow. A greater awareness of the dangers associated with these sports offer an opportunity for sports medicine and orthopedic physicians to advocate for safer equipment, improved on site medical care, and further research regarding extreme sports injuries.

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Thromboembolism Following Shoulder Arthroscopy: A Retrospective Review

Abstract ID: Paper 203

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BACKGROUND: Thromboembolism following shoulder arthroscopy is an uncommon event with fewer than 30 cases reported in literature. Arthroscopy of the shoulder is one of the most commonly performed orthopedic procedures with low associated risks. Although rare, deep venous thromboembolism (DVT) and pulmonary embolism (PE) can occur following shoulder arthroscopy. The purpose of the present study was to analyze potential risk factors for development of thromboembolism following shoulder arthroscopy and to determine the overall prevalence of this complication.

MATERIALS AND METHODS: After obtaining Institutional Review Board (IRB) approval, a retrospective case control review was performed of patients who developed DVT or PE following shoulder arthroscopy. Multiple surgeons were queried from across the United States. A total of 22 cases of DVT or PE were identified. Two control cases of shoulder arthroscopy were analyzed for each case of DVT/PE. These controls were cases done by the same surgeon performed within the same week as the reported cases of DVT/PE. The control cases did not have any reported complications. As a denominator, the number of shoulder arthroscopy cases performed by participating surgeons was collected to determine the prevalence of DVT/PE following shoulder arthroscopy. A multivariate logistic regression model was used to identify any potential risk factors for development of DVT/PE following shoulder arthroscopy.

RESULTS: A total of 17 surgeons participated in this study and had performed a total of 15,033 cases of shoulder arthroscopy during the time period of September 2002 to August 2011. Twenty-two cases of DVT and/or PE were identified in cases performed by 11 of the participating surgeons. From these 11 surgeons, 44 control cases were also analyzed. Several variables were analyzed and a multivariate analysis was performed of the following variables: compression stocking use, postoperative anticoagulation use, smoking history, age, and total surgical time. All patients were placed in the beach chair position. Two of the cases of DVT underwent general anesthesia without a block. From these variables, there was no significant correlation with the development of DVT or PE. The prevalence of DVT/PE of the 15,033 cases was 0.15%.

CONCLUSIONS: The results of our study show that although rare, thromboembolism can occur following shoulder arthroscopy. The variables analyzed in the cases of DVT/PE compared to the control cases did not show any significant risk factors. Further analysis of future cases is warranted.

Cytotoxic Effect of Corticosteroids and Local Anesthetics on Human Mesenchymal Stem Cells

Abstract ID: Paper 204

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BACKGOUND: Corticosteroids and local anesthetics are frequently used by physicians to provide short-term pain relief for patients suffering from osteoarthritis and postoperatively following arthroscopic or total joint surgery. Previous studies have shown the deleterious effects of corticosteroids on chondrocytes. The purpose of this study was to determine if corticosteroids and local anesthetics had a similar effect on mesenchymal stem cells (MSCs).

METHODS: Human MSCs were isolated and cultured from adipose tissue samples of three otherwise healthy individuals undergoing total hip arthroplasty. MSCs were exposed to various corticosteroids and local anesthetics for 60 minutes: methylprednisolone (40mg/mL), triamcinolone acetonide (40 mg/mL), dexamethasone sodium phosphate (4 mg/mL), betamethasone sodium phosphate-betamethasone acetate (6 mg/mL), 2% lidocaine, 1% lidocaine, and 0.25% bupivacaine. MSCs were also exposed to 80:20 mixtures of 0.25% bupivacaine and each of the aforementioned corticosteroids. Cells were allowed to recover in standard culture media for 24 hours. Following this, cell viability was measured using live cell counts, fluorescent staining, and mitochondrial activity.

RESULTS: The live cell counts and the proliferation assays correlated significantly (rho=0.76). All corticosteroid treatments, 2% lidocaine and 0.25% bupivacaine had a significant decrease in both live cell count and mitochondrial activity. 1% lidocaine did not exhibit a significant decrease in live cell count or mitochondrial activity.

CONCLUSIONS: Commonly used intra-articular corticosteroids and local anesthetics have a profound effect on MSCs. Further studies are needed to assess if the in-vitro effects of corticosteroids translates into in-vivo effects as well.

CLINICAL SIGNIFICANCE: Mesenchymal stem cells have been shown to increase following intra-articular injury and surgery. Since corticosteroids are frequently used by physicians to reduce pain and inflammation in these situations, the use of these agents may hinder the body’s natural healing ability.

The Effect of Lateral Meniscal Root Injuries on the Stability of the Anterior Cruciate Ligament Deficient Knee

Abstract ID: Paper 205

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INTRODUCTION: Prior research has demonstrated that the anterior cruciate ligament (ACL) acts as a restraint to anterior tibial translation and also provides rotational stability. The menisci have been shown to be secondary stabilizers and play a larger stabilizing role in the ACL-deficient knee. Root avulsion type injuries to the posterior horn of the lateral meniscus have been increasingly recognized in conjunction with ACL injury or deficiency. The purpose of this kinematic study was to evaluate the effect of a root avulsion of the posterior horn of the lateral meniscus in the ACL-deficient knee.

MATERIALS AND METHODS: Eight fresh-frozen cadaveric knees were potted and affixed to photo-reflective flags, CT scanned, and mounted into a custom activity simulator. Using a high-resolution multiple infrared camera motion analysis system, the flags were tracked and the 3D movements of the femur and tibia were recorded.

To create a simulated pivot shift, the simulator dynamically loaded each knee from 15° to 90° of flexion with all the permutations of the following: IT band force (50N, 75N, 100N, 125N, 150N, and 175N), internal rotation moments (1Nm, 2Nm, 3Nm), and valgus moments (5Nm, 7Nm). Anterior stability tests were performed by applying a 90N anterior force to the tibia at flexion angles of 15°, 30°, 45°, 60°, and 90°. Anterior tibial translation and rotational displacement were measured and compared for each knee for the following three conditions: ACL-intact, ACL-deficient, and ACL-deficient/lateral meniscus posterior root avulsion.

RESULTS: A pivot shift-type phenomenon was observed in the ACL-D and ACL-D/LMR-A conditions. The mean tibial translation of the lateral tibial condyle during the pivot shift maneuver was 2.62 mm for the ACL-I knees, 6.01 mm for the ACL-D knees, and 8.13 mm for the ACL-D/LMR-A knees. There was a statistically significant difference between the ACL-I vs. ACL-D (p-value 0.0005) and ACL-D/LM (p-value <0.0001). There was a statistically significant difference increased translation of ACL-D/LM vs. ACL-D (p-value .0146).

There was increased anterior tibial translation with a Lachman simulated maneuver at 30° and 90° of flexion in the ACL-D group ($p<0.0001$) and ACL-D/LM group ($p<0.0001$) vs. ACL-I group. No statistically significant difference was found between the ACL-D and ACL-D/LMR-A groups at 30° and 90° ($p= 0.16$, $p=0.72$, respectively).

CONCLUSION: The presence of a lateral meniscal posterior root injury further destabilizes the ACL-deficient knee when dynamic rotational loads are applied.

Click here to view Figure

Patient Characteristics Affect the Anatomic Locations of Nearby Neurovascular Structures in Meniscus Repairs

Abstract ID: Paper 206

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INTRODUCTION: Arthroscopic inside-out repair of meniscus tears remains popular due to its lower cost and strength. Injury rates of up to 38% for the saphenous nerve and 2.5% for peroneal nerve have been reported. We used magnetic resonance imaging (MRI) to define the location of the saphenous, peroneal, and popliteal neurovascular structures in medial and lateral menisci repairs.

METHODS: Axial MRIs of the knee were reviewed for 100 adult patients. To simulate virtual needle tracks, three lines were drawn along the lateral (L), medial (M), and midline (C) of the patellar tendon at the joint line. The tracks were converged on the posterior horns of the medial and lateral menisci 10 mm from the meniscal roots before continuing to the posterior knee. Vector distances from each of the needle tracks were measured to the saphenous nerve for the medial meniscus and measured to the peroneal and popliteal structures for the lateral meniscus. Patient age, gender, race, height, and weight were recorded. Descriptive statistics were calculated on Stata 12.

RESULTS: 57% of patients were female, mean age was 45.6 years (range 20-75), mean height 1.69 m (±0.10), and mean weight 85.7 kg (±18.6). 50% of patients were black, 26% non-Hispanic white, 19% Hispanic, and 5% Asian. For the medial meniscus, the vector distance of the saphenous nerve to the M, C, and L tracks were 12.2 mm (±4.8), 8.4 mm (±4.8), and 5.0 mm (±4.2), respectively. The saphenous nerve was directly on the L track in 23% of patients and on the C track in 6%. For the lateral meniscus, the vector distance of the peroneal nerve to the M, C, and L tracks was 8.1 mm (±4.5), 12.9 mm (±4.9), and 16.6 mm (±5.2), respectively. In 5% of patients, an aberrant division of the common peroneal nerve contributed to increased proximity. The vector distance of the popliteal artery to the M, C, and L tracks was 12.9 mm (±3.5), 10.8 mm (±3.5), and 8.3 mm (±3.4), respectively.

BMI <30.0 kg/m^2 was statistically significant for increased proximity of tracks to the peroneal nerve and decreased proximity to the popliteal artery. Age, race, and gender did not contribute significantly.

CONCLUSION: Extra precautions should be taken when conducting inside-out lateral meniscal repairs on non-obese patients and to avoid injuring an aberrant branch of the peroneal nerve. For medial meniscus repairs, the saphenous nerve is very proximal, consistent with the high reported complication rates.

The Prevalence of Meniscal Pathology in Asymptomatic Athletes: A Systematic Review

Abstract ID: Paper 207

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INTRODUCTION: Meniscal injuries from both activities of daily living and athletic events are common. Deficits in the meniscal cartilage can result in marked physical impairment, and have been implicated as a potential risk factor in the development of early-onset osteoarthritis. Athletes, whether professional or recreational, subject their knees to a greater amount of stress than the general population. Because of this increased demand, athletes are 12 times more likely to develop osteoarthritis than the general population.

METHODS: To determine the prevalence of isolated asymptomatic meniscal injuries in athletes, we conducted a systematic review of levels 1-4 evidence as determined by the Oxford Centre for Evidence-Based Medicine. A literature search of PubMed, MEDLINE, EMBASE, The Cochrane Collaboration of Systematic Reviews, and Cumulative Index for Nursing and Allied Health Literature, and SPORTDiscus was conducted. For the purpose of this review, “athlete” was defined as a subject who trains and competes in games or exhibitions; competitive, recreational, and high-level (high school, collegiate, and professional) athletes were included. After implementation of exclusion criteria limiting articles to only those which presented asymptomatic athletes with isolated meniscal tears, 14 articles were identified for review.

RESULTS: 295 athletes (386 knees) were identified for inclusion with an age range of 14-66 years old (means of 31.2 years). 208 subjects were men and 87 were women. Meniscal pathology was visualized with MRI or arthroscopy and graded on a 1-4 scale (grade 1, 2 indicating intrasubstance damage, grade 3, 4 indicating a tear). There was an overall prevalence of 27.2% (105/386) of knees with intrasubstance meniscal damage (grade 1, 2), and 3.9% (15/386) of knees with a tear (grade 3, 4). When the athletes were split into those who participate in pivoting sports (i.e., basketball, soccer, etc.) vs. non-pivoting athletes (marathon runners, triathletes, etc.), those in pivoting sports showed an overall prevalence of 15.3% (31/202) of knees with intrasubstance meniscal damage and 2.5% (5/202) of knees with a tear. Non-pivoting athletes showed an overall prevalence of 54.5% (61/112) of knees with intrasubtance meniscal damage, and 5.4% (6/112) of knees with a tear.

CONCLUSIONS: The overall prevalence of isolated meniscal pathology in asymptomatic athletes was 31.1%, higher than that found in the general population. Athletes, especially those who participate in long distance events, expose their knees to a greater amount of stress, which puts more stress on the menisci, and are, therefore, more likely to develop meniscal pathology.

Anterior Cruciate Ligament Graft Isometry is Affected by the Orientation of the Femoral Tunnel

Abstract ID: Paper 208

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PURPOSE: The purpose of this study was to compare ACL graft isometry with simulated suspensory femoral-sided graft fixation using transtibial, AM portal, and all epiphyseal techniques as well as apical femoral fixation. We analyzed the change in graft length and tension through knee flexion angles from 0° to 135° flexion. We hypothesized that ACL grafts are not isometric and that femoral tunnel orientation based on femoral drilling and fixation technique will alter ACL graft isometry.

METHODS: The 4 different femoral fixation techniques with the same intra-articular starting point within the center of the footprint were performed on fresh frozen cadaveric specimens in conjunction with standard tibial drilling in the center of the footprint. Fiberwire was used to simulate single bundle reconstructions. Change in graft length and tension were measured at knee flexion angles of 0°, 30°, 60°, 90°, 120°, and 135°.

RESULTS: Graft length and tension decreased from 0° through 30° and 60° and subsequently increased from 90° to 135°. The transtibial, AM portal, and apical fixation groups were similar; however, the all epiphyseal tunnel had significantly increased change in length (120°, 135°) and tension (90°, 120°, 135°).

CONCLUSIONS: Transtibial, AM portal, and apical fixation demonstrate similar changes in length and tension throughout knee range of motion. The all epiphyseal tunnel was associated with greater length and tension changes in higher degrees of knee flexion. All techniques demonstrated decreased graft length and tension with knee flexion to 90° after which they increased with further knee flexion.

CLINICAL RELEVANCE: ACL graft length and tension changes throughout knee range of motion and also depends on femoral tunnel position and fixation type. The use of an all epiphyseal tunnel should be studied further for evidence of graft attrition.

PRACTICE MANAGEMENT/EDUCATION

Septic Arthritis in Intravenous Drug Abusers: A Historical Comparison of Habits and Pathogens

Abstract ID: Poster 001

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(Presented by Michael R. Morris, M.D., Berkley, MI)

INTRODUCTION: Intravenous drug abuse (IVDA) is a common problem worldwide with more than 16 million users reported in 2008. Infectious skeletal complications, including septic arthritis, are a common sequela. The microbiology of these skeletal infections has varied widely in the literature. Early reports form the 1970s and 1980s identified Pseudomonas aeruginosa as the most common pathogen. However, recent studies in the United States and European countries have shown Staphylococcus aureus to be the most common. The increase in S. aureus species has also lead to the emergence of Methicillin-resistant Staphylococcus aureus (MRSA), with the first community-acquired MRSA outbreak occurring in 1981 at our hospital in Detroit, Michigan.

PURPOSE: To determine the most common septic arthritis pathogen in IVDA individuals in the Detroit area currently and to compare the causative organisms and their susceptibilities in IV drug abusers and how these organisms have changed over time.

METHODS: An IRB approved retrospective cohort study compared a consecutive series of IVDA patients who presented to the orthopedic service at Detroit Receiving Hospital over a ten-year period 2000-2010 (group A) with an IVDA Septic Arthritis database that was collected in the early 1980s (group B). Fisher's exact test and SAS 9.3 software were used to analyze these data sets. Endpoints were (1) bacterial species and (2) Staph species antibiotic susceptibility.

RESULTS: Fifty-eight IVDA patients with a median age of 46.5, 35 males and 23 females made up group A. Group B included 38 patients with 30 males and 8 females of median age 32.5. We found the sets to be significantly different in pathogen proportions using Fisher's exact test p=.0443. The most common organisms were Staph species (A 74.51%, B 52.63%), followed by Strep (A 7.84%, B 31.58%), Pseudomonas (A 13.73%, B 13.16%), and Serratia (A 3.92%, B 2.63%). Of the Staph species in group A, methicillin-resistant Staphylococcus aureus (MRSA) made up 56% vs. methicillin-sensitive Staphylococcus aureus (MSSA) 44%. In group B, MRSA made up 65% vs. MSSA 35%. Strep species made up 7.84% of group A vs. 31.58% group B while Pseudomonas and Serratia were similar. MSSA had a predilection to infect the knee (94.4%) while MRSA was found more often in the hip (57.1%).

CONCLUSIONS: In IVDA, MRSA is the most common pathogen causing septic arthritis in 2000-2010 vs. 1980s, the ratio of MSSA to MRSA surprisingly increasing and Strep species less common. A shift in drug use behavior may have led to this change.

The Orthopedic Manifestations of Cartilage Hair Hypoplasia

Abstract ID: Poster 002

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INTRODUCTION: Cartilage Hair Hypoplasia (CHH) is a rare metaphyseal chondrodysplasia characterized by short stature and short limbs found primarily in the Amish and Finnish. The disorder has several characteristic orthopedic manifestations including joint laxity, limited elbow extension, ankle varus, genu varum, and others. Although they exhibit orthopedic problems, the orthopedic literature on CHH patients is scant at best. The purpose of this study is to characterize the orthopedic manifestations of CHH based on the authors' unique access to the largest collection of CHH patients ever reported.

METHODS: The authors examined charts and/or radiographs in 134 cases of CHH patients, the largest case series ever reported. We analyzed the orthopedic manifestations to better characterize and further understand the orthopedic surgeons' role in this disorder. In addition to describing the clinical characteristics, we report on our surgical experience in caring for CHH patients.

RESULTS: Although data is still being analyzed, it appears that bowlegs with or without knee pain, is the most common reason a patient with CHH will seek orthopedic consultation. Of the cases reviewed thus far, 29 patients had undergone surgery, most commonly to correct genu varum. Of these surgical patients, 38 tibiae/fibulae and 8 femurs were osteotomized to correct malalignment. All patients operated on by a single surgeon (22 tibiae/fibulae, 4 distal femurs) had improvement in alignment and symptoms at final follow-up.

CONCLUSION: This paper characterizes the orthopedic manifestations of CHH and reports the successful surgical results to correct the genu varum deformity. Characterizing this condition in the orthopedic literature will likely assist orthopedic surgeons in obtaining a correct diagnosis. By characterizing this condition, we help the orthopedic surgeon to understand the common orthopedic problems for which they may seek orthopedic consultation. As important, the authors emphasize pertinent medical conditions that are critical to recognize and manage.

Effect of Vitamin E on Outcomes, Oxidative Stress Levels in Blood, Joint Fluid, and Synovial Tissue in Late Stage Knee Osteoarthritis

Abstract ID: Poster 003

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INTRODUCTION: One of the mechanisms that lead to osteoarthritis (OA) of the knee is oxidative damage induced by oxidative stress which imbalance to the antioxidative agents. Various regimens of vitamin E application have been used in OA knee patients with controversial results.

METHODS: A randomized double blind controlled trial in 66 late stage OA knee patients, who were randomly divided into two groups, was evaluated. Group A (35 patients) was assigned to take placebo, and Group B (31 patients) intake vitamin E 400 iu once daily for two months. All patients were scheduled for total knee arthroplasty at two months after the intervention start. Blood samples, Knee Society Score (KSS), and WOMAC score were collected at 2-5 days before the drug start. Then, all tests were repeated again at one day before surgery. At surgery by single surgeon, the synovial fluid and synovial tissue were blindly collected. The blood and synovial fluid were blindly evaluated for oxidative stress agents (Nitrite, Inducible Nitric Oxide Syntheses [iNOS], and Malondialdehyde [MDA]) and antioxidative agents (α-tocophorol, Ferric Reducing Antioxidant Power [FRAP], and Troloc Equivalence Antioxidant Capacity [TEAC]). The synovial tissues were evaluated for inflammation (Haematoxylin and Eosin stain) and oxidative stress (Nitrotyrosine stain). Adverse events and complications were recorded.

RESULTS: There were no differences in baseline data and clinical scores. At post-intervention, all parts of KSS and WOMAC score in group B were significantly better than group A. For oxidative stress analysis in blood and synovial fluid, MDA showed significantly decreased in group B, Nitrite was decreased in group B, but not significantly different and iNOS was increased in group B. For antioxidative agents analysis in blood and synovial fluid, TEAC and α-tocophorol were significantly increased in group B. FRAP was increased in group B, but not significant. Synovial tissue study showed significant decrease in inflammation and oxidative stress in group B.

DISCUSSION: Patients who had vitamin E showed statistically improvement in all parts of WOMAC and KSS score with neither serious side effect nor complication. Laboratory data showed decreasing in oxidative stress agents and increasing in antioxidative agents in patients who had vitamin E. In addition, there was lower number of inflammatory cells in synovial tissue. We concluded that a two-month application of 400 iu daily dose of vitamin E in late stage OA knee patients provided better improved WOMAC and KSS score with supportive laboratory data than those who had placebo.

Distribution and Growth of Orthopedic Residency Positions in the United States

Abstract ID: Poster 004

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INTRODUCTION: Previous studies have demonstrated that residents are highly likely to practice in the city or region that they trained in. This preference may have important implications on the predicted shortage of orthopedic surgeons in the near and distant future, as states with fewer training positions would face greater surgeon shortages. The goal of this study is to evaluate the current distribution of orthopedic residency positions in the United States (US) and examine how recent growth in position totals relates to state population trends.

METHODS: Training position data for all 50 states and the District of Columbia was gathered from the National Resident Matching Program's historical reports. Population data for all 50 states and the District of Columbia was gathered from the United States Census Bureau's 2010-, 2000-, and 1990-Census reports. Position density was defined as the number of orthopedic training positions for every 100,000 persons from the population of interest. Relationships were assessed by Pearson's correlation coefficients. Additional statistical analysis was performed using two-sided z-tests for proportions with a significance level of 0.05.

RESULTS: In 2010, the number of orthopedic residency positions in the US was 652. This total has increased 20.3% from 2000 (542 positions). The current total has increased 29.1% from 1990 (505 positions). The rate of increase has also risen, from 0.7% (3.7 positions) per year between 1990 and 2000 to 2.0% (11 positions) per year between 2000 and 2010. The US population has increased 9.7% and 24.1% over the same 10- and 20-year intervals, respectively, at rates of 1.3% per year from 1990 to 2000 and 1.0% per year from 2000 to 2010. Current individual state position totals are highly correlated to state populations ($r=0.822$). However, the growth in each state's position total over the past 10- and 20-year intervals is poorly correlated to its population change ($r=-0.067$ and $r=-0.042$, respectively). Nationally, there are 0.21 orthopedic training positions per 100,000 persons. Eighteen states had a statistically significant ($p<0.05$) lower position density compared to this national rate. Five states had a statistically significant ($p<0.05$) higher position density compared to the national rate.

DISCUSSION AND CONCLUSION: There appears to be a poor distribution of the current orthopedic training positions, with 7 states containing 49.8% of positions and 9 states containing none. The position density in over a third of states (35.3%) was significantly below the national figure. Additionally, although the overall increase in orthopedic training positions has outpaced the nation's population rise over the past two decades, the distribution of that growth has been inappropriate. The states with the greatest population increases demonstrated minimal, and very often zero, growth in training positions. This pattern will worsen the current disparity in position density between the states and may lead to greater orthopedic surgeon shortages in those states in the future.

Is It Time for Orthopedic Surgery to Have Its Own Residency Match: Results of Multiyear, Multicenter Questionnaire Data

Abstract ID: Poster 005

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INTRODUCTION: In 1952, the National Residency Matching Program (NRMP) was formed to create a uniform standard for matching medical students to residency programs. The purpose of this study was to evaluate the opinions of orthopedic surgery applicants with regards to the cost, effectiveness, and timeliness of the current match process.

METHODS: We present seven years of questionnaire data from the 2007 to 2013 match cycles. Surveys were distributed to all interviewed candidates at our institution during the 2012 and 2013 interview cycles, and electronic surveys were completed by current residents at 17 other programs. A five point Likert scale was utilized. Surveys were completed and submitted anonymously and were devoid of any identifying data.

RESULTS: Eighty-nine applicants completed all or part of the survey. Students spent $1,215 on average in application fees. Total costs of interview-related expenses (including travel and lodging) averaged $3,756. More than half of all applicants surveyed indicated that they took out additional loans to cover interview expenses. In 2007, medical students applied to an average of 20 programs; applicants in the 2013 interview cycle averaged 65 programs. Similarly, costs related to applying and interviewing more than tripled in the past seven years. Respondents indicated that they both applied to and interviewed at programs that they were not interested in due to concerns of inefficiencies in the current match process, and two thirds of applicants stated that they ranked programs they were not interested in to avoid going unmatched.

CONCLUSION: From our data, applicants view the current match process as both costly and inefficient. Costs of applying to residency programs have been trending up over the past seven years and the interview process now presents a significant financial burden for applicants. Orthopedics remains a highly competitive specialty and has unique needs not common to other fields of medicine. Future work will aim to refine the current process to better serve orthopedic applicants.

Resident Education and Total Knee Arthroplasty: Is There a "July Effect"?

Abstract ID: Poster 006

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INTRODUCTION: The influence of resident education in orthopedic surgery outcomes has long been scrutinized. With annual resident turnover in July, the public has questioned the safety of novice resident involvement. Thus, the purpose of this study was to examine the annual variation of short-term outcomes after primary total knee arthroplasty (TKA) with and without resident participation.

METHODS: The 2005-2011 ACS NSQIP dataset was queried for patients undergoing elective TKA using CPT codes. Cases with resident involvement were identified and then further stratified into Junior (PGY1, 2, 3), Senior (PGY4, 5), and Fellow level (PGY 6). The timing of surgery was designated into annual quarters or three-month time intervals. We compared resident cases to non-resident cases using univariate comparisons for operative times, hospital length of stay (LOS), re-operation rates, 30-day morbidity, and 30-day mortality. Resident levels were also compared for the same outcomes. Propensity score matching was introduced to control for selection bias. Chi-square and ANOVA statistics were used and significance was defined as $p < 0.05$.

RESULTS: In total, 28,686 patients were included: 7,162 resident (R) cases and 21,524 non-resident (NR) cases. Overall TKA mortality, operative time, and hospital length of stay (p=0.53, 0.17, 0.54) did not vary throughout the year. Comparative 30-day mortality remained low throughout all quarters and did not differ significantly between R (0.07-0.29%) and NR cases (0.18-0.28%), p=0.47-0.61. Morbidity was highest for both R and NR groups during the July-September quarter (R: 15.39%, p<0.001 and NR: 15.56%, p<0.001), but did not differ between R and NR groups during that quarter (p=0.57). Operative time was significantly higher in the R vs. NR group (107-111 vs. 92-94 minutes, p<0.001) across all quarters. Hospital LOS (3.53-3.60 days) did not vary with time of year or resident involvement. Level of resident training did not consistently influence surgical outcomes, as no differences were noted between Junior, Senior, and Fellow levels for operative time (p=0.28), return to OR (p=0.80), morbidity (p=0.11), and mortality (p=0.96).

DISCUSSION: Resident involvement did not increase short-term morbidity or mortality after TKA. Likewise, these short-term outcomes did not increase with resident promotion in July. Resident training level also had no detectable influence on outcomes. Resident involvement, however, did increase operative times; and this may serve as an impetus for training outside of the operating room. The public may be reassured with the apparent safety of resident participation.

LEVEL OF EVIDENCE: Level II: Prognostic

Optimizing Our Academic Medical Practice's Orthopedic/Radiology Workflow: A Resident's Involvement in Clinical Quality Improvement

Abstract ID: Poster 007

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INTRODUCTION: In this age of health care cost management, efficiency, and patient safety, quality improvement initiatives are increasingly being emphasized in private and academic medical practices. The ACGME is emphasizing the need for resident involvement in health care delivery as a part of their core competencies. In our academic orthopedic practice, we noted our physicians were waiting on patients delayed in radiology for pre-clinic radiographs which led to delayed schedules as well as increased patient waiting times. Our goal was to apply the principles of quality improvement and improve the orthopedic/radiology work flow.

METHODS: Our team analyzed the times at which our patients arrived at orthopedic check-in, radiology check-in, the time of image acquisition, radiology check-out, and examination room arrival. By use of fishbone analyses, and workflow mapping, our team identified the rate limiting steps in the orthopedic/radiology workflow and implemented pre-clinic orders, and automated reminders for earlier patient arrival with radiologic appropriate clothing. Post implementation, we re-analyzed the same parameters in addition to medical staff overtime from the changes.

RESULTS: Our analysis of the workflow mapping indicated patients made 32 steps averaging 6-7 minutes per patient with an average of >100 patients per day. After implementing these changes, this saved an average of 6 steps and saved an average of 3-4 minutes per patient; roughly a 50% reduction in time per patient. The use of an automated appointment reminder system showed that patients arrived to pre-clinic x-ray appointments twice as early compared to staff reminders. The average time in x-ray decreased, and late arrivals for the orthopedic clinic visit was < 0 minutes, despite the increase in radiographic patient load during this time. Additionally, the medical staff overtime pay reduced by >50%, producing ~$4,000 savings over a three-month span.

DISCUSSION: The steps involved in this quality improvement project allowed each department to understand the workflow and process involved in each patient visit. This initiative significantly improved workflow, simplified patient visits, and reduced appointment delays and staff overtime. This process highlighted the need for increased communication including periodic meetings to assess the interaction between these two partners in patient care. Quality improvement, the need for continued analysis of systems based practice, and its application in everyday clinical care is an essential facet of resident education.

Polymer Scaffold and Biological Engineering to Enhance Ligament Regeneration

Abstract ID: Poster 008

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HYPOTHESIS: Intra-articular ligament injuries are very difficult to treat due to their poor regeneration potential and our current attempts at surgical reconstruction often do not relieve the patient's symptoms. We hypothesized that a novel composite polymer "neoligament" would be able to be seeded with progenitor cells and growth factors would be able to regenerate native ligamentous tissue.

METHODS: Polycaprolactone fumarate (PCLF), a novel polymer previously described in our laboratory, were synthesized into macro-porous scaffolds (pore sizes 500 to 750 μm) to allow cell-cell communication and nutrient flow. Porous scaffold molds were designed using SolidWorks CAD software and printed using a SolidScape 3D printer. Adipocyte-derived human mesenchymal stem cells (aMSCs) were harvested and cultured in DMEM and 10% FBS. The analysis compared this media to media composed of DMEM with 5% platelet lysate (PL), a mixture of platelet release products. Seeding of scaffolds occurred in a dynamic bioreactor. Assays included cellular proliferation (MTS), viability (Live/Dead immunostaining), differentiation (GAG, ALP, and Total Collagen), and immunostaining for collagen I, tenascin-C, and collagen III (ligament differentiation markers).

RESULTS: PCLF scaffolds were created with pore sizes of 500 or 750 μm and porosities of 45% and 60%, respectively. After comparing multiple toxicity protocols to remove toxic byproducts, the preferred regimen lead to pore shrinkage by 10%. After dynamic cell seeding of the progenitor cells on the PCLF, the cells remained viable for 2 weeks cultured on in vitro culture plate. The cell density throughout the pores and metabolic activity of the scaffolds increased as cell proliferation continued along the 3D PCLF scaffolds ($p<0.05$). aMSC proliferation rates increased in platelet lysate (PL) compared to FBS ($p<0.05$). The cells had a low baseline expression of ALP and GAG, but increased expression of total collagen when induced by the ligament and tenogenic growth factor FGF2 ($p<0.05$). This effect was significantly augmented when cultured in the presence of PL ($p<0.01$). Immunostaining at 2 and 4 weeks for the expression of ligament markers Tenascin-C and Collagen I significantly increased with FGF and PL, comparable to human fibroblasts grown on the PCLF scaffolds.

SUMMARY: Our results demonstrate aMSCs are able to attach, proliferate, and differentiate into ligamentous phenotypes along the porous PCLF scaffold. This novel scaffold has potential in stem cell engineering and ligament regeneration.

TUMOR

Functional Outcome Measures Following Hemipelvectomy

Abstract ID: Poster 009

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INTRODUCTION: Major amputations are indicated for curative treatment of most primary tumors of the sacrum and pelvis. Previous literature suggests that patients with a hemipelvectomy level amputation are more efficient walking with crutches than walking using a prosthesis. With new advances in prosthetic components, patients are choosing to use their prostheses for primary mobility. Our objective was to investigate the difference in functional outcome measures walking with a prosthesis compared to one-legged walking with crutches following hemipelvectomy.

METHODS: We identified five patients who underwent hemipelvectomy amputation over a six-year period and are successful prosthetic users. All prostheses used the same components. All patients had worn their prostheses for at least six months. Patients were timed while doing various functional measures including: timed up and go (TUG), 5-meter walk, 400-meter walk, and stair climb tests; to evaluate functional performance ambulating with a prosthesis and without. Sex matched, age similar controls from the general population were also tested performing the same functional measures. Testing was performed during unrestrained walking at the patient's chosen velocity. Quality of life was measured by having the patients and controls respond to a SF-36 (version 1) questionnaire.

RESULTS: Controls performed better than patients following a hemipelvectomy level amputation ambulating with crutches or prosthesis in all physical categories (Table 1). However, when comparing patients with a hemipelvectomy level amputation functional measures while ambulating with a prosthesis or crutches, there was a statistical advantage for using crutches over wearing a prosthesis in the TUG, 5 meter walk, and 400 meter walk; but no difference in stair climb between the two modalities. Similarly, patients physical SF-36 score was impacted by the procedure. There was a significant decline in the patients' physical component score; however, the mental component score was no different from the general population.

DISCUSSION AND CONCLUSION: In line with previous reports, a hemipelvectomy has a drastic effect on the patients' functional status physically. Although patients still function at a physically lower level compared to the general population, they are functioning at a higher level compared to historical reports, and mentally they are on par with their peers. We feel that all patients who undergo a hemipelvectomy should be offered a prosthesis, and with this data, we hope that it will better educate physicians as well as patients as to what they can expect functionally following this life-changing event. With continued advances in prosthetic design and components, hopefully the gap in physical function will continue to close.

Click here to view Table

Long-Term Outcomes of Intramedullary Vascularized Fibulas with Massive Bone Allograft

Abstract ID: Poster 010

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INTRODUCTION: Following tumor resection, reconstruction for limb salvage surgery can be hampered by large osseous defects. Traditionally, structural allografts were used to fill these voids; however, they are hampered by a high complication rate due to the avascular bone. In order to circumvent the complications associated with this procedure, allografts supplemented with intramedullary free fibular flaps were developed to provide structural support along with the potential for revascularization and remodeling. The purpose of this study was to examine the long-term outcomes using this technique for limb salvage surgery.

MATERIALS AND METHODS: Over a 15-year period, we identified 17 patients who had undergone bone allografting using an intercalary free fibula flap for lower extremity limb salvage. The patients' radiographic and medical records were reviewed for clinical and functional outcomes as well as postoperative complications. Time to union was recorded through an evaluation of radiographs. Mankin functional outcome and Musculoskeletal Tumor Society (MSTS) rating scale was recorded for each patient.

RESULTS: There were 8 males and 9 females; average age of the patients was 11 years at the time of surgery (Table 1). On average, the follow-up of these patients was 6 years (range up to 12.3 years). The limb was able to be reconstructed and salvaged in 100% of the patients. The average time to union of the allograft and fibula to the native bone was 10 months. Six patients had to undergo an additional procedure to treat a symptomatic nonunion. The average time of non-weight bearing was 12 weeks, and the average postoperative knee range of motion was 128°. In 16 of the patients, the Mankin functional outcome was good or excellent, with an average MSTS rating of 93.9% at last follow-up. Six of the patients required a limb lengthening procedure. One patient died over the study period due to metastatic disease.

CONCLUSION: Use of large allografts supplemented with intramedullary vascularized free fibulas provides an excellent option for reconstruction of large bony defects in the lower extremity following limb salvage surgery.

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UPPER EXTREMITY

A Comparison of Perioperative Outcomes Following Total Elbow Arthroplasty in Patients with and without Diabetes

Abstract ID: Poster 011

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BACKGROUND: Studies have reported increased risks for adverse events and higher costs for patients with diabetes who undergo surgery. There are few studies specifically analyzing the effect of diabetes on outcomes after total elbow arthroplasty. We investigate the immediate perioperative outcomes and complications of patients with and without diabetes following total elbow arthroplasty.

METHODS: We evaluated the Nationwide Inpatient Sample (NIS) database from 2005-2010 for patients who underwent a total elbow arthroplasty. The NIS is a statistically representative sample of hospitals from across the nation that includes data on approximately 8 million inpatient admissions per year. A total of 3,184 patients were included in our retrospective study based on ICD-9 code selection criteria. We compared perioperative inpatient data between patients with diabetes (n= 488) and those without diabetes (n= 2696).

RESULTS: Patients with diabetes had a significantly greater mean age at the time of total elbow arthroplasty (66.8 vs. 58.5, $p<0.001$) compared to patients without diabetes. There was no statistically significant difference when comparing cost of surgery ($56,582 vs. $56,092, $p=0.833$). There was a trend approaching statistical significance that favored longer hospital stay (4.1 vs. 3.7 days, $p=.056$) in diabetic patients. A higher percentage of diabetic patients underwent arthroplasty for the indication of fracture ($p<0.001$), but a lower percentage underwent surgery for rheumatoid arthritis ($p<0.001$). Patients with diabetes had significantly increased rates of pneumonia (odds ratio [OR] = 2.7, $p=0.009$), urinary tract infection (OR=2.2, $p<0.001$), blood transfusion (OR=2.1, $p<0.001$), and non-routine discharge (OR=1.9, $p<0.001$). They also had significantly increased rates of comorbidities including anemia (OR=1.9, $p<0.001$), congestive heart failure (OR=2.9, $p<0.001$), depression (OR=1.4, $p=0.05$), hypertension (OR=6.0, $p<0.001$), obesity (OR=3.5, $p<0.001$), peripheral vascular disease (OR=4.4, $p<0.001$), and chronic renal failure (OR=3.6, $p<0.001$). Our multivariate analysis showed that diabetes was an independent predictor of the risk of perioperative pneumonia (OR=2.6, $p=0.013$) and UTI (OR=1.9, $p=0.007$). However, diabetes was not an independent predictor of hospitalization length ($p=0.75$), cost of surgery ($p=0.63$), or proportion of routine hospital discharges ($p=0.12$).

CONCLUSION: Patients with diabetes have higher rates of chronic comorbidities and perioperative complications following total elbow arthroplasty. There was a trend approaching statistical significance towards longer hospitalization lengths for diabetic patients. Cost of surgery was similar between patients with and without diabetes.

Reliability Testing of Two Classification Systems for Elbow Osteoarthritis and Post-Traumatic Arthritis

Abstract ID: Poster 012

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INTRODUCTION: Multiple classification systems have been proposed to radiographically stage patients with elbow arthritis. To our knowledge, no study has compared the reliability of the different systems. We proposed to compare the Broberg and Morrey classification of elbow arthritis to the system advanced by Hastings and Rettig based on radiocapitellar subluxation. We hypothesized that there would be no significant differences in inter-observer or intra-observer reliability between systems for either primary elbow osteoarthritis (OA) or post-traumatic arthritis (PTA).

MATERIALS AND METHODS: The radiographs of 45 patients who were diagnosed at our institution with either primary osteoarthritis (26 elbows) or post-traumatic arthritis (19 elbows) were evaluated. The highest quality anteroposterior and lateral radiographs were selected, de-identified and distributed to 6 evaluators (2 orthopedic residents, 1 sports medicine fellow, and 3 attending physicians with fellowship training in upper extremity surgery). Each evaluator graded all 45 radiographs according to the Broberg and Morrey (BM) and the Hastings and Rettig (HR) classifications on 2 occasions, at least 2 weeks apart. Patients with an absent radial head were not included in the analysis of the HR classification. Intra- and inter-observer reliability were calculated using Spearman's correlation coefficients with 95% confidence intervals (CI). Coefficients greater than 0.8 were considered to have near-perfect agreement while coefficients from 0.6-0.8 demonstrated good agreement.

RESULTS: In patients with primary OA, inter-observer reliability was 0.66 (CI 0.63-0.69) for BM and 0.64 (CI 0.58-0.69) for HR. Mean intra-observer reliability was better for BM (0.77 [CI 0.73-0.82]) than HR (0.63 [CI 0.57-0.70]). This difference in mean intra-observer reliability was statistically significant (p=0.006). In patients with PTA, inter-observer reliability was 0.65 (CI 0.62-0.69) for BM and 0.66 (CI 0.60-0.72) for HR. Mean intra-observer reliability was 0.74 (CI 0.67-0.82) for BM and 0.68 (CI 0.58-0.78) for HR. There were no significant differences in inter-observer or intra-observer reliability between attending physicians and trainees for either classification system (all p>0.10).

CONCLUSION: The BM and HR classifications both show good inter-observer and intra-observer reliability for both primary elbow osteoarthritis and post-traumatic arthritis. While intra-observer reliability for the BM classification was better than the HR system for primary osteoarthritis, both scores fell within the range of good agreement. Training level differences did not result in substantial variances in reliability for either system.

Lateral Epicondylitis and Tobacco Use: A Case-Control Study

Abstract ID: Poster 013

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PURPOSE: Although lateral epicondylitis (LE) is a very common tendinopathy, we understand little about the etiology of the disease. Tobacco use has been associated with other tendinopathies, and the purpose of this study is to determine if there is an association between the incidence of lateral epicondylitis and tobacco use.

METHODS: We performed a retrospective cohort study of adult patients diagnosed with lateral epicondylitis. Patients from a single orthopedic surgeon's practice with LE were matched to control patients with other common upper extremity conditions based on age, gender, and occupation. A total of 65 case patients and 217 control patients were included in the study. The incidence of smoking in patients with lateral epicondylitis was compared to the incidence of smoking in the control group.

RESULTS: Of the LE patients, 30/65 (46.2%) were non-smokers, 23/65 (35.4%) were former smokers, and 12/65 (18.5%) were current smokers. Of the control patients, 121/217 (55.8%) were non-smokers, 45/217 (20.7%) were former smokers, and 51/217 (23.5%) were current smokers. The odds of LE patients being former or current smokers compared to control patients were 1.45 times higher, but this was not statistically significant. Among people who did not smoke at the time of presentation, the odds of being a former smoker were 2.28 times higher in LE patients than in controls, which was statistically significant.

DISCUSSION: The odds of being a former smoker were significantly higher in patients with lateral epicondylitis compared to patients with other upper extremity conditions. Although it did not reach statistical significance, the odds of being former or current smokers were also higher in the LE group. These results suggest a relationship between smoking history and incidence of lateral epicondylitis, though more research is needed to determine the exact nature of the relationship.

LEVEL OF EVIDENCE: Prognostic, Level III

Use of Immediate and Acute Metacarpophalangeal Joint Arthroplasty in the Setting of Hand Trauma

Abstract ID: Poster 014

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PURPOSE: Although metacarpophalangeal (MCP) joint arthroplasty has emerged as a viable treatment for post-traumatic degenerative joint disease, MCP arthroplasty performed in the acute setting is uncommon. We report on the outcomes of 11 arthroplasties in 8 patients performed for trauma within 3 months of the initial injury.

METHODS: We performed a review of all patients who underwent metacarpophalangeal (MCP) joint arthroplasty acutely for a traumatic injury performed at a single institution from 1998 to 2013. T-test, univariate, and Kaplan-Meier survival analysis were performed to analyze MCP, PIP, and DIP range of motion, pain levels, revision surgeries, and complications.

RESULTS: Out of 820 MCP arthroplasties performed, 11 arthroplasties in 8 patients were performed in a traumatic setting within 3 months of the initial injury. Nine (82%) injuries were the result of a direct laceration from a sharp object over the MCP joint where the arthroplasty was performed within 24-hours of injury; while the other 2 patients underwent arthroplasty after a recurrent instability secondary to fracture comminution or soft tissue insufficiency and chondral injury. There were 7 (88%) males, with an average age of 57 years. No patients had a history of prior finger surgery, 3 (38%) had diabetes mellitus, 1 (13%) was a current or prior smoker, while no patients had a history of inflammatory arthritis. The involved fingers include 4 index, 6 middle, and 1 ring finger, while 50% were performed in the dominant extremity. Ten (91%) patients received a pyrocarbon implant, with 2 (18%) procedures augmented with local autologous bone graft.

Patients experienced excellent pain relief, with 7 out of 8 patients reporting none or mild pain at last follow-up. Postoperative grip strength, oppositional and appositional pinch strength were 31.9 (40%), 5.6 (70%), and 8.5 (40%), respectively. MCP, PIP, and DIP extension to flexion arc averaged 16.6 – 63.0, 15.0 – 81.0, and 5.4 – 68.0, respectively. Seven joints (64%) were not able to obtain full extension as last follow-up, while 4 (36%) had flexion contractures of at least 30°. These same four joints with flexion contractures in 3 patients were the only patients who reported limitations in activities of daily living, such as putting on clothes, picking up objects, and writing. Additional complications included 2 (18%) intraoperative fractures, as well as 1 pulmonary embolus within the perioperative hospitalization. Although there were no revision surgeries, 1 patient had an extensor tendon rupture at 18 months postoperatively, while another 2 patients (3 joints) had manipulation and tenolysis for flexion contractures within a year of the initial procedure. One of these patients who underwent tenolysis also had a scar revision surgery at 17 months postoperatively. No demographic factors, comorbidities, or operative factors had any significant impact on the postoperative motion, limitations, or reoperations.

SUMMARY POINTS: Metacarpophalangeal arthroplasty improves patients' pain in the acute setting of a traumatic laceration or dislocation. However, many patients experience limitations

in their total arc of motion, most likely as a result of the soft tissue injury associated with the initial injury. MCP arthroplasty should be a consideration in the acute setting for trauma in an effort to preserve the finger's arc of motion.

Atypical Flexor Tenosynovitis Infection: A Rare Cause of Carpal Tunnel Syndrome

Abstract ID: Poster 015

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INTRODUCTION: The purpose of this study was to identify patients who presented to our institution with signs and symptoms of carpal tunnel syndrome (CTS) secondary to atypical flexor tenosynovitis infection at the wrist, and to determine the outcomes of treatment.

METHODS: We identified 141 patients who presented at our institution with symptoms of CTS secondary to infection. Ten of these cases were determined to be secondary to atypical infections of the flexor tenosynovium at the wrist. Collection of data included type of microbial infection, duration of antibiotic therapy, type and number of procedures, comorbidities, and final outcome.

RESULTS: There were equal numbers of men and women, with an average age of 56.9 (±12.6) years. The most commonly presenting symptoms included swelling at the wrist with painful limited range of motion of the fingers associated with signs and symptoms of CTS. The average delay of presentation of symptoms to correct diagnosis was 67.2 (± 108.7) days. The most commonly isolated type of organisms included: mycobacterium avium intracellulare (MAI) in 3 patients (30%), and histoplasma capsulatum in 2 (20%). Treatment included single or multiple surgical débridements of the flexor tenosynovium, with an average number of 3 (±2.1) procedures combined with long-term antimicrobial therapy with an average duration of 5.6 (±6.4) months. MAI required the longest medical treatment with an average duration of 10.5 (±10.6) months. Among the isolated microbes, no specific cause of the infection was noted except for one patient who had a cat bite prior to the development of symptoms. Comorbidities associated with these atypical infections include: immunosuppression in patients with rheumatoid arthritis (2), dermatomyositis (1), renal transplant (1), and knee septic joint (1). Among those with at least 12 (±50.8) months of follow-up, 4 (40%) patients had resolution of symptoms with no recurrence, while one patient with candida parapsilosis had recurrence of infection at 33 months, another patient with chronic immunosuppresion due to MAI suffered from multiple recurrences within the first year of follow-up, and one patient with streptococcus pyogenes necessitated amputation of the index finger because his infection was complicated by sepsis.

CONCLUSION: The development of CTS due to atypical infection of the flexor tenosynovium of the wrist is uncommon. The treating physician should maintain it in the diagnostic differentials, particularly in immune compromised patients who present with signs and symptoms of CTS associated with wrist swelling and limited range of motion of the fingers. Debridement and long-term antibiotics are the main stay of treatment with good expected outcomes.

Biomechanics of the Radius Following Drilling of the Radial Tuberosity to Mimic an EndoButton Distal Biceps

Abstract ID: Poster 016

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HYPOTHESIS: A fracture through the proximal radius is a theoretical concern after Endobutton distal biceps fixation in an active patient population subjected to a fall eliciting a rotational and compressive force. We hypothesized that during simulated torsion and compression, in comparison to unaltered controls, the Endobutton distal biceps repair model will have decreased torsional and compressive strength and will fracture in the vicinity of the radial tuberosity bone tunnel.

METHODS: Ten composite radius sawbone models used and validated in previous studies for biomechanical testing were employed in this study. For the experimental model, a bone tunnel was created through the radial tuberosity to mimic the exact bone tunnel made for an EndoButton distal biceps tendon repair . The radius was then prepared and mounted on either a torsional or compression type MTS machine. The radius was then tested with a compressive load through the radial head via molded hardened putty or a torsional force about the proximal radius. Stiffness, peak load, peak torque, failure load, failure torque, and gross fracture characteristics were then collected in both control and experimental models.

RESULTS: For the radius specimens tested in compression, in controls the average stiffness was 149.86 N/mm, peak load was 661.72 N and failure load was 270.35 N. In the drilled radius tested in compression, the average stiffness was 164.45 N/mm, peak load was 741.30 N, and failure load was 333.22 N. For the radius specimens tested in torsion, the stiffness in the control was 0.778 in-lbs/Deg with a peak torque of 60.87 in-lbs and failure torque of 60.87 in-lbs. The drilled radius tested in torsion had a stiffness of 0.81 in-lbs/Deg with a peak torque of 52.58 in-lbs and failure torque of 52.58 in-lbs. The gross fracture pattern between groups was fairly similar when tested in compression. When testing in torsion, however, it was observed in the drilled radius, the fracture occurs through the bone tunnel in the radial tuberosity (Figure 1).

CONCLUSION: There is a potential concern for fracture through the vicinity of the bone tunnel in the proximal radius during torsional stressing of the proximal radius. There does not appear to be statistically significant differences in stiffness and peak loads between drilled and control radius specimens tested in compression. Distal biceps tendon repairs employing Endobutton fixation have the potential of creating important biomechanical consequences in the proximal radius.

Click here to view Figure

The Biocompatibility of a Novel Rotator Cuff Patch. An In Vivo Study

Abstract ID: Poster 017

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INTRODUCTION: Biocompatibility remains a critical issue prior to implantation of tendon patches, as some elicit a foreign body response (FBR). The effect on articular cartilage locally or systemically with placement of juxta-articular implants has not been examined. The purpose of this study is to test the in vivo biocompatibility of a novel hybrid woven and electrospun polydioxanone (PDOe) patch.

METHODS: Sixty Lewis rats were divided into four groups for infraspinatus transection. Tendons were repaired with a PDOe patch and 5-0 polypropylene sutures. Poly lactic-co-glycolic acid (PLGA) and Silk patches or a simple polypropylene suture repair were comparators. Animals were sacrificed at 1, 2, 4, 6, and 12 weeks. Immunohistochemistry was used to examine macrophage subpopulations and hematoxylin and eosin (H&E) staining was used to assess foreign-body giant cells (FBGCs) and both analyzed with a one-way ANOVA (significance level $p<.05$). Articular cartilage and paw inflammatory indices were used to determine the local and systemic effects, and biomechanical testing the tensile strength of the biomaterials over time.

RESULTS: The PDOe patch remained grossly quiescent at all time-points. There was a severe inflammatory reaction to PLGA at one and two-week time-points with copious transudate. Silk patches were associated with large fibrous capsules. There were no adverse systemic effects and articular cartilage remained normal with all biomaterials. H&E staining revealed cell ingrowth with a tenocyte-like morphology at one week post implantation in the electrospun component of the PDOe patch. Immunohistochemistry showed a higher ratio of regenerative to inflammatory macrophages for the PDOe patch compared to other constructs. PDOe had significantly fewer FBGC's (<10 fold; $p<.05$) than Silk and Vicryl patches suggesting incorporation rather than walling off. Tensile strength of the PDOe patch increased in the first 2 weeks to greater than 22 N (supra-physiologic) and gradually declined to a mean of 5 N at 12 weeks.

DISCUSSION AND CONCLUSION: The novel PDOe patch appears to be biocompatible and elicit little FBR in this model. Importantly, there was no joint reaction to the biomaterial, which has not been previously addressed. The electrospun component of the patch recapitulates native tendon architecture creating a tissue healing microenvironment directed by regenerative macrophages. The woven component of the scaffold provides tensile strength as the tendon heals and begins to degrade after healing is underway. Based on these and in vitro data, we believe this implant shows excellent biocompatibility and may proceed to human trials.

Inferior Anchor Placement in Open and Arthroscopic Bankart Repair

Abstract ID: Poster 018

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INTRODUCTION: A Bankart injury results in the disruption of the anterior-inferior glenohumeral ligament complex from the glenoid, leading to anterior shoulder instability. Surgical repair of this injury can be performed through an open or arthroscopic approach. Placement of the inferior anchor correlates with success regardless of approach. The ability to obtain the ideal anchor position comparing the two approaches has not been well studied.

METHODS: This study compares the placement of an inferior glenoid anchor between an open and an arthroscopic approach. Three cadaveric shoulders were placed in each group. The open procedure utilized a deltopectoral approach with incision of the superior two-thirds of the subscapularis to view the glenohumeral joint. The arthroscopic technique was performed using a standard posterior viewing portal and an anterior portal above the subscapularis to place the anchor. A 0.062 Kirschner wire was used to mark the position of the anchor. Fluoroscopic images were taken using Grashey AP, scapular Y, and axillary views to evaluate the placement of the wires.

RESULTS: The inferior anchor position in the open group had an average angle of 54.7° on the AP view and 64.7° on the lateral view. The arthroscopic group had an anchor position of 71.7° and 37.7° on those respective views. Both the open and arthroscopic groups averaged a 5:10 position normalized to right shoulders on the scapular Y view.

DISCUSSION/CONCLUSION: The ability to place the inferior anchor on the glenoid face was similar between the two groups as seen on the scapular Y view. However, the anchor orientation varied on the AP and axillary views. The inferior anchor orientation in the open group was closer to the ideal position, which would have an equal amount of bone circumferentially.

Outcomes of Glenoid Bone Grafting in Revision Reverse Total Shoulder Arthroplasty

Abstract ID: Poster 019

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PURPOSE: Glenoid bone loss is commonly encountered in revision shoulder arthroplasty. Reverse arthroplasty has become a very common procedure to salvage the failed prior arthroplasty, but may be compromised by glenoid bone loss. Although glenoid bone grafting is commonly used, the outcomes are largely unknown. The purpose of this investigation was to determine the outcome of revision reverse shoulder arthroplasty requiring glenoid bone grafting.

METHODS: Between 2005 and 2010, 144 consecutive revision reverse shoulder arthroplasties were performed at our institution. Glenoid bone grafting was performed in 38 shoulders. The average age was 68.2 years and average BMI of 31.6. Patients were followed for a mean of 2.75 years. Student's t-test, univariate and Kaplan-Meier survival analysis were performed.

RESULTS: At most recent follow-up, patients experienced excellent overall pain relief, with 28 (74%) patients reporting no or mild pain postoperatively compared to 3 (8%) preoperatively ($p<0.01$). Shoulder abduction and external rotation improved from 54° and 19° preoperatively to 112° and 31°, respectively ($p<0.01$). Postoperative pain was higher in patients whose index revision surgery was for instability ($p<0.04$). 79% of patients were very satisfied, and 84% felt their shoulders were improved from preoperatively. The average postoperative Constant shoulder, ASES, and simple shoulder test score were 65.0, 64.2, and 5.7, respectively. The factors that worsened functional outcomes were laborers ($p<0.01$), index revision for instability ($p<0.05$), and preoperative subluxation ($p<0.04$). .

Eight (21%) patients experienced postoperative complications, with 7 (18%) of these complications requiring revision surgery. The rate of survival free of revision at 2 and 5 years was 86% and 74%, respectively, which was lower than those who did not require glenoid bone grafting ($p<0.03$). The survival free of glenoid loosening at 2 and 5 years was 91% and 88%, respectively, worse than the patients who did not undergo glenoid bone grafting ($p<0.002$). No factors had a significant influence on overall survival or glenoid loosening rates of those who underwent grafting. .

SUMMARY POINTS: Glenoid bone grafting was required in approximately 26% of revision surgeries. The overall complication and reoperation rate was approximately 20%, partly related to the complex nature of the reconstructions included in this study. Although these complex reconstructions are associated with a relatively high rate of glenoid complications at mid-term follow-up, they provide a reasonable option in the revision setting to restore shoulder function and stability, and relieve pain.

Active Glenohumeral Internal Rotation is Similar to Passive Measurements in Patients with Unilateral Shoulder Pain

Abstract ID: Poster 020

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INTRODUCTION: Internal rotation of the glenohumeral joint (IR) is commonly measured as part of the physical examination. However, patients often note significant discomfort during passive range of motion testing, particularly internal rotation. Recently, a technique where IR is estimated with the arm in 90° of abduction with the scapula stabilized, has been shown to have near perfect inter- and intra-observer reliability. This was superior to traditional spinous process estimates. A further advantage is that this technique can be easily quantified with a goniometer. But it remains unclear whether active IR measures are similar to passive IR assessments and could, therefore, be taken without additional assistance from the examiner. We proposed to determine if there is a difference in active vs. passive measurements with this technique in patients with unilateral shoulder pain. We hypothesized there would be no difference in active vs. passive IR in symptomatic shoulders, nor in asymptomatic shoulders.

MATERIALS AND METHODS: Ninety-three consecutive patients presenting to a single shoulder surgeon with the chief complaint of unilateral shoulder pain were included. In all patients, IR measurements were made of the symptomatic and asymptomatic shoulders. IR was assessed with the arm in 90° of abduction and the scapula stabilized. In this position, patients first actively internally rotated the shoulder to the maximum extent and measurements were taken with a goniometer. Then patients were placed in the same position and the arm was passively internally rotated by the examiner to the maximum extent and measurements taken with a goniometer. All measurements were performed by a single evaluator. We compared IR in the symptomatic to asymptomatic shoulders in an independent fashion, using an independent t-test. Differences with $p<0.05$ were considered significant.

RESULTS: Average active IR of the symptomatic shoulder was 51° (0-95°) and the average passive IR was 54° (0-100°). Average active IR of the asymptomatic shoulder was 67° (20-110°) and the average passive IR was 72° (20-110°). When comparing symptomatic to asymptomatic sides, the average active IR of the symptomatic shoulder was significantly less than the asymptomatic shoulder (51° vs. 67°, $p<0.0001$). Similarly, average passive IR of the symptomatic shoulder was significantly less than the asymptomatic shoulder (54° vs. 72°, $p=0.00002$).

CONCLUSION: Passive and active IR measurements are similar in symptomatic and asymptomatic shoulders, and are within goniometric measurement error. This suggests that patients are able to demonstrate the maximum amount of glenohumeral IR without assistance or added force from examiners. Symptomatic shoulders demonstrate intuitive, yet statistically significant, active and passive IR deficits compared to the asymptomatic side.

Intraoperative Periprosthetic Fractures in Revision Reverse Shoulder Arthroplasty

Abstract ID: Poster 021

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PURPOSE: Reverse shoulder arthroplasty has shown promise for revision of failed shoulder arthroplasty. Although the risk factors and incidence of intraoperative complications in anatomic shoulder arthroplasty is well established, there is a paucity of literature in revision reverse shoulder arthroplasty. This investigation assessed the frequency, risk factors, and early outcomes associated with intraoperative periprosthetic humerus fractures.

METHODS: Using our institutional Joint Registry Database, a review of 132 consecutive patients who underwent revision to reverse shoulder arthroplasty for failed prior anatomic or reverse total shoulder arthroplasty from 2005 to 2012 was performed. Univariate regression analysis was used to assess the association of comorbities, demographics, implant fixation, and indication for revision surgery.

RESULTS: Intraoperative periprosthetic humerus fractures occurred in 13 patients (10%). Most of these fractures (69%) occurred during component removal of both cemented (7) and cementless (6) components. Intraoperative fractures only required stabilization with the prosthetic stem in 69%, while adjunctive internal fixation was required in 31% of cases, wires only (1), strut allograft and cables (1), and suture (2). Female gender, use of cement in the primary arthroplasty, and increased number of prior revision surgeries all increased the risk for intraoperative humerus fractures, but did not reach statistical significance ($p>0.12$).

There were 3 (2%) postoperative periprosthetic fractures, including a non-displaced greater tuberosity fracture 13 months postoperatively in a patient with an intraoperative fracture. The 2 other fractures occurred in patients without an intraoperative fracture, including a displaced proximal periprosthetic humerus fracture requiring revision surgery and a distal humeral shaft fracture requiring ORIF. No other patient in either group required revision surgery for humeral component loosening. Overall, there was no difference in revision rate ($p=0.38$), with 1 (8%) patient with an intraoperative fracture patient requiring revision surgery compared to 15 (12%) patients in the group without an intraoperative fracture. The two-year survival rate for intraoperative humerus fractures was 89%, while those without intraoperative fractures had a two-year survival of 84%. There was no difference between the groups in postoperative pain levels, shoulder abduction, or Neer shoulder scores, or Constant shoulder scores ($p>0.18$).

SUMMARY POINTS: Intraoperative humeral fractures occur in approximately 10% of shoulders undergoing revision surgery, secondary to the difficulty with component removal and poor remaining bone stock. When properly stabilized, these fractures have no effect on overall final outcome. The risk seems to be highest for female patients, multiply operated shoulders and prior cement fixation.

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Reverse Total Shoulder Arthroplasty vs. Hemiarthroplasty for Proximal Humerus Fractures: A Systematic Review

Abstract ID: Poster 022

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INRODUCTION: Treatment of acute three- and four-part proximal humerus fractures in the elderly population is a challenging problem. Comminution of the fracture fragments and osteoporotic bone lead to a high rate of failure of ORIF techniques. For this reason, hemiarthroplasty has historically been the gold standard for management of displaced and comminuted fractures of the proximal humerus in elderly patients. However, high rates of tuberosity nonunion and malunion may compromise post surgical outcomes following shoulder hemiarthroplasty. Recently, the application of reverse shoulder arthroplasty (RSA) to complex, comminuted proximal humerus fractures in the elderly has been reported. This study constitutes a systematic review of the literature reporting outcomes of RSA for treatment of acute, complex proximal humerus fractures.

METHODS: A review of multiple medical databases was performed and yielded 15 studies for potential inclusion. Bibliography cross referencing performed on studies identified in the initial search yielded an additional 9 studies for potential inclusion. Potential papers were manually reviewed. After application of inclusion and exclusion criteria, 12 studies were included in the systematic review.

RESULTS: Twelve studies (all level III or IV evidence) reporting outcomes of 285 patients undergoing RSA for acute, complex proximal humerus fractures were included for analysis. Mean age and clinical follow-up was 77.5 years and 31.4 months. Four-part proximal humerus fractures (85.6%) were more common than three-part (14.4%). At final follow-up, mean forward flexion, external rotation, and abduction achieved following reverse shoulder arthroplasty was 116°, 25°, and 98°, respectively. Mean clinical outcomes scores including ASES, DASH, and Constant scores were 71.4, 40.6, and 55.2, respectively. Scapular notching was found in 32.3% of patients at final follow-up. The overall complication rate was 69.4%.

Three studies directly compared cohorts of patients receiving RSA to those treated with hemiarthroplasty. There was no statistical difference in either range of motion or clinical scores at final follow-up between those undergoing either RSA or hemiarthroplasty.

CONCLUSIONS: Surgical management of acute, proximal humerus fractures in elderly patients with RSA leads to acceptable functional and clinical outcomes. RSA may be beneficial over hemiarthroplasty in older patients who are at risk for tuberosity nonunion or malunion due to poor bone quality or inability to cooperate with postoperative rehabilitation protocols. At this time, there is insufficient high-level evidence to recommend specific indications for RSA over hemiarthroplasty for acute proximal humerus fractures.

A Subcutaneous Plating Technique for Complex Humerus Fractures

Abstract ID: Poster 023

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PURPOSE: A subcutaneous bridge plating technique was developed for treatment of complex fractures of the distal humerus in which traditional means, including casting, external fixation (which spans the elbow), and internal fixation, in our hands has led to limited elbow movement. The aim of this study was to describe the outcomes of this novel technique for fixation of fractures of the humerus from various causes.

METHODS: A retrospective review following IRB approval was performed who underwent subcutaneous plating of complex humerus fractures between 2010-2012. Indications for surgery included compromised skin that precluded open reduction and internal fixation, where an external fixator could be used and where immobilizing the elbow may compromise outcome.

TECHNIQUE: A subcutaneous locked plate was inserted with two incisions, one at the lateral epicondyle and another high on the arm, resting superficial to the lateral intramuscular septum. The 10-14 hole narrow large fragment locking plate was passed subcutaneously along the lateral part of the arm. Two to three locked screws were placed in the distal humerus, and two to three more locking screws were placed in the upper three holes of the plate once the humerus was reduced. Care was taken to avoid the radial and axillary nerve paths. Once the screws were locked in place, the wounds were closed.

RESULTS: Eight males and one female, with average age of 28 at time of injury, were included. Mechanisms of injury included gunshot wounds, polytrauma, fall from height, and iatrogenic fracture. The subcutaneous bridge plating technique resulted in an averaged estimated blood loss of 104 mL. Average ROM at final follow-up was 14-125° with a pronation/supination of 60° in each direction. Removal of the hardware was performed, on average, 16 weeks from index surgery. Average Quick DASH scores at final follow-up were 28. There were no neurovascular complications associated with the procedure.

CONCLUSION: This technique provided adequate fixation and healing with minimal blood loss and minimal violation of soft tissue about the fracture site. We feel this internal subcutaneous fixation for the humerus has benefit in ease of use and preservation of elbow range of motion in fractures we found difficult to treat in the past. We also think it may be beneficial in the use of damage control orthopedic surgery and in obese individuals where a sugar-tong splint may not suffice.

PEDIATRICS

Which Pediatric Clavicle Fractures Are Managed Surgically?

Abstract ID: Poster 024

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INTRODUCTION: Until recently, clavicle fractures in children have been treated in a sling or brace with good short-term results. Studies in adults, however, have shown lower nonunion rates and improved biomechanics with surgical treatment of displaced, shortened fractures. The purpose of this study is to compare the characteristics, complications, and indications of operative and nonoperative clavicle fractures in children and adolescents.

METHODS: We identified all cases of pediatric clavicle fractures treated at our center over an eight-year period between January 2005 and January 2013. The medical records and radiographs were reviewed to determine injury mechanism and severity, fracture pattern, treatment, and complications. Injury severity was assessed as high, medium, and low. Patients with medial or distal metaphyseal fractures, intra-articular fractures, pathologic fractures, or incomplete injury films were excluded.

RESULTS: During the study period, 362 pediatric patients with 371 midshaft clavicle fractures were identified, including 219 adolescents (226 clavicle fractures) aged 10-17. In this series, 348 were treated nonsurgically, resulting in one nonunion (0.3%). Adolescent and male patients were more likely to have a high-energy injury mechanism ($p<0.001$, $p<0.001$, respectively). No patient under age 14 had surgical management. Of the 226 fractures in adolescents, 23 (10%) were treated surgically. These 23 fractures were displaced and shortened a mean of 2.0 cm (vs. 0.9 cm of shortening in nonsurgical displaced fractures, $p<0.001$). Comminution was more common in the surgical group (65% vs. 21% of fractures, $p <0.001$). Mean age of adolescents treated surgically was 15.4 years (range 14-17) compared to a mean of 14.1 years ($p<0.001$) in the nonsurgical group. Five (22%) of the 23 patients treated surgically experienced a complication, including refracture (n=2), implant removal for prominence (n=2), and nonunion with implant failure requiring revision surgery (n=1). Pediatric orthopedic surgeons treated 78 displaced fractures, resulting in eight surgeries (10%). Non-pediatric orthopedic specialists treated 46 displaced fractures, 15 of which were treated operatively (33%, $p=0.0035$).

DISCUSSION AND CONCLUSION: In our series, 10% of clavicle fractures in adolescents were treated with surgery, with comminution and shortening greater than 1.5 cm as the primary indications. Refracture or additional surgery occurred in 22% of fractures postoperatively. Following closed treatment, complications related to healing was minimal. Long-term follow-up studies evaluating the clinical results of shortened, comminuted clavicle fractures in children are needed to determine the optimal management to restore function in these patients.

Does Skeletal Maturity Affect Pediatric Pelvic Injury Patterns, Associated Injuries, and Treatment Intervention?

Abstract ID: Poster 025

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BACKGROUND: Pediatric pelvis fractures are rare injuries, most frequently caused by high energy trauma. Major associated injuries are common. Due to the high elasticity and flexibility of the immature pelvis, different fracture patterns occur as compared to adults. The purpose of this study was to analyze whether skeletal maturity affects pediatric pelvic fracture pattern, associated injuries, and initial treatment.

METHODS: Between 2002 and 2011, 90 consecutive children with pelvis fractures were retrospectively analyzed at a Level I teaching trauma center and followed in a large orthopedic private practice. Skeletal maturity was defined as closed triradiate cartilage. Forty-one (46%) were skeletally immature and 49 (54%) skeletally mature. Mean age was 11.5 years (2-16). Fractures were 23 A2, 1 A3, 4 B1, 44 B2, 16 B3, and 2 C2 according to AO/OTA classification. OTA B and C fractures were 26 LC1 (lateral-compression), 20 LC2, 10 LC3, 4 APC1 (anterior-posterior-compression), 5 APC2, and 1 VS (vertical-shear) injury according to Young and Burgess. Treatment of the pelvis fracture was operative in 28 (31%) children and nonoperative in 62 (69%) children. Mechanism of injury, Injury Severity Score (ISS), deaths, and associated injuries were recorded.

RESULTS: Seventy-one (79%) injuries were caused by traffic accidents. More complex fractures occurred in skeletally mature vs. immature children (p=0.014). Seventy-five percent (12/16) B3 fractures, 100% (2/2) C2 fractures, 80% LC3 fractures (8/10), and 80% (4/5) APC2 fractures occurred in skeletally mature children. Skeletally mature children had a significantly higher rate of operative fracture treatment (p=0.009). The Injury Severity Score in skeletally mature children was higher 25 (1-66) than in skeletally immature children 17 (4-43) (p=0.013). Eighty-four percent (41) skeletally mature and 78% (32) skeletally immature children sustained associated injuries of the head (32 vs. 41), abdomen (14 vs. 20), thorax (16 vs. 25), spine (2 vs. 5), upper extremity (6 vs. 6), and lower extremity (6 vs. 9). Twenty-two percent (11) of all skeletally mature children sustained urinary tract injuries, but only 7% (3) of all skeletally immature children (p=0.049). One skeletally mature and one immature child died because of associated extrapelvic injuries.

CONCLUSION: The majority of pediatric pelvic fractures are caused by traffic accidents. Skeletally mature children are more likely to sustain more complex fracture patterns with a higher rate of operative treatment. The skeletally mature have a higher rate of associated injuries and higher injury severity score than immature patients.

Recent National Trends and Outcomes for Pediatric Supracondylar Humerus Fractures in the United States

Abstract ID: Poster 026

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INTRODUCTION: Supracondylar humerus fractures (SHF) are one of the most common orthopedic injuries in the pediatric population. The purpose of this study was to assess recent national trends for SHF in the United States (US) and evaluate acute/perioperative outcomes for this injury group.

METHODS: International Classification of Disease - 9th Revision diagnosis codes were used to search the National Hospital Discharge Survey (NHDS) for pediatric patients admitted to US hospitals with SHF for each year from 2001-2010. Data regarding patient demographics, month of injury, vascular/neurologic injury, compartment syndrome, injury treatment, blood transfusion, mortality, hospitalization length, discharge disposition, and hospital location were gathered from the NHDS. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test, z-test for proportions, and chi-squared test with alpha=0.05.

RESULTS: 1,026 pediatric patients admitted with SHF were identified. There were 34.8 cases per 100,000 hospital admissions. This injury prevalence remained stable from 2001-2007, with no correlation with time (r=-0.08) over that interval. SHF demonstrated significant seasonal variation (p=<0.01), with most injuries occurring in the summer (32.0%) and the fewest in the winter (15.3%). Mean age of SHF patients was 5.8 years (range 0.33-17). The group included 516 males and 510 females. Although gender remained stable across the years (p=0.39), age significantly decreased with time, from an average 5.94 years in 2001-2005 down to 5.48 years in 2006-2010 (p=0.02). 994 (96.9%) fractures were closed and 32 (3.1%) were open. The percentage of open fractures did not change with time (p=0.52). 17 (1.7%) SHF were associated with peripheral nerve injury, most commonly the ulnar (50% of specified cases), median (37.5%), or radial nerve (12.5%). 8 (0.8%) SHF were associated with peripheral vascular injury, with all eight cases (100%) being the brachial artery. There were no reported cases of compartment syndrome. 789 (76.9%) SHF underwent a closed reduction internal fixation (CRIF), and 145 (14.1%) underwent open reduction internal fixation (ORIF). Location of the hospital significantly impacted surgical treatment (p=0.01), with the highest rate of ORIF (22.7%) seen in the Midwest and the lowest rate (11.7%) seen in the West region of the US. 1 (0.1%) patient required a blood transfusion. Average length of stay for SHF was 1.4 days (range 1-15). Length of stay did not change with time (p=0.65). 1,018 (99.2%) patients went directly home after their inpatient stay, with only 7 patients (0.7%) requiring admission/transfer to a short-term care facility. 1 (0.1%) patient died during their admission.

DISCUSSION AND CONCLUSION: Pediatric SHF remain common in the US, and this study documents for the first time their significant seasonal variation. Although the overall incidence has been stable, the injury appears to be occurring in younger patients for unclear reasons. Most SHF are closed and very rarely include neurovascular injury. Most operative SHF are being treated with CRIF. Interestingly though, surgical treatment choice varies based on hospital location. This may be related to regional training differences or availability of pediatric orthopedic subspecialists.

FOOT AND ANKLE

Increasing Stiffness of Syndesmotic Fixation Causes Abnormal Talar Displacement During Simulated Weightbearing in a Cadaveric Model

Abstract ID: Poster 027

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INTRODUCTION: Syndesmotic injury, reduction, and fixation techniques have recently garnered significant clinical interest. The role of syndesmotic fixation on the subtle biomechanics and motion of the tibiotalar joint remains poorly understood. The purpose of the present study was to evaluate how the stiffness of fixation across an anatomic syndesmosis affects tibiotalar motion through a weightbearing range of motion in a cadaver model.

METHODS: Nine cadaveric ankles were dissected to expose the fibula, tibia, and talus while leaving ankle ligaments, the syndesmosis, and the interosseus membrane intact. To accurately determine motion, rigid clusters of reflective markers were attached to the tibia, the distal fibula, and talus. Each specimen was axially loaded with 600N in 20° plantar flexion, 10° plantar flexion, neutral, 10° dorsiflexion, and 20° dorsiflexion using a custom-built ankle simulator installed in an MTS Bionix. Fixation levels tested included one 3.5 mm screw, two 3.5 mm screws, one 4.5 mm screw, two 4.5 mm screws, and two 4.5 screws with the deltoid sectioned.

RESULTS: Abnormal inferior displacement of the talus over the full course of motion (20° plantar flexion to 20° dorsiflexion) was observed and correlated with increasing fixation stiffness. The inferior displacement average was found to be 0.6 mm, -0.22 mm, -0.22 mm, -0.28 mm, -0.41 mm for testing conducted with one 3.5 mm screw, two 3.5 mm screws, one 4.5 mm screw, and two 4.5 mm screws, and two 4.5 screws with the deltoid sectioned. The radii of variability calculated for motion across the nine specimens in each tested degree of motion indicate a general trend toward increasing variability of motion with increasing fixation stiffness, especially at the extremes of motions (20° plantar flexion to 20° dorsiflexion).

DISCUSSION AND CONCLUSION: Fixation across the syndesmosis logically alters the biomechanical relationship between the distal tibia and fibula. While the importance of an anatomic reduction and stable fixation to promote healing is well supported, there is no uniform recommendation regarding many aspects of treatment, including optimal method of stabilization, screw size, screw number, or need for screw removal. Our findings demonstrate that increasing stiffness of fixation across the syndesmosis causes abnormal talar displacement. The talar displacement measured in this cadaver model could potentially cause substantial changes in tibiotalar contact stresses in vivo, and may have important clinical implications.

The Prediction of Ulcer Location in Patients with Diabetes Using Clinical Evaluation, Radiographic Parameters, and Plantar Pressure

Abstract ID: Poster 028

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BACKGROUND: Early detection and prevention strategies for diabetic foot ulcer, such as unloading of a pre-ulcerated area or a superficial ulcer, can prevent ulceration and promote accelerated healing. While mechanical derangements have been recognized as risk factors of foot ulceration, definitive guideline to predict the ulcer location is lacking. The purpose of this study is to determine if the association between ulcer location, plantar pressure, and foot deformity from both clinical and weightbearing radiographs.

MATERIALS AND METHODS: Eighty-seven consecutive patients with diabetic neuropathy and foot ulceration were prospectively enrolled. They were evaluated for ulcer location, clinical deformity (hindfoot varus/valgus, midfoot abduction/adduction), radiographic deformity (hindfoot alignment, calcaneal pitch, Meary's angle, and dynamic plantar pressure using EMED-SF platform. The plantar foot was evaluated according to a novel zoning system (Figure 1) and grouped into medial zone (zone 1,2,5) and lateral zone (zone 4,6). The ability of clinical deformity, radiographic parameters, and dynamic plantar pressure was evaluated for the prediction of ulceration in the medial (zone 1, 2, and 5) or lateral (zone 4 and 6) zones. Sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio of each diagnostic modality were analyzed.

RESULTS: The diagnostic characteristics of each test are listed in Figure 1. None of the clinical or radiographic parameters appeared to be highly valuable in the prediction of ulcer location due to the lack of sensitivity. Clinical midfoot adduction/abduction was superior to the clinical hindfoot varus/valgus. Meary's angle appeared to be the best radiographic measurement. The peak dynamic plantar pressure was modestly sensitive for the prediction of ulceration in the medial zone, but was not sensitive for lateral zone.

CONCLUSION: Clinical appearances and radiographic parameters were poor predictors in ulcer location in patients with diabetic foot ulcer. Peak dynamic plantar pressure was promising especially when the peak pressure located in the medial zone. The relationship between foot malalignment and the ulcer location was not supported by this study. Further studies including evaluation of both deformities and tendon contractures in a larger group of pre-ulcerated high-risk patients are required.

Level of evidence: Level II, prospective study

Key word: Diabetic Foot Ulceration, Plantar Pressures, Foot Deformities
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The Arterial Anatomy of the Posterior Tibial Nerve in the Tarsal Tunnel

Abstract ID: Poster 029

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INTRODUCTION: Neurologic symptoms of the posterior tibial nerve in the tarsal tunnel can be multifactorial. Occasionally, compression due to a distinct mass occurs, but a vascular etiology has also been proposed. The arterial anatomy supplying the posterior tibial nerve and its branches has not been well described, but may provide insight into the etiology of tarsal tunnel symptoms. The purpose of this study is to provide a quantitative description of the arterial anatomy of the posterior tibial nerve in the tarsal tunnel.

METHODS: 40 adult cadaveric specimens (20 matched pairs) were amputated below the knee. The anterior tibial, posterior tibial, and peroneal arteries were injected with India Ink and Ward's Blue Latex. The specimens were frozen for 48 hours and then thawed. In 20 limbs, the soft tissues were debrided with 6% sodium hypocholorite, exposing the arterial branches supplying the nerves. In 20 limbs, the nerve was removed and the microvascular anatomy determined via the Spalteholz technique. The location of the branches relative to bifurcation of the nerve and the abductor fascia was recorded. The density of vessels in vessels/centimeter was calculated. The Student's T-test was used to compare vascular density of the nerves.

RESULTS: Macroscopically, the PTN had an average of 3 vessels entering at an average of 1.0 cm, 2.7 cm, and 4.2 cm, proximal to the medial malleolus. The MPN and LPN were supplied by an average of 3 vessels and 2 vessels, respectively. These vessels supplying the MPN and LPN were concentrated at the abductor fascia.

A more detailed view of the vascular network was seen microscopically. In this evaluation, 2 (2.1 ± 0.8) vessels entered the PTN at 2.3 ± 0.8 cm and 4.9 ± 0.9 cm proximal to the bifurcation. Distally, 2 (2.3 ± 0.8) vessels entered the MPN at 1.9 ± 1.2 cm and 4.1 ± 0.7 cm distal to the bifurcation. The LPN was supplied by 2 (2.4 ± 1.0) vessels entering the nerve at 1.4 ± 0.8 cm and 3.8 ± 0.9 cm distal to the bifurcation. There was consistently a vessel supplying the MPN and LPN that entered the nerve near the abductor fascia, with a mean distance of 0.7 cm and 0.6 cm from the fascia to the nearest vessel, respectively. The density of the vessels in the PTN proximal to the bifurcation was 0.23 vessels/cm. The vascular density of the MPN was 0.29 vessels/cm and LPN was 0.32 vessels/cm. The difference in vascular density between the PTN and each of its branches was statistically significant ($p<0.05$).

CONCLUSION: This study demonstrates the posterior tibial nerve and its branches have an abundant arterial supply. These findings suggest that this rich vascular network may render the posterior tibial nerve and its branches susceptible to nerve compression secondary to vascular congestion. Additionally, as these arterial branches are concentrated at the abductor fascia, the combination of vascular and fascial compression may combine to elicit neurologic symptoms.

SPORTS

ACL Graft Failures: Correlations with Lateral Knee Anatomic Factors in Men

Abstract ID: Poster 030

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INTRODUCTION: There is increasing evidence that lateral knee geometry is an important risk factor for primary ACL injury; however, no studies exist in the literature associating lateral knee geometric factors with primary ACL reconstruction failure. We studied lateral knee geometric factors in men, as studies suggest male knee anatomy is significantly more heterogeneous than females. We hypothesized that male patients undergoing revision ACL surgery will demonstrate increased relative convexity of the lateral femorotibial joint surfaces and an increased posterior tibial slope when compared to literature standards for uninjured controls and successful primary ACL reconstructions.

METHODS: A retrospective chart review was conducted between 2007-2012. Twenty-eight male patients undergoing revision ACL reconstruction were identified. Measurements were made in the mid-lateral sagittal plane and included tibial plateau radius of curvature (TPr), distal femoral radius of curvature (Fr), maximal femoral anteroposterior articular length (FAP), maximal tibial anteroposterior articular length (TPAP), and posterior tibial slope (PTS). The measurements were compared to literature standards controls.

RESULTS: ACL graft failures in this study displayed a significantly more convex lateral tibial plateau (TPr 31.62 mm) when compared to controls and single-time ACL injured athletes ($p<0.05$). The mean tibial plateau anteroposterior articular length (TPAP) in this study is 31.15 mm; this is significantly shorter than both controls and single-time ACL injured athletes ($p<0.05$). The mean distal femoral radius of curvature (Fr) is 26.70 mm. The mean maximal femoral anteroposterior articular length (FAP) is 72.01 mm. The mean lateral posterior tibial slope (LPTS) is -6.25°; Fr, FAP, and LPTS are no different than literature cited controls. There were no significant differences in lateral knee geometry between subjects with regard to graft type (allograft vs. autograft) or timing of ACL graft failure (<1 year vs. >1 year).

DISCUSSION: Our data suggests males who have a shorter and more highly convex lateral tibial plateau compared to literature cited controls and single-time ACL injured subjects may be at greater risk for re-injury after ACL reconstruction. The posterior tibial slope, however, does not appear to differ than uninjured literature controls or single-time ACL injured subjects. This data suggests that the most important lateral knee geometric risk factor recurrent ACL injury is the short and convex nature of the lateral tibial plateau and not posterior tibial slope.

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3D Characterization of the ACL's Femoral Footprint

Abstract ID: Poster 031

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BACKGROUND: There is increasing use of 3D CT for researching ACL reconstructions and tunnel placement. However, there is limited 3D CT data on the ACL footprint. The purpose of this study is to define the native ACL femoral footprint using 3-D surface reconstructions of computed tomography (CT) imaging of cadaveric knees.

METHODS: The femoral insertion of the anterior cruciate ligament was meticulously dissected and marked with drill holes in seven cadaveric knees. CT scans were performed on each specimen, and 3-D computer models were created. Distance from the condyle edges to the margins of the footprint were referenced to the total condylar size. This was performed both parallel and perpendicular to the femoral axis as well as the intercondylar notch.

RESULTS: The mean condylar depth (c/C) ratios along the axis of the femur were 0.45 ± 0.06 for the anterior border, 0.44 ± 0.08 for the posterior border, 0.26 ± 0.07 for the proximal border, and 0.63 ± 0.08 for the distal border. The mean notch (n/N) ratios for the four margins were 0.37 ± 0.04 for the anterior border, 0.67 ± 0.08 for the posterior border, 0.49 ± 0.07 for the proximal margin, and 0.50 ± 0.06 for the distal border. The mean c/C ratios parallel the intercondylar notch measured 0.23 ± 0.03 for the anterior border, 0.27 ± 0.04 for the posterior border, 0.37 ± 0.04 for the proximal border, and 0.12 ± 0.02 for the distal border. The mean n/N ratios perpendicular to the intercondylar notch measured 0.11 ± 0.06 for the anterior border, 0.52 ± 0.09 for the posterior border, 0.29 ± 0.06 for the proximal border, and 0.30 ± 0.06 for the distal border.

CONCLUSIONS: This study provides reference measures of the femoral footprint of the ACL using 3D CT. It will assist future studies that utilize advanced imaging to evaluate accuracy of anterior cruciate ligament reconstruction.

A Novel Technique for Pediatric Partial Transphyseal Anterior Cruciate Ligament Reconstruction

Abstract ID: Poster 032

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INTRODUCTION: With increased sports participation, increasing numbers of anterior cruciate ligament (ACL) ruptures are seen in the skeletally immature. Growth disturbances after pediatric ACL reconstruction are more likely to occur at the femoral physis; thus, partial transphyseal techniques may be a better surgical option in this population. We report the outcomes of our novel technique. An arthroscopic-assisted ACL reconstruction using quadruple looped hamstring graft with a synthetic graft extender and a distal femoral physeal sparing technique restored knee stability in all cases with no incidence of growth disturbance at an average of 3.3 years follow-up in this case series.

METHODS: Case series of all patients whom underwent this novel procedure at our facility with at least two-year follow-up. A retrospective review on all patients gathered information including injury mechanism, associated injuries, time to surgery, rehabilitation protocol, length of follow-up, incidence of growth disturbance/deformity, and ability to return to pre-injury activity level. Eligible patients were invited to return for repeat physical examination, KT-1000 measurement, scanogram, and to complete a Lysholm knee scale and International Knee Documentation Committee (IKDC) score.

RESULTS: This procedure entails a transphyseal tibial tunnel with an over-the-top femoral position. A #12 French red-rubber catheter and fiber-tape suture are utilized as a synthetic graft extender for the quadruple looped hamstring graft which is secured over a screw and washer proximally and distally. The first procedure was performed in 2007 and 17 patients underwent the operation through 2012. Eight of the 17 patients had greater than two year follow-up and 6 of the 8 (75%) participated in the study. All injuries occurred during sporting activity with a twisting mechanism. Fifty percent of the patients had an associated meniscal tear. The average age of the 17 subjects was 12.4 years old with an average time to surgery of 78 days. For the six patients who participated in the study, the average length of follow-up was 3.3 years (range 2.0-5.5 years). On physical examination of the involved extremity compared to the contralateral limb, the average difference in knee flexion was 1.5° and in thigh circumference was 0.8 cm. All patients had a stable ligamentous examination. The difference in KT-1000 measurements at 20 lb and 30 lb were 0.9 and 1.0 respectively. No significant differences in limb length or angulation were detected on scanogram or AP lower extremity radiographs. The average Lysholm knee and IKDC scores were 91.5 and 92.7, respectively.

CONCLUSION: Arthroscopic-assisted ACL reconstruction using quadruple looped hamstring graft with a synthetic graft extender and distal femoral physeal sparing technique restored knee stability in all cases with no incidence of growth disturbance at an average 3.3 years follow-up. This technique is an option for the skeletally immature population at risk for growth disturbance during ACL reconstruction.

Neurovascular Injuries in Acute Knee Dislocations: A Retrospective Review of Initial Vascular Evaluation Utilizing a Selective Angiography Algorithm

Abstract ID: Poster 033

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INTRODUCTION: With increasing reports of acute knee dislocations in the morbidly obese through seemingly benign mechanisms, further investigation is required to understand the most appropriate initial evaluation of neurovascular injury in these patients. While some authors advocate for routine arteriography for all patients with knee dislocation, others have reported success with selective arteriography. We proposed to review our experience with a selective arteriography algorithm to determine its utility with specific emphasis on the morbidly obese population.

METHODS: All patients presenting to our institution with an acute knee dislocation over a five-year period (2007-2012) were included. Patients with a normal neurovascular examination and/or ankle-brachial indices greater than 0.9 were clinically observed. Those with abnormal ABI (< 0.9) but palpable pulses underwent arteriogram at the discretion of the attending physician, while patients with pulse discrepancy compared to the contralateral side received arteriography. Missed injuries were defined as worsened clinical examination resulting in further radiographic or invasive evidence of vascular injury prior to discharge. Clinical data, including the presence of vascular and neurological injuries, was collected. Patient demographic data was also compiled and analyzed referable to the presence of neurovascular injuries. Statistical analysis was performed using Pearson's Chi-Square, ANOVA, and students paired t-test where appropriate. Differences with $p < 0.05$ were considered significant.

RESULTS: Fifty-three patients were included in the study. The rate of popliteal artery injury was 17% (9/53) and peroneal nerve injury 38% (20/53). There were no missed vascular injuries using the selective arteriography algorithm as defined by no patients with evidence of worsening exam and/or radiographic evidence of injury prior to discharge. Extreme obesity (BMI > 40) was significantly associated with popliteal artery injury ($p = 0.01$), and the mean BMI was increased (40 vs. 33) in patients with popliteal artery injury ($p = 0.04$). Trends toward statistical significance for popliteal artery injury were time to reduction greater than six hours ($p = 0.07$) and transfer from another facility ($p = 0.17$). A trend was also noted toward popliteal artery injury in falls from a standing height ($p = 0.22$) while peroneal nerve injury was significantly higher with this ultra-low-velocity mechanism ($p = 0.02$).

CONCLUSIONS: The rates of neurovascular injury after acute knee dislocation in this study are significant and consistent with previous literature. There were no missed vascular injuries utilizing a selective arteriography algorithm. Extreme obesity and an ultra-low-velocity mechanism are associated with an increased risk of neurovascular injury in acute knee dislocation with no evidence to suggest arteriography is obligatory in this population.

Restoration of Neuromuscular Control During the Pitch After Operative Treatment of SLAP Tears

Abstract ID: Poster 034

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BACKGROUND: Superior labral anterior-posterior (SLAP) tears are a common cause of shoulder pain and dysfunction in overhead throwers. Treatment outcomes remain unpredictable with a large percentage of athletes unable to return to sport. Persistent pain from the LHB (long head biceps) has been postulated as etiology of failure following repair. Previous authors have hypothesized that maximal stress is placed upon the biceps anchor during the cocking phase and that SLAP tears likely occur during this phase.

OBJECTIVES: We hypothesized that operative treatment of SLAP tears with repair or tenodesis would result in persistent alterations in neuromuscular control of the biceps during the overhand pitch post-operatively.

METHODS: We evaluated the activity of the biceps muscle in the overhand pitching motion and correlate this activity with throwing phase in healthy collegiate and semi-professional pitchers, pitchers status-post SLAP repair, and pitchers status-post biceps tenodesis. Patients were at least one year postoperative and had returned to pitching with a painless shoulder. Subjects pitched from a regulation-sized mound while surface electrodes collected electromyographic (sEMG) signals at 1500 Hz from the long- and short-heads of the biceps, the deltoid, the infraspinatus, and the latissimus dorsi. Motion analysis data was captured at 120 Hz with a 14-camera three-dimensional markerless motion analysis system. At least five pitches were performed by each subject. sEMG data was then normalized to maximal manual muscle testing and then divided into previously described pitching phases (wind-up, stride, cocking, acceleration, deceleration, follow-through).

RESULTS: Ten pitchers participated: 6 normals and 4 status-post SLAP repair or tenodesis. No significant differences were observed in long head, short head, deltoid, infraspinatus, or latissimus activity between normal and postoperative patients during cocking, acceleration, or deceleration, although there was a trend towards compensatory overactivity in the short-head of the biceps in patients status-post tenodesis and towards disordered overactivity in the long-head of the biceps in patients status-post SLAP repair.

CONCLUSIONS: Simultaneous EMG and motion analysis of pitchers status-post operative treatment of SLAP tears suggests that tenodesis and repair can restore physiologic neuromuscular control during the pitch. Alterations in activity in the short and long-head of the biceps may remain during the cocking phase in pitchers with a full painless return to play. Further study is needed to determine potential differences between patients with persistent pain following surgery, as well as differing treatment modalities (tenotomy, tenodesis, repair).

KEYWORDS: Superior labral anterior-posterior tears, pitching, biceps tenodesis

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Upper Extremity Motion in the Overhand Pitch: Evaluation of Tenodesis and Repair for SLAP Tears

Abstract ID: Poster 035

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BACKGROUND: Superior labral anterior-posterior (SLAP) tears are a common cause of shoulder pain and dysfunction in overhead throwers. Treatment outcomes remain unpredictable with a large percentage of athletes unable to return to sport. Persistent pain from the LHB (long head biceps) has been postulated as etiology of failure following repair. Previous authors have hypothesized that maximal stress is placed upon the biceps anchor during the cocking phase and that SLAP tears likely occur during this phase.

OBJECTIVES: We hypothesized that operative treatment of SLAP tears with repair or tenodesis would result in restoration of physiologic pitching timing and motion in those patients able to return to play.

METHODS: We evaluated kinematics and timing of the overhand pitching motion in healthy collegiate and semi-professional pitchers, pitchers status-post SLAP repair, and pitchers status-post biceps tenodesis. Patients were at least one year post-arthroscopy and had returned to pitching with a painless shoulder. After a complete warm-up, subjects pitched from a regulation-sized mound while motion analysis data was captured at 120 Hz with a 14-camera three-dimensional markerless motion analysis system. High-speed (120 Hz) video was simultaneously collected to confirm accurate tracking. At least five pitches were performed by each subject. Pitches were then divided into previously described pitching phases and events within the pitch were normalized to percent of the pitch. Thorax, shoulder, and elbow kinematics were then evaluated.

RESULTS: Ten pitchers participated: 6 normal and 4 status-post SLAP repair or tenodesis. There were no significant differences between normal and postoperative patients in thoracic, shoulder, or elbow flexion, abduction, or rotation at foot strike, shoulder maximal external rotation, or ball release. No significant differences were seen in lead knee flexion at foot strike or ball release or stride length normalized to subject height. No significant differences were seen in the timing of initiation of thoracic rotation, peak thoracic angular velocity, peak shoulder angular velocity, peak elbow angular velocity, or length of the cocking and acceleration phases.

CONCLUSIONS: Operative treatment of SLAP tears can succeed in restoring physiologic pitching motion and timing, suggesting that operative treatment does not permanently disrupt pitching mechanics. Further study is needed to determine potential differences between differing treatment modalities (tenotomy, tenodesis, repair). To the best of the author's knowledge, this is the first report of pitching motion analysis in patients' status-post shoulder surgery.

KEYWORDS: Superior labral anterior-posterior tears, pitching biomechanics, biceps tenodesis

Pitching Speed and Glenohumeral Adaptation in a High School Population

Abstract ID: Poster 036

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INTRODUCTION: Glenohumeral internal rotational deficit (GIRD) and increased glenohumeral external rotation (IGER) are common findings in baseball pitchers. This change in effective range of motion has been described as an adaptation to the continuous, high demands placed on the shoulder of a baseball pitcher. No study, to our knowledge, has focused on the adaptation of GIRD and IGER as it relates to pitching speed.

METHODS: Twenty-two asymptomatic high school varsity pitchers' shoulders were evaluated. Using standard goniometric technique, passive external and internal glenohumeral range of motion was measured in both throwing and non-throwing arms. Measurements were evaluated using a student t-test to evaluate for statistical significant range of motion differences. Player demographics including height, weight, arm length, age, and modified DASH scores were assessed.

In-game pitch speeds were then acquired using a Jugs Cordless Radar Gun. Fifteen straight pitches were recorded and the fastest pitch was used for evaluation. Pitch speeds were correlated to player's GIRD, IGER, and physical demographics using Spearman's rank correlation coefficient, Wilcoxon rank-sum tests, and Kruskal-Wallis test.

RESULTS: Average age of pitchers was 16.9 years old. Average throwing arm external rotation was significantly greater compared to non-throwing arm (143.00° vs. 130.32°, p value= .0005). Internal rotation of the player's throwing arm was significantly less compared to their non-throwing arm (85.55° vs. 100.91°, p value=.001). In comparing total shoulder arch of motion, both shoulders were similar with regards to total arc of motion (throwing shoulder 228.55 vs. non-throwing shoulder 231.23, p value= .822).

Average max velocity was 77.7 mph (max 88, min 66). There was no significant correlation in comparing maximum pitch velocity with GIRD (p=0.683) or the IGER (p=0.241). We also did not find any correlations between pitching velocity and player age, height, weight, arm lengths, or handedness.

CONCLUSION: The stress of pitching creates adaptations to the throwing shoulder, even in young athletes. The total range of motion of the throwing arm does not appear to change; rather change is demonstrated as an increase in external rotation and a lack of internal rotation. Although these adaptations may have a positive effect on the pitching performance, there appears to be no significant correlation with a pitchers maximum velocity and the amount of adaptation in shoulder range of motion.

An Analysis of Major League Baseball Pitchers' Velocity Before and After Ulnar Collateral Ligament Reconstruction

Abstract ID: Poster 037

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BACKGROUND: Baseball pitchers routinely undergo reconstructive surgery for ulnar collateral ligament (UCL) ruptures. To our knowledge, there has not been a study specifically analyzing the velocity of pitches thrown by pitchers after surgery. We attempt to examine these measurements in a cohort of major league baseball (MLB) pitchers before and after UCL reconstruction.

METHODS: Forty-one MLB pitchers between the years 2008 to 2010 were identified in our retrospective cohort study as players recovering from UCL reconstruction. Performance data from 28 pitchers over a minimum of four seasons each were analyzed. A pair-matched control group of pitchers who did not have a known UCL injury were analyzed for comparison.

RESULTS: After implementing our exclusion criteria (N=6), we found that the rate of return to major league play was 80% (28/35) by a minimum follow-up of two years after surgery. There was a small clinical, but statistically significant, decrease in fastball and changeup velocity for each post-injury year. Curveball velocity was statistically lower in post-injury year 2 and 3. However, mean changes in velocity of the pitches thrown by these players were not significantly different compared to a control group. In terms of performance data, the mean innings pitched was statistically different only for the year of injury and the first post-index year. There were no differences between the two groups in regards to commonly used baseball statistical performance measurements including earned run average, batting average against, walks per 9 innings, and strikeouts per 9 innings.

CONCLUSION: Pitchers who returned to the major league level following UCL reconstruction showed no significant difference in pitch velocity and common performance measurements compared to a control group.

KEYWORDS: baseball pitcher, ulnar collateral ligament, elbow injury, major league baseball, velocity, performance

Analysis of Mechanical Failures After Anatomic Acromioclavicular Joint Reconstruction

Abstract ID: Poster 038

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BACKGROUND: Acromioclavicular (AC) joint injuries are commonly encountered in orthopedic practice. Recent studies have advanced a technique for anatomic reconstruction. However, there remains a paucity of literature investigating postoperative failures. We proposed to analyze our series of anatomic AC joint reconstructions to evaluate risk factors that may predict failure. We hypothesized there would be no difference in failure rates relative to any of these variables.

MATERIALS AND METHODS: We performed a retrospective review on a consecutive series of anatomic AC joint reconstructions from 2007-2013. Forty-three patients were included in the study, 33 male and 10 female. The average patient age was 39.7 years (range 20-68). Failure was defined as loss of AC joint reduction with concomitant pain and/or dysfunction requiring revision surgery. Multiple variables were analyzed in an attempt to identify risk factors for failure. Injury characteristics evaluated included: acute vs. chronic injury and severity of AC joint disruption. Surgical techniques evaluated included: graft choice, use of interference screws for graft fixation, use of additional non-biologic fixation, concomitant distal clavicle excision, and superior AC capsule reconstruction. Patient factors evaluated included: age, sex, BMI, involvement of dominant extremity, occupation, smoking status, and diabetes mellitus. Independent t-tests were used for numeric variables. Nominal data were evaluated using nonparametric statistical analyses with Fisher's Exact test.

RESULTS: Two patients underwent revision surgery due to infection and were excluded from the analysis of mechanical failures. Seven patients (16%) underwent revision due to failed reconstruction with pain. There was a significantly lower failure rate in patients where interference screws were used for graft fixation (7% vs. 44%, p=0.016). Similarly, a significantly lower failure rate was found in patients who underwent concomitant distal clavicle excision. (9% vs. 60%, p=0.018). Reconstructions with non-biologic fixation in addition to the tendon graft also trended toward lower failure rates (9% vs. 43%, p=0.055). The failure rate was lower in type III injuries (10%) than type V injuries (22%), but this difference did not reach statistical significance due to the small size of the re-operative group.

CONCLUSION: Anatomic AC joint reconstruction resulted in a 16% mechanical failure rate in this series. Multivariate analysis of 14 factors found that the use of interference screw fixation and concomitant distal clavicle excision were statistically significant protective factors against failure. There was also a strong trend toward a lower failure rate with use of additional non-biologic fixation.

Biomechanical Analysis of Humerus Fracture After Subpectoral Biceps Tenodesis with an Interference Screw

Abstract ID: Poster 039

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INTRODUCTION: Subpectoral biceps tenodesis has recently become popular due to its simplicity, preservation of length-tension relationship, biomechanical advantage of an interference screw, and low complication rate. The purpose of this study was to determine if there is an increased risk of humerus fracture after subpectoral biceps tenodesis with an interference screw and to determine if screw size is a factor.

METHODS: Twenty matched pairs of previously embalmed cadaveric humeri were randomized with respect to side and size of interference screw. Subpectoral biceps tenodesis was performed using either a 6.25 or 8 mm interference screw with the contralateral limb serving as a control. All humeri were then stripped of surrounding soft tissue with the exception of the biceps tendon on the operative limb. Each humerus was tested to failure in external rotation using a torsional protocol at 1°/sec on an MTS Mini Bionix test frame.

RESULTS: Humeri in both groups fractured primarily in 2 ways: a spiral fracture extending most of the length of the diaphysis and catatrophic fracture in which the diaphysis splintered into many fragments. The majority of fractures (90%) in the tenodesis group fractured through the screw hole. Two-way ANOVA with repeated measures showed a significant reduction in maximum torque ($p<0.00001$) and fracture torsion angle ($p<0.0001$) in the tenodesis group compared to controls; however, there was no significant difference between screw sizes (Table 1). Paired t-tests for the combined screw sizes (both 6.25 mm and 8.0 mm) showed significant differences between tenodesis limbs and native limbs (Table 1; Figure 1) for both maximum torque ($p<0.00001$) and torsional angle at fracture ($p<0.0001$).

CONCLUSION: There is an increased risk for humerus fracture after subpectoral biceps tenodesis with an interference screw. The size of the screw did not make a significant difference.

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Average Glenoid Defect Size: A Systematic Review

Abstract ID: Poster 040

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PURPOSE: (1) Evaluate the existing literature to better define the size of glenoid defects in patients with anterior instability, (2) determine if there is a correlation between defect size and treatment outcomes, and (3) determine the time trend of reporting numeric measurements of glenoid defect size.

METHODS: We performed a literature search using the PubMed database for the following terms: “Glenoid Bone Loss”, “Glenoid Defect”, “Glenoid Bone Defect”, and “Bony Bankart” in search of clinical studies on anterior instability with numeric values measuring glenoid defect size. We excluded studies with size requirements in their entry criteria; studies with pathology other than anterior instability in their entry criteria; patients with known prior surgery; and studies with fewer than 10 subjects. Our search produced 66 studies that met all criteria, 26 of which gave numeric measurements of defect size.

RESULTS: Twelve studies (n=1030) gave defect size ranges for percent loss of glenoid width (54.7% had a bony defect, 24.0% of the total sample size had a defect >20%, 9.3% had a defect >25%). Five studies (n=376) gave defect size ranges for percent loss of glenoid area (69.9% had a bony defect, 10.1% of the total sample size had a defect >20%, 4.5% had a defect >25%). Twelve studies involved a treatment, nine reported outcomes with respect to defect size; there was a trend towards worse outcomes in shoulders with larger preoperative defects. From 1981-2000, 5.6% (1 of 18) of the studies reported numeric measurements of glenoid defect size. From 2001-2012, 54.3% (25 of 46) of the studies reported numeric measurements of glenoid defect size.

CONCLUSIONS: (1) In studies measuring percent loss of glenoid width, 24.0% had defects >20%. In studies measuring percent loss of glenoid area, 10.1% had defects >20%. (2) There was a trend towards worse outcomes in shoulders with larger preoperative defects. (3) The incidence of reporting numeric glenoid measurements of glenoid defect size is only 54.3% since 2000. (4) There is significant variability in the way bone loss is measured and calculated. Some studies used intraoperative measurements, others used radiographs, and others used CT. Additionally, some studies reported percent loss of glenoid width, others percent loss of glenoid area, and others percent loss of glenoid circumference. (5) Moving forward, we recommend improved reporting of numeric measurements of glenoid defect size as well as more uniformity in how these defects are measured and what outcome measures are used to evaluate treatment.

Patterns of Injury Among Collegiate Wrestlers at an Elite Division I NCAA Wrestling Program: An Epidemiological Study

Abstract ID: Poster 041

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BACKGROUND: Wrestling is a physically demanding sport in which injury is common. More than 6,000 athletes compete in the sport at the NCAA level every year. Despite the magnitude of these numbers, little is known about the epidemiology of these injuries and the factors that influence return to competition.

PURPOSE: To describe the patterns of injury and associated factors, in addition to surgical treatment and its effect on return to participation in one Division I NCAA wrestling program over nine seasons (2001-2011).

STUDY DESIGN: Descriptive epidemiology study.

RESULTS: From 2002 to 2011, 125 wrestlers were varsity participants at a single NCAA Division I institution (University of Iowa). We identified 1,034 musculoskeletal injuries, skin injuries, and concussions in 120 athletes (96% of participants). Eighty-two percent of athletes missed at least a single day secondary to these injuries, while 69% were unable to complete in at least one match. The average number of exposures per year was calculated at 4,275 for all athletes. The injury rate was estimated at 19.6 (SD 16.5) per 1,000 exposures. The rate of injuries reqiuring surgery was estimated to be 1.4 (SD 2.1) per 1,000 exposures. Weight class, competition record, age at injury, and eligibility status did not have a significant effect on the rate or type of injury. A significant difference was noted, however, in those athletes who returned to competition following surgery, showing athletes that returned ultimately competed in more matches (62.4 vs. 18.2, $p<=0,0001$), had more total wins (45.2 vs. 12.1, $p<0.0001$), and a higher win loss percentage (67.5 vs. 51.2 $p>0.01$) than those who did not return following their intervention.

CONCLUSION: Return to competition following surgical intervention is dependent on many factors in addition to the severity of injury and surgery type, and wrestlers, coaches, and physicians should be aware of these data and their implications.

Variability of Brachial Artery Position with Elbow Flexion and Forearm Rotation

Abstract ID: Poster 042

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INTRODUCTION: Injury to the brachial artery (BA) is a rare but potentially devastating complication of elbow arthroscopy. Despite this known risk, a paucity of data exists regarding the anatomic course of the BA in this area. The goal of this study was to define the location of the BA at the elbow and determine its variability with elbow flexion and forearm rotation.

METHODS: Three fresh-frozen cadaveric elbows were obtained. The BA was identified at the most proximal segment of the specimen and injected with barium contrast. Anteroposterior (AP) and lateral fluoroscopic images were then obtained with the elbow placed in maximum extension, 90° of flexion, and maximum flexion. Images with the forearm in maximum supination, neutral rotation, and maximum pronation were obtained at each elbow flexion position. Digital imaging software was then used to identify the BA and measure its vector distance to the coronoid fossa on lateral views and to the medial epicondyle on lateral and AP views. Elbow flexion angle was also measured radiographically for each position. Relationships were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using ANOVA with alpha=0.05.

RESULTS: The distance between the BA and medial epicondyle on lateral views demonstrated a very strong positive correlation (r=0.91) with elbow flexion. The distance between the BA and the coronoid fossa on lateral views demonstrated a similarly strong positive correlation (r=0.61) with elbow flexion. On lateral views, the mean distance between BA and medial epicondyle was 32.4 mm at the 90° elbow flexion position, 22.7 mm at maximum extension, and 38.8 mm at maximum flexion. These differences were statistically significant ($p<0.01$). The mean distance between BA and medial epicondyle was 31.5 mm in neutral forearms, 30.2 mm in pronated, and 32.2 in supinated. These differences were not statistically significant ($p=0.85$). On lateral views, the mean distance between BA and coronoid fossa was 24.6 mm at the 90° elbow flexion position, 18.4 mm at maximum extension, and 26.9 mm at maximum flexion. These differences were statistically significant ($p<0.01$). The mean distance between BA and coronoid fossa was 22.2 mm in neutral forearms, 22.1 mm in pronated, and 25.5 mm in supinated. These differences were not statistically significant ($p=0.39$). On AP views, the mean distance between BA and medial epicondyle was 11.2 mm at the 90° elbow flexion position, 21.9 mm at maximum extension, and 5.6 mm at maximum flexion. These differences were statistically significant ($p=0.01$). The mean distance between BA and medial epicondyle was 13.6 mm in neutral forearms, 6.6 mm in pronated, and 23.6 mm in supinated. These differences were also statistically significant ($p=0.01$).

DISCUSSION AND CONCLUSION: The location of the BA at the elbow varies with the degree of elbow flexion and forearm rotation. Elbow flexion increased the distance to the medial epicondyle on both lateral and AP views and the distance to the coronoid fossa on lateral views. Both flexion and supination increased the distance to the medial epicondyle on AP

views. This suggests that utilization of an anteromedial portal during elbow arthroscopy is safest in regards to BA injury with the elbow flexed and the forearm supinated.

The Functional Movement Screen as a Predictor of Injury in Professional Basketball Players

Abstract ID: Poster 043

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INTRODUCTION: The Functional Movement Screen (FMS) is designed to detect deficits and asymmetries in the movement patterns of athletes that predispose them to injury. This tool has been found to be predictive of injury in select populations including firefighters and professional football players, but has not been studied in professional basketball players. We hypothesized that injured players would have lower FMS scores than uninjured players, and that an FMS score of 14 would be predictive of injury in this population.

METHODS: Pre-season FMS testing was performed on all members of a single team in the National Basketball Association (NBA) over the course of four seasons. Injury was defined as a musculoskeletal condition that prevented an athlete from participating in practices or games for at least one week. The data was retrospectively analyzed to determine the ability of the FMS to accurately predict time lost due to injury over the course of a season.

RESULTS: A total of 34 players met inclusion criteria, including 17 injured (INJ) and 17 non-injured (NOINJ) subjects. The mean FMS score for all subjects was 13.2 (range: 7-19; SD=2.6). The INJ group mean was 13.8 (SD=2.3); the NOINJ group mean was 12.6 (SD=2.7). The independent t-test did not demonstrate a significant difference between FMS means for injured and uninjured groups ($p=0.164$). Indeed, the injured group had a higher FMS mean score than the non-injured group. Of the seven tests that comprise the FMS, only the hurdle test score showed a significant correlation with future injury, and this was a positive correlation with a higher score predicting injury ($p=0.004$).

CONCLUSION: While the Functional Movement Screen is a valuable tool for identifying deficits and asymmetries of movement in some athletic activities, it is not predictive of injury in male professional basketball players.

SPINE

Reduction in Deep Surgical Site Infections After Implementation of a Multimodal Infection Control Protocol for Pediatric Instrumented Spine Surgeries

Abstract ID: Poster 044

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INTRODUCTION: Deep surgical site infections (SSI) are a potentially severe and disastrous complication in pediatric spine surgeries and are often associated with patient morbidity and increased cost. In an effort to reduce SSI in pediatric instrumented spine surgeries, a multimodal infection control protocol was implemented. The purpose of this study was to evaluate SSI before and after the implementation of the multimodal infection control protocol.

METHODS: An IRB approved retrospective chart review at a single institution identified 356 pediatric instrumented surgical spine cases from 2008 to 2011. Exclusion criteria included subjects greater than 18 years of age, history of previous infections, or infections related to index surgeries outside the study period. The multimodal prevention protocol implemented included preoperative skin cleansing with chlorhexidine sponge, standardized antibiotic administration, elimination of razors in the operating room, and standardized chlorhexidine surgical site preparation. The protocol was fully implemented in June 2009. SSI was defined as any deep tissue infection requiring hospital readmission for subsequent surgery or intravenous antibiotic administration. Only infections presenting within one year after the index spine surgery were used to calculate SSI rates; however, all infections that presented during the study period were reviewed. Statistics were used to analyze the data.

RESULTS: SSI rate decreased 43% after implementation of the multimodal protocol, from 3.9% (5/127) to 2.2% (5/229). Decreases in SSI rates after implementation were seen in both idiopathic (1.6% to 0%) and non-idiopathic instrumented spine surgery cases (8.9% to 5.1%), but increased in traumatic cases (0% to 5.9%). Although not typical, the cost of a single infection to the institution was as high as $400,000.

CONCLUSION: Implementation of a multimodal infection control protocol reduced SSI in pediatric instrumented surgical spine cases at a single institution. The changes made were systematic and achieved without extensive monetary expenditures. Patient safety and cost savings associated with preventing even a single infection were tremendous.

The Effect of Common Arm Positions Used for X-ray Measurements of Sagittal Alignment on the Gravity Line: Which Position Most Resembles the Anatomic Position?

Abstract ID: Poster 045

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BACKGROUND: Arm position is critical for the identification of landmarks and the measurement of sagittal alignment. Sagittal alignment is traditionally measured using the C7 plumb line and scoliosis films. The “gravity line”, an orthogonal line taken from the center of pressure of a force plate has been described as a more accurate reflection global balance. While it has previously been suggested that the clavicle position is optimal for obtaining radiographs, little is known how various arm positions reflect normal resting posture and influence the gravity line.

PURPOSE: Compare the gravity line (GL) for different standing scoliosis film protocols to provide recommendations to obtain radiographs that accurately reflect resting posture.

METHODS: Prospective case-control (Type II): The GL is represented by the sum of ground reaction forces as measured on a consumer level force plate (Wii Balance Board). Group 1: 23 non-scoliotic (age=28±3; BMI=23±5) and Group 2: 92 scoliosis (age=59±1; BMI= 28±7) were subject to 10 second stance protocol on a force plate. The subjects were asked to stand with their knees locked in extension, and the arms placed in: (1) neutral (N) position (arms resting on the sides of the body); (2) supported (S) (hands supported on the wall); (3) clavicle (C) (PIP joints on top of the clavicle). The GL was calculated for each position (using custom software designed in LabView) as average of the values collected during the pose, and compared with repeat measures ANOVA; mean (95% CI).

RESULTS: In group 1, the GL was significantly shifted forward in the clavicle position (C) when compared to (S) and (N) (-1.78 cm [-0.92 to -2.63] vs. -2.87 [-2.01 to -3.73] and -2.39 [-1.53 to -3.24], p=0.016). Similarly, in group 2, the GL was significantly shifted forward in the clavicle position (C) when compared to (N) and (S) (-2.81cm [-2.38 to -3.24] vs. -3.18 [-2.76 to -3.61] and -3.74 [-3.31 to -4.16], p<0.0001). In the wall-supported position (S), the GL was significantly shifted backwards when compared to (N) (p<0.0001). The sway path length was significantly shorter with the supported (S) position in both group 1 and group 2 (p<0.0001).

CONCLUSIONS: While the clavicle pose may provide optimal radiographic visualization of the spine, this pose shifts the GL anteriorly to the normal position, while the arm supported pose shifts the GL posteriorly to the normal position. These differences could affect measurements causing up to 6 cm difference in the SVA. Surgeons should be aware of these positional differences and consider them in their pre- and postoperative evaluation of radiographs.

Treatment of Neuromuscular Scoliosis with Universal Clamp Fixation

Abstract ID: Poster 046

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PURPOSE: Treatment of neuromuscular scoliosis has utilized many types of fixation to attach rods to the spine including hooks, screws, and wires. Universal clamps are a sublaminar implant that provides similar correction power to pedicle screws, but can be used like a luque wire. A significant advantage is the greater surface areas of bony contact. It can be extremely useful in salvage situations or in patients with osteopenic bone. The wide polyester band can be attached with a stainless steel or metal clamp.

METHODS: We reviewed our Pediatric Spinal Deformity Database. Twenty patients, 12 males and 8 females, ages 3 to 28 (median 13) underwent 21 procedures with implantation of universal clamps. Seventeen have neuromuscular scoliosis and three have syndromic scoliosis.

RESULTS: When used in combination with other implants, they were most commonly used at the thoracolumbar junction (11 at T10 and T11, 12 at T12, 16 at L1, and 10 at L2). In salvage procedures, they were most often used at the proximal thoracic region (8 at T1, 5 at T2, 7 at T3, and 6 at T4). Different constructs were used including Luque-Galveston fixation (11), a hybrid construct (4), all pedicle screw constructs (4), and one in which only universal clamps were used. Fifteen of the cases were primary posterior spinal fusions, but two were anterior/posterior procedures, two were growing rod procedures, and two were revision procedures. The median surgical time was 6 hours and 13 minutes, ranging from 4 hours and 20 minutes to 8 hours and 40 minutes. No neurologic deficits were noted postoperatively. Median curve correction was 65.4% of the preoperative curve, ranging from 37% to 89%.

CONCLUSION: Universal clamps are a useful addition to the set of implants available to correct spinal deformity. They have a wide sublaminar surface area, which is useful in osteopenic bone. They are also an excellent alternative for situations in which the pedicle is not an option for fixation. They can be used in patients with a metal allergy who are better served with sublaminar fixation.

SIGNIFICANCE: In a patient with a poor bone quality, an unusually stiff curve, or failure of previous fixation, this study demonstrates a successful alternative method of fixation.

True Length of the Spine in Patients with Idiopathic Scoliosis

Abstract ID: Poster 047

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INTRODUCTION: In patients with scoliosis, total body height is diminished as a result of the curved spine. We developed a formula to calculate the true spinal length in patients with idiopathic scoliosis (IS). The aim of the study was to calculate the length of the curved spine and compare it with the length directly measured on radiographs.

METHODS: Postero-anterior long film standing radiographs of the spine of consecutive patients with IS were reviewed. The Cobb angle (α) and the direct distance between the upper end vertebra and the lower end vertebra (h) for each structural and compensatory curves were measured. The length of each curve (c) was calculated in our computer program using the formula: $c=\alpha h/2\sin\alpha/2$. For each curve, the calculated length was compared to the length of the curvature measured on the radiograph with an electronic ruler. Paired t-test, and Pearson's linear correlation were used.

RESULTS: Forty-one patients (128 curves) were analyzed. There were 35 females and 6 males, in the mean age of 13.5 years (10-17.5 years). The mean Cobb angle for all the curves was 38° (8-75°). There were 80 curves with Cobb angle ≥30° and 48 with Cobb angle <30°. The mean calculated and mean measured length of the scoliotic curve was 132 mm (54 – 242 mm) and 135 mm (54 – 246 mm) respectively. The mean difference between these lengths was 2.4 mm (99% confidence interval: 1.6–3.3 mm) and was statistically significant ($p<0.0001$). There was strong correlation between the calculated and measured lengths of the curves (Pearson's linear correlation coefficient: 0.99). The mean difference between the calculated and measured lengths of the curves for the curves with Cobb angle >30° was 3.5 mm (2.7–4.4 mm) and 0.6 mm (0.1–1.22 mm) for the curves with Cobb angle <30°. The differences were statistically significant ($p=0.002$ and $p<0.001$, respectively) with strong correlation (Pearson's correlation coefficient: 0.99 and 0.99).

CONCLUSIONS: The method of calculating the length of the curve using the Cobb angle seems to be simple and accurate. Only one additional parameter measured on the radiograph is needed (the linear distance between upper and lower end vertebra). The statistically significant differences between the calculated and directly measured lengths of the curves are not clinically relevant, because the total body height is measured with accuracy of at least 5 mm. The strong linear correlation between the methods supports the accuracy of our method in all Cobb angle ranges tested.

Pediatric Pancreatitis After Scoliosis Surgery

Abstract ID: Poster 048

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PURPOSE: The purpose of this study is to highlight the incidence of pancreatitis in pediatric patients undergoing spinal surgery for scoliosis, and to evaluate our experience with this well-known problem.

METHODS: A prospectively collected, Institutional Review Board approved Pediatric Orthopedic Spine database (1992-2012) was reviewed to identify patients who were diagnosed with pancreatitis after undergoing spinal surgery for scoliosis. Additional evaluation of the relevant notes was performed to ensure accurate diagnosis of pancreatitis by fulfillment of the Atlanta criteria (typical abdominal pain, amylase/lipase >3 times the upper limit of normal, confirmatory findings on cross-sectional abdominal imaging). The incidence, timing of presentation, demographics, primary and secondary diagnoses, curve magnitude, and laboratory studies were included in this study.

RESULTS: Out of 1,005 patients (age range 1-21 years, 295 male, 710 female), who underwent a primary procedure for scoliosis (mean Cobb angle of 61°, range 25° -137°), there were 6 confirmed cases of pancreatitis in 3 males and 3 females (age range 8-15 years). Their mean preoperative Cobb angle was 76° (range 34° -103°). Three of these patients had neuromuscular scoliosis associated with cerebral palsy, one associated with Retts syndrome, one with muscular dystrophy, and one female with severe adolescent idiopathic scoliosis. Of 45 patients who had removal of instrumentation after scoliosis surgery, one 17-year-old male with Wolf-Hirschman syndrome and infected metal had confirmed pancreatitis. Two of the patients were readmitted with pancreatitis after discharge home post their spinal procedure. The earliest presentation was postoperative day 5, and all were diagnosed by day 10. Supportive management was required for all, with no further surgical intervention. No patient who underwent a revision procedure had pancreatitis.

CONCLUSION: Acute pancreatitis in children is increasing, and is attributable to multifactorial etiologies. While the incidence is low in our patient group who underwent spinal surgery for scoliosis, it is higher than in the pediatric population as a whole, and must, therefore, be a consideration in assessing any child after scoliosis surgery who presents with abdominal pain.

Increasing Hospital Charges for Adolescent Idiopathic Scoliosis in the United States

Abstract ID: Poster 049

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BACKGROUND: Hospital charges and utilization rates for adult spine surgery have far outpaced inflation and population growth. However, trends adolescent idiopathic scoliosis (AIS) fusions have not been well investigated.

METHODS: We used ICD-9 billing codes to query the Kid's Inpatient Database (KID), and identified 24,505 AIS fusion cases from 1997-2009. Data was trended over time, and contrasted against adult spinal surgeries, closed pinning of supracondylar humerus fractures, and pediatric medical admissions for pneumonia. In order to identify specific drivers of charges, we queried 40 AIS cases from our own hospital's billing system from 2003-2012, and categorized the charge data. Dollar amounts were adjusted for inflation to 2009 dollars.

RESULTS: National utilization rates for AIS fusions have remained constant over time, whereas utilization of adult spinal procedures increased three fold over the study period ($p<0.001$). There was a decided shift towards posterior only procedures, with an 80% decrease in the utilization of anterior thoracic fusions ($p<0.0001$). Mean hospital charges for AIS spinal fusions increased from $49,901 in 1997 to $144,800 in 2009, a 190% increase, averaging 15.8% annually ($p<0.0001$). Mean charges for adult spinal procedures increased at a similar rate (13.4% annually, $p<0.0001$). In contrast, hospital charges for the other non-spine conditions increased to a lesser degree (range of 7%-9.1% annually, $p<0.001$ for each). At our own institution, spinal implant charges increased 24% annually, while surgeon charges decreased 0.5% annually, and all other charges increased only 7.5% annually. Over time, our surgeons used greater numbers of pedicle screws, fewer hooks, and greater total numbers of implants per surgery and per level fused ($p<0.05$ for each). Surgeon charges accounted for 30% of the total hospital bill in 2003, but this fell to 14.5% in 2012. Implant charges were 27.6% of the total hospital bill in 2003, but rose to account for 53% in 2012.

CONCLUSIONS: While utilization rates for AIS fusions have remained constant over time, hospital charges have increased substantively, and there has been a shift towards performing posterior only surgeries. This corresponds to the widespread adoption of posterior based pedicle screw constructs. A review of our own financial records, and comparison of the trends against other common conditions, indicates that spinal implant charges may be the primary driver of increased hospital charges. Policies directed towards implant cost-savings may, thus, have the largest impact while further cuts to the already declining physician reimbursement may be less efficacious.

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Comparison of S2-Alar Iliac Screw and Iliac Bone Pelvic Fixation in the Reconstruction of Adult Spine Deformities

Abstract ID: Poster 050

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INTRODUCTION: One classic technique to achieve pelvic fixation is to insert an iliac bolt starting at the posterior superior iliac spine. Because of difficulties related to this technique, the S2-alar iliac (S2-AI) screw technique was adopted. These screws do cross the sacroiliac (SI) joint, though, potentially resulting in joint damage, loosening, and pain. We compared the incidences of SI joint changes, loosening, screw-related pain, and failure of fixation in patients with S2-AI screws and patients with iliac bolts.

METHODS: Twenty-eight patients who had S2-AI screws placed as part of a long fusion were retrospectively compared to 32 patients with iliac bolts. Radiographs were assessed at 6 weeks, 3, 6, and 12 months and then at least annually thereafter for loosening around the pelvic screws, erosions or sclerosis of the SI joints, or failure of the lumbopelvic fixation. The time to development of these changes was recorded. Patients who required removal of their pelvic implants due to SI joint pain were also noted.

RESULTS: The average follow-up for the S2-AI group was 33 +/- 6 months compared to 45 +/- 15 months for the iliac bolt group. In the S2-AI group, 8 patients (28%) developed screw lucencies an average of 17 months postoperatively, compared with 4 patients in the bolt group (12%) an average of 18 months postoperatively (p=0.19). SI joint changes were seen in 8 patients in the S2-AI group (28%) compared with 6 in the bolt group (19%) (p=0.54). However, these occurred an average of 12.5 months postoperatively in the S2-AI group, compared with 27.5 months in the bolt group (p=0.04). Three patients in the S2-AI group had removal of their pelvic screws due to pain compared to 2 in the iliac bolt group. Finally, 2 patients had failure of their lumbopelvic fusion in the S2-AI group (7%) compared to 9 in the bolt group (28%) (p=0.05).

CONCLUSION: S2-AI screws have similar rates of SI joint changes, lucencies, and incidences of screw removal due to pain compared to iliac bolts, but with a lower rate of construct failure. However, the changes in the SI joint occur significantly quicker with S2-AI screws, perhaps due to SI joint penetration. Longer follow-up may reveal that this leads to greater incidences of SI joint pain.

Thoracic Volume Modeling in Adolescent Idiopathic Scoliosis: The Effect of Increasing Cobb Angle and Sagittal Contour on Pulmonary Function

Abstract ID: Poster 051

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BACKGROUND: Scoliosis has been shown to have detrimental effects on pulmonary function, traditionally measured by pulmonary function tests (PFTs), which is theorized to be correlated to the distortion of the spine and thorax, but has not been quantified.

PURPOSE: To define the effect of sagittal contour and Cobb angle on thoracic volume in patients with adolescent idiopathic scoliosis using computer modeling to obtain volume measurements from two-dimensional radiographs.

STUDY DESIGN: Retrospective modeling reconstructions of thoracic volumes from coronal and sagittal radiographs.

METHODS: Images were obtained from adolescents with idiopathic scoliosis enrolled in a multicenter database (PPSS) with Lenke type 1 curves with increasing coronal Cobb angles and with neutral and hypokyphotic sagittal alignment, measured by sagittal profile T5-T12. Blender 2.63a™ software was used to construct a three-dimensional computational model of the spine from two-dimensional radiographs. Validation of this technique has shown differences of thoracic volumes between CT and this method to have a maximum error of 3.8% and a mean error of 2.4%.

RESULTS: There was moderate inverse correlation between Cobb angle and thoracic volume in samples with neutral sagittal contour ($r = -0.629$) and a weak inverse correlation in the samples with hypokyphotic sagittal contour ($r = -0.458$). A weak inverse correlation was also noted between the sagittal angle and thoracic volume in the neutral and hypokyphotic groups ($r = -0.490$, $r = -0.436$). Significance of these correlations may be verified with larger sample sizes.

CONCLUSIONS: Despite a small sample size, a weak to moderate negative correlation between Cobb angle and thoracic volume was observed in samples with hypokyphotic and neutral sagittal contour respectively. Additionally, a weak inverse correlation was also noted between the sagittal angle and thoracic volume in the neutral and hypokyphotic groups. This provides pilot data suggesting the expected correlations.

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Plate Fixation in Cervical Spine: Paramedian Screw Configuration Compared to Unilateral Configuration

Abstract ID: Poster 052

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OBJECTIVE: This study compared the fixing strength and stability achieved by a unilateral plate screw configuration against a standard cervical fixation plate, using a single-level corpectomy and allograft strut graft model.

METHODS: Multidirectional in vitro flexibility tests were performed using a robotic spine testing system. Human cadaveric spines were assessed for spinal stability after vertebral corpectomy and anterior instrumentation. Specimens were mounted cranially and caudally on custom jigs which were then attached to load cells on the robotic system's end effector and base pedestal. C2-T1 spine specimens (n=6) were tested intact and then following C5 corpectomy (vertebral body was excised), allograft placement, and anterior plate fixation. The surgeons performed a uniform corpectomy and reconstruction of each specimen in a protocol fashion.

Two plates were compared: a unilateral four-hole cervical plate designed to obtain rigid fixation using four convergent fixation screws all placed unilateral to the vertebral midline and standard cervical plate with bilateral plate screw configuration. The plate testing sequence was selected at random to limit bias. Fixation screws were matched for length and diameter.

Pure moments were applied under load control (maximum 1.8 Nm) in flexion, extension, left/right lateral bending (LB), and left/right axial rotation (AR). Vertebral motion was measured using an optoelectronic system. Mean relative range of motion (ROM) between C4 and C6 was compared among groups using repeated measures Analysis of Variance (significance level of 0.05).

RESULTS: In comparing the intact construct and two different plates in all planes of motions, only motion in extension (intact vs. unilateral plate, p=0.003; intact vs. standard plate, p=0.001) and left axial rotation (intact vs. unilateral plate, p=0.019) were significantly affected. In terms of immediate cervical stability after one-level corpectomy and placement of an allograft reconstruction, the unilateral plate showed comparable stiffness to standard plate in all three motion planes (flexion [p=0.993], extension [p=0.732], Left LB [p=0.683], Right LB [p=0.546], Left AR [p=0.082], and Right AR [p=0.489]). The unilateral plate showed a trend towards improved stiffness in axial rotation. In no direction did the unilateral configuration prove significantly less stiff than the traditional configuration.

CONCLUSION: A unilateral plate design proposed here requires minimal dissection and retraction beyond the midline of tissues susceptible to scar, postoperative pain and swelling. Our study suggests that a unilateral plate can be configured to provide comparable fixation strength and torsional stiffness compared to traditional, widely accepted plate designs.

Perioperative Outcomes in Patients with and without Workers' Compensation Claim Treated with Spinal Fusion

Abstract ID: Poster 053

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INTRODUCTION: Workers' Compensation (WC) status has been shown to correlate with worse long-term outcomes after spinal fusion procedures. Perioperative results in WC population have not been well analyzed. The purpose of this study was to evaluate perioperative outcomes for WC and non-workers' compensation (NWC) patients, when matched for age and gender.

METHODS: The National Hospital Discharge Survey (NHDS) database was searched using International Classification of Diseases - Ninth Revision (ICD-9) codes for patients admitted to U.S. hospitals for spinal fusion between 2001 and 2010. ICD-9 codes were then used to analyze patient demographics, hospital length of stay (LOS), in-hospital adverse events (deep vein thrombosis [DVT], pulmonary embolus [PE], blood transfusion, mortality), and discharge disposition. To match study groups, age was limited to patients between the ages of 25-45 in both groups and women were excluded from both groups (as most WC patients were men). Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test and z-test for proportions with a significance level of 0.05.

RESULTS: 807 WC spinal fusion patients and 2,967 NWC spinal fusion patients were identified. The WC group had a mean patient age of 38.2 years vs. 38.5 years in NWC group ($p=0.095$). The average hospital LOS was insignificantly shorter for WC (3.4 days vs. 3.6 days, $p=0.085$). The DVT rate was significantly lower for WC patients (0.0% vs. 0.24%, $p=0.0081$). However, no significant difference was noted between WC and NWC in regards to rate of PE (0.12% vs. 0.10%, $p=0.87$) or blood transfusion (1.5% vs. 2.0%, $p=0.28$). Mortality rate was significantly lower in the WC group (0.0% vs. 0.24%, $p=0.0081$). The rate of discharge to home was insignificantly higher in the WC group (94.0% vs. 92.4%, $p=0.09$). The rate of fusion for WC and NWC groups both demonstrated negative correlations with time, $r=0.92$ versus $r=0.67$, respectively. WC accounted for 23.4% of the spinal fusions performed between 2001-2005 and significantly decreased to 18.1% between 2006-2010 ($p<0.001$).

CONCLUSIONS: Compared to NWC patients, WC patients have similar LOS and are just as likely to be discharged to home. WC patients are less likely to suffer a DVT or to die while hospitalized. This study suggests that origin of inferior long-term results in WC patients after spinal fusion is not related to the immediate postoperative period.

National Trends in Utilization of Kyphoplasty and Vertebroplasty

Abstract ID: Poster 054

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INTRODUCTION: Vertebroplasty and kyphoplasty are both common procedures used to treat vertebral compression fractures. Controversy currently exists regarding which procedure is preferable, although several recent studies have demonstrated improved results with kyphoplasty. The purpose of this study was to assess recent national trends in vertebroplasty and kyphoplasty and to evaluate perioperative outcomes for each.

METHODS: The National Hospital Discharge Survey (NHDS) database was searched using International Classification of Diseases - Ninth Revision (ICD-9) codes for patients admitted for vertebroplasty or kyphoplasty between years 2005-2010. ICD-9 codes were then used to analyze patient demographics, hospital length of stay (LOS), in-hospital adverse events (deep vein thrombosis [DVT], pulmonary embolus [PE], mortality, blood transfusion), and discharge disposition. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test and z-test for proportions with a significance level of 0.05.

RESULTS: 513 patients who underwent vertebroplasty and 1,619 patients who underwent kyphoplasty were identified. The vertebroplasty group had a mean patient age of 76.0 years and included 122 men and 391 women. The kyphoplasty group had a mean patient age that was insignificantly higher of 76.3 years ($p=0.4$) and included 457 men and 1,162 women. Men significantly accounted for more kyphoplasty (28.2% vs. 23.8%, $p=0.042$). The average LOS was significantly longer for vertebroplasty (7.1 days vs. 5.0 days, $p<0.01$). The DVT rate was significantly lower for vertebroplasty (0.19% vs. 0.99%, $p=0.011$). However, no significant difference was noted between vertebroplasty and kyphoplasty in regards to rate of PE (0.39% vs. 0.19%, $p=0.49$), mortality (0.60% vs. 0.87%, $p=0.52$), or blood transfusion (3.3% vs. 1.8%, $p=0.08$). The rate of discharge to a rehabilitation facility was significantly higher in the vertebroplasty group (38.8% vs. 26.9%, $p<.01$). The rate of vertebroplasty demonstrated a strong positive correlation with time ($r=0.58$). Vertebroplasty was utilized in 19.4% of the operatively treated compression fractures (combined total number of vertebroplasties and kyphoplasties) between 2005-2007 and increased to 25.5% between 2008-2010 ($p<0.01$).

CONCLUSIONS: Compared to vertebroplasty, this study demonstrates that kyphoplasty is associated with shorter hospitalizations and a decreased need for postoperative rehabilitation. Despite these improved perioperative outcomes, the use of vertebroplasty appears to be rising, although there are still more kyphoplasties being performed in the U.S. overall. The reasons for these changes are unclear, but it may be related to the availability of interventional radiologists.

Correlation Between the Type of Implant and Its Sagittal Position After Anterior Cervical Corpectomy

Abstract ID: Poster 055

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INTRODUCTION: Anterior cervical corpectomy and fusion (ACCF) is frequently performed in the setting of spondylotic spinal cord compression. There are no reports in the literature describing how the type of interbody device used affects its placement in the corpectomy defect. The purpose of this study is to evaluate the postoperative sagittal placement of three commonly used implants in ACCF.

METHODS: All consecutive patients who underwent ACCF at our institution were analyzed. Interbody used included allograft, titanium mesh cage (TMC), or polyetheretherketone (PEEK) cage. True lateral cervical spine radiographs were used for measurements. The position of the implant/graft was measured by the center of the implant's footprint on each endplate (of superior and inferior vertebrae) as a percentage of the entire endplate, anterior to posterior. ANOVA was used to analyze differences in sagittal position among implant/graft type on each endplate and paired-t test was used in order to compare symmetric placement of implant/graft on superior and inferior endplate. $P < 0.05$ was considered significant.

RESULTS: Seventy-four patients met our inclusion criteria, 27% had allograft, 43% had TMC, and 30% had PEEK cage. The mean age at the time of surgery was 56 +/- 12 years, and 49% of patients were male. All attending surgeons (N=3) stated that their preoperative plan included placement of all implant graft in a central sagittal position on both endplates (center of the implant footprint at 50% [midpoint] of AP endplate dimension at both inferior and superior vertebrae). Results of the measurements revealed that sagittal position did not differ among allograft, TMC, and PEEK on the superior vertebrae with mean placement of 38.6%, 38.0%, and 38.4% respectively (p=0.966). On the inferior vertebrae, sagittal position differed among implant type with allograft being placed more anteriorly than PEEK with mean placement of 36.1% vs. 46.3%, respectively (p=0.018). Also, the center of the implant's footprint on the endplate of superior vertebrae compared to the endplate on inferior vertebrae differed significantly for PEEK cage's with mean placement of 38.7% and 46.3%, respectively (p=0.006).

CONCLUSION: Despite surgeon's intention, allografts were placed more anterior when compared to PEEK cages on the endplate of inferior vertebrae while PEEK cages were placed asymmetrically with the cage being placed more anteriorly on the superior than the inferior vertebrae. Surgeons should take these findings into consideration.

Effects of Sequential Unilateral Facetectomy on Cervical Spinal Stability

Abstract ID: Poster 056

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IINTRODUCTION: Previous classic cadaveric studies have concluded that instability of the cervical spine occurs after a complete laminectomy and resection of more than 50% of the bilateral capsule or of the bilateral facet joints at one cervical spinal level. No cadaveric biomechanical study has ever looked into the effects of unilateral sequential facet resection without a full laminectomy. This study is the first multidirectional in vitro flexibility test on human cadaveric spines to assess spinal stability after unilateral sequential facet resection.

METHODS: Human cadaveric C2-T1 specimens (n=7) were tested intact and then underwent a right sequential unilateral facetectomy at the C6–C7 level. The width of the facet joint was measured using a digitizing probe and then, sequential resection was made as a percentage of the facet width (25%, 50%, 75%, and 100%). The following loading conditions were applied using a robotic spine testing system: applied moments (2.0 Nm) were used to simulate flexion-extension (FE), lateral bending (LB), and axial rotation (AR). In addition, a constant vertical load of 40N was used to simulate head weight. Vertebral motion was measured using an optoelectronic system. Mean relative range of motion (ROM) was compared among groups using repeated measures analysis of variance at a significance level of 0.05. Post-hoc Tukey-Kramer analysis ($p<0.05$ considered statistically significant) was used for multiple comparisons between groups.

RESULTS: When comparing the ROM in FE, we found no statistically significant change in motion following sequential right unilateral facet resection (25%, 50%, 75%, and 100%) when compared to intact. In LB, only the complete unilateral facet resection (100%) resulted in a significant increase in motion of 8% ($p=0.005$) when compared to intact. In AR, there was a significant increase in motion following 75% (motion increase: 18.5%, $p=0.03$) and 100% (motion increase: 33.8%, $p<0.001$) facet resection respectively. A graphical representation of the change in ROM with respect to (wrt) intact ROM is shown in Figure 1 for each stage of facetectomy.

Figure 1: Relative Change in ROM wrt to Intact for 25%, 50%, 75%, and 100% facetectomy

CONCLUSION: The cervical spine under FE motion is not significantly affected by unilateral facet resection. However, significantly higher cervical spine mobility can occur following unilateral facet resection of 75% and above in LB and AR. Our findings suggest that unilateral facet resections are not as destabilizing to the cervical spine as are bilateral facetectomies, and up to 75% of unilateral facet resection did not bring any instability to the spinal segment in any plane of motion.

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Comparison of Subsidence Rates Between Large and Small Footprint Cages in Anterior Cervical Interbody Fusion

Abstract ID: Poster 057

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SUMMARY: In a retrospective comparative radiographic review of 68 patients (132 levels), use of large footprint cages seem to protect cervical fusion segments from subsidence compared to small footprint cages.

INTRODUCTION: Subsidence rates of different types of cages have been described. There is wide variation in reported rates from 0-56%. The aim of this study was to compare the subsidence rate between small and large footprint cages. The secondary is to determine if a correlation exists between subsidence and health outcome scores.

METHODS: We reviewed 132 levels (68 cases) of ACDF using small (14x11, 14x12, 12.5x11.5 mm) and large (15x13, 16x14, 18x16 mm) footprint polyetheretherketone (PEEK) cages. The Small Footprint Group (SFG) had 79 levels (45 cases) and the Large Footprint Group (LFG) had 53 levels (24 cases). Immediate postoperative and six-month lateral cervical radiographs were evaluated for subsidence by measuring the anterior disc height (ADH) and posterior disc height (PDH) at each level. Subsidence was defined as a decrease >1 mm on either the ADH or PDH. Neck Disability Index (NDI) was used to assess health outcomes. Chi-square was used to test for significance between the SFG and LFG (α=0.05). T-test was used to test for significance in NDI between the subsidence (SG) and non-subsidence group (NSG) (α=0.05).

RESULTS: There was a statistically significant difference between the subsidence rate of the SFG (54%; 43/79) and LFG (34%; 18/53) (p=0.02). Overall mean subsidence was 0.9 ± 1.0 mm (range: 0-4.2) anteriorly and 1.0 ±1.1 mm (range: 0-4.4) posteriorly. There is a decreasing trend of subsidence rate when larger cages are used (Figure 1). Mean NDI improvement was 16 (from 51 to 35; average follow-up: 13 months) for the NSG and 9 (from 51 to 42; average follow-up: 13 months) for the SG (p=0.23).

CONCLUSION: Use of large footprint cage seems to lower the subsidence rate. However, it is unclear whether this radiographic finding translates to clinical significance.

Click here to view Figure

Lumbar Spine Posterior Subcutaneous Fat Thickness: Correlation with Body Mass Index

Abstract ID: Poster 058

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PURPOSE: Patients with higher BMIs generally have a thicker subcutaneous layer that may increase the need for retraction and the duration of the procedure. Obesity as determined by body mass index (BMI) of greater than 30 has been correlated with increased risk of perioperative complications. However, BMI is crude, not accounting for body mass distribution. Subcutaneous fat thickness is a stronger risk factor for surgical site infection (SSI) than BMI. The purpose of this study was to provide normative data between BMI and subcutaneous fat thickness in the posterior lumbar spine.

METHODS: 983 adult (≥20 years old) chest/abdomen/pelvis CTs from our morphomics registry (10/2001-9/2011) were analyzed using a custom MATLAB script. The distance from the spinous processes of T12 to L5 directly posterior to the skin at the midline were automatically measured. These measures were compared with BMI, obtained at the time of the CT scan, and a linear regression with prediction intervals was determined for each level (T12-L5) and gender.

RESULTS: Data presented as mean (±standard deviation). 392 (39.5%) females, 591 (60.5%) males. Mean age (years) was 44.9 (±18.0) for females, 45.3 (±17.4) for males. Mean BMI was 27.7 (±7.9) for females, 25.9 (±7.0) for males. Mean fat thickness (mm) was 26.2 (±14.6) at T12, 24.4 (±14.6) at L1, 25.7 (±15.3) at L2, 31.4 (±18.1) at L3, 38.4 (±19.3) at L4, and 42.2 (±19.1) at L5. Fat thickness was moderately correlated with BMI for the entire population (r^2=0.37–0.41, $p<0.001$). Females (r^2=0.46–0.57, $p<0.001$) and males (r^2=0.44–0.53, $p<0.001$) had similar correlations. Using a linear regression model, each additional unit of BMI was associated with an increase in fat thickness from approximately 1.5 to nearly 2.0 mm depending on the level, with the magnitude of this association in order from highest to lowest for L4, L5, L3, T12, L2, and L1 (all $p<0.001$).

CONCLUSION: Posterior midline lumbar spine fat thickness and BMI are moderately correlated. However, the range of subcutaneous fat thickness for a specific BMI can be quite large. The lower lumbar subcutaneous fat thickness had a higher association with BMI than did the upper levels. Subcutaneous fat thickness is a strong risk factor for SSI in lumbar spine procedures, and targeted therapy towards this risk factor may be more economical in decreasing morbidity and costs associated with SSI than BMI.

Obstacles to Early Mobilization After Spinal Fusion and Effect on Hospital Length of Stay

Abstract ID: Poster 059

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BACKGROUND: Recovery after spinal fusion continues to be refined through better multidisciplinary care. Various recovery protocols exist, all which incorporate and emphasize early and immediate postoperative mobilization. Mobilizing patients on the day of surgery is thought to improve functional recovery of range of motion and reduce hospital length of stay (LOS).

METHODS: All patients undergoing elective primary or revision spinal fusion between August 2010 and June 2011 within a four-hospital health system were retrospectively reviewed. Patients evaluated by physical therapy (PT) the day of surgery were included in the study analysis. Ambulation was attempted the day of surgery with PT, with or without the use of assistive devices. If a distance of at least 30 feet was not reached, a questionnaire indicating the reason(s) was completed. Distance ambulated on the day of surgery, obstacles impeding ambulating 30 feet, and LOS were recorded. Patients reaching the in-patient unit after 1500 hours were excluded.

RESULTS: Seventy percent of patients (320/457) successfully ambulated at least 30 feet on the date of surgery. Forty-seven patients were not evaluated secondary to personnel related factors. A total of 85 patients ambulated under 30 feet, citing most commonly: orthostasis/hypotension 29.4% (25/85), drowsiness 25.9% (22/85), nausea (23.5%), pain (17.6%), drowsiness (15%), fatigue (8.2%), and pain (10%), as limiting reasons. The average LOS of patients ambulating at least 30 feet the day of surgery was 1.85 days vs. 2.79 days in those ambulating less ($p<0.05$).

CONCLUSION: The benefits of early postoperative mobilization are well recognized and this study highlights major obstacles limiting early ambulation after spinal fusion. Focusing continued multidisciplinary efforts towards such factors as postoperative hypotension, nausea, drowsiness, and pain after elective spinal fusion may further improve our development of rapid recovery programs. Furthermore, ambulating a distance of at least 30 feet the day of surgery correlates with a statistically significant shorter LOS.

Stand Alone Anterior Lumbar Interbody Fusion for Degenerative Disc Disease of the Lumbar Spine: Results with a Two-Year Follow-Up

Abstract ID: Poster 060

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BACKGROUND: Multiple methods of lumbar fusion have been performed to treat low back pain associated with degenerative disc disease; several of which are associated with significant surgical morbidity and cost. The purpose of this study was to report the radiographic, clinical, and functional outcomes of a consecutive series of patients diagnosed with single or bi-level degenerative disc disease between L4 and S1 treated with stand alone anterior lumbar interbody fusion (ALIF) (either one or two-level) and use of recombinant human bone morphogenetic protein (rhBMP-2) for bony fusion with instrumented fixation. These results were compared to published data for 360° fusion and total disc replacement (TDR).

METHODS: The patient population included 67 females and 46 males (mean age: 43±10 years) at a single spine center who underwent a 1- or 2-level lumbar spine fusion, utilizing stand alone ALIF. Sixty-nine percent (n=76) had one level fusions and 31% (n=33) had two level fusions. Surgical data collected included blood loss, operative time, total length of hospital stay, and complications. Preoperative Oswestry Disability Index (ODI) and visual analog scale (VAS) scores were compared to postoperative scores at two years' time. Preoperative and postoperative radiographs, at minimum of two years' time, were compared using Image Scope 7.0 to evaluate for bony fusion and maintenance of disc height (both fused level and adjacent segment). Data were analyzed using Multivariate Analysis of Variance (MANOVAs) and t-tests.

RESULTS: Patients' two-year postoperative disc height was significantly greater at the fused level than the preoperative disc height ($p<0.0001$); there was no significant difference between pre- and postoperative disc height at the level adjacent to fusion. Patients' two year ODI and VAS scores significantly improved from pre-surgery ($p<0.0001$). Moreover, intraoperative time was significantly less with ALIF (65 minutes for single level, 90 minutes for bi-level) than 360o fusions (229 minutes) and TDR (121 minutes). Estimated blood loss was significantly less ($p<0.0001$) with ALIF (49mL for single level, 51mL for bi-level) than 360° fusions (465mL) and TDR (204mL). Hospital stay was also significantly shorter ($p<0.0001$), 2.5 days for single level, 2.9 days for bi-level, than 360° fusions (4.4 days) and TDR (3.5 days).

CONCLUSIONS: Patients treated with stand alone ALIF have decreased pain and improved quality of life; as measured with VAS and ODI when compared to the 360° fusion and TDR. Furthermore, at two years' time, no significant loss of disc height was noted at the adjacent level.

A Granulomatous Mass Surrounding a Maverick Total Disc Replacement Causing Iliac Vein Occlusion and Spinal Stenosis: A Five-Year Follow-Up

Abstract ID: Poster 061

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PURPOSE: To evaluate the long-term progression of a granulomatous mass resulting from a host response secondary to metal on metal total disc arthroplasty.

INTRODUCTION: Degenerative lumbar disc disease is a well-known cause of back pain. Definitive operative treatment for discogenic disease leading to low back pain is primarily with interbody arthrodesis. Due to some potential downfalls with this form of treatment, there has been an impetus to develop other potential surgical options to manage low back pain secondary to discogenic disease. In 2004, total disc replacement became a treatment option for the painful degenerative lumbar disc in the United States. This option does not come without potential complications; studies have shown that there can be a granulomatous response to metallic wear debris in prosthetic joints. Additionally, there has been a published case report showing the development of a granulomatous mass at the level of a total disc prosthesis three years following implantation resulting in symptomatic spinal stenosis and iliac vein occlusion.

METHODS: Single patient case report of a female who initially presented to our institution at the age of 35 with symptomatic spinal stenosis and iliac vein occlusion with resultant deep venous thrombosis (DVT) linked to a granulomatous mass at the level of a total disc arthroplasty. Acute management was to treat the spinal stenosis, which involved debulking of the posterior extension of the mass, posterior spinal decompression, and arthrodesis. The anterior extension of the mass was not addressed due to concern for vascular compromise. The iliac vein occlusion and subsequent DVT was treated pharmacologically and with an IVC filter. The patient was followed for the first 18 months with close clinical and ultrasound follow-up. At the five-year point, the progression of the granulomatous mass was evaluated with a CT myelogram.

RESULTS: Pathologic tissue evaluation in this patient was consistent with a granuloma and metal wear particles, leading to the determination that the mass was the result of metallic wear debris generated by the total disc replacement. Initial surveillance over an 18-month course was performed with serial ultrasound examinations, which did not show significant progression of the mass. Five years after initial presentation, the patient returned with an acute exacerbation of lower extremity pain and weakness. Advanced imaging, including an MRI and a CT myelogram were obtained, showing arachnoiditis, with no evidence of mass effect from the granulomatous mass. Furthermore, the myelogram showed that anterior extension of the mass that was not addressed on initial presentation had decreased in size.

CONCLUSION: In this case, a granulomatous mass resulting from a host response secondary to metal on metal total disc arthroplasty led to symptomatic spinal stenosis and iliac vein occlusion. The primary concern in this case was surveillance of the mass after the initial course of management to monitor its progression. Both CT and MRI are limited by metal induced artifact and are not practical for routine screening. The results five years after management with posterior decompression and arthrodesis showed no progression of the granulomatous mass; this finding reveals that the arthrodesis prevented motion at the level of the prosthetic disc, thus,

preventing further metallic wear debris. Therefore, removing the inciting source can not only prevent the enlargement of a granulomatous mass, but can also result in its decrease of size over time.

Biomechanical Evaluation of Thoracic Spine Stability Following a Simulated T9 Burst Fracture

Abstract ID: Poster 062

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BACKGROUND CONTEXT: The thoracic spine is unique due to the sternocostovertebral articulations and musculature that provide additional strength and stability. Treatment of burst fractures involves stabilization of the unstable site. A well-accepted construct is posterior instrumentation three vertebral levels above and two vertebral levels below the injury due to its structural stability. Short segment fixation in the treatment of thoracolumbar burst fractures with no ventral column support has shown to lead to kyphosis and implant failure. Classical biomechanical models have involved thoracic spines disarticulated from the ribcage; however, the biomechanical influence of the rib cage on fracture stabilization and the use of short segment constructs for mid-thoracic fractures have yet to be investigated.

PURPOSE: Biomechanical evaluation of different fixation systems for stabilizing a burst fracture at T9 with an intact rib cage.

STUDY DESIGN: Human cadaveric biomechanical study.

PATIENT SAMPLE: A total of 8 human cadaveric spines, C7 – L1 with intact rib cage.

OUTCOME MEASURES: Range of motion (ROM) between T8 and T10.

METHODS: A robotic spine testing system (KUKA, Germany) was used for the flexibility test to apply continuous pure moment (±5 Nm) to simulate flexion-extension (FE), lateral bending (LB), and axial rotation (AR). Intersegmental rotations were measured using an optoelectronic system (Optotrak, Northern Digital Inc.). Flexibility tests were conducted first on intact specimens, and then sequentially repeated again after surgically induced fracture at T9 followed by placement of four construct patterns. The four construct patterns were sequentially tested in a non-destructive protocol, as follows: 3 above/2 below (3A/2B), 1 above/1 below (1A/1B), 1 above/1 below with vertebral body augmentation (1A/1B VA), and vertebral body augmentation only (VA). A repeated measures analysis of variance was used to compare the segmental range of motion (ROM) between surgical treatments (T8 - T10).

RESULTS: Mean ROM increased by 86%, 151%, and 31% in LB, FE, and AR respectively after fracture. In LB, there was significant reduction compared to intact, for all three instrumented construct patterns: 3A/2B (-92%, p=0.0004), 1A/1B (-63%, p=0.0132), and 1A/1B w/VA (-66%, p=0.0150). In FE, only 3A/2B showed a significant reduction in motion (-90%, p=0.0113). For AR, there was significant reduction for only three construct patterns: 3A/2B (-66%, p=0.0001), 1A/1B (-53%, p=0.0001), and 1A/1B w/VA (-51%, p=0.0002). In comparing between the four construct patterns, we found that statistically, only three construct patterns (3A/2B, 1A/1B, and 1A/1B w/VA) showed comparable stability in all three motion planes.

CONCLUSIONS: Our study showed that statistically, there is no significant difference in the stability of the three instrumented constructs tested (3A/2B, 1A/1B, 1A/1B w/VA) when the thoracic ribcage is intact. Fractures that might appear more grossly unstable when tested in the disarticulated spine, may be, significantly bolstered by the ribs and sternum. This may affect relative importance of segmental spinal instrumentation in restoring stability to the spine in clinical practice. Thus far, our findings would support that a shorter construct with or without vertebral augmentation can stabilize the spine to the extent that a longer construct would.

Biomechanical Stability of Uniplanar, Monoaxial, and Polyaxial Pedicle Screw Configurations in a Porcine Single-Level Lumbar Burst Fracture Model

Abstract ID: Poster 063

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INTRODUCTION: This study is a biomechanical assessment of the stability of several combinations of uniplanar, polyaxial, and monoaxial screws configured in a short-segment posterior instrumentation construct using a porcine L1 burst fracture model. For short-segment posterior fixation constructs, it is unknown which combination of these screws (MMMMMM, PPPPPP, PMPPPPMP, MMUPUPMM, PMUPUPMP) produces the best biomechanical stability in a single-level lumbar fracture model. The goal of this study is to determine which of these constructs will exhibit the greatest stiffness, based on the slope of the linear regression line of the force-displacement curves of each specimen.

MATERIALS AND METHODS: Twenty-five fresh-frozen thoracolumbar vertebrae were procured from mature pigs. They were then divided into 5 groups, thawed and the T14-L2 segments isolated. Each specimen was instrumented posteriorly as described above. The L1 vertebral body was then osteotomized anteriorly, simulating an L1 burst fracture. The spines were placed into a materials testing machine and stressed two degrees in axial rotation, flexion/extension, and lateral bending. Force and angular displacement were recorded.

RESULTS: All stiffness curves were linear throughout the tested movements, (average $r2=0.9914$). No failure of the fixation construct occurred in any specimen. Differences were considered significant when they were present in both right/left bending and in counterclockwise/clockwise torsion. Flexion/extension represent anatomically different movements, and were considered separately.

In torsional movement, the stiffness in the all-monoaxial control group was significantly greater than the PMUPUPMP group in both clockwise and counterclockwise directions ($p<0.034$). The PMPPPPMP group had greater stiffness than the PMUPUPMP and the MMUPUPMM group in both directions ($p<0.004$). There was no difference in stiffness when the all-monoaxial group was compared to the all-polyaxial group and when compared to the PMPPPPMP group.

In lateral bending, the all-monoaxial and all-polyaxial groups were not significantly different. The PMPPPPMP group was more stiff than the PMUPUPMP group ($p<0.022$).

In flexion/extension, the all-polyaxial and all-monoaxial groups showed no consistent differences. The PMPPPPMP group demonstrated greater stiffness than the MMUPUPMM group in both directions ($p<0.014$). In flexion, the PMPPPPMP group showed greater stiffness than both the PPPPPP and PMUPUPMP groups.

CONCLUSIONS: The results demonstrate that the use of uniplanar screws at the fractured level provides less stability in flexion/extension, rotation, and lateral bending than the use of polyaxial screws. Also, the addition of monoaxial screws above and below the fracture confers added stability.

30-Day Mortality After Single Level ACDF: Identification of Risk Factors and Emphasis on the Safety of Outpatient Procedures

Abstract ID: Poster 064

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BACKGROUND: Risk factors for complication after single-level anterior cervical discectomy and fusion (ACDF) remain poorly defined, and prior studies on the safety of outpatient procedures have been compromised by selection bias. Thus, the purpose of this study was to identify the incidence and risk factors for complication from a large prospectively collected database, with a separate emphasis on the safety of outpatient procedures.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) prospectively collects 30-day morbidity and mortality data from over 480 hospitals around the United States. We queried this database to identify cases of single-level elective ACDF. Univariate and multivariate analyses were used to identify risk factors for complication, and a propensity score model was used to create matched inpatient and outpatient cohorts.

RESULTS: Of 2,914 cases identified, 597 (20.5%) were treated as outpatients and 2,317 (79.5%) received inpatient treatment. The overall incidence of any systemic morbidity was 3.2% (Table 1). There were 5 mortalities (0.2%), 4 in the inpatient cohort and 1 in the outpatient cohort. The one outpatient mortality occurred in a patient with a difficult airway. Patient age over 65 years, BMI over 30 kg/m^2, ASA class of 3 or 4, current dialysis, current steroid use, recent sepsis, and operative times greater than 120 minutes were each independent risk factors for complication in the multivariate analysis (Table 2). After propensity score matching to control for comorbidities, there were no significant differences in complication rates between inpatients and outpatients, and outpatient treatment was not a risk factor for complication in the multivariate analysis.

CONCLUSIONS: Single-level elective ACDF had low complication rates, with no additional risk seen with outpatient as compared to inpatient procedures. It seems reasonable to consider inpatient admission for any patient with the risk factors identified here, particularly difficult airways. This information may be useful to surgeons when performing informed consents, for medical optimization, and for selecting patients most appropriate for outpatient treatment.

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TRAUMA

Negative Pressure Wound Therapy and the Financial Impact of Delay in Discharge for Self-Pay and Medicaid Patients

Abstract ID: Poster 065

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INTRODUCTION: Negative Pressure Wound Therapy (NPWT) is a beneficial adjunct for wound management across multiple specialties. Potential barriers for use in the Medicaid or self-funded population are the limited ability to have home therapy. This article reviews the financial consequences for unnecessary inpatient hospital days in these patient populations when they could otherwise be managed with home NPWT therapy.

METHODS: Upon IRB approval, a retrospective medical record and billing database review was done from January 2006 to December 2009 identifying patients that received NPWT at an academic level 1 trauma center. All NPWT was categorized according to medical service use, indication for use, length of therapy, and identification of patients that were only hospitalized because home NPWT was not available. The average daily charges for inpatient care were determined for those patients that were identified as having prolonged stays due to NPWT availability once it was indicated that NPWT was identified as the reason for delay in discharge. No statistical analysis was performed.

RESULTS: Twenty-five patients were identified that had prolonged inpatient hospital stays secondary to home NPWT availability. The average number of excess hospital days was 4.63, which translates into $148,375 of avoidable inpatient charges.

CONCLUSION: More efficient “charity” care programs and Medicaid exemption processes could lead to substantial healthcare savings in self-funded and Medicaid patients that require prolonged NPWT.

Clinical Outcomes of Use of a Constant Tension External Tissue Expander for Complex Wound Management

Abstract ID: Poster 066

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PURPOSE: The purpose of this study was to determine the clinical effectiveness of use of a constant tension external tissue expander to aid in complex wound management.

HYPOTHESIS: The tissue expander decreases the need for autograft soft tissue procedures in management of complex orthopedic wounds.

METHODS: A retrospective medical record review was performed to identify all patients that had the Dermaclose (Wound Care Technologies, Inc.) device used to aid in closure of complex wounds. Primary outcomes evaluated included wound type and size, dehiscence, and reoperation. Secondary outcomes included patient comorbidities including tobacco use that could affect wound healing potential.

RESULTS: Eleven patients with 12 wounds were identified that had the Dermaclose device used as part of their complex wound management. Wound types included 2 postoperative dehisced posterior elbow wounds, 1 infected open femur fracture wound dehiscence, 1 thigh wound, 2 lateral leg fasciotomy wounds, 2 infected open tibia fracture wounds, 1 postoperative medial tibial operative wound, 1 below knee amputation wound dehiscence, 1 above knee amputation wound dehiscence, and 1 open fibula fracture wound. Wound size varied from approximately 7.5 to 180 centimeters squared. Eight of the 12 (67%) wounds were closed primarily after the initial application of the Dermaclose device. One (8%) wound dehisced after delayed primary closure was obtained and accounted for one of the five wounds that required secondary procedures. Two of the five wounds require smaller split thickness skin grafts than anticipated after Dermaclose application. Four of the five wounds requiring secondary procedures had a history of infection. Three patients used tobacco and one patient had poor nutrition.

CONCLUSIONS: Constant external tissue expanders can be used successfully to either aid in delayed primary closure of complex wounds or decrease the size and type of soft tissue procedures required for wound healing.

Comparison of Free Composite Serratus Anterior Rib and Free Fibula Flaps for Acute One-Stage Reconstruction of Traumatic Gustilo IIIB and IIIC Injuries

Abstract ID: Poster 067

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INTRODUCTION: Many treatment modalities have been described to treat bone and soft tissue defects following high-energy trauma. Historically, the use of free vascularized fibular grafts, along with a separate free muscle transfer provided soft tissue coverage, as well as an osteoinductive and osteoconductive environment. Free composite serratus anterior rib flaps provide both a muscle for soft tissue coverage as well as a vascularized bone graft in a single procedure. The purpose of this study was to compare the use of free composite serratus anterior rib flaps to free fibula grafts with or without supplemental free muscle transfers for the treatment of severe open fractures with regards to postoperative complications, time to treatment, and union.

METHODS: We retrospectively reviewed the medical records of patients undergoing a free composite serratus anterior rib flap (n=5) or free fibula graft (n=8) for the treatment of a severe open fracture (Gustilo Type IIIB or IIIC) within 3 months of injury. Medical records were examined for the mechanism of injury (MOI), injury severity score (ISS), time from injury to free tissue transfer, medical comorbidities, surgical complications, and time to radiographic and clinical union. .

RESULTS: All the patients in the serratus anterior group were male, with an average age of 26 at the time of injury. Four patients sustained grade IIIB open tibia fractures; one patient sustained a grade IIIC open distal radius and ulna fracture. The MOI included motorcycle collisions (n=2), motor vehicle collisions (n=2), and pedestrian struck by car (n=1), with an average ISS of 17.6 (Table 1). On average, patients underwent free tissue transfer within 2 weeks from the time of injury, with radiographic and clinical union at 8 months. Three patients (60%) underwent a reoperation. At last follow-up, on average 17 months following surgery, there were no graft failures. In the free fibula group there was an even distribution of males (n=4) and females (n=4), with an average age of 28 years at the time of injury. Three patients sustained grade IIIB open tibia fractures, three patients sustained grade IIIB open femur fractures, one patient sustained a grade IIIC open distal radius and ulna fracture, and one patient sustained a grade IIIC open humerus fracture. The MOI included motor vehicle collisions (n=4), motorcycle collisions (n=2), gunshot wound (n=1), and ATV collision (n=1), with an average ISS of 18.6 (Table 1). On average, patients underwent free tissue transfer within 6 weeks from the time of injury, with radiographic and clinical union at 11 months. Seven patients (88%) underwent a reoperation. At last follow-up, on average 51 months following surgery, there were two graft failures (25%).

CONCLUSION: Free composite serratus anterior rib flaps can be successfully used to acutely treat high-energy traumatic fractures with associated soft tissue injury, result in fewer graft failures, and have a lower reoperation rate when compared to free fibula grafts.

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Intravenous Application of CD271-Selected Mesenchymal Stem Cells During Fracture Healing

Abstract ID: Poster 068

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INTRODUCTION: Cellular therapies have great appeal for treatment of fractures. Mesenchymal stem cells (MSC) are essential for fracture healing. Previous studies utilizing phenotypically modified MSC fail to produce bone in vivo. The ability to demonstrate unmodified MSC's ability to home to a fracture site when transplanted intravenously would improve our understanding of MSC and their ability to aid in bone formation for clinical applications.

PURPOSE: The purpose of this study was to (1) demonstrate migration kinetics of injected MSC in a mouse fracture model using undifferentiated MSC and (2) evaluate the viability of undifferentiated MSC obtained from medullary reamings, and demonstrate their fracture healing ability.

MATERIALS AND METHODS: Intramedullary reamings were under IRB approval. Undifferentiated (MSC) were isolated using the CD-271 marker and expanded in culture. Near infrared fluorescence (NIF) labeled MSC were suspended in solution. A standardized femur fracture model was created in immunodeficient nude mice and labeled MSC were injected into tail veins of study mice at various time post fracture: Group 1 injected day 1, Group 2 injected day 3, and Group 3 injected day 7 post-fracture. All mice underwent sequential NIF imaging of both femurs at 24 hours, 48 hours, and 7 days post injection. Mice were sacrificed at 3 weeks post injection, and histologic analysis completed.

RESULTS: When analyzed as a whole, significant migration of MSC was seen at 24 hours ($p=0.004$), and 7 days post injection ($p=0.013$). Individual groups were then analyzed at each time frame. Group 1 demonstrated significant MSC migration to the fracture site compared to its own control contralateral non-fractured femur that was maintained through all time points. $P=0.043$ at 24 and 48 hours, and $p=0.042$ at 7 days. For group 2 injections 3 days post fracture, significant difference was found at 24 hours ($p=0.043$), but not at 48 hours or 7 days ($p=0.5$ and $p=0.225$ respectively). No significant difference was found for group 3, injection 7 days after fracture ($p=0.18$ at 24 hours, $p=0.18$ at 48 hours). Cells of human origin were localized at the fracture site in mice.

CONCLUSION: This model demonstrates the ability to expand a population of unmodified MSC from an exogenous source, and use these cells to augment fracture healing. Migration of MSC can be identified through NIF techniques and temporal relationships regarding injection time relative to injury appears to be the crucial factor in terms of augmenting fracture callous.

Recent National Trends and Outcomes for Traumatic Hip Dislocation in the United States

Abstract ID: Poster 069

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INTRODUCTION: Traumatic hip dislocations (THD) are orthopedic emergencies. Although relatively rare in the United States, they can have devastating complications and associated injuries. The purpose of this study was to assess recent national trends in THD in the United States (U.S.) and to evaluate acute/same-admission outcomes for this injury group.

METHODS: International Classification of Disease - 9th Revision (ICD-9) diagnosis codes were used to search the National Hospital Discharge Survey (NHDS) for patients admitted to the surveyed U.S. hospitals with a THD for each year from 1997-2010. Data regarding patient demographics, month of injury, fracture, internal organ injury, neurovascular injury, hospitalization length, discharge disposition, blood transfusion, venous thrombosis (VT), pulmonary embolism (PE), and mortality were gathered from the NHDS. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using student's t-test and the z-test for proportions with a significance level of 0.05.

RESULTS: 233 patients admitted with THD were identified. There were 7.9 cases per 100,000 hospitals admission. This injury frequency remained stable from 2001-20010, showing no correlation with time (r=-0.08) over that interval. 28.8% of cases occurred in the summer months, 24.0% occurred in the fall, 23.6% occurred in the winter, and 23.6% occurred in the spring, but this seasonal variation was not statistically significant (p=0.62). Mean age of THD patients was 43.6 years (range 0.25-92). The group included 128 males and 105 females. 142 (60.9%) patients were identified as 'white' and 31 (15.3%) were identified as 'black'. Patient age, gender, and ethnicity remained stable across the years studied (p=0.24, p=0.90, and p=0.17, respectively). 73 (31.3%) THD patients had spine and/or trunk fractures, 21 (9.0%) had internal organ injuries, 20 (8.6%) had lower limb fractures, 13 (5.6%) had upper limb fractures, and 13 (5.6%) had skull fractures. 4 (1.7%) THD patients had associated peripheral nerve injuries and 1 (0.4%) had an associated peripheral vascular injury. 16 (6.9%) patients received a blood transfusion, 2 (1.7%) were diagnosed with VT, and 3 (1.3%) were diagnosed with PE. Average length of stay for THD was 6.2 days (range 1-53). Length of stay did not change with time (p=0.60). 153 (79.7%) patients went directly home after their inpatient stay and 39 (20.3%) required admission/transfer to a rehabilitation center or other skilled nursing facility. 2 (0.9%) patients died during their admission.

DISCUSSION AND CONCLUSION: The prevalence and pattern of THD has remained essentially stable over the past 10 years. In the U.S., it continues to occur most commonly in white middle-aged males. Although associated with relatively long hospitalization lengths, most THD patients can be discharged directly to home. Only 20% require additional post-admission facility care. The associated fracture frequency is high with THD, but neurovascular injuries are rare and few patients develop acute/same-admission complications such as VT, PE, or need for blood transfusion.

Radiographic Evidence of Femoroacetabular Impingement Increases the Risk of Traumatic Dislocation of the Hip

Abstract ID: Poster 070

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INTRODUCTION: Traumatic hip dislocation is most commonly the result of high-energy trauma. It is known that there are often associated acetabular and femoral head fractures. The objective of this study is to investigate the possible association between dislocation of native hips and radiographic evidence of femoroacetabular impingement (FAI) and/or concomitant acetabular or femoral head fracture.

METHODS: A retrospective review was performed on traumatic dislocations of native hips at an urban Level 1 trauma center between 2004-2013. Demographic data and associated injuries were recorded. Radiographs and computed tomography scans were reviewed and the following measures were recorded: lateral center edge angle (LCEA), Tőnnis angle, acetabular depth, caput callum diaphysis (CCD) angle, alpha angle, and femoral head-neck offset. These values were compared between patient groups and statistical comparisons performed with Student's t-test and the z-test for proportions with alpha=0.05.

RESULTS: We identified 118 patients with a diagnosis of hip dislocation. Twelve patients were excluded due to lack of true dislocation. Of the remaining 106 patients, 85 were men and 32 women, with an average age of 33 years (range: 8-78). Ninety-nine patients (93.4%) had associated acetabular or femoral head fracture.

Thirty-three percent of patients had radiographic crossover sign of the dislocated hip. Coxa profunda was seen in 43.7%, and no patients had protrusio. Seventy-two percent of patients had at least one radiographic marker for pincer-type FAI and 89% for CAM-type FAI. At least one radiographic marker for both pincer and CAM-type FAI was seen in 64%.

Mean LCEA in dislocated hips was 35.2° (range: 18.4-50.2°), mean Tőnnis angle was 4.9° (range: -7.7-17.7°), mean acetabular depth was 5.2 mm (range: 0-14.4 mm), and mean CCD angle was 135.5° (range: 117.2-159.9°). All of these measurements were within normal range and did not meet radiographic criteria for FAI ($p < 0.001$). Mean alpha angle was 55.1° (range: 37.7-95.4°), and femoral head-neck offset was 5.8 mm (range: 0-17.8 mm); these both met criteria for FAI ($p<0.001$).

No significant difference was seen on subgroup analysis regarding most radiographic measures. There was a significant difference in acetabular depth between dislocated and non-dislocated sides (5.2 and 3.5 mm, respectively) ($p < 0.001$). There was an increased alpha angle >50° in 61% of fracture-dislocations, but in only 37% of unfractured patients ($p<0.05$).

CONCLUSION: An association was seen between radiographic FAI and traumatic dislocation of a native hip in this series of patients. A large percentage of patients had at least one radiographic sign of pincer or CAM-type FAI. Dislocated patients had on average increased

alpha angles and smaller femoral head-neck offset. There was no significant difference between other radiographic measurements for FAI and historical controls. Subgroup analysis showed a similar trend, with a higher percentage of fracture-dislocations having an alpha angle >50°. When comparing dislocated vs. uninjured hips, the dislocated side had greater acetabular depth, but no statistically significant difference in other radiographic markers. These findings suggest an association between radiographic FAI and increased risk of traumatic hip dislocation and acetabular fracture. This study helps increase the body of knowledge regarding FAI and presents another pathologic result of this anatomic variant.

Level of Evidence: III

Time to Surgery for Definitive Fixation of Hip Fractures: A Look at Outcomes Based Upon Delay

Abstract ID: Poster 071

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BACKGROUND: Morbidity and mortality after hip fracture in the elderly is often influenced by non-modifiable comorbidities. Time-to-surgery is a modifiable factor that may play a role in postoperative morbidity. This study investigates outcomes and complications in elderly hip fracture surgery as a function of time-to-surgery.

METHODS: Using American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) 2011 data, a study population that includes demographics, comorbidities, and surgical outcomes was generated using CPT codes for hemiarthroplasty (27125), percutaneous or open fixation of femoral neck fractures (27235, 27236), and fixation with a screw and side plate or intramedullary fixation (27244, 27245) for peritrochanteric fractures. Triads (<24 hours to surgical intervention, 24 to 48 hours, and >48 hours) were randomly matched for surgery type, sex, age, and ASA class. Unadjusted and adjusted matched analyses of time-to-surgery effect on complications and outcome were performed via generalized linear models. Surgery-to-discharge time was modeled using unadjusted and adjusted clustered proportional hazards regression.

RESULTS: Study population: 2,904 hip fractures; and 968 matched triads waiting <24 hours to surgical intervention, 24 to 48 hours, and >48 hours were identified. Unadjusted models showed the >48 hour group had greater overall complication rate (18.8%) ($p=0.011$), length of stay (10.7days) ($p<0.001$), and had greater surgery-to-discharge time (hazard ratio, 95% Confidence Interval: 0.73, 0.67-0.79) ($p<0.001$). Early surgical intervention did not increase overall complication rate ($p=0.011$), readmission rates ($p=0.593$), or mortality ($p=0.316$). Adjusted analyses showed persistent trend toward increasing complications with increasing time-to-surgery (although no longer statistically significant, $p=0.595$), as well as increased total length of stay ($p<0.001$), and increased surgery-to-discharge time ($p<0.001$).

CONCLUSION: Early surgical intervention in a comorbidity-adjusted population of elderly hip fracture patients does not increase overall complications, readmissions, or 30-day mortality. Time-to-surgery >48 hours is associated with costly increased total length of stay and surgery-to-discharge time as well as a trend toward increased overall complication.

Combined Open Reduction and Internal Fixation of Ipsilateral Clavicle and Multiple Rib Fractures: Effects on Lung Volume

Abstract ID: Poster 072

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PURPOSE: Rib fractures as a result of trauma are common. Rib fracture stabilization has become an increasingly accepted practice for flail chest. Anecdotally, there have been reports of gross chest wall asymmetry in patients with clavicular fractures and multiple rib fractures. Our study will investigate the impact of surgical management for ipsilateral clavicle fracture and multiple rib stabilization on lung volume. We hypothesize that clavicle fixation in patients with clavicle fracture and multiple fixated rib fractures will result in improved lung volumes compared to patients treated non-operatively.

METHODS: A retrospective review of a prospectively collected database of patients with traumatic rib fractures and ipsilateral clavicular fractures who underwent open reduction and internal fixation of fractured ribs. Imaging studies were reviewed to assess lung volumes using ImageJ software. Conversion factors for left vs. right lung area and volumes were obtained after analysis of normal chest films.

RESULTS: Mean follow-up was 11 months, n=15, clavicle fixation n=4, non-operative n=11. There were no differences between the groups (clavicle fixation vs. nonoperative). Both groups showed similar improvement in lung volumes at postoperative assessment and at follow-up (p=.18). Patients who underwent clavicle fixation demonstrated a statistically significant change in lung volume at follow-up compared to at presentation (Mean delta=992 cm^3, p=0.007).

CONCLUSIONS: Operative management of clavicular fractures and concurrent rib fractures results in improved lung volumes radiographically. This improvement is not statistically different compared to non-operative clavicular fracture and surgical rib fracture management. Further investigation is needed.

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A Freely-Available Electronic Toolbox for Fracture Templating and Surgical Planning Using Microsoft PowerPoint™

Abstract ID: Poster 073

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BACKGROUND: Tracing of fracture fragments and the use of templates to plan fracture reduction and fixation has been popularized through the AO Trauma Group. Unfortunately, the ability to hand-trace x-ray films has become difficult as x-ray films have been largely replaced with digital imaging technology. Commercially-available software packages have emerged to template digital images, but they are expensive and they are limited by their inflexibility to manipulate fracture fragments as one would do in the OR or on tracing paper.

PURPOSE: We present a novel way to create comprehensive, digital surgical plans for orthopedic trauma using Microsoft PowerPoint™. We hypothesize that our electronic toolbox will prove to be an effective tool to aid resident education and adherence to basic principles of fracture fixation.

METHODS: Our electronic toolbox is drawn for use with Microsoft PowerPoint™. Digital AP and lateral x-rays of the fracture are imported into PowerPoint™. These x-rays can be from any PACS or a digital photo of a regular x-ray. Digitized versions of orthopedic implants are reliably sized to the x-ray with a simple PowerPoint™ manipulation. The user then traces the outlines of the fracture pieces. The underlying image of the x-ray is deleted, leaving the user with all the fracture pieces in outline. The pieces are then reduced using a reversed x-ray of the contralateral uninjured extremity or a sample film. Implants are selected and aligned. Each step of the process is stored on a separate slide to produce a step-by-step presentation. Twenty cases were templated, and the tactic was compared to postoperative x-rays to assess for accurate implant sizing. An example using an ankle fracture is demonstrated in the figure below.

RESULTS: This program was successfully used to produce a reliable step-by-step preoperative tactic that accurately approximates the size of used implants.

CONCLUSION: The electronic tool box and PowerPoint™ technique aids in the production of the AO preoperative tactic for digital x-ray images. It is easy to use and is available as freeware.

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Arthroscopically Assisted Fixation of Unicondylar Intra-Articular Tibial Plateau Fractures

Abstract ID: Poster 074

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BACKGROUND: Tibial plateau fractures requiring surgical treatment are severe injuries with potentially devastating consequences. Traditionally, these fractures were treated with open reduction and internal fixation. First reports that arthroscopy may be used as a tool in reduction and fixation of tibial plateau fractures were published in the 1980s. Few studies have described and reported on this technique in significant numbers since.

HYPOTHESIS: Arthroscopically assisted reduction of unicondylar intra-articular tibial plateau fractures with percutaneous fixation can be used safely without significant loss of reduction, minimal complications, limited operating time, and comparable outcomes to open approaches.

STUDY DESIGN: Case series; Level of evidence, 4

MATERIALS AND METHODS: A total of 25 patients consecutive (13 male and 12 female) with the average age of 46 who sustained a lateral split, split depression, or pure depression type tibial plateau fracture (Schatzker types I-III) and were offered arthroscopically assisted percutaneous fixation from 2009-2012 were followed for a minimum of 3 months (range 3 months-3 years). All procedures involved arthroscopic assistance of fracture reduction, percutaneous application of either crushed cancellous allograft or biocompatible calcium phosphate, and percutaneous screw fixation. Preoperative radiographs were compared to postoperative radiographs at a minimum of 3 months (range 3 months-2 years) for maintenance of reduction.

RESULTS: The average operative time was 95 minutes. The average number of screws used for fixation was 2 (range 1-4). The average initial depression measured on radiographs was 8 mm. The average postoperative residual depression was 0.9 mm (range 0-3 mm) based on radiographs at 3 months. Two of 26 patients required hardware removal.

CONCLUSION: Arthroscopically-assisted reduction of unicondylar intra-articular tibial plateau fractures with percutaneous fixation is a technique that can be used safely without significant loss of reduction, minimal complications, and limited operative time. Further study into objective patient outcomes is necessary to make adequate comparisons to open approaches.

Bilateral Tibial Shaft Fractures: A Multicenter Analysis
Abstract ID: Poster 075

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INTRODUCTION: Bilateral tibial shaft fractures represent high-energy trauma. While bilateral femur fractures and their treatment and complications are fairly well defined in the literature, there is limited coverage of bilateral tibia fractures. We present a multicenter study on bilateral tibial shaft fractures (BTF) and analyzed the systemic injuries and complications most commonly associated with these fractures.

METHODS: IRB approval was obtained at 3 Level 1 trauma centers. A retrospective review of medical records was performed to identify all BTF patients treated between 2004-2009. Demographics, injury measures, treatments, and complications were collected. Categories were evaluated and ranked based on frequency of occurrence. Descriptive statistics were completed.

RESULTS: There were approximately 1,500 tibial shaft fractures treated between 2004-2009 at the centers. Of these, we identified 68 BTF patients (19 females and 49 males) with sufficient records for inclusion. The average age was 39 years (range 15-83). There were 80 open fractures (59% of all tibias) in 55 patients (81% of patients). Twenty-five patients (37%) had bilateral open tibia fractures. The average ISS was 21 (range 4-50) with other musculoskeletal trauma being the most common associated injury (53 patients, 78%), followed by chest trauma (40 patients, 59%), facial trauma (27 patients, 40%), head trauma (26 patients, 38%), and abdominal trauma (26 patients, 38%). Large variability was found in units of blood transfused (average 4 units, range 0-37), days in ICU (6.5 days, range 0-50), and length of inpatient stay (20 days, range 3-89). Forty patients (60%) required mechanical ventilation during admission. Two patients (3%) were casted as definitive treatment, 67 patients (97%) were surgically treated for 129 tibias (95% of all fractures), and 4 patients (5%) required an amputation as initial treatment). Fourteen patients (21%) developed nonunions, 13 patients (19%) had compartment syndrome, and 34 patients (50%) were affected by delayed union, superficial wound infections, and other nonsurgical complications. Twenty-nine patients (43%) required subsequent surgery to promote healing on one or both limbs. There were 6 mortalities (9%).

CONCLUSION: This study includes the largest group of BTF patients reported in the existing literature. BTF patients demonstrated a high rate of open fractures, accompanying severe systemic injuries, and high rates of complications. Orthopedic surgeons must balance early surgical treatment with the presence of associated injuries. Patients need to be educated regarding the complications and possibility of subsequent surgeries to promote healing of these serious injuries.

Osteomyoplastic Amputations: Results in Trauma Patients

Abstract ID: Poster 076

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INTRODUCTION: Amputations in trauma patients remain a difficult endeavor. They are often associated with considerable morbidity and mortality. The Lower Extremity Assessment Project (LEAP) has shown that patient-perceived outcomes after limb salvage are similar to those after amputation. We examined our surgical results of osteomyoplastic amputations in our trauma patient population.

METHODS: We prospectively reviewed a cohort of patients that received amputations due to traumatic injuries from 2003-2011. Information gathered included: age, sex, amputation type (acute, delayed, and elective), injury, mechanism of injury, total number of surgeries, complications, final level of amputation, and prosthetic use. Acute amputations were defined as traumatic amputations or amputations performed at presentation. Delayed were defined as attempted limb salvage but conversion to amputation during original hospitalization. Elective were defined as a painful or non-functional lower extremity requiring revision amputation. Enrollees consented to complete Short Form-36 questionnaires at baseline and for at least 4 annual follow-up visits.

RESULTS: Records were found for 76: 55 males (72%) and 21 females (28%). Ages ranged from 5-77 years (mean of 36) with 15-24 accounting for 29%. Major trauma accounted for 75%, motor vehicle collision (34%), motorcycle collision (20%), and oil field (17%). Delayed amputation was the most common at 40%, followed by acute (35%), and elective (25%). No observed or statistical difference in the total number of procedures performed between acute (6.31) vs. delayed (7.41) ($p>0.9$). Final amputation level was transtibial in 67% and transfemoral in 23%. Complication rate requiring additional surgery was 50% for acute, 59% for delayed, and 35% for elective. There was no statistical significant difference among acute vs. delayed ($p>.26$). Wound complications were the most common complication (35%), wound infection/dehiscence (20%), and deep infection (15%). Short-form 36 outcomes were available for 31 patients. Patients reported an average of 35.47 in the Physical Component Summary (PCS) and 48.33 on the Mental Component Summary (MCS). All respondents are currently using a prosthetic.

CONCLUSION: Our surgical results were similar to the LEAP study. Surprisingly, our cohort seems completely emotionally adapted to their disability. Hopefully we can identify differences in our cohort and use them as education for our patients. Care of traumatic amputees continues to be a difficult task, one that is best performed as a team approach, including surgeon, prosthetist, and rehabilitation. Holistic approach must be taken to our patients, taking care to address both physical and mental aspects of their care.

Functional Outcomes After Both Bone Forearm Fractures in Adults

Abstract ID: Poster 077

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PURPOSE: The purpose of this study was to evaluate mid-term outcomes in adults after both bone forearm fractures (BBFF).

METHODS: A retrospective review was completed for patients from 18-75 years old who were treated with open reduction and internal fixation (ORIF) for a fracture of the radius and ulna at three Level 1 Trauma Centers. Exclusion criteria were ipsilateral humerus fractures and previous forearm fractures. Eligible patients were sent three questionnaires to complete - the Disabilities of the Arm, Shoulder, and Hand (DASH), Short Form-12 (SF-12), and questions about post-injury experience. Included was the statement, “The emotional problems caused by the injury have been more difficult than the physical problems” as a screening tool for PTSD. Any patients screening positive were offered information on psychological services. Chi square tests (or Fisher's exact test when appropriate) were used to analyze nominal level data. For continuous level data, t-tests were used.

RESULTS: Twenty-nine patients (15 males, 12 females) returned the materials. The average age was 44 years (range 18-63). The forms were completed an average of 60 months (range 14-145 months) after ORIF. The mean score on the DASH was 22 (range 0-88), which is higher than the national normative values reported suggesting increased disability. Women had higher DASH scores than men ($p<0.05$). Patients had mean SF-12 Mental Component Scores (MCS) of 51 (range 19-67) and Physical Component Scores (PCS) of 46 (range 20-58). This mean PCS is below the average range according to the norm-based scoring. Twenty-one subjects participated in PT (72%). Patients who participated in PT had higher scores on the DASH ($p<0.05$), and lower scores on the SF-12-PCS and SF-12 MCS ($p<0.05$) indicating increased disability and decreased subjective view of personal health. Eight patients (28%) screened positive for PTSD. This group consisted of four males and four females with an average age of 41 years and a mean DASH score of 34. The mean SF-12 PCS score was 39 and SF-12 MCS score was 40, both of which were lower than the non-PTSD group indicating a lower subjective level of health in this group ($p<0.05$).

CONCLUSIONS: Long after surgery, results demonstrate patients with BBFF have decreased functional outcomes. Our data suggest that patients have adequate access to PT and the opportunity to maximize their outcome. However, patients with these injuries may be at increased risk for PTSD and subsequently at risk for decreased level of subjective health.

Vertical Displacement in Lateral Compression Type 2 (LC-2) Pelvic Fractures

Abstract ID: Poster 078

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PURPOSE: Young and Burgess lateral compression type 2 (LC-2) pelvic fractures are classically described as rotationally unstable but vertically stable fracture patterns. The purpose of this study was to measure vertical displacement in a series of patients with LC-2 pelvic fractures.

METHODS: We reviewed a consecutive series of 48 patients with LC-2 pelvic fractures that presented to our institution over a 4-year period. Digital imaging of the pelvis at the time of presentation including computed tomography (CT) and plain films including an anteroposterior (AP), inlet, and outlet views were reviewed. Vertical displacement of the affected hemipelvis was measured by five techniques: (1) measuring displacement of the fracture fragment near the sacroiliac (SI) joint on the coronal CT scan images, (2) measuring displacement of the femoral head on the AP view, (3) measuring displacement of the femoral head on the outlet view, (4) measuring displacement of the iliac crest on the AP view, and (5) measuring displacement of the ischial tuberosity on the AP view.

RESULTS: The average vertical displacement of the affected hemipelvis measured on the CT scan was 3.9 mm (range 0-16.2 mm). 21 of 48 (43.8%) patients had no vertical displacement. 17 (35.4%) patients had greater than 5 mm of vertical displacement, and 4 (8.3%) patients had greater than 10 mm of vertical displacement. For non-displaced fractures on CT scan, measurement of vertical displacement on plain x-ray produced inconsistent results.

CONCLUSION: LC-2 fractures frequently demonstrate vertical displacement, contrary to the original description of this fracture pattern. Furthermore, measurement of vertical displacement by plain radiographs is often unreliable, and is best visualized on coronal CT scan images. The potential for vertical displacement and instability exists in LC-2 pelvic fractures, and surgical treatment should address both rotational and vertical instability.

HIP

Bonding Strength of Polycaprolactone/Polyvinyl Alcohol Nanofibers to the Titanium Implant Surface

Abstract ID: Poster 079

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INTRODUCTION: There is a clinical need for orthopedic implants with “bone-like” nanoscale topography that promote rapid osseointegration. The purpose of this study was to develop coaxial electrospun nanofibers (NFs) composed of polycaprolactone (PCL) and polyvinyl alcohol (PVA) polymers arranged in a sheath-core structure. The bonding strength of PCL/PVA NFs to the titanium (Ti) implant surface is described.

MATERIALS AND METHODS: Bone holes (diameter = 2.54 mm; depth = 15 mm) were made in the cadaveric porcine tibia. Ti rods coated with PCL/PVA NFs (diameter = 2.5 mm, length = 60 mm, and NF thickness = 50 µm) were inserted into the bone holes using an Instron device at the speed of 10 mm/min. Bones with Ti rods were incubated in PBS at 37°C for 2 or 7 days. The friction force (push in and pullout) and scanning electron microscopy (SEM) were used to measure bonding strength.

RESULTS AND DISCUSSION: The maximum friction force for insertion was 20 N. The force required to pull out the Ti rods from bone 2 days after incubation was 10 N. The NF coating remained intact on the surface of Ti rods after pullout. SEM images showed that the NF network matrix remained intact and distributed evenly on the Ti rod surface after pullout. Partial degradation of NFs (both in and out of bone holes) could be found 7 days after incubation in PBS at 37°C. Friction force applied (during insert and pullout) did not cause visible disruption, delamination, or folding of NFs along the Ti rod surface. There are few studies regarding the bonding strength of polymer NFs to the Ti surface. The mechanisms of the bonding strength of NFs to Ti surface observed are, in part, due to a hydrogen bonding between the crystalline degrees of PCL and TiO_2. The proven bonding strength of PCL/PVA NFs to the Ti surface may allow new bone ingrowths, forming a seamless matrix network between surrounding bone and Ti surface.

The Source Effect of Donor Site, Gender, and Age on Mesenchymal Stem Cells Obtained During Arthroplasty

Abstract ID: Poster 080

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INTRODUCTION: Mesenchymal Stem Cells (MSCs) may be harvested from multiple sources including bone, cartilage, and marrow. However, the influence of source gender, donor site, and age on MSCs is controversial. The purpose of this investigation is to compare the effect of donor site (hip vs. knee), gender, and age on the sample weight and amount of tissue digested in the preparation of MSCs obtained from discarded bone, cartilage, and marrow from the hip and knee.

METHODS: We prospectively harvested discarded bone, cartilage, and marrow obtained at the time of 5 female and 8 male primary total knee arthroplasties (TKAs) and 6 male and 6 female total hip arthroplasties (THAs). Bone was cleared of soft tissue, chipped, and ground under sterile conditions. The prepared bone was weighed and incubated for 1 hour in collagenase. The sample weight of raw bone, cartilage, and marrow was compared to the weight of material actually digested in the process of MSC preparation. The effect of donor site, gender, and age on sample weight and amount digested were compared with analysis of variance.

RESULTS: The mean sample weight and amount digested from female knees was 26.35g ± 6.88g and 24.19g ± 9.27g, respectively. The mean sample weight and amount digested from male knees was 32g ± 12.18g and 30.26g ± 11.32g, respectively. The mean sample weight and amount digested from female hips was 52.78g ± 8.54g and 49.13g ± 9.42g, respectively. The mean sample weight and amount digested from male hips was 77.5g ± 11.3g and 76.5h ± 13.4g, respectively. There was an interaction effect of both donor site and gender with significantly greater sample weight and amount digested for the hip vs. the knee ($p<0.001$). Hip and knee samples from males produced significantly greater ($p=0.002$) sample weight and amount digested ($p=0.001$). Male hips produced significantly higher sample weights and quantity of bone available for digest (interaction effect: $p=0.03$ for both outcomes) overall. There was no significant effect of age on donor site ($p=0.49$) or gender ($p=0.18$) with respect to age.

CONCLUSION: A greater quantity of bone, marrow, and cartilage is available from discarded tissue obtained during THA vs. TKA. Male donors produce the most material for MSC harvest with male hips yielding the greatest sample weight and amount available for digest overall. Age was not predictive of sample weight or amount of bone digested.

Surgical Hip Dislocation is a Versatile and Safe Approach for Diverse Hip Pathologies

Abstract ID: Poster 081

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INTRODUCTION: Surgical hip dislocation (SHD) is most commonly performed for treatment of femoroacetabular impingement (FAI). There are very few published studies reporting SHD as an approach to manage other intra- and peri-articular hip disorders. The purpose of this study is to describe our experience with SHD performed for non FAI-pathologies with special attention to recurrence of hip disease and complication rates.

METHODS: Thirty-five patients (35 hips) (19 female, 16 male) underwent SHD approach for non-FAI pathologies between October 2003 and January 2013 (out of a total number of 277 SHD). The average age at the time of surgery was 27.5 years (range, 11-53 years). Procedures were performed for synovial chondromatosis (n=8), pigmented villonodular synovitis (n=7), osteochondroma (n=5), fracture (n=5), osteonecrosis (n=4), tumors (n=3), enchondroma (n=2), and for removal of heterotopic bone associated with round ligament avulsion (n=1). Hips were evaluated at a mean follow-up of 1.8 years (range 0.2 to 7.8). Medical histories and radiographs were reviewed for characteristics of hip pain and range of motion, functional status, procedures performed and accessibility to hip structures, rehabilitation, trochanteric union, complications using the modified Dindo-Clavien classification of surgical complications (Sink et al) and recurrence of the disease.

RESULTS: SHD allowed access to all intra-articular hip pathology and near complete synovectomy when treating synovial disease. Complete exposure to periarticular structures and areas that are not accessible with less invasive techniques was possible (posterior wall and head fractures for fixation and removal of acetabular floor or femoral head and neck tumor lesions). There were no trochanteric nonunions or osteonecrosis associated with the procedure itself. According to the adapted classification system, there were 2 grade I, 1 grade II, 0 grade III, and 2 grade IV complications. Nine hips (25.7%) required hardware removal and three (8.5%) required conversion to total hip arthroplasty because of continued pain or recurrence of disease.

DISCUSSION AND CONCLUSION: SHD is a versatile and safe approach to treat multiple hip pathologies. It allows access not only to the hip joint itself, but also allows treatment of periacetabular and femoral head and neck lesions safely. Clinical results were satisfactory and the complication rate associated with the procedure itself was low. We recommend considering SHD in treatment of patients with hip pathology other than FAI that may not be amenable to treatment with less invasive techniques such as hip arthroscopy.

Combined Surgical Hip Dislocation and Proximal Femoral Osteotomy for Severe Hip Deformities

Abstract ID: Poster 082

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INTRODUCTION: In patients with severe proximal femoral deformities, the combined surgical hip dislocation (SHD) and proximal femoral osteotomy (PFO) can be performed to optimize deformity correction while also addressing intra-articular pathologies. There is a paucity of data regarding the details of this surgical technique and the clinical efficacy of the procedure. The purpose of this study was to analyze the early clinical and radiographic results of combined SHD/PFO in treating severe, complex proximal femoral deformities. Secondly, surgical technique details and refinement will be presented.

METHODS: Retrospective review of patients who underwent combined SHD and PFO was performed. Clinical data including patient demographics, radiographic measurements, and patient-rated outcome scores were collected.

RESULTS: 17 patients (17 hips) treated with a combined SHD/PFO were identified. Previous history of SCFE and complex FAI were the most common etiologies for the deformity (41.2%), Perthes-like deformity and acetabular dysplasia were prevalent in 24% of the patients, and two of the patients (12%) had avascular necrosis of the femoral head. There were 8 females and 9 males. The average age was 17.6 years (range, 11-31), BMI (22 kg/m^2), and average follow-up was 2.1 years. Conversion to total hip arthroplasty was performed in 2 patients (11.8%). In the remaining patients, the Harris Hip score improved significantly by 20.0 points (57.7 to 77.7, $p<0.05$). The UCLA score improved from 6.25 to 7.1 ($p=0.5$), and the WOMAC improved from 42.0 to 24.2 ($p=0.2$). Analysis of radiographs revealed no change in radiographic OA. The average neck-shaft angle was increased 135.17° to 139.7° ($p=0.2$). The trochanteric height improved from -14.4 mm to -6.1 mm ($p<0.05$). The head/neck offset ratio improved from -0.09 to 0.05 ($p<.05$). The frog lateral alpha angle (79.9° to 63.9°, $p<.05$) and the cross-table alpha angle (70.9° to 44.1°, $p<.05$) also improved.

DISCUSSION AND CONCLUSION: Treatment of severe hip deformities with combined SHD/PFO demonstrated consistent radiographic deformity correction with improved head/neck offset and height of the trochanter in relation to the femoral head. The clinical data indicates combined SHD/PFO is associated with improved hip function and improved outcome scores in most patients with an acceptable rate of conversion to total hip arthroplasty. Recent refinements in the technique have facilitated surgical precision.

Is There Variability in the Volume of the Hip Joint Capsule? Quantifications of Hip Capsular Volume Using a Novel Technique

Abstract ID: Poster 083

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INTRODUCTION: There is a growing body of evidence that the hip capsule has a role in stabilizing the hip joint, but the hip joint capsule has been poorly described. The purpose of this study is (1) to quantify the capsular volume in patients with hip pain and (2) to determine if there are demographic or morphologic factors that are associated with capsular volume.

METHODS: A retrospective chart review was performed from 2006 to 2012 of consecutive patients who presented to a single institution with hip pain. Inclusion criteria were patients with hip pain who had plain radiographs with Tönnis grade 0 or 1 with a magnetic resonance arthrogram (MRA). Demographic data were collected as well as radiographic data. A novel technique for the quantification of capsular volume was described using a reconstructed plane along the femoral neck axis with OsiriX software. A similar technique was used to measure the femoral head volume. A ratio of the capsular to femoral head volume was calculated. Associations were analyzed using an independent sample T-test with significance at $P < 0.05$.

RESULTS: Seventy-eight patients met study criteria with 25 males and 53 females. The mean age was 31.3 ± 9.2 years old with a mean BMI 28.5 ± 10.2. The mean alpha angle was 53.78 ± 10.67, Tönnis angle was 8.28 ± 5.23, and lateral center edge angle (LCEA) was 31.13 ± 5.59. The mean capsular volume, femoral head volume, and capsular:femoral head volumes ratio were 488.4 ± 169.01, 193.35 ± 56.63, and 2.57 ± 0.66, respectively.

There was no statistically significant association between gender, LCEA, Tönnis or alpha angle with capsular volume ($P = 0.149, 0.482, 0.866, 0.884$), or to capsular:femoral head volume ratio ($P = 0.227, 0.172, 0.143, 0.392$). There was a significant relationship between femoral head volume and gender ($p = 0.006$) with females having smaller head sizes. The intraclass correlation coefficient (ICC) for intra- and inter-observer reliability of the capsular volume measurements is 0.96 and 0.85, respectively.

CONCLUSION: We describe a reliable radiographic measurement for hip capsule volumes from MRAs. Neither demographic nor radiographic measurements are predictive of capsular volume size. There was a statistically significant difference between gender and femoral head volume, but no differences were observed with gender and capsular volume and capsular:femoral head volume ratio. There were no macroscopic anatomical differences evident on MRA. Future studies will be necessary to determine if there is variability in the biomechanical characteristics of the hip capsule.

Intermediate Term Results of the Bernese Periacetabular Osteotomy for the Treatment of Severe Acetabular Dysplasia

Abstract ID: Poster 084

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INTRODUCTION: The Bernese periacetabular osteotomy (PAO) has been shown to be effective to reduce or eliminate the symptoms for years or indefinitely for patients with symptomatic acetabular dysplasia. For those patients with severe acetabular dysplasia with subluxation of the femoral head or presence of secondary acetabulum, surgical realignment procedures remain controversial and the efficacy of acetabular reorientation has been questioned. The purpose of this study was to analyze the intermediate to long-term clinical and radiographic results of the PAO in the treatment of adolescent and young adult patients with symptomatic severe acetabular dysplasia.

METHODS: This is a retrospective review of patients who underwent a PAO for severe acetabular dysplasia as defined by patients having a Lateral Center Edge Angles less than 5°. Preoperatively, all patients had hip pain and sufficient hip joint congruency on radiographs to be considered candidates for the osteotomy. Clinical data including patient demographics, radiographic measurements, and patient-rated outcome scores (Harris Hip score) were collected.

RESULTS: The hip preservation database of one of the authors was queried and 23 patients (29 hips) were identified who had been treated with a PAO for severe acetabular dysplasia. There were 16 females and 7 males. The average age at the time of surgery was 19 years (range, 11-36), BMI (22 kg/m^2), and average follow-up was 79.8 months. Radiographic analysis demonstrated an average improvement of 39.8° (from -12.3° to 27.5°, $p < 0.001$) in the lateral center-edge angle, an average improvement of 41.9° (from -13.5° to 28.4°, $p<0.001$) in the anterior center-edge angle, and an average improvement of 26.6° (from 34.6° to 8.0°, $p<0.001$) in Tönnis angle. The hip center was translated medially an average of 8.7 mm (from 19.3 mm to 10.6 mm, $p<0.001$) and the extrusion index improved an average of 33.5 (from 51.2 to 17.7, $p<0.001$). The Harris Hip score improved 12.1 points (from 68.9 to 81.0, $p<0.01$). Conversion to total hip arthroplasty occurred in 2 patients (7%).

DISCUSSION AND CONCLUSION: The Bernese periacetabular osteotomy can be effective for the treatment of severe acetabular dysplasia. Our clinical and radiographic outcomes demonstrate improved hip function and major deformity correction, respectively. These data indicate that the mid- to long-term outcomes of the PAO in the treatment of severe acetabular dysplasia are favorable for the majority of patients.

Does Previous Hip Osteotomy Compromise Total Hip Arthroplasty Procedures and Outcomes? A Systematic Review
Abstract ID: Poster 085

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INTRODUCTION: The utilization of hip osteotomy surgery has increased over the past several years, yet the impact of these procedures on subsequent total hip arthroplasty (THA) continues to be debated. The purpose of this study was to perform a systematic review of the literature to determine the procedure complications, clinical results, and survivorship of THA following previous hip osteotomy.

METHODS: A comprehensive search of PubMed, Embase, Scopus, CINAHL, and CENTRAL was conducted. The inclusion criteria were: English language, minimum Level III evidence, and minimum two-year follow-up. The search strategy yielded 1,474 articles for review with ten studies meeting inclusion criteria.

RESULTS: Four articles involving THA after previous pelvic osteotomy were included. There was no significant difference between patients with previous pelvic osteotomy vs. those with a nonoperated hip in terms of clinical outcomes or survivorship (osteotomy 71.2-100% vs. control 80.4-100%). Furthermore, no differences in the accuracy of component placement or complications were identified. For patients undergoing THA after previous femoral osteotomy, six studies were included. Survival of the prosthesis was comparable between the control and study groups in three studies (90-100%), but lower for the study group in three (osteotomy 75-93.3% vs. control 89.9-100%). One study noted an increased dislocation and infection risk in the osteotomy group while another identified a higher fracture risk. A single study showed significantly different acetabular component abduction and anteversion angles between groups. Operative time and blood loss were significantly higher in the study groups when documented. However, no significant differences in outcome scores were noted.

DISCUSSION AND CONCLUSION: THA following previous pelvic osteotomy provides pain relief and improved function with similar complication rates, clinical outcomes, and survivorship compared to nonoperated hips undergoing THA. Results following previous femoral osteotomy are more variable, with some studies demonstrating increased procedure difficulty and complications, yet similar clinical outcome scores.

Multimodal Analgesia with Fascia Iliaca Blockade for Acute Pain Management Following Hip Arthroscopy

Abstract ID: Poster 086

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PURPOSE: The purpose of this study was to evaluate the utility of multimodal analgesia with fascia iliaca blockade (FIB) and for acute pain control in patients undergoing hip arthroscopy.

METHODS: Thirty consecutive patients undergoing primary hip arthroscopy were prospectively studied. All patients were treated preoperatively with ultrasound-guided single injection FIB and multimodal analgesia. Data collected included postoperative nausea, numeric rating scale (NRS) pain scores during rest and activity, opioid consumption during the first five days (recorded as tablets of 5 mg hydrocodone/500 mg acetaminophen), and overall patient satisfaction with analgesia.

RESULTS: This study included 23 female and 7 male patients with a mean age of 34 years (range 14-58). No patient required medication for postoperative nausea. The overall NRS scores were an average of 3.9 on postoperative day (POD) 0, 3.6 on POD 1, 3.4 on POD 2, 2.9 on POD 3, 3.0 on POD 4, and 2.7 on POD 5. The average tablets of opioid taken were 1.5 on POD 0, 1.2 on POD 1, 1.3 on POD 2, 1.0 on POD 3 and 4, and 0.9 on POD 5. Overall, 20 patients rated their postoperative pain control as very satisfied (67%), and 10 patients as satisfied (33%). There were no complications or side effects from the FIB.

CONCLUSION: In this prospective study, multimodal analgesia with FIB following hip arthroscopy was safe and effective. The quality of early postoperative analgesia provided by the FIB was excellent and resulted in low opioid consumption, high quality of pain relief, and high overall patient satisfaction.

Level of Evidence: Level II, prospective case series

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Avoidance of Femoral Neck Fractures After Hip Resurfacing in a High Risk Population

Abstract ID: Poster 087

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INTRODUCTION: The incidence of femoral neck fractures in females after hip resurfacing is 3-4%, and the majority occurs within the first year of surgery. Osteopenia and femoral head blood supply disruption may increase this risk. A specific surgical approach coupled with protected initial weight bearing and activity restrictions for one year postoperatively may help to avoid this complication without limiting hip function, even in females with osteopenia.

METHODS: A consecutive cohort from 2007 to 2008 of 78 (87 procedures, 9 staged bilateral) female patients that underwent hip resurfacing arthroplasty was reviewed retrospectively. Inclusion criteria for the study were: patients with history of osteopenia or osteoporosis; risk factors for osteoporosis without recent bone mineral density (BMD) or radiographic signs of osteopenia. Preoperative BMD of the femoral neck, demographics, body mass index (BMI), comorbidities, complications, postoperative hip, and pelvic radiographic studies and Harris Hip Scores (HHS) were collected for these patients. Procedures were performed using an anterolateral approach under spinal anesthesia. The postoperative rehabilitation regimen following by all patients included six weeks of protected weight-bearing followed by avoidance of running, jumping, heavy lifting, and strenuous exercise for one year.

RESULTS: Forty-two patients with risk of osteoporosis were identified. Average age was 53.4 years (range, 38-64) and BMI 29.4 (range, 18.0-43.2). Preoperative diagnoses included osteoarthritis (n=32, 76%), developmental dysplasia (n=8, 19%), rheumatoid arthritis (n=1, 2%), and osteonecrosis (n=1, 2%). Osteopenia in the femoral neck (T-score between -1.0 and -2.5) was diagnosed by BMD in 10 patients, but no osteoporosis was diagnosed. Femoral head component size was ≥ 46 mm in 40 (95%) and ≤ 44 mm in 2 (5%) procedures. Thirty-four patients (80.1%) had 24 months minimum follow-up (26.7±8.8 months). Preoperative HHS was 57.2±1.7, at 1 year 97.7±1.2 and at 2 years 98.3±0.7. There was no incidence of femoral neck fractures. Other complications included 1 acetabular component revision due to loosening at 24 months, 1 heterotopic bone formation treated conservatively, 1 superficial infection, and 1 deep vein thrombosis.

CONCLUSION: Hip resurfacing performed using an anterolateral approach, coupled with a cautious postoperative weight bearing and activity level, allows this procedure to be performed in females with low risk of femoral neck fractures at 2 years without limitation of hip function evidenced by HHS.

Using the Circle Theorem to Estimate Acetabular Version from a Single Anteroposterior Hip Radiograph

Abstract ID: Poster 088

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IINTRODUCTION: Position of the acetabular cup is a major factor in the range of motion and risk of dislocation after total hip arthroplasty. However, there is no well-established technique for accurately and easily estimating acetabular cup version intraoperatively or postoperatively. The objective of this study was to evaluate a recently proposed method for measuring acetabular cup version on a single plain radiograph of the hip, which is based on one of the circle theorems in basic geometry.

METHODS: Radiographic version is defined as the angle between the cup face plane and a plane perpendicular to the body coronal plane. Using this definition, a metal hemispheric cup was placed in a pelvic sawbone model at a series of known angles of radiographic version (based on direct goniometer measurement). Cup inclination, pelvic tilt, and pelvic rotation were held constant for all version angles. A single antero-posterior hip radiograph was then obtained and reviewed for each version angle. The acetabular cup version was next estimated by using a compass and protractor in accordance with the circle theorem. Statistical analysis was performed utilizing Student's t-test with an alpha=0.05.

RESULTS: Twenty known angles of version were evaluated: 11 anteverted angles, 7 retroverted angles, and 2 neutral angles. Mean difference between the circle theorem estimate and the true version was 0.90° (range -2° to 3°). There was no statistically significant difference between the circle theorem's estimates and the true version (p=0.84). Similarly, there was no significant difference between the anteverted estimates (mean difference 0.91) and the retroverted estimates (mean difference 0.86, p=0.95).

DISCUSSION AND CONCLUSION: Methods of measuring component position are essential for evaluating surgical technique, monitoring cup stability, and maximizing patient outcomes. Radiographic version of an acetabular cup can be estimated by using the circle theorem. This theorem can provide a quick, easy, and accurate estimate of version with the use of simple instruments (compass and protractor) and readily available plain radiographs.

An Analysis of the Accuracy of Radiographic Reference Markers for Digital Templating in Total Hip Arthroplasty

Abstract ID: Poster 089

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INTRODUCTION: Few studies have directly assessed the accuracy of using a known radiographic marker to determine magnification of digital radiographs. The purpose of our study was to determine if radiographic markers provide an accurate control of image magnification in digital radiography.

METHODS: We performed a retrospective analysis of 103 consecutive patients presenting with a digital pelvic radiograph and a history of THA. All measurements were performed using the OrthoView software. Measurements were performed under two circumstances. First, the radiograph was calibrated with a radiographic marker of known diameter (measurement #1). Second, the magnification factor was arbitrarily set at 120% (measurement #2). The diameter of the prosthetic femoral head was measured and compared to the known diameter. Intraclass correlation coefficients (ICC) were calculated to evaluate the level of agreement between the measured head diameter and the known head diameter. Stratified analyses were used to evaluate the effects of gender, age, and BMI on the level of agreement between the measured and known head diameter.

RESULTS: The overall ICC for measurement #1 was 0.910 (95% CI 0.871-0.938). The overall ICC for measurement #2 was 0.952 (95% CI 0.924-0.969). This difference was not significant. When controlling for gender, the ICC for measurement #1 in females was 0.791 (95% CI 0.680-0.871) and for measurement #2 was 0.943 (95% CI 0.888-0.968). This was statistically significant. The ICC for measurement #1 in males was 0.919 (95% CI 0.852-0.955) and measurement #2 was 0.936 (95% CI 0.885-0.964). This difference was not significant.

DISCUSSION: Our results suggest that female gender is a risk factor for inaccurate calibration of digital radiographs when attempting to use a digital marker. We are cautious when calibrating radiographs of females with a digital marker. Further study is necessary to determine if 120% is the ideal magnification factor, or if another magnification factor might provide more accurate correlation.

Acute Delayed Infection: Increased Risk in Failed Metal-on-Metal Total Hip Arthroplasty?

Abstract ID: Poster 090

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BACKGROUND: There is increasing evidence of the detrimental biologic consequences unique to metal-on-metal bearing (MoM THA) such as soft tissue necrosis and pseudotumor formation, which could potentially lead to other types of failures such as infection. The authors have treated several patients with late acute hematogenous infection in patients with ASR XL THA.

MATERIALS AND METHODS: We retrospectively reviewed a cohort of 143 consecutive primary MoM THA (124 patients), performed at our institution from June 2006 to February 2010 with the DePuy ASR™ XL Acetabular Hip System (112 patients) and DePuy ASR™ Hip Resurfacing System (31 patients) with a minimum follow-up of 3 years.

RESULTS: We identified 8 cases (5.6%) with confirmed periprosthetic deep infection. Four cases (2.8%) presented as late acute infection (>12 months postoperative) and 4 (2.8%) (presented between 3 and 12 months postoperative). The microbiologic profile for those infections presenting late was: E. coli (1), Strep. viridans (1), Propionibacterium acnes (1), and Staph. epidermidis (1). For those infections presented between 3 to 12 months: Strep B Hemolytic GBS (2), Staph. epidermidis (1), and MSSA (1). One case presented with positive culture of the synovial fluid from the hip aspiration, associated also with cell count of 74000 in the same sample, but intraoperative cultures were negative. Two hips required I and D with component retention, two hips underwent I and D with acetabular revision, and 5 hips were treated with two-stage exchange. None have further surgery or have had recurrence of infection.

CONCLUSIONS: In our series, failure for infection is a significant factor that affects the survivorship of the ASR MoM implant. The rate of infection was almost 4 times higher (5.6%) compared to previous historical cohorts from our institution (1.3%). In metal-backed patellar component TKA, a significant increased RR of late infections has been reported, we propose that the same mechanism (attendant synovitis, effusion, and relative hyperemia in the presence of the particulate metal debris) may explain the increased risk of bacterial seeding in MoM THA.

Synovial Inflammatory Response to the Failed Metal-on-Metal Total Hip Arthroplasty

Abstract ID: Poster 091

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BACKGROUND: Pathologic inflammatory reactions to prosthetic metallic byproducts in failed metal-on-metal bearing total hip arthroplasty are known to involve activation and infiltration of lymphocytes into the peri-articular soft tissues in what has been termed adverse local tissue response (ALTR).

OBJECTIVES: We hypothesized that these lymphocytic inflammatory reactions would extend intra-articularly towards the source of the metallic debris.

MATERIALS AND METHODS: We performed a retrospective review of the aspiration data from revisions performed for ALTR and for other causes of aseptic failure. ALTR was defined as any patient revised from painful metal-on-metal bearing components with preoperative elevated serum ion levels and/or extensive intraoperative metallosis or corrosion in the absence of periprosthetic sepsis, aseptic loosening, or any other discernible cause of failure. Patients with periprosthetic sepsis were excluded.

RESULTS: Two hundred and four patients were included. Of these, 18 were diagnosed with a MOM reaction, 76 with aseptic loosening, and 110 with other aseptic causes. Patients with MOM reactions were more likely to be young (p=0.044) males (p=0.004) revised early after their primary arthroplasty (mean of 3 vs. 10 years, p=0.001). There were no significant differences in percent of patients with an abnormal preoperative serum CRP, but patients with MOM reactions were significantly less likely to have an abnormal preoperative serum ESR (p=0.01). Aspirate data did not significantly differ between patients with MOM reactions and all other patients, with no significant differences in WBC count (2982±8534 vs. 1689±2776 [mean±standard deviation], p=0.861), segmented cell count (43±30 vs. 50±29, p=0.344), lymphocyte cell count (31±23 vs. 28±21, p=0.640), monocyte cell count (23±23 vs. 20±20, p=0.487), absolute segmented cell count (431±446 vs. 1041±2521, p=0.361), absolute lymphocyte cell count (2237±7715 vs. 363±763, p=0.977), or absolute monocyte cell count (454±821 vs. 273±537, p=0.311). Among the MOM reaction patients with serum metal ion testing, the mean serum chromium level was 16.0±33.5 ng/mL, the mean serum cobalt level was 24.9±32.6, and the mean serum titanium was 26.1±27.6. Using mean and standard deviation as determined in our data set, a power analysis was conducted and aspirates from 419 MOM reactions and 4,189 patients with other failure etiologies (for a total sample size of 4,608 patients) would need to be collected to find a statistically significant difference between groups in lymphocyte counts, should one exist.

DISCUSSION: In comparison of patients with metal-on-metal total hip arthroplasties revised for reactions to metallic debris and those patients revised for other causes of aseptic failure, there were no significant differences with respect to WBC count, segmented cell count, lymphocyte cell count, or monocyte cell count. These results suggest that the extra-articular lymphocytic infiltrations may not extend intra-articularly.

Successful Detection of Failed Recalled Metal-on-Metal (MoM) Hip Replacements After Surgeon Initiated Follow-Up

Abstract ID: Poster 092

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INTRODUCTION: The Articular Surface Replacement (ASR) metal-on-metal (MoM) hip prostheses were recalled in August 2010 because of a higher than normal failure rate and reports of adverse reaction to metal debris (ARMD). Communications from several medical associations have given specific guidelines for surveillance of MoM prostheses. The objective of this paper is to report patient response to surgeon-initiated contact after a recalled MoM hip replacement and its effect on revision rates.

METHODS: 108 patients undergoing 124 ASR DePuy hip replacements were performed between June 2006 and February 2010. The average age at surgery was 49 years (range, 22 to 70) and 89% were males. After the ASR recall, a letter describing the recall and requesting follow-up was mailed to all patients. All records were reviewed and dates of follow-up and clinical evaluation (blood workup, x-rays, and clinical outcomes) before and after the letter was sent were documented. Reoperation and revision rates were recorded.

RESULTS: Before the company recall, 112 hips (91%) were classified as having a satisfactory replacement follow-up. After the recall letter was sent, 91 of 124 hips (73%) were evaluated within the first year. By then, 45 hips were symptomatic. 23 out of these 45 underwent workup and MoM screening and resulted in 4 hip revisions (2 ARMD, 1 infection, and 1 pain/impingement). During the following 19 months, an additional group of 19 hips were assessed. Within this group, 7 were symptomatic and 3 underwent workup and MoM screenings. Four additional hip revisions were indicated (3 ARMD, 1 infection). Within the group that was seen in the first year (n=91), 53 hips subsequently returned and were evaluated with appropriate testing for new or persistent symptoms. At this point, 11 additional hips were revised (10 ARMD and 1 loose cup). Altogether, 19 of 124 hips (15.3%) were revised at an average of 3.2 years.

DISCUSSION AND CONCLUSION: Surgeon-initiated contact after recall process led to an increase in symptom awareness and a large number of patients returning promptly for medical evaluation (almost 75% within 1 year and 90% within 2.5 years). This resulted in a 15.3% revision rate of this implant at an average of 3.2 years, most commonly for ARMD. We recommend that surgeons contact patients directly in case of implant recall as an effective way of bringing patients in for evaluation in order to minimize potential complications associated with failure of these implants.

Systemic Inflammatory Markers and Joint Aspirate Cell-Count Are Unable to Differentiate Between Bacterial or Fungal Periprosthetic Infections

Abstract ID: Poster 093

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BACKGROUND AND RATIONAL: Fungal periprosthetic joint infection (F-PJI) is a rare entity. The characteristics of systemic inflammatory markers and joint aspirate cell count analysis obtained in patients with F-PJIs have not been fully assessed. The ability to diagnose involvement of F-PJI preoperatively may optimize the surgical and medical management of these patients.

STUDY QUESTION: Are preoperative joint fluid cell counts and systemic inflammatory markers different between patients with F-PJI and bacterial PJI?

METHODS: The medical records of 44 patients with fungal periprosthetic joint infections from 1/1/2002 to 12/31/2011 were reviewed. Thirty-two were purely fungal and 12 were mixed (bacterial/fungal) infections. Preoperative joint aspiration fluid analyses, peripheral white count, ESR, and CRP values were documented in 89% of cases. Sixteen (36%) cases had preoperative synovial fluid aspirations performed. Receiver-Operator curves (ROC) were calculated to determine the predictive value of these inflammatory markers. Values were compared to 59 culture-positive confirmed bacterial infection aspirates treated by one surgeon at the same institution over the same time period.

RESULTS: The mean ESR values for F-PJI and bacterial PJI cases were 39.64 mm/h and 41.10 mm/h, respectively. The mean CRP values for F-PJI and bacterial PJI were 41.95 mg/L and 65.42 mg/L, respectively. The mean total nucleated cells for F-PJI and bacterial PJI were 11,928.4 with 81% Neutrophils and 36,901 with 73% Neutrophils, respectively. The sensitivities, specificities, negative predictive values, and positive predictive values for all tests were comparable in all groups.

DISCUSSION: In this study, fluid analyses and preoperative systemic inflammatory markers were unable to differentiate between fungal, mixed, or bacterial PJIs. When there is a clinical suspicion, fungal and bacterial periprosthetic tissue cultures should be obtained in the setting of multiply failed THA or TKA infection.

CONCLUSION: Early detection and treatment is needed, and the systemic inflammatory markers and cell count analyses from aspirations do not discriminate whether an infection may be of fungal origin.

A Novel Protocol to Classify Hip Aspirates in the Evaluation of Patients with Dual-Taper Femoral Stems

Abstract ID: Poster 094

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INTRODUCTION: Reports of neck-stem corrosion in dual-taper femoral stems complicated by adverse local tissue reaction (ALTR) have raised concern. The evaluation of ALTR includes clinical exam, Metal Artifact Reduction Sequence (MARS) MRI, and serum labs including metal ion levels. MRI and ion levels have been proposed as gold standards, with hip aspiration mainly used to exclude infection. Our experience, however, suggests that qualitative evaluation of hip aspirates may be a sensitive indicator of hip pathology. We present a new protocol to classify hip aspirates, and correlations to MRI, lab studies, and surgical findings.

METHODS: This was a single center, retrospective case series of 12 hips in 11 patients. The cohort included six women and five men, with an average age of 70.9 years (range 63-82), who underwent primary THA with a dual-taper femoral component. Patients were an average of 2.88 years post THA. Each underwent serologic studies, MARS MRI, and fluoroscopically-guided hip aspiration. Three patients underwent revision surgery.

RESULTS: Nine of 12 hips were symptomatic. ESR and CRP were normal in all patients. Serum Cobalt was elevated in 8/11 patients and Chromium was normal in all patients. MRI was completed in all 12, with abnormal findings in 8/12. Findings included pericapsular fluid collections, joint effusion, and capsular dehiscence. Synovial fluid aspirates were classified as follows: I (normal appearance, clear, serous, <10cc), II (larger volume, dark amber or brown color, normal viscosity), III (cloudy, white moderately viscous), IV (thick, pus-like, highly viscous). There were 3 Class I, 2 Class II, 2 Class III, and 5 Class IV aspirates. All patients who underwent revision were Class IV. There was correlation between markedly abnormal MRI and Class IV aspirate; however, 2 patients had normal MRIs (and normal metal ion levels) with Class IV aspirates. At time of revision, one of these patients had extensive tissue necrosis around the hip.

DISCUSSION: Patients with dual-taper femoral stems are at risk of neck-stem corrosion and ALTR. We propose that the qualitative evaluation of synovial fluid from hip aspiration is a useful and sensitive indicator of underlying pathology. This classification system may help clinicians predict the need for more rapid surgical intervention, particularly when patients are asymptomatic, or if MRI and lab studies are either normal or inconclusive. Whether the synovial fluid classes represent unique pathological responses or progressive stages of a common pathology is not known and requires further investigation.

Chromium and Cobalt Levels and Associated MARS MRI Findings in Previously Unreported Design of Chrome Cobalt Modular Neck

Abstract ID: Poster 095

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PURPOSE: Wright Medical has a long history of modular neck hip implants, but had fracture issues with the original titanium necks. They subsequently changed to chrome cobalt modular necks. Direct contact between these dissimilar metal parts in the modular femoral component brings into consideration the possibility of similar adverse reactions of metal-on-metal articulations that have been previously described in other designs.

METHODS: A retrospective review of 10 patients with Wright Medical chrome cobalt modular necks who were evaluated with chromium and cobalt metal ion levels as well as Metal Artifact Reduction Sequence (MARS) MRIs was performed. Pseudotumors were classified by MRI based on wall thickness, T1/T2 signal, shape, and location and given a corresponding type of I, II, or III. For each patient, symptoms or lack thereof were recorded, and time since surgery noted.

RESULTS: Of 10 patients tested, 9 were symptomatic, and 1 was asymptomatic. The patient that was asymptomatic at last clinical visit at 14 months postoperative while symptomatic patients averaged 18 months since initial surgery before symptoms began. Those with metal-poly articulation had an average cobalt level of 1.6, ceramic-ceramic articulation had level of <1, and metal-on-metal had level of 2.9. Five patients had pseudotumor by MRI (2 type I, 1 type II, and 2 type III pseudotumors).

CONCLUSION: It appears that an unintended consequence of changing from titanium to chrome cobalt modular neck may be occurring secondary to corrosion at neck-stem junction.

SIGNIFICANCE: This reaction does not appear to be design-specific as these findings are similar to our findings in Stryker Rejuvenate stems. Surgeons evaluating patients with these and other similar stems should be aware of this complication and consider ion testing and MARS MRI.

Radiation Exposure During Fluoroscopic Guided Direct Anterior Approach for Total Hip Arthroplasty

Abstract ID: Poster 096

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INTRODUCTION: The direct anterior approach for total hip arthroplasty (DA THA) has become an increasingly popular technique. Fluoroscopic guidance for bone preparation and component placement is a common adjunctive tool during this approach. With increasing utilization of radiation in medical care, there is increase concern with new radiation exposure. There is no published data on patient radiation doses from fluoroscopically guided DA THA. The purpose of this study is to better understand the patient and surgeon exposure utilizing this technique.

METHODS: This is a single surgeon, prospective cohort study. A consecutive series of patients undergoing primary DA THA over a period of three months were studied. All patients underwent primary total hip arthroplasty through the direct anterior approach utilizing fluoroscopic guidance for preparation of bone surfaces, implantation of real implants, and adjustment of leg length and offset. The Dose-area product (DAP) ($GYcm^2$) and fluoroscopy time (seconds) were recorded for each case. Additionally, the surgeon exposure was recorded by wearing a dosimeter. For control, another surgeon performing the posterior approach for total hip arthroplasty without fluoroscopic guidance wore a dosimeter during primary total hips for the same period of time.

RESULTS: During the period of 3 months, 39 patients underwent DA THA. Data relating to patient dose for these 39 patients undergoing fluoroscopic guidance for these procedures have been analyzed. Median dose-area product (DAP) readings are presented. The median DAP was higher than some other previously studied orthopedic fluoroscopic procedures at 0.7800 (minimum 0.341, maximum 1.7). The average fluoroscopy time was 0.54 minutes.

CONCLUSION: This is the first study to report the radiation exposure of patients and surgeons in a consecutive prospective series of fluoroscopically guided DA THA. The median DAP was 0.780 and the average fluoroscopy time was 0.54 minutes. This information can aid in informing patients and surgeons on choice of approach for total hip arthroplasty, and may aid in setting reference dose levels for this procedure.

Introducing the Direct Anterior Approach to THA Into Your Practice: A Senior Surgeon's Look at If, How, and Why

Abstract ID: Poster 097

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PURPOSE: This review describes the risks and benefits of choosing to introduce the Direct Anterior Approach (DAA), and outlines a rational way that surgeons can decide if they should learn and offer this approach to appropriate patients.

METHODS: A retrospective study was performed comparing patients who underwent THA with the standard posterolateral approach vs. the direct anterior approach. Demographics, operative information, and pre- and postoperative Harris Hip Score (HHS) evaluations were collected. Radiographic data and short-term complications were also evaluated.

RESULTS: Procedure time was significantly different between groups ($p<0.0001$), where procedure time averaged 23 minutes longer for the DAA. Mean blood loss between groups was also significantly different ($p=0.0018$), where the DAA averaged 244 cc more blood loss.

Mean abduction angle for the DAA was 42° vs. 50° for the posterolateral approach ($p<0.0001$). Mean version for the DAA was 21° vs. 18° for the posterolateral approach ($p=0.0233$). There were no differences between the groups when comparing HHS except for postoperative visit 2 pain ($p=0.0291$) and postoperative visit 2 adduction ($p=0.0248$).

The choice of stem influenced the type of complications ($p=0.0442$) in the DAA only, but the number of overall complications did not differ significantly between groups ($p=0.1737$). The complication that occurred most often in the DAA was late periprosthetic fracture. The complications that occurred most often in the posterolateral group were wound issues and dislocations.

The results indicate that the learning curve for an experienced surgeon who is beginning to use the direct anterior approach is a minimum of 20-30 THAs.

CONCLUSION: The DAA offers several benefits. However, to minimize the risk of introduction of this procedure, the surgeon and his team need to plan the learning approach, structure the introduction using familiar and predictable implants, and adjust the indications through careful patient selection. Thorough discussions with the patients are important for a successful introduction.

Predictors and Complications of Blood Transfusion in Total Hip and Knee Arthroplasty

Abstract ID: Poster 098

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INTRODUCTION: Increased attention has been paid toward perioperative optimization to minimize the need for postoperative blood transfusions in patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA). The purpose of this study was to determine preoperative, operative, and postoperative predictors of transfusion and identify complications associated with transfusions.

METHODS: A retrospective chart review of clinical records from 1,795 patients who underwent total hip arthroplasty (THA) or total knee arthroplasty (TKA) at our institution between January 1, 2011, and December 31, 2012. After excluding patients if they had a bilateral procedure, partial arthroplasty or revision surgery, a total of 1,573 patients were ultimately included. Logistic regression evaluated variables predictive of transfusion and a stepwise logistic model determined the best fit multivariate model. A Wilcoxon two-sample test, a Spearman's correlation, and a linear regression to analyze the number of units transfused.

RESULTS: Of the 1,573 patients included in the study, 949 patients underwent TKA and 624 patients THA. Eighty-eight (9.27%) TKA patients received a blood transfusion compared to 166 (26.6%) THA patients. Significant predictors for transfusion are: hemoglobin OR 0.62 (95%CI, 0.53, 0.76, p=0.001), age 1.45 (1.19,1.77, p=0.001), female gender 2.60 (1.55,4.43, p=0.001), body mass index 0.84 (0.72,0.98, p=0.027), creatinine 1.35 (1.05,1.74, p=0.020), TKA 0.39 (0.25,0.63, p=0.001), operating room time 1.25 (1.05,1.74, p=0.029), estimated blood loss 1.14 (1.06,1.24, p=0.001), and intra-operative fluids 1.04 (1.01,1.07,p=0.012). DVT rate was 1.9% and not statistically significant, but infection rate amongst transfused patients was 13.3% higher than non-transfused patients (p=0.001).

CONCLUSION: The rates of blood transfusion at our institution were 9.27% in TKA and 26.6% in THA. Increased age, female gender, and BMI were predictive of transfusions. Rates of transfusion increased with longer OR time, EBL, and IVF. DVT rates were similar regardless of transfusion, but infection rates were statistically higher in the transfused patients.

The Effect of BMI on Outcomes in Total Joint Arthroplasty

Abstract ID: Poster 099

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INTRODUCTION: Hip and knee arthroplasty (THA, TKA) are safe and effective procedures with reliable and reproducible outcomes. Complications are considered indicators of quality and will soon be publically reported and linked to reimbursement. However, certain preoperative variables may predispose patients to increased risk of complication. In this study, we aim to utilize a large national database to investigate the effect of obesity on medical and surgical complications in patients undergoing total hip and knee arthroplasty.

METHODS: Using the American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) 2011 data, a study population was generated using the CPT code for THA (27130) and TKA (27447). The sample was stratified into underweight (BMI <20), normal weight (BMI >20-30), and obese (BMI >30) cohorts. Univariate analysis of demographic variables, preoperative comorbidities, and surgical outcomes was performed using non-parametric Wilcoxon rank-sum test for continuous variables and Fisher's exact test or chi-square test for categorical variables. Variables with ≥10 occurrences and a significance of 0.20 or less on univariate analysis were incorporated into multivariable models to investigate the association between BMI and specific postoperative outcomes.

RESULTS: Study population: 46,515 patients (17,522 THA, 28,993 TKA); 54% were considered obese (42% THA, 60% TKA). Both THA and TKA obese populations were younger ($p<0.001$), African American ($p<0.001$), more likely to smoke ($p<0.001$) and drink alcohol ($p<0.014$), more likely diabetic ($p<0.001$), hypertensive ($p<0.001$), and have multiple medical comorbidities ($p<0.05$). Postoperative surgical and medical complications, including superficial surgical site infection (SSI) were more common in both THA and TKA obese populations ($p<0.001$). Deep SSI occurred more frequently only in the obese population following THA ($p<0.001$). Multivariate regression analysis indicates that a BMI>30 is independently linked to increased surgical complications following THA (OR=1.99, 95%CI 1.524-2.59; $p<0.001$) and TKA (OR=1.48, 95%CI 1.18-1.89; $p<0.001$). However, obesity was not linked to overall incidence of postoperative medical complications, reoperation, or death in either group. BMI<20 is associated with higher risk of medical complication following both THA (OR=1.94, 95%CI 1.54-2.29; $p<0.001$) and TKA (OR=1.47, 95%CI 1.10-1.97; $p<0.001$).

CONCLUSION: Having a BMI outside of the normal range, places patients at increased risk for postoperative complications following total joint arthroplasty. While obesity increases risk for surgical complications such as surgical site infection, being underweight is linked with increased risk for medical complications. BMI should be part of the informed consent process and included in risk adjustment models for public reporting and reimbursement following THA and TKA.

Primary Total Hip Arthroplasty for Osteonecrosis of the Femoral Head in Patients with Human Immunodeficiency Virus

Abstract ID: Poster 100

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Osteonecrosis of the femoral head (ONFH) has been recognized as a distinct entity in patients infected with the Human Immunodeficiency Virus (HIV). The incidence has been reported to be 0.3% to 0.5%. The purpose of this study was to evaluate the clinical and radiographic outcome in a consecutive series of primary total hip arthroplasty (THA) performed for ONFH in HIV patients.

MATERIAL AND METHOD: Sixteen patients underwent 23 THAs under one single surgeon over a 13-year period (1998-2011) with average follow-up 5 years. All patients were male and contracted HIV through sexual contact. Risk factors for ONFH included: protease inhibitors in 74%, hypercholesterolemia in 21.7%, alcohol abuse in 13%, and steroid use in 8.7%. Radiographic review included preoperative Ficat classification and postoperative evaluation of cup angle, cup height, and cup lateralization distance. The mean CD4 count was 377 (14-900), and viral load was 70 (0-126k). Clinical outcome was assessed using the Harris Hip Score.

RESULTS: There were no infections, symptomatic deep vein thrombosis or pulmonary embolism, or dislocations. One patient had fever of unknown origin during the hospital stay. Four hips in 3 patients underwent revision for aseptic loosening. Three patients died: 1 from AIDS at 10 months, 2 with unknown causes at 52 and 84 months respectively. Harris hip score was on average 43 preoperative and 87 at last follow-up.

CONCLUSION: THA is safe and efficacious in a young and relatively healthy group of HIV infected patients. As medical management has allowed these patients to have near normal life expectancy, it is therefore important to continue to monitor these patients carefully for wear and loosening.

Primary Total Hip and Knee Arthroplasty: The Impact of Payer Mix

Abstract ID: Poster 101

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INTRODUCTION: The demand for total hip arthroplasty (THA) and total knee arthroplasty (TKA) continues to grow annually and the costs of providing joint replacement surgery remain a growing concern for the patient, the provider, and the payer. Healthcare reform and new payment models may pose a significant threat to the long-term viability of joint replacement procedures. The purpose of this study is to review the overall impact of payer mix, by analyzing the direct and indirect costs, the revenue, and the net profit (loss) associated with THA and TKA.

METHODS: All primary THA and TKA performed during 2011 were reviewed using ICD-9 code 81.51 for THA and ICD-9 code 81.54 for TKA. Only patients who underwent unilateral primary THA and TKA with complete financial data were included. The data was grouped by payer and the costs were sorted as direct and indirect costs (professional and technical). Reimbursement data was correlated by ICD-9 code and reviewed to determine net profit (loss) of each procedure for the hospital.

RESULTS: A total of 210 primary THA and a total of 318 primary TKA performed at a large metropolitan level one trauma center in 2011 were ultimately included. Of the THAs performed, the payer mix was as follows: Payer A 47.6%, Medicare 35.2%, Payer B 7.1%, Payer C 3.8%, Payer D 1.9%, Medicaid 0.5%, and other 3.8%. Of the TKAs performed, the payer mix was as follows: Payer A 59.4%, Medicare 28%, Payer B 7.5%, Payer C 1.9%, Payer D 2.8%, and Medicaid 0.3%. The average direct cost across payers was $14,476 for THA and $13,415 for TKA. The cost of primary total knee implants were capped at $3,150 and all primary total hip implants $3,750. The average total cost for THA was $21,223 and $19,678 for TKA. The average net profit was $595 for THA and $2,454 for TKA. A profit/loss analysis by payer was performed.

CONCLUSION: The payer mix between THA and TKA are similar, but THA has 7.2% greater Medicare population compared to TKA which has a proportionally larger private payer market. Both procedures were ultimately profitable as an aggregate after calculating for direct and indirect costs, but TKA ($2,454/case average) was significantly more profitable than THA ($595/case average). A relative shift in case load from THA to TKA, or even a subtle shift in payer mix, could have a profound impact on overall profitability.

The Influence of Comorbidities on Hospital Costs and Length of Stay Following Total Hip Arthroplasty

Abstract ID: Poster 102

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INTRODUCTION: Total hip arthroplasty (THA) has been heralded as the operation of the century for its ability to reduce pain and restore function. Multiple factors, including the obesity crisis, have lead to rising utilization and costs. Thus, the purpose of this study was to examine the influence patient characteristics have on hospital charges and length of stay (LOS).

METHODS: The 2009 National Inpatient Sample (HCUP-NIS) dataset was queried using ICD-9-CM codes to identify patients between ages 40 and 95 and undergoing elective THA. We used weighted estimates of national procedure volume and patient comorbidities defined by the Agency for Healthcare Research and Quality (AHRQ) and identified them using standard methods described by Elixhauser. Generalized linear models, based on Poisson regression analysis, were used to estimate the influence of individual patient characteristics on hospital charges and (LOS).

RESULTS: In 2009, an estimated 277,564 patients underwent THA in the U.S. Of these, 16.6% patients had no comorbidities while 28.2% had three or more. The most common conditions included hypertension (60.8%), diabetes (14.4%), and obesity (13.3%). Mental disorders were found in 10.2%, renal failure in 3.7%, and AIDs in 0.13% of patients. Mean hospital charges were $49,740 and mean hospital LOS was 3.5 days. With incremental comorbidities, both hospital charges and length of stay increased ($p < 0.01$). Both marginal charges and LOS rose with inpatient mortality (+$24,165, 1.2 days), patients with recent weight loss (+$20,487, 2.3 days), metastatic disease (+$11,245, 1.8 days), minority race (+$13,098, 0.6 days), pulmonary-circulatory disorders (+$5,048, 1.0 days), AIDs (+$7,248, 0.3 days), and more. Patients treated in the West region had higher marginal charges but a lower LOS (+$24,164, -0.2 days).

DISCUSSION: Hospital charges and length of stay after THA rise dramatically with the multiply-comorbid patient. Current reimbursement schemes fail to adequately adjust for many of these patient characteristics. As the payments for arthroplasty continue to decline, policy makers should focus on providing fair compensation and quality metrics to hospitals and surgeons treating the comorbid; otherwise, significant restrictions in access to care may occur.

Fungal Periprosthetic Infection is Associated with a Poor Outcome

Abstract ID: Poster 103

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BACKGROUND AND RATIONAL: Fungal periprosthetic joint infections (F-PJIs) are rare. Less than 100 cases have been reported to date in the literature. The results of surgical management and clinical outcomes of patients with F-PJI have not been fully assessed.

STUDY QUESTION: What are the demographics and outcomes of patients with F-PJI managed with different surgical strategies?

METHODS: 43 patients with F-PJIs treated at our institution between 1/1/2002 and 12/31/2011 and followed for at least 18 months were enrolled in this study. The mean time from index arthroplasty to F-PJI diagnosis or resection was 4.5 years (range: 30 days to 27 years). The mean age was 68 years and 47% of the episodes occurred in females. There was equal distribution between TKA and THA. 73% of cultures were fungal only while the rest were mixed (bacterial/fungal). Candida albicans was the fungal organism in 52% of cases. 33 of 43 (77%) had experienced prior episodes of bacterial PJIs. 40% of the joints were resected prior to diagnosis of fungal involvement in the joint space (mean time from resection to fungal infections was 153 days). Patients were followed until death, joint failure, latest or loss of follow-up.

RESULTS: The mean follow-up from surgery was 30 months (range: 1 to 10 years). The average number of surgical procedures to treat F-PJI was 3 (range: 1 to 7). Of the 43 F-PJIs, 16 (37%) underwent a 2-stage surgery, 16 (37%) underwent permanent resection, 6 (14%) underwent amputation, and 2 (5%) required arthrodesis. In addition, 2 (5%) underwent I and D with retention of components and one was aspirated and suppressed with antifungal therapy. Following therapy, 16 had failure of treatment with persistent infection (5 of 22 knees and 11 of 21 hips). The 5-year cumulative incidence free of recurrence of PJI in patients treated with 2-stage surgery was 63% for knees and 53% for hips.

DISCUSSION: The outcome of patients with F-PJI managed with two stage or debridement and retention was poor. Only a third of patients were considered candidates for two stage reimplantation surgery and within this group, only 61% had a successful outcome. Despite undergoing permanent resection, 10 of 16 (63%) patients still had evidence of joint involvement and were on chronic suppression. The rest of the patients were treated with amputation, arthrodesis, or I and D and were infection-free at last follow-up. Since F-PJIs are associated with a poor outcome, a better understanding of risk factors and novel management strategies may be warranted.

CONCLUSION: The outcome of patients with F-PJI is poor. Only one third of patients are candidates for reimplantation, and only half of those are free of infection at 5 years.

High Failure Rates of Current Reconstructive Strategies for Bilateral Pelvic Discontinuity

Abstract ID: Poster 104

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INTRODUCTION: Bilateral pelvic discontinuity (BPD) is characterized by complete dissociation of the superior and inferior pelvis secondary to bone loss or fracture. The end-result is a freely mobile inferior pelvis at the level of each discontinuity which presents a significant reconstruction challenge. This clinical entity has not been described previously and the results of surgical treatment are not known.

METHODS: We retrospectively reviewed all identified cases of pelvic discontinuity treated with revision THA at one institution between 1997 and 2011. We identified 135 pelvic discontinuities in 22 men and 106 women (average age 66). Within this group, 6 patients had bilateral simultaneous PDs and were treated with staged surgery (average time between procedures was 9.5 months). Mean follow-up was 6 years (range 3.8 to 11.5 years). All were women (age range 49-73). Preoperative, intraoperative, and postoperative data was obtained from medical records and radiographic imaging was reviewed pre- and postoperatively for the characteristics of the dissociation and to assess PD healing and fixation of components after surgery.

RESULTS: There were no preoperative factors that could distinguish these patients from the rest of the group of discontinuities (3 RA, 2 AVN, 1 DDH). The preoperative Paprosky classification included 1 IIB (8.3%), 1 IIC (8.3%), 5 IIIA (41.7%), and 5 IIIB (41.7%). The reconstructions performed included 2 cup/cage, 5 posterior plating and uncemented cup, 3 cage alone, and 2 cups only. Ten of 12 hips had at least one complication postoperatively. At final follow-up, only 1 patient (16.7%) had radiographic evidence that both discontinuities had healed (posterior plate with uncemented cup) while the other 5 patients had persistent bilateral discontinuities.

DISCUSSION: BPD is rare (8.8% of 135 hips with PD), but presents the surgeon with a major reconstructive challenge. Only one patient went on to radiographic healing with current treatment strategies. Continued motion of the contralateral pelvic dissociation may prevent adequate union of the surgically treated dissociation during staged sequential treatment and may account for the high failure rates. Surgeons should be aware of the challenges presented by this diagnosis and develop strategies to improve outcomes. Efforts to improve construct rigidity on both sides may improve the surgical outcomes for this difficult problem.

Tantalum Revision Shell with Liner Cementation Provides Excellent Outcomes in Primary Total Hip Arthroplasty

Abstract ID: Poster 105

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SUMMARY SENTENCE: Primary total hip arthroplasty with cementation of a polyethylene liner into a modern porous coated revision shell shows satisfactory results at an average follow-up of 7.7 years.

INTRODUCTION: Whereas liner cementation is common in revision total hip arthroplasty, the authors were unable to find any published data for use in primary total hip arthroplasty utilizing a modern tantalum revision shell.

METHODS: From a single institution registry, we identified 91 primary total hip arthroplasties in 91 patients in which a cementless tantalum coated revision shell was inserted with cementation of a cross-linked polyethylene liner. These were inserted as a surgeon preference. The average age was 54 years (range 15-91 years). Demographic data, revision rates, and clinical and radiographic outcomes were recorded. The average clinical follow-up was 7.7 years (range 2-12.1 years). The mean radiographic follow-up was 5.5 years. The indication in most cases was osteoarthritis (OA) (n-59) followed by post-traumatic arthritis (n=12), osteonecrosis (n=8), rheumatoid arthritis (n=5), and other (n=7).

RESULTS: One hip (1.1%) had an early dislocation that was treated non-operatively. Four hips (4.4%) were revised for late recurrent dislocation with only one of them exhibiting frank polyethylene liner wear at ten years follow-up. One hip (1.1%), with a known history of native septic arthritis, underwent revision for deep periprosthetic infection. The combined revision and reoperation rate was 6.6% at final follow-up. The remainder of the acetabular shells and cemented liners showed no evidence of loosening or progressive osteolysis.

DISCUSSION AND CONCLUSION: Though uncommon, utilization of a porous coated Tantalum revision shell with polyethylene liner cementation in the setting of primary total hip arthroplasty provided secure fixation and a 0% revision rate for aseptic loosening at a 7.7 year follow-up.

Early Survival Difference of Two Porous Metal Acetabular Components After Hip Arthroplasty Revision

Abstract ID: Poster 106

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INTRODUCTION: Acetabular component fixation after revision total hip arthroplasty (rTHA) is challenging and may impair long-term component survival. Uncemented porous metal ingrowth surface components made of either titanium or tantalum have shown promising results. Despite widespread use, there are no comparative studies of these products. This study aimed to compare early survival of titanium and tantalum high porosity acetabular components after rTHA.

METHODS: Revision THA cases performed from 2002 to 2010 were identified at a high-volume academic institution. Demographics, cause of index revision, follow-up, subsequent revisions, and failure of the components was collected retrospectively. Cases that used the studied components were enlisted in a single continuous cohort and compared in two groups: titanium vs. tantalum components in terms of demographics and survival, with endpoint defined as any failure requiring acetabular component removal. Parametric statistics and a Kaplan-Meier survival analysis were used for comparison.

RESULTS: Of 1,382 rTHA cases, high porosity tantalum or titanium acetabular components were used in 153 cases (tantalum: n=83 and titanium: n=70). Mean follow-up was 30.2 and 25.6 months for tantalum and titanium groups, respectively. There were no demographic differences between groups. Main cause of index revision was aseptic loosening for both groups, 63 (41.2%) and 46 cases (30.1%), followed by infection 13 (8.5%) and 18 cases (11.8%) in the tantalum and titanium groups, respectively. Other causes included instability, periprosthetic fracture, and component malposition. There was no difference between causes of index revision distribution between groups. At the latest follow-up, there were 10 and 4 failures in the tantalum and titanium groups, respectively (p=0.16).

CONCLUSION: There is a trend of lower survival of high porosity tantalum acetabular components when compared with titanium ones after rTHA at a minimum 2-year follow-up. Longer follow-up and larger cohort studies are needed to corroborate this early finding and confirm long-term survivorship.

KNEE

Financial Impact of a Multi-Disciplinary Preoperative Risk Stratification Program for Joint Arthroplasty

Abstract ID: Poster 107

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INTRODUCTION: Complications following hip and knee arthroplasty often require prolonged hospital admission periods and added hospital resources which ultimately results in increased costs per hospital stay. However, if patients are preoperatively risk stratified, and optimized for surgery, many complications may be avoided. We hypothesized that hospital costs related to joint arthroplasty will decrease through the use of a multi-disciplinary preoperative risk stratification program.

METHODS/MATERIALS: We retrospectively reviewed a cohort of 2,640 hip and knee arthroplasty cases performed at one hospital from January 2008 until August 2012. We excluded all non-elective trauma cases. The cohort was separated into a non-triage group (N) and a triage group (T). Group (N) consisted of 1,142 cases that were performed prior to the formation of a multi-disciplinary preoperative risk stratification program for joint arthroplasty at the hospital. Group (T) consisted of 1,498 cases that were performed after the formation of the preoperative risk stratification program. These two groups were first compared through Chi square testing with regards to the American Society of Anesthesiologists' (ASA) grade and the age adjusted Charleston co-morbidity index (ACI) score preoperatively. Postoperatively, the two groups were compared through student t-testing with regards to length of stay (LOS), and both major and minor complication rates up to 30 and 90 days.

RESULTS: The preliminary results have shown a statistically significant difference in length of stay between the two groups ($p<0.001$) with group (T) experiencing, on average, a half of a day decrease in length of stay when compared to group (N). We found no statistically significant difference in complication rates between the two groups at either 30 or 90 days postoperatively; ($p=0.421$) and ($p=0.669$), respectively. Approximately $823,900 was saved over the study period. We also discovered a statistically significant difference in the baseline (ASA) grade, and (ACI) score between the two groups; ($p<0.01$) and ($p=0.0037$) respectively, showing that, on average, group (T) had both a higher (ASA) grade and a higher (ACI) score than group (N).

CONCLUSION: A preoperative, risk stratification program significantly decreased the average (LOS) per hip and knee arthroplasty in a group with significantly higher (ASA) grades and (ACI) scores in this retrospective study.

Evaluation of the 3-D, Weightbearing Orientation of the Normal Adult Knee Using Low Dose Radiation

Abstract ID: Poster 108

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(Presented by Jeffrey B. Stambough, M.D., St. Louis, MO)

INTRODUCTION: Concepts such as constitutional varus and kinematic alignment hypothesize that reproduction of a patient's native anatomy may improve results in total knee arthroplasty (TKA). However, prior assessments of normative, adult alignment are limited by the use of 2-dimensional imaging, in which limb rotation and anatomic variations affect alignment measurements. The purpose of this study was to use 3-D, weight-bearing images corrected for rotation, to report normative data of limb alignment and joint line orientation in asymptomatic, adult knees.

METHODS: 100 subjects (200 lower extremities, average age 35 + 11.5 years, 58% female), with no history of symptoms or treatment, were prospectively recruited to receive weight-bearing, simultaneous biplanar imaging of both lower extremities using a novel, low-dose imaging technology. 3D images were created using parametric modeling and corrected for limb rotation, from which multiple anatomic parameters were measured.

The HKA was used to categorize knees as varus (<3°), valgus (>3°), or neutral (0° + 3°), and the mechanical lateral distal femoral angle (mLDFA) was used to assess if the knee joint line was perpendicular to the mechanical axis of the femur (90° + 3°), or if joint line obliquity was present (<87° or >93°). Student's t-tests were used to compare clinical measurements between males and females ($p<0.05$=significant).

RESULTS: Of 200 knees, 70% were neutral, 19.5% were varus, and 10.5% were valgus, with males having more varus than females (-.5° + 2.9° vs. 0.14° + 2.3°, $p=0.0004$). The proportion of male subjects with at least one knee in varus or valgus, was 40.5% and 11.9% respectively (vs. 15.5% and 19.0% in females). 52.5% of all knees had joint line obliquity (45.2% of males, 57.8% of females). Only 31% of knees were in both neutral alignment and lacked joint line obliquity.

CONCLUSION: The long-term impact of restoring a patient's native anatomy on outcomes of TKA must still be determined, but currently, a neutral mechanical axis and perpendicular joint line does not achieve this in 69% of knees. This study is the first to provide 3-D, normative data of alignment and joint line obliquity in a large population of asymptomatic, adult knees.

Defining a Vascular "Safe Zone" for Lateral Release in Total Knee Arthroplasty: A Clinical MRI Study

Abstract ID: Poster 109

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BACKGROUND: Lateral release during total knee arthroplasty (TKA) remains a common procedure done to improve patellar maltracking associated with significant valgus deformity. Complications associated with lateral release are possibly related to alterations to patella blood supply. The superior and inferior lateral geniculate arteries (SLGA/ILGA) are thought to contribute significantly to peripatellar vascular anastomoses and are in danger of transection or injury during a lateral release, which may subsequently lead to increased risk of hematoma formation or patella avascular necrosis. It may not always be possible to see either the SLGA or ILGA with direct vision during lateral release, and, thus, lack of knowledge of their anatomic position may lead to inadvertent injury. To our knowledge, there are no published studies documenting the superior and inferior borders of these arteries.

PURPOSE: In this study, we determine the position of the superior and inferior lateral geniculate arteries with respect to anatomic landmarks obtainable on contrast magnetic resonance imaging scans performed on the knees of living subjects. In doing so, we establish a "safe zone" through which a lateral release could be performed without compromising the vascular supply to the patella or increasing the risk of developing a subsequent hematoma. We also determine whether the position of the arteries varies with respect to patient height.

METHODS: An IRB approved the assessment of all patients who obtained a contrast knee MRI scan at our institution. We assessed MRIs from November 2008 to January 2012. Patients with large effusions, altered bony anatomy, knee contractures, extensive synovitis, and tumors were excluded from analysis. Sagittal and axial T1 post-contrast cuts were used to assess four distance parameters. The takeoff of the SLGA and ILGA in relation to their respective patella poles was assessed on the mid-sagittal view of the patella. Next, a parasagittal view through the midpoint of the lateral compartment was used to determine the distance of the SLGA from the distal femoral condyle and the distance of the ILGA from the proximal tibia plateau. Confidence intervals of the mean were set to 95%.

RESULTS: A total of 44 patients were assessed. The average age was 42.4 years. The average height was 169.1 cm. The average takeoff of the SLGA was 1.7 mm superior to the superior pole of the patella (CI 0.1 – 3.2 mm) and 54.8 mm superior to the distal lateral femoral condyle (CI 52.6 – 56.9 mm). The average takeoff of the ILGA was 19 mm inferior to the inferior pole of the patella (CI 17.6 – 20.4 mm) and 4.6 mm inferior to the proximal lateral tibia plateau (CI 3.3 – 6.0 mm). There was no correlation to patient height with any distance parameter, thus implying the artery position was height invariant.

CONCLUSIONS: We determined the superior and inferior extent for performing a lateral release. The superior border is in line with the superior pole of the patella, whereas the inferior border extends approximately 15–19 mm distal to the inferior pole of the patella. Thus, an approximate 5 cm "safe zone" exists with a patella height of 35 mm. This does not vary based

on patient height. We believe this provides important anatomic information in preserving the vascular supply to the patella and reducing risk of hematoma formation during a lateral release.

The Impact of Patient Specific Guides and Mechanical and Kinematic Alignment on Patient Satisfaction and Function After TKA

Abstract ID: Poster 110

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INTRODUCTION: Several studies have examined the ability of Custom Cutting Guides (CCG) to avoid outliers and achieve certain alignment targets, but few studies have evaluated the impact of CCG on patient satisfaction and function following total knee arthroplasty (TKA).

METHODS: One center performed TKA targeting neutral mechanical axis (MA) with CCG and standard instrumentation. A second center used CCG to approximate pre-arthritic knee alignment (kinematic axis; KA). Both centers used the same cemented cruciate-retaining implant, with patella resurfacing. Patients were evaluated by an independent, third party survey center with expertise in administering medical outcomes questionnaires for federal agencies. Interviewers were blinded to treatment group and administered questionnaires determining satisfaction, residual symptoms/function, and pre-arthritic and postoperative activity level utilizing previously published survey instruments.

RESULTS: 234 MA TKA patients were interviewed; 59 CCG, 175 standard instrumentation. CCG patients had higher pre-morbid UCLA Scores (7.5 vs. 6.9, p=0.04), but postoperative scores were virtually identical (6.6 vs. 6.7). No differences approached significance for satisfaction or residual symptoms, so the two groups of MA TKA were combined for comparison with KA TKA.

89 KA TKA with CCG patients were interviewed. Compared to the 234 MA TKAs, the pre-morbid and postoperative UCLA scores were identical (7.0 and 6.7 for both). More KA TKAs were satisfied with degree of pain relief (99% vs. 95% for MA TKA, p=0.04) and trended towards significance for function (knee feels normal, 90% vs. 82% for MA TKA, p=0.12). In terms of satisfaction and residual symptoms, fewer KA TKAs had problems getting in/out of a chair (16% vs. 27% for MA TKA, p=0.05).

CONCLUSION: CCG with MA TKA was associated with no difference in patient satisfaction or residual symptoms compared to MA TKA with standard instrumentation. CCG with KA TKA, however, had higher satisfaction than MA TKA and warrants further study.

Preoperative Lab Values Correlated with Surgical Outcomes in Total Knee Arthroplasty Patients

Abstract ID: Poster 111

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SUMMARY: Optimizing patient health prior to TKA is important in minimizing postoperative complications. Using a regression model, increasing ASA score was associated with increasing severity of complications.

INTRODUCTION: Diabetes has been shown to impair early wound healing in primary total knee arthroplasty (TKA) procedures and is associated with increased rates of postoperative complications. The purpose of this study was to identify laboratory parameters from preoperative clearance examinations that correlated with postoperative complications in primary TKA. Ideally, these parameters could then be optimized prior to surgery to minimize the risk of postoperative complications in diabetic patients undergoing a TKA procedure.

METHODS: Laboratory data was retrospectively obtained from 96 TKA patients, with equal numbers of male and female, diabetic and non-diabetic patients. All patients had received a TKA from the principle investigator from August 2008 to April 2012. In addition to demographics, data included complete blood count, metabolic panel, urine analysis, prothrombin time, and Knee Society Scores. Complication data at up to one-year follow-up was categorized as: presence of any complication, return to operating room (OR), and deep venous thrombosis (DVT). Data was then compared between groups and correlated with complication data.

RESULTS: Overall, 33.4% of patients had complications in the study (n=32); 16.7% had minor complications, 10.4% returned to the OR, and 6.3% experienced DVT. Age was more likely to predict DVT (p=0.068). In the diabetic group, men were likely to have minor complications 8.69% (n=4) and women were more likely to have serious complications (return to OR or DVT) 6.5% (n=3). Further analysis of blood glucose, body mass index (BMI), American Society of Anesthesiologists (ASA) scores, age, and gender using ordinal regression with a logit link function (model p=0.009), found ASA score (p=0.090) to be most closely associated with predicting severity of complications, while BMI and age were not as significant (p=0.332 and p=0.207, respectively).

DISCUSSION: In matched cohorts of relatively unhealthy patients, complications frequently occur and are associated with increasing ASA score. The significance of the ordinal regression model emphasizes the importance of considering age, gender, diabetic status, BMI, and ASA as contributory factors when assessing the likelihood of complications in preoperative TKA patients. Despite the variance in blood glucose of the control group, mean blood glucose for each group of complications was relatively higher, and variance decreased as complications increased in severity. These results support the need for optimizing patient health prior to TKA, especially modifiable risk factors such as blood glucose that contribute to ASA score.

Click here to view Table

Vasopressor Support During ICU Admission Predicts Poor Survivorship After Primary Total Knee Arthroplasty (TKA)

Abstract ID: Poster 112

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SUMMARY SENTENCE: Five percent of elective primary total knee replacements required ICU admission; mortality rate for patients requiring vasopressors was 37.5% at final follow-up with a 30-day mortality rate of 12.5%.

INTRODUCTION: Rarely, patients undergoing elective knee replacement surgery will be admitted to the intensive care unit (ICU). The subset of primary TKA patients who require ICU management has been poorly studied. We sought to characterize the risk factors for ICU admission, as well as outcomes associated with ICU care.

METHODS: From a single-institution registry (2002-2012), 12,774 consecutive primary total knee arthroplasties were reviewed. The average age was 69.7 years (range, 30-96). Those patients requiring ICU admission were compared to those who did not. Demographic data, perioperative complications, and in-hospital mortality were recorded. Particular attention was paid to use of vasopressor use during ICU management.

RESULTS: 633 patients required ICU admission, representing 5% of all primary TKA patients. Sixteen ICU patients (2.5% of all ICU admits) received vasopressor support for refractory hypotension. 37.5% of the patients requiring vasopressors were deceased at final follow-up. The 30-day, 90-day, and 1-year mortality rates were 12.5%, 31.3%, and 31.3%, respectively. The mortality rate for those ICU patients who did not need vasopressors was 17.3% at final follow-up, with a 0.49% mortality rate at 30-days. The mortality rate at final follow-up for those patients who did not go to the ICU was 7.6%. Age, American Society of Anesthesiologists (ASA) classification, and operative time were significantly higher between patients admitted to the ICU and non-ICU patients. Length of stay was significantly longer for patients requiring vasopressors ($p<0.001$).

DISCUSSION AND CONCLUSION: Five percent of primary THA patients required ICU admission, and those patients who required vasopressor treatment had a 37.5% mortality rate at final follow-up with a 30-day mortality rate of 12.5%. Strategies to further optimize this particularly sick subset of orthopedic patients is important.

Caution! High Rate of Positive Cultures in Referred Patients with Antibiotic Spacers

Abstract ID: Poster 113

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INTRODUCTION: A two-staged exchange for infected TKA has become the standard of care. Not infrequently, patients with an infected TKA are referred to another facility for persistent infection after an initial resection and antibiotic spacer have been placed. Little literature exists reporting outcomes to suggest how these patients should be managed. The purpose of this study is to report outcomes of patients with infected TKAs treated with initial debridement/resection referred to another center for definitive management.

MATERIALS AND METHODS: We identified all patients treated for an infected TKA from 2000-2012 whose initial surgical treatments were performed somewhere other than the definitive treatment center. Fifty-four patients (average age 64) were retrospectively reviewed and followed for at least 6 months after their definitive treatment. Primary outcome measures were rates of re-debridement, positive cultures at the time of re-debridement, rates of re-implantation, and re-infection after re-implantation.

RESULTS: The most common (25/54 knees) organism identified at the time of presentation was Staphylococcus (15 MSSA, 11 MRSA). All knees were re-debrided with antibiotic spacer exchange. Twenty-seven of these 54 knees had retained cement from their index arthroplasty identified at the time of re-debridement. Of the 54 knees, 22 (41%) grew an organism from a culture taken at the time of re-debridement. Forty-nine out of 54 (91%) knees were ultimately re-implanted with a TKA. Of the 49 knees re-implanted, only 1 (2.0%) had positive cultures at the time of re-implantation.

CONCLUSION: Patients referred for persistent infection after initial debridement and resection of their TKA have favorable results using re-infection after re-implantation as an endpoint. Re-debridement with removal of retained cement and antibiotic spacer exchange was performed in all patients. The high rate of positive cultures (41%) at the time of re-debridement strongly suggests that additional debridement and spacer exchange prior to proceeding with TKA re-implantation should be considered in this group.

Impact of Postoperative Wound Complications on Functional Outcomes After Primary Total Knee Arthroplasty

Abstract ID: Poster 114

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INTRODUCTION: Hematomas, drainage, and other non-infectious wound complications following total knee arthroplasty (TKA) have been associated with long-term sequelae, such as deep infection; however, the impact of these complications on function is unknown. This study compares range of motion (ROM) and functional outcomes in patients who were readmitted for wound complications following TKA to outcomes in patients without complications.

METHODS: Over a five-year period, 15 patients were readmitted for non-infectious wound complications within 90 days of an elective TKA. Each patient was matched to two patients who underwent TKA during the same period without complications, based on age, body mass index, and preoperative ROM. Range of motion, pain, and Knee Society Function Scores were compared between the two groups at minimum one year follow-up.

RESULTS: The average preoperative ROM in patients with wound complications was 4.2° to 109°. At mean follow-up of 2.1 years, these patients had an average ROM of 1.9° to 103°. The mean Knee Society Function Score improved from 33 to 46, which was not statistically significant ($p = 0.26$). Seventy-two percent of patients rated their pain as mild or greater. Patients without complications had similar preoperative ROM--3.8° to 107°. However, they had greater improvement in preoperative flexion contractures (mean improvement -3.5° vs. -2.3°, $p = 0.0004$) and average Knee Society Function Score (mean improvement 20 vs. 13 points, $p = 0.03$) at an average of 1.8 years. Fewer patients had mild or greater pain (34% vs. 72%, $p = 0.04$).

CONCLUSION: At two-year follow-up, patients with wound complications following TKA have greater flexion contractures, greater pain, and less improvement in Knee Society Function Scores, when compared to patients without wound complications following TKA.

Wound Complications with Therapeutic Anticoagulation After Total Joint Arthroplasty

Abstract ID: Poster 115

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INTRODUCTION: Venous thromboembolic events (VTE) are the most common complication following total joint replacement. This study prospectively compared mobile compression devices (MCDs) and warfarin regarding safety and efficacy for preventing VTE postoperatively and monitored related complications.

METHODS: Patients undergoing elective primary or revision knee or hip arthroplasty were enrolled in this prospective study. Patients were stratified to standard or high risk anticoagulation according to local clinical protocol.

Standard risk patients wore MCDs 10 days and took aspirin 6 weeks postoperatively. High risk patients received adjusted-dose warfarin 4 weeks and compression stockings 6 weeks postoperatively. Patients were followed prospectively for 6 months and monitored for complications, symptomatic VTEs, and hospital readmissions.

Changes in local clinical protocols affecting anticoagulation included changes in risk stratification and introduction of tranexamic acid (TXA) during surgery. Participants enrolled prior to changes in risk stratification were considered Phase 1; those after were considered Phase 2. Participants enrolled prior to institution of TXA were considered pre-TXA and after post-TXA.

RESULTS: 2,053 participants were eligible for 6 week follow-up. Of those, 1,336 were standard risk and 717 were high risk. The rate of VTE (DVT/PE) at 6 weeks was 0.4% in both risk groups (p=0.82). No differences were found in procedure (knee vs. hip p=0.54; primary vs. revision p=0.22), phase (p=0.82), or TXA status (p=0.41). Rate of major bleeding was significantly higher in high risk patients (2.4%) than standard risk (0.6%; p=.001). Again, no differences were found in procedure (knee vs. hip p=0.87; primary vs. revision p=0.97), phase (p=0.74), or TXA status (p=0.78).

CONCLUSION: Using MCDs for preventing VTE was equivalent to warfarin, even after changes in risk stratification and introduction of TXA. Use of MCDs resulted in a statistically significant decrease in major bleeding events compared to warfarin, which is important for patient satisfaction and reducing hospital readmissions.

Dodging Wound Problems in Complex Revision TKA: Laser-Assisted Indocyanine Green Angiography for Assessing Intraoperative Wound Viability

Abstract ID: Poster 116

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BACKGROUND: Complex revision total knee arthroplasty wound necrosis is a devastating complication. Laser-assisted indocyanine green angiography (LA-ICGA) technology provides surgeons with an objective, real-time assessment of skin perfusion in the operating room. This allows for surgeons to tailor closure/coverage of the surgical site to meet the anticipated problem, potentially avoiding complex flap soft tissue reconstructions while preventing skin necrosis or wound breakdown in primary closures. The purpose of this study is to review the use of LA-ICGA in complex revision total knee arthroplasty.

METHODS: Beginning in mid-2011, a LA-ICGA System was used to evaluate complex revision total knee arthroplasty soft tissue viability in cases where there was a perceived need for potential soft tissue reconstruction. A total of seven patients considered high risk for wound complications undergoing complex resection or revision total knee arthroplasty from 2011 to 2013 were included.

RESULTS: Skin and soft tissue coverage in seven complex revision or resection total knee arthroplasty wounds were evaluated with the LA-ICGA System. All incisions went on to heal without necrosis, or need for secondary flap coverage, skin grafting, or wound debridement/revision. LA-ICGA provides an objective assessment of perfusion, giving the surgeon the confidence that wound closure does not impair perfusion of the anterior knee skin flaps.

CONCLUSION: Implementation of LA-ICGA provides the surgeon with an objective assessment of skin flap perfusion resulting in reduction in complications as well as a decrease in the rate of skin necrosis. The objective assessment of skin flap perfusion allows the surgeon to tailor wound closure intraoperatively, in real-time, accommodating for the individual patient's skin perfusion. This paper is the first to describe the technology's use in a series of revision total knee cases.

Recent National Trends and Outcomes for Pulmonary Embolism After Total Knee Arthroplasty in the United States

Abstract ID: Poster 117

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INTRODUCTION: Pulmonary embolism (PE) is a rare but potentially devastating complication of total knee arthroplasty (TKA). Despite significant healthcare resources devoted to preventing PE, limited national data exists regarding the early results of this effort. The purpose of this study was to assess recent national trends in PE occurrence after TKA and evaluate patient outcomes related to this adverse event.

METHODS: International Classification of Disease - 9th Revision (ICD-9) procedure codes were used to search the National Hospital Discharge Survey (NHDS) for patients admitted to select U.S. hospitals after primary TKA for each year from 2001-2010. ICD-9 diagnosis codes were then used to identify patients from this population who developed an acute PE during the same admission. Data regarding patient demographics, hospitalization length, discharge disposition, lower extremity deep vein thrombosis, mortality, and hospital size/location were gathered from the NHDS. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test, z-test for proportions, and chi-square analysis with alpha=0.05.

RESULTS: 35,220 patients admitted for a primary TKA were identified. 159 (0.045%) of these patients developed an acute PE during the same admission. After adjusting for fluctuations in annual TKA performed, the development of PE after TKA demonstrated a weak negative correlation with time (r=-0.17), insignificantly decreasing from an average rate of 0.049% between 2001-2005 to 0.041% between 2006-2010 (p=0.26). Hospital size was found to significantly impact the occurrence of PE, with the lowest rate in hospitals under 100 beds (0.23%) and the highest rate in those with over 500 beds (0.65%, p=0.01). No significant differences in PE rate were noted based on U.S. region (p=0.38). Mean age of patients with PE was 67.7 years. This group included 54 men and 105 women. The non-PE group had a mean patient age that was insignificantly lower at 66.6 years (p=0.21) and included 12,450 men and 22,611 women. Gender was not significantly different (p=0.68) between those with and without PE. The number of medical co-morbidities was significantly higher in those with PE (mean 6.42 diagnoses) than those without PE (mean 4.89 diagnoses, p<0.01). Average hospitalization length also varied based on PE status, with significantly longer stays for those with PE (8.2 days, range 2-53) compared to those without PE (3.7 days, range 1-95, p<0.01). Rate of deep vein thrombosis was higher in the PE group (12.7%) vs. the non-PE group (0.48%, p<0.01). Mortality was also significantly higher for the PE group (3.9%) compared to the non-PE group (0.09%, p<0.01). Discharge disposition did not significantly vary based on PE status, with 61.5% of PE patients and 64.0% of non-PE patients discharged directly home (p=0.59).

DISCUSSION AND CONCLUSION: This study demonstrates that PE can have a significant impact on patient outcomes and healthcare costs, resulting in a 43-fold increase in mortality and a doubling of the inpatient admission duration. Additionally, although the risk of PE after primary TKA remains rare, efforts to prevent or minimize this complication over the last 10 years have not significantly impacted its occurrence at the national level. PE risk appears to be greatest in patients with multiple medical co-morbidities and established DVTs. Interestingly,

PE rate also demonstrated variability based on hospital size. The reasons for this are not clear, but we suspect larger hospitals are more likely to be tertiary-care centers and, therefore, care for more medically-complex patients.

Popliteal Artery Location in Total Knee Arthroplasty

Abstract ID: Poster 118

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INTRODUCTION: Injury to the popliteal artery (PA) is a rare but known risk of total knee arthroplasty (TKA), particularly during proximal tibial osteotomy and osteophyte removal. The goal of this study was to define the location and of the PA as it relates to the tibial osteotomy site in TKA.

METHODS: Magnetic resonance imaging (MRI) of the knee was reviewed for 100 adult patients. On axial images, the location of the PA was measured approximately 5 mm below the joint, the typical location of the tibial osteotomy. The distance between the PA and the tibial plateau was recorded in vector, medial-lateral (ML), and anterior-posterior (AP) directions. The vector distance was the shortest distance from the PA to any point on the tibial plateau. The ML measurement was the distance from the PA to the midline of the tibial plateau and the AP measurement was the distance from the PA to the tibial plateau, along a line in the anterior-posterior direction. Age, gender, ethnicity, height, and weight were recorded from each patient's medical chart. Statistical comparisons were made using Student's t-test and ANOVA analysis with a significance level of 0.05.

RESULTS: The study included 47 males and 53 females with a mean patient age of 41.5 years (range = 18-76), mean height 169.2 cm, and mean weight 84.8 kg. 52% percent of patients were African-American, 26% non-Hispanic Caucasian, 20% Hispanic, and 2% Asian. The mean vector distance was 7.06 mm (range = 2.2-15.1, standard deviation = 2.94), mean medial-lateral (ML) distance was 4.83 mm lateral (range = 0.0-13.0, standard deviation = 3.55), and mean anterior-posterior (AP) distance was 7.87 mm (range = 2.2-15.7, standard deviation = 3.18). Significant differences were seen in mean vector distances when comparing patients age ≤40 years to those >40 years (6.40 mm vs. 7.71, p=0.03), patients <82 kg to those ≥82 kg (6.27 mm vs. 7.73, p=0.02), and patients with body mass index (BMI) <29 to those ≥29 (6.19 mm vs. 7.81, p=0.0097). PA location did not vary significantly based on gender, ethnicity, or height.

CONCLUSIONS: This study demonstrates that the course of the PA is variable and can dangerously approach the tibial plateau, reaching as close as 2.2 mm. The location of the PA also appears to vary, with closest values found in patients that are ≤40 years old, weight <82kg, and BMI <29. Caution needs to be taken during TKA, particularly when demographic risk factors are present.

Prepatellar Fat Thickness Ratio as an Indicator of Infection Risk Following Total Knee Arthroplasty

Abstract ID: Poster 119

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CONTEXT: For decades, obesity has been a known risk factor in the development of osteoarthritis of the knees. As the obese population continues to grow, the prevalence of total knee arthroplasty (TKA) is likely to increase respectively. Following TKA, postoperative surgical site infection (SSI) is a significant cause of morbidity.

PROBLEM: Investigation of the correlation between obesity, as defined by Body Mass Index (BMI), and risk of SSI following TKA has been met with mixed results.

ASSESSMENT OF PROBLEM: It is our belief that this conflict is a result of the generalized nature of the BMI measurement and that a specific study of fat distribution surrounding the knee will yield a more precise corollary to SSI.

INTERVENTION/INSTRUMENT: We created the novel prepatellar fat thickness ratio (PFTR). Using preoperative lateral knee radiographs, this ratio describes the thickness of fat anterior to the patella relative to the patella thickness.

STUDY DESIGN: Records for all TKAs performed at our institution by two of the authors from 2006-2010 were retrospectively reviewed (N=530) and measured independently by two investigators.

MAIN AND SECONDARY OUTCOME MEASURES: PFTR was calculated and patient charts were subsequently reviewed for evidence of postoperative infection and other descriptive statistics.

RESULTS: There was no significant difference in measurements obtained by the two investigators. Approximately 2.3% (n=12) of the study sample developed a SSI. Logistic regression determined that for every 0.925 increase in PFTR, a patient's risk of developing a post-surgical infection increased 2.523 times (CI 95%). The ROC Curve analysis demonstrated that the PFTR variable performed the best for infection status predictability (p=0.03; AUC=0.68). Any PFTR above a 1.0 was estimated to have an above normal (2.5%) risk of infection, above 1.75 a 5% risk of infection, above a 2.5 a 10% risk, and above 3.0 was a 15% risk of infection.

CONCLUSIONS: PFTR was the best predictor (p=0.01) of SSI in our study. Only BMI >30.0 and the PFTR showed significant predictive value for infection. However, this BMI categorical determination does little to aid in risk stratification of patients. The PFTR allows for a simple approximation of infection risk using data easily obtained from preoperative lateral knee radiographs.

IMPLICATIONS FOR FURTHER STUDY: We believe that this novel ratio holds promise as a tool in the risk stratification of patients before undergoing TKA.

Medial Knee Fat Thickness: Correlation with BMI and Cross-Sectional Area of the Knee

Abstract ID: Poster 120

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INTRODUCTION: Obesity (BMI≥30) is a risk factor for surgical site infection (SSI) in total knee arthroplasty. However, BMI is crude and does not account for body mass distribution. Fat thickness is a better predictor for postoperative wound complication than BMI and obesity in many areas of the body. No studies have correlated BMI with medial knee subcutaneous fat depth. This study was designed to provide normative data between BMI and medial knee subcutaneous fat thickness.

METHODS: 1,123 adult PE protocol CTs from our morphomics registry were analyzed automatically using MATLAB (Natwick, MA). The distance from the skin to the anteromedial femoral condyle was determined at the level of the epicondyles, mimicking the medial peripatellar approach to the knee. Cross-sectional area of the knee was also determined. These were compared with BMI and a linear regression with prediction intervals was determined for gender and cross-sectional area.

RESULTS: Data presented as mean (±standard deviation). 654 (58%) females and 469 (42%) males. Mean age 54.5 years (±17.5). Mean BMI 29.8 (±8.9). BMI was moderately correlated with wound depth (r^2=0.383) and cross-sectional area (r^2=0.588), with cross-sectional area of the knee being moderately correlated with fat thickness (r^2=0.548). Females had a higher correlation between BMI and wound depth (r^2=0.4434 vs. r^2=0.2537), similar correlation between BMI and cross sectional area (r^2=0.5845 vs. r^2=0.5997), and a higher correlation between cross-sectional area and wound thickness (r^2=0.5953 vs. r^2=0.439) than males. Each additional unit of BMI was associated with an increase in medial knee fat thickness of 1.61 mm (1.56-1.67 95%CI); higher for females (1.66 mm, 1.59-1.73 95%CI) than males (1.45 mm, 1.37-1.54 95%CI). ($p<0.005$ for all comparisons).

CONCLUSION: Subcutaneous fat thickness is a risk factor for SSI, and targeted therapy towards this risk factor may be more economical in decreasing morbidity and costs associated with SSIs than BMI. Cross-sectional area of the knee is more strongly correlated with wound depth than BMI and can be estimated with a circumferential measurement of the knee.

Is Screening for Periprosthetic Joint Infections Using ESR and CRP per AAOS Clinical Guidelines Cost Effective?

Abstract ID: Poster 121

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BACKGROUND: Until recently, there has been no consensus of the best approach to dIfferentiating aseptic from septic loosening in joint replacement patients. The recent AAOS Clinical Practice Guideline Summary that was published in 2010, tasks orthopedic surgeons with the strong recommendation of obtaining ESR and CRP for all patients needing hip and knee arthroplasty revision surgery and aspirating the joint based upon these results. The purpose of this study is to determine from our patients whether this guideline has been helpful and cost effective in determining periprosthetic joint infections.

METHODS: We retrospectively reviewed charts of 50 consecutive patients who underwent revision total hip or knee arthroplasty. Each patient received an ESR and CRP level prior to operation and patients with known periprosthetic joint infections were excluded from the study. As guidelines recommend, aspiration with cultures and cell count were obtained on all knees with either elevated ESR or CRP and all hips with both ESR and CRP elevated. We then determined how many patients needing revision arthroplasty of the hip or knee benefited from ESR, CRP, and aspiration by finding subclinical periprosthetic infection and changing the intraoperative treatment. Hospital charge data was used to report cost of this protocol.

RESULTS: Sixty-four percent (32/50) patients had elevated ESR and/or CRP. Eighteen patients (12 hips; 7 knees) required joint aspirations per the guidelines. None of the aspirations were positive for bacterial growth. The total hospital charges for aspiration and cultures in this patient population were $81,712.44. No sub clinical infection was identified.

CONCLUSION: Although guidelines may more readily diagnose every case of subclinical joint infection, we must continue to evaluate the cost of this type protocol in a busy revision practice.

Synovial Aspirate Characteristics: Do Successful and Failed Total Knee Arthroplasties Differ?

Abstract ID: Poster 122

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SUMMARY SENTENCE: Prospectively collected synovial aspirations of patients with painless well-functioning total knee arthroplasties (TKA) were compared to various causes of failure and found to have significantly lower WBC counts.

BACKGROUND: Synovial aspiration has been used to differentiate periprosthetic sepsis from other causes of failure in revision TKA. These analyses have always compared varying causes of TKA failure without having a baseline of normal results for comparison. There are no previous reports describing the attributes of synovial fluid after a successful, painless TKA or how these aspirations compare to aspirates in various causes of failure.

METHODS: The operative logs of the two senior authors were assessed and all patients who underwent revision TKA since 2004 were retrospectively reviewed. Simultaneously, patients at least six months status post TKA with a painless and well-functioning joint were prospectively aspirated. Age, gender, Charlson comorbidity index (CCI), body mass index (BMI), time from primary replacement to aspiration, and synovial aspirate characteristics were collected. Aseptic loosening was defined as gross intraoperative movement in the absence of infection; periprosthetic sepsis was defined using a combination of criteria as previously validated in the literature. Mann-Whitney U tests and t-tests were performed as appropriate for data normality.

RESULTS: 212 with failed TKAs and 10 patients with painless TKAs met our inclusion criteria. Causes of failure other than aseptic loosening and prosthetic sepsis included periprosthetic fractures, component malpositioning, polyethylene wear, arthrofibrosis, and reimplantation after placement of an antibiotic impregnated polymethylmethacrylate spacer. No significant differences existed in age, gender, BMI, CCI, or time from primary TKA to aspiration ($p>0.378$ in all cases). WBC counts, segmented cell counts, lymphocyte cell counts, monocyte cell counts, absolute segmented cell count, absolute lymphocyte cell count, and absolute monocyte cell counts significantly differed between patients with aseptic loosening, periprosthetic sepsis, other causes of failure, and patients with well-functioning TKAs, with the normal patients having lower WBC counts and lower lymphocyte counts ($p<0.001$ for each variable, Table 1.)

DISCUSSION: Aspiration characteristics in patients with painless, well-functioning TKAs do differ from those with failed TKAs of various etiologies, suggesting synovial aspiration may play a role in differentiating extra-articular from intra-articular causes of knee pain after TKA. Surgeons may be suspicious of an intra-articular source of pain with WBC counts of >1000. To the best of the author's knowledge, this is the first report of the characteristics of synovial fluid in painless, well-functioning TKAs.

Click here to view Table

Serum Inflammatory Markers for Periprosthetic Knee Infection in Obese vs. Non-Obese Patients

Abstract ID: Poster 123

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INTRODUCTION: Elevated C-reactive protein (CRP) (>1.0 mg/dL) and Erythrocyte Sedimentation Rate (ESR) (>30 mm/hr) help diagnose periprosthetic joint infection (PJI). However, obesity is a pro-inflammatory state with elevated baseline CRP. This study sought to determine appropriate CRP and ESR cut-off values for PJI in obese patients after total knee arthroplasty (TKA).

METHODS: 1,507 consecutive revision TKA patients (2001-2008) at a large academic institution were retrospectively reviewed for demographics, comorbidities, medications, and laboratory values (CRP, ESR, CBC, synovial fluid cell count, cultures). Patients with no synovial aspiration (n=1,359) or no body mass index (n=41) were excluded. Musculoskeletal Infection Society criteria were used to classify the remaining 107 patients into four cohorts: (1) non-infected, non-obese (n=15); (2) non-infected, obese (n=27); (3) infected, non-obese (n=23); and (4) infected, obese (n=42). Data were analyzed using Student's t-tests and receiver operating characteristic curves.

RESULTS: Age, gender, comorbidities, and use of immune-modulating medications were similar among obese and non-obese cohorts. Calculated predictive cut-off values were 3.6 and 1.4 mg/dL for CRP, and 36.5 and 32.5 mm/hr for ESR, for obese and non-obese patients, respectively. Areas under the curve were 0.893 and 0.887 for CRP, and 0.906 and 0.894 for ESR, in obese and non-obese patients, respectively. Compared to traditionally reported values, the new CRP cut-off for obese patients achieved higher accuracy, specificity, and positive predictive value, but poorer sensitivity and negative predictive value. For non-obese patients, the new CRP cut-off outperformed the traditional cut-off value in every aspect except sensitivity, in which the two were equivalent.

CONCLUSION: Obese patients may require higher CRP cut-off in PJI diagnosis than non-obese patients. While traditional cut-off values may cause over-diagnosis in obese patients, we recommend using CRP with other clinical factors to better screen for PJIs in these patients, since a missed PJI can lead to devastating complications.

Cementless vs. Cemented Tibial Implants in Primary Total Knee Arthroplasty

Abstract ID: Poster 124

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INTRODUCTION: The ideal fixation for tibial components in total knee arthroplasty (TKA) remains controversial as minimal data exists comparing the two fixation modalities. We hypothesize that cementless compared to cemented fixation will have a higher early implant failure rate related to aseptic loosening in primary TKA.

METHODS: We identified 148 primary TKAs in 129 subjects (17 bilateral) for this study by matching 74 cemented tibial implant cases to 74 consecutive cementless cases from a data repository of 379 operative TKAs from 2008 to 2012. Subjects were matched on age, body mass index (BMI), and gender and only included if they had no history of prior open knee surgery and had complete data for Knee Society Scores and radiographic follow-up. Patient demographics were as follows: mean age 56±6 years, 59 males/89 females, mean BMI 37±8 kg/m^2 (range 23 - 64). There were no significant differences in age (p=0.475), gender (p=0.867), or BMI (p=0.526) between both cohorts. Chi squared and Student's t-tests were used to compare complication rates and Knee Society Scores with a significance level set at $p<0.05$.

RESULTS: In our sample, there were 5 revisions, 6 cases of radiographic tibial loosening, and 1 postoperative ankle fracture due to a fall. All 5 revisions were for aseptic tibial loosening in the cementless tibia group (p=0.066). Five of the 6 patients with radiographic loosening underwent the aforementioned revisions with one patient functioning well despite the loose component. Cemented fixation showed significantly greater improvement in Knee Society function scores 6-week follow-up, as cemented patients improved by a mean of 5 points, while cementless patients showed an average decrease of 5 points in score (p=0.007). At 12 months, cemented patients improved by a mean of 17 points while cementless patients improved by 10 points (p=0.235). At 6 weeks, Knee Society pain scores improved by a mean of 17 points in cemented patients and 15 points in cementless cases (p=0.736). At 12 months, cemented patients improved by a mean of 21 points while cementless patients improved by 24 points on average (p=0.631).

CONCLUSION: Despite showing a higher rate of tibial loosening and revisions, cementless tibial implantation yields clinical pain and function scores that are comparable to cemented fixation. The question remains can we improve upon early aseptic loosening in cementless TKA and what percentage of early failure is worth the benefit of potential lifelong fixation associated with biologic ingrowth of tibial components.

Total Knee Arthroplasty in Blount Disease and Blount-Like Deformity

Abstract ID: Poster 125

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INTRODUCTION: Blount disease, also known as tibia vara, is accompanied by additional deformities including internal torsion, proximal tibia procurvatum, and soft tissue abnormalities. There is a higher predisposition in those who are obese, of African ancestry, and who began to walk at a premature age. An increased risk for TKA prosthesis failure exists in obese patients; however, to our knowledge, there has never been a study examining TKA in patients with Blount disease. This abstract describes a series of patients undergoing TKA with Blount disease or Blount-like deformity and highlights potential difficulties in this patient population.

METHODS: Cases were provided by recall from four academic arthroplasty surgeons, past or present, at our institution. These charts were reviewed for demographic data, measurement of preoperative metaphyseal-diaphyseal angles, notes of surgical procedures performed, and length of follow-up.

RESULTS: Five cases were identified from 2004-2010, four males and one female. Four were African American and one Caucasian. Eight TKAs were performed. Average age at index procedure was 50.8 years (median 52). Average BMI was 35.9 (median 38). Two patients had procedures for weight loss. The average proximal tibia metaphyseal-diaphyseal angle was 19.8°, with only one knee in the series being less than 18°. Four of eight (50%) knees required a constrained insert at index procedure. Additionally, one of the knees not needing a constrained insert did require a tibial stem. Mean follow-up was 48 months (median 22 months). One patient has gone on to need two revisions on each knee, now having hinged prosthesis at the age of 46. No other patient has yet required revision.

CONCLUSIONS: Patients needing TKA with Blount disease or Blount-like deformity present a challenging clinical problem. They are relatively young and obese with substantial deformity of the proximal tibia. Intraoperatively, this requires extensive release for soft tissue balancing that, in this series, required an increased need of constrained inserts. The patient with longest follow-up (nearly 10 years) has required several revisions for instability. Appropriate discussion of revision risks is important when considering TKA in these patients.

Severe Coronal Plane Deformity in Total Knee Arthroplasty Utilizing Patient Specific Instrumentation

Abstract ID: Poster 126

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INTRODUCTION: Patient specific instrumentation (PSI) is an innovative technology in total knee arthroplasty. With the use of a preoperative MRI or CT scan, custom guide blocks are individually manufactured for each patient. PSI utilizes a measured resection technique rather than a primarily ligament balancing technique. This has the potential to negatively affect the operating surgeon's ability to achieve optimal soft tissue balancing, which is especially critical in patients with severe lower extremity malalignment. It remains unclear whether a surgeon using PSI can achieve optimal soft tissue balancing using a measured resection technique. The purpose of this study is to evaluate the efficacy of PSI in patients with severe preoperative limb alignment deformities.

METHODS: Fifty PSI total knee arthroplasties were performed on 46 patients (21 male, 25 female) using a Patient Specific Instrumentation. Each patient included in the study had a minimum preoperative deformity of at least 10° varus or valgus measured on preoperative long leg standing radiographs, preoperative software, or both. Preoperative mechanical axis alignment measurements were obtained using the PSI preoperative planning software and were manually calculated using preoperative long leg standing radiographs. Postoperative mechanical axis alignment measurements were calculated using plain long leg standing radiographs. The Knee Society Scoring System was used to evaluate clinical and functional outcomes at 1 to 6 months postoperatively.

RESULTS: Average preoperative deformity as calculated with the PSI preoperative planning software and as measured on plain radiographs were 11.5° and 13.3°, respectively. Average postoperative mechanical axis was 3.4° (0.1°-14.4°) measured from plain radiographs. The average angle between the femoral mechanical axis (FMA) and femoral component was 88.1° (79.3°-93.7°). The average angle between the tibial mechanical axis (TMA) and tibial component was 88.1° (78.4°-90.7°). The average difference between the femoral mechanical and anatomic axes was 6.2° (4.2°-9.1°). No patients required soft tissue releases intraoperatively. The American Knee Society criterion showed an aggregate average score of 81.5. .

CONCLUSION: Patient specific instrumentation (PSI) is an innovative technology in TKA utilizing a measured resection technique. It has not been previously established whether or not this technology is effective at restoring optimal soft tissue balance in TKA. This study demonstrates that PSI is capable of producing favorable radiographic and clinical outcomes in a subset of patients with at least 10° of malalignment preoperatively. We believe PSI is an accurate and effective tool for use in patients with severe preoperative angular deformities of the knee.

Total Knee Arthroplasty without Superficial Medial Collateral Ligament Release for Varus Arthrosis

Abstract ID: Poster 127

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INTRODUCTION: It is frequently stated that to be successful, a total knee arthroplasty (TKA) must be “aligned and stable”. The technique for obtaining a "stable" TKA has historically focused on balance wherein the Media Collateral Ligament (MCL) and Lateral Collateral Ligament (LCL) are equally tensioned throughout range of motion. Most surgeons have suggested that MCL release is necessary in the correction of varus deformity to lengthen a "contracted" MCL so that the MCL and LCL can be equally tensioned. The senior author has 14 years of experience with TKA implantation without release of the superficial MCL using a prosthesis that is more stable on the medial side than the lateral. We hypothesize that TKA using this prosthesis does not require superficial MCL release in order to produce a stable arthroplasty.

METHODS: For this study, we retrospectively reviewed 100 consecutive TKAs for the presence of preoperative osteoarthritis with varus deformity. These patients were evaluated with a telephone for survey regarding symptoms of pain and instability. At the time of the writing of this abstract, 46 patients with 58 TKAs responded to our survey.

RESULTS: Average varus deformity was 9.8° (maximum varus deformity of 23°) and 37% reported pain while only 14% had symptoms of severe, sharp, or constant pain (the remaining only reporting dull intermittent pain). Eight percent reported any symptoms of instability or giving away and 95% reported satisfaction with their outcome. Using logistic regression neither pain ($p=0.546$) or instability ($p=0.585$) was associated with degree of varus deformity corrected.

CONCLUSION: Based on the current data, we conclude that medial release is not necessary to produce a stable TKA when this type of asymmetric prosthesis is implanted.

Highly Cross-Linked vs. Conventional Polyethylene in Posterior-Stabilized Total Knee Arthroplasty at a Minimum Five-Year Follow-Up

Abstract ID: Poster 128

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INTRODUCTION: Although commonly used, the clinical performance of highly crosslinked polyethylene in total knee arthroplasty (TKA) remains unknown and concerns exist regarding fatigue resistance and oxidation, particularly in posterior-stabilized (PS) designs. The purpose of this study is to compare highly crosslinked and conventional polyethylene in a PS TKA design at a minimum of 5 years.

METHODS: A prospective cohort study of 114 consecutive TKAs in 83 patients was performed as a subset of a multi-center prospective study. All TKAs utilized an identical PS design. Conventional polyethylene inserts were used in 50 knees, and second-generation highly cross-linked polythethylene inserts were implanted in 64 TKAs. All patients were followed with clinical outcome measures (Short-Form 36, Knee Society Scores, WOMAC and LEAS) and radiographically for a minimum of 5 years.

RESULTS: The mean age of the highly cross-linked polyethylene group was 4 years less than the conventional group (p=0.03). There was no difference in BMI (p=0.3) or preoperative outcome measures between groups with numbers available. Seven patients died or were lost to follow-up and one underwent revision for infection at 3 months postoperatively. 103 TKAs obtained minimum 5-year follow-up. Mean Knee Society Scores were 12 points higher (p=0.01) and 14 points higher (p=0.005) in the physical function subset of the SF-36 in the highly cross-liked polyethylene group. There was no difference in the other outcome measures with the numbers available. There was no radiographic osteolysis or mechanical failures related to the tibial polyethylene in either group.

CONCLUSION: Mechanical failure or radiographic osteolysis was not observed with either conventional or highly cross-linked polyethylene in this PS TKA design at mid-term follow-up. To our knowledge, this is the first minimum 5-year follow-up of highly cross-linked polyethylene in a posterior-stabilized design. While the results support comparative safety, longer-term follow-up is warranted to determine if wear resistance and mechanical properties of highly crosslinked polyethylene are maintained.

SIGNIFICANCE: Concerns regarding early fatigue failure and mechanical complications related to the PS post-cam articulation of highly-crosslinked polyethylene in TKR were not substantiated at a minimum of 5 years clinical follow-up in this prospective cohort study. Highly cross-linked polyethylene demonstrated clinical equivalency compared to conventional polyethylene, even when used in a younger and presumably more active patient group.

Flexion-Extension Gap in Cruciate-Retaining vs. Posterior-Stabilized Total Knee Arthroplasty: A Cadaveric Study

Abstract ID: Poster 129

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INTRODUCTION: The purpose of this study is to re-evaluate experimental model results using half-body specimens with intact extensor mechanisms and navigation to evaluate cruciate-retaining (CR) and posterior stabilized (PS) component gaps through an entire range of motion.

METHODS: Eight sequential testing regimens were conducted with knee intact, with CR TKA in place, with PS TKA with quadriceps tendon in place, and with PS TKA with sectioned quadriceps tendon in place, with and without traction at each stage. The amount of traction used was 22N. Each knee (n=10) was taken through 6 full ranges of motion at every stage. At each stage, corroboration of navigation findings was attempted using a modified gap balancer to take static gap measurements at 0° and 90° with 12 in. lbs of torque applied.

RESULTS: There was not a significant difference between loaded and unloaded component gaps, and there was no statistically significant difference in component gapping between CR and PS knees throughout a full range of motion. When comparing the static flexion-extension gap data to that of Mihalko study, the difference in full extension gap data was statistically significant (current study: 0.11±0.82 mm, Mihalko: 0.4±0.45 mm). However, the difference in 90° flexion gap data was significant (current study: 0.09±1.48 mm; Mihalko: 5.26±1.90 mm). A comparison of the sectioned unloaded and sectioned loaded quadriceps tendon constructs was done, giving a range of distraction of tibio-femoral gaps from 1.85 to 5.22 mm and 1.46 to 4.60 mm, respectively. When compared to Mihalko study, at full extension the distraction tibio-femoral gap was 1.45 mm (quadriceps sectioned unloaded) and 1.06 mm (quadriceps loaded) more.

CONCLUSION: There was no difference in kinematics when comparing CR and PS TKA component designs. We conclude that the sectioned quadriceps tendon influences knee flexion-extension gaps in a PS TKA construct. This finding suggests that intact extensor mechanisms may be required to perform proper kinematic studies of TKA.

Preoperative Patient Education for Hip and Knee Arthroplasty: Financial Benefit?

Abstract ID: Poster 130

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PURPOSE: Total knee and hip arthroplasty is a commonly performed surgical procedure. As the population ages, the numbers of these procedures are predicted to increase. Maximizing patient outcomes and decreasing healthcare delivery costs will be essential to creating a higher value U.S. healthcare system. The purpose of our study was to analyze the effect of a multidisciplinary preoperative education program (Joint Academy) on various outcomes that affect overall cost of primary hip and knee arthroplasty.

METHODS: A retrospective review of 904 patients' charts that underwent primary total hip and knee arthroplasty from October 1, 2010, to September 31, 2011, at a single institution was performed. We then compared 102 patients who did not have preoperative education to 802 patients who did have preoperative education through the Joint Academy (JA). We looked at patient length of stay (LOS), discharge disposition, and internal hospital cost. Linear regression was performed on all data to look for statistical significance.

RESULTS: We found that those patients that participated in JA had a length of stay that was 2.12 days less than those that did not participate in the Joint Academy. We also found that in the JA group, patients were 62% more likely to be discharged to home vs. patients in the non-JA group. We also found that the JA group had lower internal hospital costs; with the JA group on average costing $1,493 less than the non-JA group. All referenced findings were statistically significant.

CONCLUSION: When looking at future global or episodic payment plans in the future, all costs of care delivery will be scrutinized. To our knowledge, internal hospital costs have not been evaluated in any other studies in regards to preoperative patient education. The decrease in variable costs seen at our institution with JA patients may help justify the benefit of allocating resources to preoperative patient education programs and in turn decrease the overall cost of hip and knee arthroplasty.

SIGNIFICANCE: The Joint Academy decreased patient length of stay, improved their chances of discharge to home, and decreased internal hospital costs. Multidisciplinary preoperative patient education may provide a cost efficient means to reduce overall healthcare cost and improve a patient's ability to return home more quickly.

Equivalence Testing of Traditional Electrocautery, Argon Beam Coagulation, and Bipolar Sealer in Primary Total Knee Arthroplasty

Abstract ID: Poster 131

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INTRODUCTION: Controversy exists regarding cost-effectiveness of hemostasis methods in arthroplasty.

METHODS: This is a retrospective cohort study of 280 primary total knee arthroplasty (TKA) cases (203 bipolar sealer [BS], 36 Argon Beam Coagulation [ABC], 41 traditional electrocautery [TE]) in which we used estimated blood loss (EBL), 48-hour wound drainage, operative time, and change in hemoglobin (at <24 hours postoperatively and upon discharge) to compare hemostatic effectiveness. Given the hypothesis that all techniques are clinically equivalent, Two-One-Sided-Tests (TOSTs) of equivalence were run (JMP software, alpha=0.05). Clinical insignificance thresholds were 150mL of EBL or wound drainage, 1g/dL change in hemoglobin, and 10 minutes of operative time. Demographics and transfusion requirements were analyzed with ANOVA and Chi-Squared tests.

RESULTS: Age (p=0.1487), sex (p=0.5554), and indication (p=0.3983) were not significantly different among cohorts. Mean BMI was statistically but not clinically different (ABC=40.9kg/m^2±1.6, BS=35.8kg/m^2±0.7, TE=35.6kg/m^2±1.5, p=0.0120). Mean EBL was equivalent among cohorts (ABC=83mL±169, BS=56mL±62, TE=131mL±275, p_{ABC-BS}<0.0001, p_{ABC-TE}=0.0004, pBS-TE=0.0005). Mean wound drainage was equivalent between ABC (576mL±296) and BS (608mL±392, p=0.0412), but not TE (375mL±333, p_{ABC-TE}=0.7259, p_{BS-TE}=0.9038). Excluding patients who received transfusions, mean changes in hemoglobin at <24 hours postoperative were equivalent (ABC=2.09g/dL±0.82, BS=1.68g/dL±0.96, TE=1.78g/dL±0.98, p_{ABC-BS}=0.0002, p_{ABC-TE}=0.0014, p_{BS-TE}<0.0001). Mean change in hemoglobin upon discharge was equivalent among all cohorts (ABC=2.87g/dL±1.13, BS=2.99g/dL±1.15, TE=3.17g/dL±1.67, p_{ABC-BS}<0.0001, p_{ABC-TE}=0.001, p_{BS-TE}<0.0001). Mean operative times were not equivalent (ABC=89min.±17, BS=99min.±26, TE=101min.±17, p_{ABC-BS}=0.4985, p_{ABC-TE}=0.6520, p_{BS-TE}=0.0770). Utilization of postoperative transfusions was not significantly different among cohorts ($\chi 2$=3.679, p=0.1589).

CONCLUSION: While operative times are longer with TE, its EBL, changes in hemoglobin, and transfusion necessities are equivalent to ABC and BS. TE is also less expensive and had reduced postoperative drainage; thus, the expense of newer technologies may not be justified.

Recent National Trends and Outcomes for Unilateral and Bilateral Total Knee Arthroplasty in the United States

Abstract ID: Poster 132

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INTRODUCTION: Patients with bilateral knee arthritis will often inquire about having both knees replaced simultaneously. Although single-stage/same-admission bilateral total knee arthroplasty (TKA) is an option for these patients, controversy exists regarding its risks and benefits over unilateral TKA. The purpose of this study was to assess recent national trends in unilateral and bilateral TKA and to evaluate perioperative outcomes for each group.

METHODS: International Classification of Disease - 9th Revision (ICD-9) procedure codes were used to search the National Hospital Discharge Survey (NHDS) for patients admitted to select U.S. hospitals after unilateral and bilateral TKA for each year from 2001-2010. Data regarding patient demographics, hospitalization length, discharge disposition, blood transfusions, lower extremity deep vein thrombosis (DVT), pulmonary embolism (PE), mortality, and hospital location were gathered from the NHDS. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test, z-test for proportions, and chi-square analysis with a significance level of 0.05.

RESULTS: 35,220 patients admitted for TKA were identified. 2,154 (6.1%) of these patients had bilateral TKA completed during a single admission. 33,066 (93.9%) patients had only a unilateral TKA performed. After adjusting for fluctuations in annual TKA performed, the use of bilateral TKA demonstrated a moderate negative correlation with time ($r=0.61$), significantly decreasing from an average utilization rate of 6.4% between 2001-2005 down to 5.8% between 2006-2010 ($p=0.03$). The location of the hospital was found to significantly impact the utilization of bilateral TKA, with the lowest rate seen in the West region (4.3%) of the U.S. and the highest rate seen in the Midwest region (7.9%). The mean age of bilateral TKA patients was 64.6 years. This group included 900 men and 1,254 women. The unilateral group had a mean patient age that was significantly higher at 66.8 years ($p<0.01$) and included 11,604 men and 21,462 women. Gender was significantly different ($p<0.01$) between those with bilateral TKA (41.8% male) and those with unilateral TKA (35.1% male). Average hospitalization length also varied based on TKA status, with significantly longer stays for those with bilateral (mean 4.2 days) compared to those with unilateral (mean 3.7 days, $p<0.01$). The rate of blood transfusion was significantly higher in the bilateral TKA group (36.4%) vs. the unilateral TKA group (16.9%, $p<0.01$). There was no difference in the rate of DVT (0.65% vs. 0.65%, $p=0.99$), but the rate of PE was significantly higher in the bilateral TKA group (0.97% vs. 0.42%, $p=0.01$). Mortality was not significantly different for bilateral TKA (0.15%) when compared to unilateral TKA (0.11%, $p=0.64$). Discharge disposition significantly varied based on TKA status, with only 46.2% of bilateral patients able to go directly home after their inpatient stay, compared to 64.9% of unilateral patients ($p<0.01$).

DISCUSSION AND CONCLUSION: This study demonstrates that, despite a younger patient population, bilateral TKA is associated with more blood transfusions, higher rates of PE, longer hospitalizations, and more post-admission rehabilitation requirements than unilateral TKA. Possibly due to these reasons, as well as diminishing reimbursement, the use of bilateral TKA in

the U.S. appears to be declining. Interestingly, bilateral TKA utilization demonstrated variability based on hospital region. The reasons for this are not immediately clear, but may be related to differences in regional training or insurance reimbursement.

Correlation of Patient Confidence in Attaining Treatment Goals and Outcomes After Knee Arthroplasty

Abstract ID: Poster 133

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INTRODUCTION: Risk stratification for adverse outcomes and improvement of function after total knee arthroplasty (TKA) is needed to appropriately devote limited resources to patients in most need. Additionally, TKA outcomes drive assessment of quality and payment of services; therefore, a risk stratified assessment is paramount for an objective evaluation. This stratification can be affected by multiple factors including patient motivation. This study attempted to identify the correlation of patient's preoperative confidence in their ability to return to desired activity level after TKA and improved outcomes and function.

METHODS: A continuous series of all TKA procedures (uni- and bilateral primary and revisions) from January 2008 to December 2010 in a large healthcare system was retrospectively reviewed. Patients included reported pre- and postoperative knee injury and osteoarthritis outcomes scores (KOOS) and SF-12 scores, and responded to a question regarding the desired activity level they wanted to attain after surgery. Additionally, a level of confidence (0-10 scale) in attaining such goals was reported. Gender, age, body mass index, level of education, and smoking status were collected. Additionally, length of stay (LOS), 30-day readmission and reoperation, and 1-year infection rates were collected. Correlation of patient confidence in attaining treatment goals and the outcomes collected was established using multiple linear and logistic regression models that were adjusted for gender, age, BMI, baseline SF-12 mental component scores, college education, smoking status, baseline functional scores, and length of follow-up.

RESULTS: Of 1314 eligible primary TKA, 28 bilateral and 203 revision TKA patients, 1020 primary, 18 bilateral and 177 revision TKA patients completed their postoperative questionnaires with an average follow-up of 430, 411, and 376 days, respectively. Patients were confident in achieving their functional outcomes, with an average score of 7.7 (standard deviation: 2.1; range 0-10) for primary TKA, 9.3 (standard deviation: 0.5; range 9-10) for bilateral TKA, and 6.4 (SD: 2.6; range 0-10) for revision TKA patients. There was direct correlation of patient confidence in attaining treatment goals and shorter LOS ($p=0.005$), and no correlation with readmission, reoperation, and infection. Patient confidence was correlated with improved function and pain KOOS ($p<0.001$) and SF-12 physical scores ($p<0.001$) after primary TKA. Only physical function ($p<0.044$) was affected by patient's confidence after revision arthroplasty.

CONCLUSION: Patient's confidence in attaining treatment goals after primary TKA has a direct correlation with shorter LOS and improved function. Patient motivation and factors affecting it should be weighted when stratifying patients undergoing TKA and measuring outcomes.

Total Knee Arthroplasty in the 80-Year-Old and Older Patient Population

Abstract ID: Poster 134

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BACKGROUND: In recent years, as total knee arthroplasty (TKA) has widely come to be viewed as a safe and successful surgical operation, the age range and demographic diversity of prospective patients considering TKA has noticeably expanded. As noted by Patil and Wakankar (2008), due to such knowledge, garnered from two decades of investigation into the intricacies of TKA procedures, surgeons' comfort levels in proceeding with surgery on those increasingly advanced in age, specifically patients aged 80 and older, have rocketed. Keeping in mind the ceaselessly rising age of TKA patients, the primary concern of this study will be to analyze the validity and efficacy of TKA performed in patients of the 80 and over age range, searching for contraindications, and weighing the consequences of performing surgery in a physically fragile population.

OBJECTIVES: The purpose of this study was to compare the early clinical outcomes of total knee arthroplasty in the patient population 80 years of age and older to a matched control group of patients between the ages of 55 and 65.

METHODS: A retrospective analysis of 55 consecutive patients 80 years of age and older (study group) was performed, and compared to 66 consecutive patients between the age of 55 and 65 (control group). All procedures were performed by one surgeon under a single anesthetic. The same preoperative patient selection criteria were used for all patients.

Clinical outcomes were assessed including anesthesia type, tourniquet time, length of stay, transfusion rate, preoperative hemoglobin, postoperative hemoglobin, preoperative range of motion, postoperative range of motion, DVT, and PE. Knee Society Score (KSS) and Functional KSS were assessed preoperatively and 1 year postoperatively. Anatomic and mechanical axis evaluation was also performed on all patients with long standing radiographs pre- and postoperatively.

Discharge disposition, fall episodes, manipulation under anesthesia, revision, and patient satisfaction scores were also evaluated. A control group of 66 consecutive patients undergoing unilateral total knee arthroplasty during this same time period were identified and matched for the year of surgery, and prosthesis type. The same selection criteria were used for the control group and the same data points were evaluated.

RESULTS: Fifty-five consecutive patients 80 years of age and older undergoing total knee arthroplasty were retrospectively reviewed and compared to 66 consecutive patients between the ages 55 and 65. There was no statistically significance difference in the number of falls, MUA, and revision TKA between the control group and the study group ($p< 0.05$). Patient satisfaction scores, length of stay, and activity scores were also similar between the two groups, with no statistically significant difference ($p<0.04$).

The Knee Society Scores at 52 weeks follow-up were also comparable; however, the Knee Functional Scores were different between the two groups with a functional score of 61 for the study group, and a functional score of 82 for the control group at one-year follow-up. In addition, a higher percentage of the study group patients were discharged to an assisted care facility than the control group.

The average anatomic axis was 6° valgus with a neutral mechanical axis restored in all patients.

CONCLUSION: Total knee arthroplasty continues to be a highly successful surgical procedure for the treatment of osteoarthritis of the knee. With the changing demographics of the aging population, the incidence of total knee arthroplasty will continue to rise, particularly in the more elderly patient population. With appropriate patient selection and preoperative evaluation, high success in the 80-year-old and older population can be achieved comparable to the younger patient. With appropriate clinical indications, total knee arthroplasty can be a highly successful treatment alternative for the older patient, and should not be avoided as a treatment alternative based on age alone.

Technique Does Affect Resection Symmetry and Thickness of the Patella During Total Knee Arthroplasty: A Prospective, Randomized Controlled Trial of Three Techniques

Abstract ID: Poster 135

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INTRODUCTION Patellar instability and anterior knee pain are known possible complications during total knee arthroplasty (TKA); however, risks may be reduced by resurfacing the patella in a symmetric fashion to the appropriate thickness. The accuracy of various resection techniques has not been compared head to head. The purpose of this study was to evaluate the effectiveness of 3 different resection techniques: use of cutting guide, free hand resection with haptic feedback, and a novel free hand technique utilizing four quadrant measurements.

METHODS: A total of 75 patients undergoing elective TKA were prospectively enrolled and randomized to receive patellar resurfacing by one of the 3 study techniques. All procedures were completed by 3 arthroplasty surgeons, and each performed all of the study techniques in equal proportions. Variables analyzed included pre-resection thickness, goal for resection thickness, symmetry of resection, obtainment of resection goal, and time to complete. Symmetry was evaluated by measuring patellar thickness in four quadrants and noting the discrepancy between the thickest and thinnest regions. Obtainment of goal was analyzed by noting the difference between the resection goal and the actual thickness obtained.

RESULTS: Of the patients undergoing patellar resection by either use of a cutting guide (Group 1, n=25), free hand with haptic feedback (Group 2, n=25), or free hand with four quadrant feedback (Group 3, n=25), the mean post-resection asymmetry noted was 1.74 mm, 1.46 mm, and 0.98 mm ($p=0.021$) for groups 1, 2, and 3, respectively. The most accurate method for restoring thickness was the haptic feedback method (0.61 mm mean discrepancy) followed by the novel four quadrant technique (0.83 mm) and the patellar cutting guide (1.50 mm) ($p<0.001$). The average time to complete each technique was 129 seconds (s), 103 s, and 109 s respectively for groups 1, 2, and 3 ($p=0.309$). Statistical significance was not obtained when comparing the outcomes of surgeons historically preferred techniques to their less preferred techniques ($p=0.078$).

CONCLUSIONS: Use of a patellar cutting guide resulted in increased patellar asymmetry and decreased accuracy in obtaining desired patellar thickness compared to the other study techniques. It also required slightly more time to complete. When performing patellar resurfacing during TKA, great care should be taken to ensure that precise bony resection is performed, especially when using a patellar cutting guide as this technique tends to produce a less symmetric patellar resection than the free hand methods described in this study.

Less Invasive Surgical Approaches Do Not Affect Patellar Tilt and Tracking After Knee Arthroplasty

Abstract ID: Poster 136

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SUMMARY: There was no difference in postoperative patellar tilt in patients undergoing UKA through three different surgical approaches.

INTRODUCTION: In total knee arthroplasty (TKA), surgical approach is one of several factors (femoral rotation, coronal plane alignment, resurfacing of patella, etc.) that may be associated with potential for patellar maltracking and subsequent anterior knee pain. The effects of surgical approach on patellar tilt can be studied independent of femoral or tibial implant positioning or patellar resurfacing in patients undergoing UKA. We asked whether the surgical approach had an effect on lateral patella tilt in patients undergoing UKA.

METHODS: 255 knees (208 patients) underwent MB UKA by a single-surgeon from November 2006 to March 2013. There were 102 females (123 knees) and 106 male (132 knees) with an average age of 63.6 ± 11 years. All knees fit Nuffield criteria for MB UKA. These were performed through mini-mid-vastus (114 knees), sub-vastus (80 knees), and mini-medial parapatellar (61 knees) approaches. Patellar tilt was measured on sky line radiographs as described by Greslamer et al. Pre- and postoperative patellofemoral tilt were compared using paired t-test. The preoperative, postoperative, and change in patellofemoral tilt was compared for each surgical approach using analysis of variance (ANOVA).

RESULTS: The difference in preoperative patellofemoral tilt between different approaches was not significant (p=0.4). The average tilt changed from 8.6° ± 4.3° preoperatively to 8.5° ± 4.5° postoperatively (p=0.8) which was not significant. The tilt changed postoperatively by 0.4° ± 3.8° through mini-medial parapatellar approach (n=48), -0.1° ±3.2° through mini-mid-vastus approach (n=102) and -0.3° ±3° for sub-vastus approach (n=64). Neither the resulting or change in postoperative tilt was significantly different between the formerly described approaches (p= 0.6, p=0.4).

DISCUSSION: In knees undergoing UKA, patellar tilt was not affected by different types of less invasive surgical approaches. Factors other than approach need to be considered when performing conventional TKA in order to minimize patellar tilt and maltracking.

Polymethyl Methacrylate Utilization in Primary Total Knee Arthroplasty: Potential Cost Savings

Abstract ID: Poster 137

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With the rising cost of healthcare in the United States, surgeons should be aware of opportunities to decrease costs without affecting quality of care. A study was conducted to analyze if the cost of primary total knee arthroplasty could be reduced by defining a minimal amount of polymethyl methacrylate bone cement needed. The unused portion of cement was collected from 70 primary total knee arthroplasties performed by 6 surgeons at our institution. After measuring the mass and volume of the cement samples from each case, we determined that on average only 52.04% of 1 unit of cement (40 grams) was implanted to fix the components when mass was considered. Only 52.64% of 1 unit of cement was implanted on average when volume was considered. There were no cases in which more than 1 unit of cement was implanted. We conclude that 1 unit of bone cement (40 grams) is sufficient for a primary total knee arthroplasty at our institution.

Revision Total Knee Arthroplasty for Patients Less Than 55 Years of Age

Abstract ID: Poster 138

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INTRODUCTION: Total knee arthroplasty (TKA) is being performed for an increasing number of younger patients who are expected to contribute an increased TKA revision burden. The results of revision TKA for patients younger than 55 years of age at the time of surgery have not been defined.

METHODS: Retrospective review of preoperative and postoperative clinical, functional, and activity scores for 78 young revision TKA patients (83 knees) at a mean follow-up of 6 years after surgery (range 1-13.4 years), compared to an age and gender matched cohort of primary TKA patients with mean 6-year follow-up (2.6-14.0 years). Mean BMI was similar for both groups (34.9 vs. 33.6 kg/m^2, $p= 0.33$).

RESULTS: The most common indications for revision TKA included aseptic loosening (27%), infection (19%), stiffness (13%), and instability (13%). Revision TKA patients experienced improvement in Knee Society clinical score (16 points) and Knee Society functional score (30 points), SF-12 Mental Function score (7.3 points) and UCLA activity level (1.1 points). Among primary TKA patients, the improvement in Knee Society scores (22 points, 39 points, $p<0.02$), and SF-12 Physical Function Scores (9.7 vs. 1.3, $p<0.001$) were more substantial. Mean UCLA activity scores only increased modestly from baseline in both groups (1.11 vs. 1.09 points, $p= 0.55$). Thirteen revision TKA patients (17%) experienced a postoperative complication within the first year of surgery, and 11 patients (14%) underwent a revision surgery within the first 2 years of their revision TKA. The most common reasons for re-revision were infection (6%) or instability (4%).

DISCUSSION AND CONCLUSION: Revision Total Knee arthroplasty can be effective for improving pain and function for patients less than 55 years of age with failed primary knee replacements. Improvement is not as substantial as for patients undergoing primary TKA, increases in patient activity level are modest, and over 20% of patients either experienced a postoperative complication or required subsequent re-revision surgery. Recurrent infection and instability are the most frequent challenges to improved pain and function for this patient group.

Revision Total Knee Arthroplasty in the Setting of Infection Using a Semi-Constrained Prosthesis

Abstract ID: Poster 139

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INTRODUCTION: Revision arthroplasty in the setting of a prosthetic joint infection (PJI) is a challenging surgical problem. Although many studies have examined revision total knee arthroplasty in the setting of infection, few studies control for the level of constraint used in the revision surgery. Our study purpose was to evaluate the survival rate of a single, semi-constrained implant when placed in a previously infected joint, as well as to define risk factors for implant failure or repeat infection.

MATERIALS AND METHODS: Seventy-eight total knee arthroplasties with a history of a PJI, revised with the fixed-bearing Total Condylar III implant were identified at our institution from August 1994 through November 2002. Patients were evaluated at regular time intervals to obtain information regarding implant failure as determined by revision of any component, repeat infection, range of motion (ROM), pain, and Knee Society Scores. Statistical analysis was performed using Student's T-test, Fisher Exact tests, and Kaplan-Meier Survival Curve, with statistical significance of p-value <0.05.

RESULTS: Thirty-four males and 41 females with an average age of 69 years were included. At an average follow-up of 7.5 years, 23 (29%) of patients underwent repeat revision surgery. Survival rates at 5 and 10 years were 71% and 64%, respectively. The most common reason for repeat revision surgery was recurrent infection (18, 78%), diagnosed at an average of 32 months following the index revision procedure. Infection-free survival was 77% at five years and 68% at ten years. Smoking, BMI, and acute inflammation at the time of reimplantation demonstrated a trend toward decreased implant survival with a hazard ratio of 3.58, 1.06, and 2.38, respectively ($p=0.052$, $p=0.12$, and $p=0.15$). Increased BMI also correlated with a significantly increased risk for repeat joint infection, with a 1.08 increase in relative risk per unit increase in BMI ($p<0.05$). Patients whose implants survived beyond 10 years experienced significant improvements in pain and range of motion compared to preoperative values ($p<0.01$ and $p=0.02$). Average Knee Society Clinical scores also improved to 86.6 at 10 years, from 54.4 preoperatively ($p=0.01$).

DISCUSSION: Revision total knee arthroplasty in the setting of a previous PJI continues to be a challenging problem with a high risk of implant failure or recurrent infection. Both smoking and increased BMI increase the patient's risk for complications. However, patients whose implants have survived over 10 years' experience significant improvements in function and pain relief.

Perioperative Outcomes of Revision Total Knee Arthroplasty

Abstract ID: Poster 140

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INTRODUCTION: Total knee arthroplasty (TKA) is the seventh most common procedure performed by orthopedic surgeons in the United States. The purpose of this study was to assess national trends in TKA revision and to evaluate perioperative outcomes.

METHODS: The National Hospital Discharge Survey (NHDS) database was searched using International Classification of Diseases - Ninth Revision (ICD-9) codes for patients admitted for primary and revision TKA between years 2001-2010. ICD-9 diagnosis and procedure codes were used to analyze patient demographics, hospitalization length, adverse events (pulmonary embolus [PE], deep vein thrombosis [DVT], blood transfusion, mortality), and discharge disposition. Trends were evaluated by linear regression with Pearson's correlation coefficient (r) and statistical comparisons were made using Student's t-test and z-test (significance level of 0.05).

RESULTS: 35,220 patients who underwent primary TKA and 3,462 patients who underwent revision TKA were identified. The rate of revision TKA demonstrated a strong positive correlation with time ($r=0.76$), accounting for 103.2 per 100,000 hospital admissions between 2001-2005; significantly increasing to 137.8 per 100,000 between 2006-2010 ($p<0.01$). The primary TKA group had a mean patient age of 66.6 years and included 12,504 men and 22,716 women. The revision TKA group had a significantly lower mean patient age of 65.9 years ($p<0.01$) and included 1,416 men and 2,046 women. Men significantly accounted for more revision TKA (40.9% vs. 35.5%, $p<0.01$). Average hospitalization length was significantly longer for revision TKA (4.9 days vs. 3.7 days, $p<0.01$). PE rate was significantly lower for revision TKA (0.11% vs. 0.42%, $p<0.01$). Mortality was significantly higher for revision TKA (0.38% vs. 0.11%, $p=0.0112$). No significant difference was noted between primary and revision TKA for the rate of DVT (0.65% vs. 0.45%, $p=0.10$), blood transfusion (18.1% vs. 18.3%, $p=0.68$), or discharge to home status (64.0% vs. 64.6%, $p=0.46$).

CONCLUSIONS: This study demonstrates that the rate of revision TKA is rising (its use increased 34.6% in 10 years), and the revision TKA group had more mortality, longer hospitalization, more men, and younger patients. Though the number of DVTs was not significantly different, more PEs were seen in the revision TKA group for unclear reasons.

Tibial Plateau Coverage in UKA: A Comparison of Patient Specific and Standard Implants

Abstract ID: Poster 141

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INTRODUCTION: Tibial component fit, specifically significant overhang of tibial plateau or underhang of cortical bone, can lead to pain, loosening, and subsidence. The purpose was to utilize morphometric data to compare size, match, and fit between patient specific and incrementally sized standard unicompartmental knee arthroplasty (UKA) implants.

METHODS: CT images of 20 medial UKA knees and 10 lateral UKA knees were retrospectively reviewed. Standard and patient-specific implants were modeled in CAD, utilizing sizing templates and patient-specific CAD Designs. Virtual surgery maximized coverage of tibial plateau while minimizing implant overhang. Tibial plateau implant coverage was evaluated for fit and incidence of overhang/undercoverage.

RESULTS: Patient specific implants provided significantly greater cortical rim coverage vs. incrementally sized standard implants, 77% vs. 43% (range 41-46%) respectively medially ($p<0.0001$) and 60% vs. 37% (range 29-41%) laterally ($p<0.0001$). Patient-specific and standard implants' arc length were evaluated for percent of implant edge on cortical bone, 84% vs. 55% (range 48-59%) medially ($p<0.0001$), and 79% vs. 57% (range 53-60%) laterally ($p<0.0001$). Average amount of overhang/undercoverage of cortical rim area differed in patient-specific and standard implants: 0.24 mm vs. 0.46 mm maximum overhang, ($p=0.043$); 0.87 mm vs. 3.01 mm maximum undercoverage medially ($p<0.0001$); 0.14 mm vs. 0.59 mm maximum overhang, ($p=0.05$); 1.19 mm vs. 2.26 mm maximum undercoverage laterally ($p=0.017$). Anterior overhang yielded 25 -75% and 30-80% of medial and lateral implants respectively in standard implant group; no overhang in patient-specific implant group.

CONCLUSIONS: Tibial plateau anatomy variability produces difficulty optimizing coverage and preventing significant implant overhang/undercoverage with standard unicompartmental implants. Using virtual implantation, standard implants were undersized to avoid overhang. However, we encountered significantly more overhang in standard implants vs. patient specific cohort. This study removed variability matching tibial tray and femoral standard group implant placement. Patient-specific implants provide superior cortical bone coverage and fit while minimizing issues of overhang and undercoverage seen in standard implants.

Patellar Fracture Following Patellofemoral Arthroplasty
Abstract ID: Poster 142

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PURPOSE: Advanced isolated patellofemoral osteoarthritis is commonly treated with patellofemoral arthroplasty (PFA). Currently, there is a paucity of data regarding patellar fracture after undergoing this procedure. The goals of this study are to (1) determine the factors that are associated with patellar fracture following PFA and (2) compare outcomes of patients with and without this postoperative complication.

METHODS: A retrospective review of the medical records of patients undergoing patellofemoral arthroplasty for the treatment of osteoarthritis at our institution from 2003 to 2011 was conducted. Patients with at least two year follow-up were included. Patient demographics, previous surgeries, patellar thickness, performance of lateral release, Insall-Salvati ratio, component size, time to fracture, and fracture type and location were recorded. Additionally, the Knee Society clinical rating system, the Tegner Activity Level scale, and the UCLA Activity Score were used as outcome measures. Postoperative radiographs were reviewed for the presence of patellar fracture. Clinical outcomes and factors associated with postoperative patellar fracture were analyzed using univariate statistical models.

RESULTS: 77 patients (70 females, 7 males) with a mean age of 56 (range 36-82) years and a mean follow-up of 4 (range 2-9) years met inclusion criteria. Seven patients had patellar fractures after PFA with a mean time to fracture of 34 (median 28, range 16-64) months. All were type I fractures (stable patellar component with intact extensor mechanism), which were treated nonoperatively. Decreased patellar thickness and larger trochlear component size (medium and large) were associated with a greater incidence of fracture ($p<0.001$, $p=0.01$). All other potential factors collected had no association with this postoperative complication. There was no significant difference in clinical and functional outcomes between those patients with and without patellar fracture (Table 1).

CONCLUSION: Our data suggests that decreased patellar thickness and the use of larger trochlear component sizes increase the risk of type I patellar fractures following PFA. Patients with this postoperative complication, however, demonstrated no significant difference in clinical or functional outcomes at a mean follow-up of four years.

Click here to view Table

Correctable Tibiofemoral Subluxation Should Not Be Considered a Contraindication to Mobile Bearing UKA

Abstract ID: Poster 143

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INTRODUCTION: There is no specific guideline in the literature to whether subluxation of the tibiofemoral joint should be considered a contraindication to Mobile Bearing UKA. The purpose of this study was to assess different grades of tibiofemoral subluxation and correction of the structural disorder after MB UKA.

METHODS: 255 knees (208 patients) underwent MB UKA by a single surgeon from November 2006 to March 2013. There were 102 females (123 knees) and 106 male (132 knees) with an average age of 63.6 ± 11 years. The preoperative tibiofemoral subluxation was estimated as equal or greater than 0 millimeters and ≤5 millimeters for 157 knees (Grade I), >5 millimeters and ≤11 millimeters for 95 knees (Grade II), and >11 mm for the remaining 3 knees (Grade III). Pre- and postoperative tibiofemoral subluxation were compared using paired t-test. The change in tibiofemoral subluxation was compared based on the preoperative subluxation grades using analysis of variance (ANOVA).

RESULTS: A total of 232 knees graded as grade I postoperatively. The postoperative grade remained as grade I for 146 (93%). It was improved from grade II to grade I for 86 knees (91%) and from grade III to grade II in another three knees (100%). The tibiofemoral subluxation decreased in 206 knees (174 patients). The tibiofemoral subluxation significantly decreased from 4.4 ± 2.5 millimeters preoperatively to 2.3 ± 1.7 millimeters postoperatively ($p<0.0001$). The average change was -0.9 ± 1.8 millimeters, -4 ± 2 millimeters and -7.9 ± 2.1 millimeters for patients graded preoperatively as I, II, and III, respectively ($p<0.0001$).

CONCLUSION: MB UKA can effectively correct tibiofemoral subluxation. As long as the subluxation is correctable on a stress view and patient fulfills all other Nuffield criteria, MB UKA is a viable alternative for patients and surgeons considering knee arthroplasty.

Patient-Specific Instrumentation in Fixed-Bearing Unicompartmental Knee Arthroplasty: Early Clinical Results

Abstract ID: Poster 144

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BACKGROUND: Patient-Specific Instrumentaion (PSI), using rapid protyping technology and three-dimensional MRI imaging, has been developed in total knee arthroplasty to improve implant positioning, operating room efficiencies, as well as creating a more consistent and conservative approach to the method of bone preparation. This technology has now been developed for unicompartmental knee arthroplasty (UKA) potentially providing the same benefits of improved accuracy of the procedure, improved efficiencies, and improved clinical outcomes.

OBJECTIVES: The purpose of this study was to evaluate the early clinical outcomes of UKA using a patient-specific instrumentation (PSI).

METHODS: Thirty-four consecutive patients undergoing a fixed-bearing unicompartmental knee arthroplasty using patient-specific instrumentation were prospectively reviewed after appropriate IRB approval. All procedures were performed by one surgeon under a single anesthetic. Preoperative selection criteria were used for all patients to verify the indication for unicompartmental knee arthroplasty. This also included a preoperative MRI combined with 3-dimensional imaging to create a preoperative surgical plan, and the development of a patient-specific cutting guide.

Clinical outcomes were assessed including anesthesia type, tourniquet time, length of stay, preoperative hemoglobin, postoperative hemoglobin, preoperative range of motion, postoperative range of motion, DVT, and PE. Knee Society Score (KSS) and Functional KSS were assessed preoperatively, 6 months, and 1 year postoperatively. Anatomic and mechanical axis evaluation was also performed on all patients with long-standing radiographs pre- and postoperatively.

Polyethylene component size, femoral component size, and tibial component size were evaluated and correlated with the preoperative predicted component sizing of the MRI generated surgical plan.

RESULTS: Thirty-four consecutive UKA PSI patients were prospectively reviewed. There were no DVTs, or PEs. There were no cases of deep infection. Average age was 64.4 years old with average BMI of 31.1. Average preoperative KSS score was 52, with a postoperative KSS score of 93 at an average follow-up of 9 months. Average preoperative Functional KSS score was 56, with an average postoperative Functional KSS score of 91. Average ROM at one year postoperative was 0° of extension and 126° of flexion. Average anatomic axis was 2.6° valgus with a neutral mechanical axis restored in all patients.

Tibial polyethylene thickness was found to be consistent and conservative with 8 mm polyethylene used in 27 patients (79.4%), 9 mm used in 6 patients (17.6%), and 10 mm polyethylene used in 1 patient (2.9%).

Six femoral components were downsized from the preoperative plan to avoid patellofemoral impingement, and 5 tibial components were downsized to avoid tibial overhang.

CONCLUSION: When the degenerative changes in the knee are confined to the medial compartment, unicompartmental knee arthroplasty can be a viable option with a high likelihood for excellent early and long-term clinical outcomes. Although patient selection remains a critical factor for achieving high success, accurate surgical technique and accurate surgical instrumentation are equally important. With the use of rapid prototyping technology and 3-D MRI imaging, preoperative evaluation and planning can be performed with the ability to create patient-specific instrumentation. Clinical outcomes similar to traditional methods of UKA can be achieved with this new technique, with the potential to achieve a more a simplified, consistent, and conservative surgical approach. Further prospective comparative studies are necessary to validate the long-term clinical benefits.

Patient Specific Instrumentation with Pre-Existing Ipsilateral Hardware

Abstract ID: Poster 145

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INTRODUCTION: Total knee arthroplasty (TKA) is an effective operation for the management of osteoarthritis of the knee. Conventional technique utilizing manual instrumentation (MI) makes use of intramedullary femoral guides and either extrameduallary or intrameduallary tibial guides. While these methods can achieve excellent results in the majority of patients, those with ipsilateral hardware may preclude the accurate use of these techniques.

Patient-specific instrumentation (PSI) is an alternative innovation for TKA. Utilizing magnetic resonance imaging or computed tomography, custom guide blocks are fabricated based on a patient's unique anatomy. In this study, we sought to evaluate the accuracy of PSI techniques in patients with previous ipsilateral hardware, which would make the use of MI technically challenging and possibly subject to inaccuracy.

METHODS: We identified 16 patients with pre-existing ipsilateral hardware. Fourteen patients included in the study had a pre-existing total hip arthroplasty on the ipsilateral side, 1 had a pre-existing sliding hip screw, and 1 patient had a pre-existing cephalomedullary nail. Postoperative mechanical axis alignment measurements were performed using plain long-standing radiographs. The American Knee Society Score was used to evaluate clinical outcomes postoperatively.

RESULTS: Sixteen total knee arthroplasties were performed using Zimmer NexGen PSI, all in the setting of previous ipsilateral hardware placement. Average postoperative mechanical axis was 3.1° measured from plain radiographs. Average angle between the femoral mechanical axis and femoral component was 90.0°. Average angle between the tibial mechanical axis and tibial component was 90.6°. At an average of 4.5 months follow-up, American Knee Society knee scores show an aggregate average score of 82.94.

CONCLUSION: Patient-specific instrumentation is an innovative technology in TKA that replaces the use of intramedullary femoral guides. This study demonstrates that PSI is capable of producing favorable radiographic and clinical outcomes despite pre-existing ipsilateral hardware, which may preclude the use of customary manual instrumentation.

The Next Generation: Monitored Real-Time Patient Specific TKA

Abstract ID: Poster 146

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PURPOSE: Early developments of computer-assisted TKA focused on improving technical aspects of registration, usability of instrumentation, and improvements in alignment. There was minimal adoption of these technologies due to high costs and lack of clinical outcomes demonstrating improvement.

Patient specific instrumentation (PSI) involving preoperative three-dimensional imaging and engineering of patient specific guides have been more actively embraced. Reportedly, up to 14% of orthopedists in the U.S.--despite the fact that scientific evidence has been mixed--are using three-dimensional technologies.

The next generation is merging these technologies to give the surgeon control of the patient specific TKA process. Sophisticated morphing technology coupled with innovative instrumentation allows MONITORED real time PSI – affording the surgeon a means to fully understand the knee deformity being addressed, make decisions based on quantitative information, and to resect and position parts as planned, confirming position easily. Additional ability to perform and monitor balancing is also available.

The purpose of this study was to validate a new navigation system, and eventually use PSI with it to determine how well these technologies work together.

METHODS: From April 2012 to April 2013, 62 TKAs in 56 patients underwent TKA using a new navigation system. Twenty-four knees had CR TKA for varus deformity, 5 for valgus deformity; 27 had PS TKA for varus deformity, 5 for valgus deformity. All data was retrospectively reviewed and entered into a database for analysis.

RESULTS: The average AP alignment was 4.0°; the average clinical ROM at the most recent follow-up for CR TKA was 107° vs. 112° for PS TKA which was not significantly different. One knee has been revised to a more constrained insert for CR deficiency.

SIGNIFICANCE: These cases were to validate the integrity of the instruments and software of a new navigation system. In April 2013, personalized instrumentation has been introduced into the practice to easily position femoral resection pins through a single, navigated instrument. This represents the newest application of three dimensional technologies and continues the field moving toward technologies that allow the surgeon to directly control all aspects of patient specific TKA.

Postoperative Alignment in Patient-Specific vs. Conventional Total Knee Arthroplasty

Abstract ID: Poster 147

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INTRODUCTION: Patient specific total knee arthroplasty utilizes magnetic resonance imaging (MRI) to allow the surgeon to place components into the patients' pre-arthritic natural alignment. The current study set out to compare postoperative radiographic measurements and intra-operative parameters in patient specific TKA compared to conventional TKA.

METHODS: Twenty-three patients obtained a preoperative MRI of their arthritic knee, from which patient-specific cutting guides were machined to control intraoperative cuts. These patients were compared to 17 of the senior surgeon's conventional total knee replacements. Pre- and postoperative mechanical axis and anatomical axis were compared for each patient, as well as femoral and tibial component alignment in the AP and lateral planes. We also compared operating room time, tourniquet time, hemoglobin/hematocrit drop, and need for postoperative blood transfusion between the two groups.

RESULTS: Postoperatively, the average mechanical alignment for the MRI and conventional groups were 2° of varus and neutral zero, respectively. There were 8 outliers in the MRI group (7 varus, 1 valgus) and 7 outliers in the conventional group (2 varus, 5 valgus). Anatomical axis measured 3.5° valgus and 5° valgus in the MRI and conventional groups, respectively. There were 8 outliers in the MRI group (3 varus, 5 valgus) and 7 outliers in the conventional group (1 varus, 6 valgus). Given the numbers available for this study, there was no significant difference between the two groups in regards to mechanical and anatomical axis, femoral and tibial component alignments as measured on AP and lateral radiographs, operating time, tourniquet time, and average hemoglobin/hematocrit drop.

CONCLUSION: In the present study, patient specific TKA did not yield better postoperative alignment when compared to conventional TKA. Furthermore, there was no advantage seen in regards to operating time, tourniquet time, and average hemoglobin/hematocrit drop.

Modern Computer Navigation in Total Knee Arthroplasty Provides Value by Reducing Blood Loss

Abstract ID: Poster 148

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INTRODUCTION: Efforts continue to reduce blood loss in total knee arthroplasty (TKA). Computer-assisted surgery (CAS) has been shown to reduce outliers in component position and improve functional outcomes in TKA, yet few studies have reported specifically on blood loss. This study purpose was to determine whether a modern abbreviated CAS protocol would reduce blood loss in TKA compared to conventional instrumentation.

METHODS: A retrospective cohort study of 100 consecutive patients was performed comparing an abbreviated and modern CAS protocol vs. conventional IM instrumentation. All TKAs utilized an identical surgical technique without any hemostatic agent. Blood loss was determined using drain output, change in hemoglobin, and calculated blood loss. A cost analysis compared the CAS protocol to the cost associated with tranexamic acid (TXA) to reduce blood loss and long-leg alignment radiographs to optimize component position.

RESULTS: Height, weight, BMI, and preoperative hemoglobin were similar between groups. The CAS group demonstrated a decrease in hourly drain output (CAS 33.8 ml; conventional 40.5 ml; $p = 0.024$), decreased change in hemoglobin (CAS 2.2; conventional 3.1; $p < 0.001$), and estimated total blood loss (CAS 925 ml; conventional 1327 ml; $p < 0.001$) compared to conventional instrumentation. No patients in either group required a blood transfusion. Cost-analysis demonstrated CAS was less expensive than using TXA and long-leg alignment radiographs, with a savings of $564 for 200 TKAs annually and $284 for 100 TKAs annually.

CONCLUSION: Abbreviated CAS is effective in reducing blood loss in TKA comparable to TXA, likely due to avoidance of the femoral IM canal. Along with proven advantages of accurate component placement and improved functional outcome after TKA, the blood conservation supports CAS providing value in healthcare and obviates the need for advanced preoperative imaging and TXA, and can be used in patients regardless of cardiac or thromboembolic risk.

Femoral Bow Predicts Postoperative Malalignment in Revision Total Knee Arthroplasty

Abstract ID: Poster 149

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IINTRODUCTION: Revision total knee arthroplasty often utilizes stemmed components for additional implant fixation. Very little is published on the variability of femoral and tibial bowing, and to our knowledge, no literature exists on the impact bowing has on postoperative knee alignment. The purpose of this study was to define the variability of the femoral and tibial bow in our patient population, and to determine the impact these have on postoperative alignment.

METHODS: After IRB approval, a search was performed to obtain patients who underwent revision TKA at our institution from 2003 – 2012. Of these, 277 patients had full-length standing x-rays and were evaluated for femoral and tibial coronal bowing, as well as preoperative and postoperative hip-knee-ankle (HKA) axis. Pearson's coefficients were used to assess inter-rater reliability.

RESULTS: The femoral bow varied from 10.1° varus to 8.4° valgus with an average of 1.52° ± 0.18° varus. The tibial bow varied from 5.9° varus to 10° valgus with an average of 1.25° ± 0.13° valgus. Preoperative HKA axis averaged 3.08° ± 0.35° varus. Postoperative HKA axis averaged 0.86° ± 0.25° varus. Inter-rater reliability was high for tibial bow (r=0.88), femoral bow (r=0.86), and HKA axis measurements (0.97). There was a significant correlation between femoral bow greater than 4° and postoperative HKA axis malalignment (r=0.402, p=0.008). There was no significant correlation between tibial bow and postoperative HKA axis (r=.311, p=0.531). Overall, 39.7% of patients deviated 3° or greater from a neutral mechanical axis with a significant difference in femoral bow (0.94° ± 0.31°) compared to those that did not deviate greater than 3°.

CONCLUSIONS: Tibial and femoral coronal bow is variable in patients undergoing revision TKA. A femoral bow greater than 4° was significantly correlated with postoperative HKA axis malalignment. Almost 40% of our patients demonstrated a 3° or greater deviation in postoperative mechanical axis with a significantly increased femoral bow. This trend was observed with tibial bow as well although not significantly. Clearly, femoral bow has an important effect on postoperative limb alignment and should be carefully assessed prior to revision total knee arthroplasty.

Magnetic Resonance Imaging vs. Long-Standing Radiography in Assessment of Preoperative Mechanical Axis in Total Knee Arthroplasty

Abstract ID: Poster 150

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INTRODUCTION: Accurate assessment of preoperative mechanical axis is important for the preoperative planning of a total knee arthroplasty (TKA). Long-standing radiography is typically the standard modality for measuring mechanical axis in TKA. However, magnetic resonance imaging (MRI) has recently been increasingly utilized with the emergence of patient specific instrumentation (PSI). The purpose of the present study was to compare the consistency and precision of magnetic resonance imaging (MRI) and long-standing radiography in assessing preoperative mechanical axis.

METHODS: Forty-five consecutive PSI TKA were performed by a single surgeon. Preoperative long-standing radiographs were obtained and measured to determine mechanical axis. MRIs were obtained preoperatively and analyzed by PSI software to determine mechanical axis. Measurements were compared between the two modalities to assess correlation and differences in distribution. Discrepancy between modalities was calculated for each patient and analyzed to assess trends.

RESULTS: Preoperative mechanical axis correlated between radiograph and MRI modalities ($r=0.8556$; $p<0.05$). Although there was no discernible difference in average mechanical axis between the modalities, measurements showed greater variation and a larger spread when measured by radiograph compared to MRI (SD 7.3° vs. 5.1°). Average discrepancy in mechanical axis between radiograph and MRI was 3.6° (range 0.1° to 12.4°). Extreme varus deformity (>10°) as determined by radiograph was associated with higher discrepancy.

DISCUSSION: Long-standing radiography showed a strong correlation with MRI in determining preoperative mechanical axis. Radiograph-based measurements showed greater variation and a larger spread than those based on MRI. Discrepancy between modalities was largest in patients with extreme varus deformity, with MRI measurements indicating less deformity than radiography. The effect of bearing weight in long-standing radiographs may overestimate deformity. This study suggests that long-standing radiography and supine MRI are comparable in assessing preoperative mechanical axis in patients with mild to moderate deformity.

Sagittal Plane Placement of the Femoral Component in TKR: How Should It Be Measured?

Abstract ID: Poster 151

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INTRODUCTION: Especially in PS TKR where cam post impingement can occur and contribute to failure, sagittal plane femoral component positioning (to avoid flexion) is paramount. The purpose of the study was to compare differences in the measurement of femoral component flexion on standard 17 inch short lateral knee radiographs and long-leg (full leg) lateral radiographs to determine any benefit of the long-leg radiographs. Secondarily, the authors evaluated the relationship of the amount of femoral bowing on the placement of the femoral component in flexion.

METHODS: A retrospective cohort of 390 consecutive primary TKAs, performed by a single surgeon, were evaluated for this study. Standing full-leg-length lateral and standard lateral radiographs were used to determine the degree of femoral shaft bowing and the amount of femoral component flexion. Component flexion was assessed using the Knee Society method on two different radiographic views: full-leg-length lateral and standard lateral radiographs (17 inch cassette). The relationship between sagittal femoral shaft bowing and femoral component flexion was assessed for linear correlation. Inter- and intraobserver variability in terms of radiographic measurements were performed.

RESULTS: The amount of femoral component flexion, as measured on full-leg-length lateral radiographs, correlated with the amount of femoral shaft bowing (p-value < 0.05). There was a statistically significant (p-value <0.0001) difference between full-leg-length lateral and standard lateral radiographs in terms of the mean femoral component flexion measured with long-leg films demonstrating greater femoral component flexion. Knees with greater sagittal plane bowing were placed in greater femoral component flexion (p-value < 0.05). Statistical analysis included Pearson correlations (2-tailed) and Wilcoxon Signed-rank test.

CONCLUSION: Increasing sagittal plane bowing of the femur was associated with placement of the femoral component in increasing flexion during TKA. Standard lateral radiographs under-estimated the amount of femoral component flexion. When studying TKR component placement in the sagittal plane (i.e., computer-assisted surgery, cam post impingement, gait analysis), our study suggests that long leg sagittal radiographs are important.

Patient Specific Instrumentation Does Not Improve Coronal Plane Alignment in Total Knee Arthroplasty

Abstract ID: Poster 152

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INTRODUCTION: Patient-specific instrumentation (PSI) was developed to improve the accuracy of component positioning in total knee arthroplasty (TKA). The purpose of this study was to perform a meta-analysis to determine if PSI improves the postoperative mechanical alignment of the leg compared to conventional instrumentation (CI) in TKA.

METHODS: A systematic review and meta-analysis was performed including prospective, randomized studies comparing postoperative coronal alignment between PSI and CI after TKA. Exclusion criteria were studies without a comparison group, studies that did not report the coronal alignment postoperatively, studies investigating kinematically-aligned TKAs, and unicompartmental knee arthroplasty. Data analyzed included mean postoperative coronal mechanical alignment of the limb, and the number of outliers >3° from neutral mechanical alignment in each group. Statistical analysis was performed with Fisher's exact test.

RESULTS: Seven studies met inclusion criteria evaluating 519 total patients undergoing TKA (270 PSI and 249 CI). The mean coronal alignment was 0.82° from neutral mechanical alignment in the PSI group, and 0.93° from neutral mechanical alignment in the CI group, which was not statistically significant. There were fewer outliers (>3° from neutral mechanical alignment) in the PSI group (22.1%) than in the CI group (24.7%), but this was not statistically significant (p=0.58).

DISCUSSION: Using patient specific instrumentation does not significantly improve the postoperative mechanical alignment of the limb after TKA. Moreover, patient specific instrumentation does not decrease the number of outliers (>3° from neutral mechanical alignment) compared to conventional techniques.

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Della Valle, Craig J. 2014 Program Committee Chair	3b – ConvaTec, DePuy, a Johnson & Johnson Company; 3b, 5 – Biomet, Smith & Nephew; 4,5 – CD Diagnostics; 5 – Stryker; 7 – Journal of Bone and Joint Surgery-American, SLACK Incorporated; 8 – Orthopedics Today, SLACK Incorporated; 9 – American Association of Hip and Knee Surgeons, Arthritis Foundation, Knee Society, Mid-America Orthopaedic Association
McLain, Robert F. Membership Committee Chair	9 – Mid-America Orthopaedic Association
Otterberg, Erik T. Education Committee Chair	9 – Lakeside Hospital, Mid-America Orthopaedic Association
Mahoney, Craig R. Exhibits Committee Chair	3b, 4 – Trak Surgical, Inc; 5 – Smith & Nephew; 9 – AAOS, Mercy Medical Center, Mid-America Orthopaedic Association, Polk County Medical Society
Trousdale, Robert T. Member at-large (one year)	1, 3b – DePuy, a Johnson & Johnson Company, MAKO, Wright Medical Technology; 9 – Mid-America Orthopaedic Association
Barnes, C. Lowry Member at-large (two years)	2- ConvaTec, DJO; 3b, 5 – Wright Medical Technology; 5 – ConforMIS, DePuy, a Johnson & Johnson Company; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Surgical Orthopaedic Advances, Orthopedic Knowledge Online; 9 – Arkansas Orthopaedic Society, HipKnee Arkansas Foundation, Mid-America Orthopaedic Association
Froimson, Mark I. Member at-large (three years)	2 – Care Fusion; 3b, 4 – Medical Compression Systems; 8 – American Journal of Orthopedics, Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons, American Orthopaedic Association, Mid-America Orthopaedic Association
MAOA STAFF	
Kluck, Pam	n
McKinley, Sue	n
PROGRAM COMMITTEE	
Della Valle, Craig J., Chair	3b – ConvaTec, DePuy, a Johnson & Johnson Company; 3b, 5 – Biomet, Smith & Nephew; 4,5 – CD Diagnostics; 5 – Stryker; 7 – Journal of Bone and Joint Surgery-American, SLACK Incorporated; 8 – Orthopedics Today, SLACK Incorporated; 9 – American Association of Hip and Knee Surgeons, Arthritis Foundation, Knee Society, Mid-America Orthopaedic Association
Macalena, Jeffrey A.	9 – Mid-America Orthopaedic Association
Markiewitz, Andrew D.	7 – American Board of Orthopaedic Surgery, Inc., CRC Press; 8 – Hand, Journal of Bone and Joint Surgery-American, Journal of Hand Surgery-American; 9 – Academy of Medicine of Cincinnati,

	AAOS, Mid-America Orthopaedic Association, Ohio State Medical Association
McLaughlin, Jeffrey R.	1, 2, 3b, 5 – Biomet; 9 – Mid-America Orthopaedic Association
Miller, Benjamin J.	9 – Mid-America Orthopaedic Association, Musculoskeletal Tumor Society
Wolf, Brian R.	8 – Orthopaedic Journal of Sports Medicine; 9 – American Orthopaedic Society for Sports Medicine, Mid-America Orthopaedic Association
EXHIBITS COMMITTEE	
Mahoney, Craig R., Chair	3b, 4 – Trak Surgical, Inc; 5 – Smith & Nephew; 9 – AAOS, Mercy Medical Center, Mid-America Orthopaedic Association, Polk County Medical Society
Guyton, James L.	9 – Mid-America Orthopaedic Association
McIntosh, Amy L.	3b – Synthes; 9 – Mid-America Orthopaedic Association
Meyer, Frederick N.	2 – Auxilium; 8 – Journal of Bone and Joint Surgery-American, Journal of Hand Surgery-American; 9 – AAOS, American Orthopaedic Association, Clinical Orthopaedic Society, Mid-America Orthopaedic Association
Stannard, James P.	2 – AOSSM/AAOS, RTI, Medtronic (Kyphon Products), 2, 3b - Smith & Nephew, Sonoma Orthopedics; 3b – DePuy, a Johnson & Johnson Company, Medtronic Sofamor Danek, Synthes; 5 – Kinetic Concepts, Inc.; 7 – Theime; 8 – Journal of Knee Surgery; 9 – Mid-America Orthopaedic Association, Orthopaedic Trauma Association
EDUCATION COMMITTEE	
Otterberg, Erik T., Chair	9 – Lakeside Hospital, Mid-America Orthopaedic Association
Gioe, Terence J.	4 – Eli Lilly, Johnson & Johnson; 5 – DePuy, a Johnson & Johnson Company; 9 – American Board of Orthopaedic Surgery, Inc., American Joint Replacement Registry, Mid-America Orthopaedic Association
Laughlin, Richard T.	2 – AO North America, Smith & Nephew, Synthes; 3b – World Arthrosis Organization; 3b, 9 – Premier Health Partners Orthopaedic Institute, South Surgery Center, LLC; 3c – Community Tissue Bank; 5 – Grants: AOFAS, Ohio Third Frontier, Orthopaedic Trauma Association; 5, 9 – Wright State University Boonshoft School of Medicine; 9 – Dayton Area Graduate Medical Education Consortium, Mid-America Orthopaedic Association, Wright State Physicians, Inc.
Throckmorton, Thomas W.	2, 3b, 5 – Biomet; 3b – Zimmer; 7 – Saunders/Mosby-Elsevier; 8 – American Journal of Orthopedics; 9 – AAOS, Mid-America Orthopaedic Association
PRESENTERS, CO-AUTHORS, and MODERATORS	
Abdel, Matthew P.	n
Ablah, Elizabeth	n
Abrams, Geoffrey D.	4 – Amgen Co, Johnson & Johnson, MedCo, Merck, Pfizer
Achilefu, Samuel	n
Adams, Brent D.	2, 6 – Medtronic
Adams, Brian D.	1, 2, 3b, 7 – Integra Life Sciences, Extremity Medical; 3b, 5 – Tornier; 8 – Springer-Hand; 9 – American Association for Hand

	Surgery
Adelani, Muyibat A.	n
Agarwal, Sudha	8 – Plos One
Aguwa, Okezie	9 – AAOS
Aho, Johnathon M.	n
Akers, Kevin S.	n
Akers, Walter	n
Akhavan, Sina	n
Alander, Dirk H.	3b – Corelink, Ulrich USA; 4 – Pfizer; 9 – AAOS, American Spinal Injury Association
Albert, Michael C.	3b – OrthoPediatrics; 9 – AAOS, American Academy of Pediatrics, Pediatric Orthopaedic Society of North America, Scoliosis Research Society
Alexander, Jerry	n
Allan, D. Gordon	5 – Corin USA, DePuy, a Johnson & Johnson Company
Allen, Benjamin J.	n
Alvi, Hasham M.	n
Amendola, Annunziato	1, 3b – Arthrex, Inc.; 1, 4 - arthrosurface; 3c, 4 – MTP Solutions; 5 – Moximed; 7 – Springer, Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Clinical Journal of Sports Medicine, Foot and Ankle International; 9 – AAOS, American Board of Orthopaedic Surgery, Inc., American Orthopaedic Society for Sports Medicine; International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine
Amini, Michael H.	n
Anderson, Christopher P.	n
Anderson, John G.	1, 2, 3b – Stryker; 3b – Biomet; 4 – Pfizer; 5 – Biomimetic; 9 – American Orthopaedic Foot and Ankle Society
Anderson, Linda K.	n
Anderson, Michael J.	n
Anderson, Shaunnah	n
Andrews, Karen L.	n
Aneja, Arun	n
Antoniak, Derrick	n
Arsoy, Diren	n
Arunakul, Marut	n
Ashraf, Ali	n
Asomugha, Eva U.	n
Au, Brigham K.	n
Auer, Ronald	n
Axibal, Derek	n
Azar, Frederick M.	4 – Pfizer; 7 – Elsevier; 9 – AAOS, Campbell Foundation, St. Jude Children's Research Hospital
Azatyan, Inga	n
Azzam, Michael G.	n
Baboldashti, Nasim Zargar	n
Baca, Geneva R.	n
Bach, Bernard R., Jr.	5 – Arthrex, Inc., CONMED Linvatec, DJ Orthopaedics, Ossur, Smith & Nephew, Tornier; 7 – SLACK Incorporated; 9 –

	American Orthopaedic Society for Sports Medicine
Bachmann, Keith R.	n
Badve, Siddharth	n
Baghdadi, Yaser M. K.	n
Bair, Tina L.	n
Baker, Erin A.	3b, 5 – Globus Medical; 5 – Zimmer; 6 – Arthrex, Inc., Musculoskeletal Transplant Foundation, Stryker Corporation; 9 – Lumbar Spine Research Society
Baker, Kevin C.	3b, 5 – Globus Medical; 5 – Arthrex, Inc., Zimmer
Banerjee, Rahul	9 – AAOS
Banglmaier, Richard	n
Baran, Sean	n
Barkoh, Kaku	n
Barnes, C. Lowry	2- ConvaTec, DJO; 3b, 5 – Wright Medical Technology; 5 – ConforMIS, DePuy, a Johnson & Johnson Company; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Surgical Orthopaedic Advances, Orthopedic Knowledge Online; 9 – Arkansas Orthopaedic Society, HipKnee Arkansas Foundation, Mid-America Orthopaedic Association
Barnett, Michael D.	n
Barrack, Robert L.	1, 3b, 5, 6 – Stryker; 5 – Biomet, Medical Compression Systems, National Institutes of Health (NIAMS & NICHD), Smith & Nephew, Wright Medical Technology, Inc.; 7 – The McGraw-Hill Companies, Inc., Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Journal of Bone and Joint Surgery-American, Journal of Bone and Joint Surgery-British; 9 – Hip Society, Knee Society
Barrett, Ian J.	n
Barron, Donna K.	n
Barsoum, Wael K.	1 – Exactech, Inc.; 1, 2, 3b, 5 – Stryker; 1, 5 – Zimmer; 4 – Custom Orthopaedic Solutions, iVHR, Otismed; 5 – Active Implants, Cool Systems, DJO, Inc., Orthovita
Bartsch, Adam	n
Bauer, Jennifer M.	n
Bauer, Thomas W.	3b – Stryker; 8 – Journal of Bone and Joint Surgery-American, Journal of Orthopaedic Science, Springer
Bayer, Jennifer L.	n
Beal, Matthew D.	1, 3b, 5 – Medacta; 3b, 5 – Zimmer; 5 – National Institutes of Health (NIAMS & NICHD), MAKO Surgical, Stryker
Beals, Corey T.	n
Bean, Gregg W.	n
Beason, David	n
Beaty, James H.	7 – Saunders/Mosby-Elsevier; 8 – Journal of Bone and Joint Surgery; 9 – Orthopaedic Research and Education Foundation
Beaule, Paul E.	1 – Wright Medical Technology, Inc.; 2, 3b – Smith & Nephew, MEDACTA; 3b, 5 – Corin USA; 5 – DePuy, a Johnson & Johnson Company; 7 – Journal of Bone and Joint Surgery-American
Becker, Hillary A.	N

Bedair, Hany S.	3b – Zimmer
Bedard, Nicholas A.	n
Bednarski, Caroline	n
Behery, Omar A.	n
Beicker, Clint	n
Belkin, Mark	n
Beltinck, Kiel	n
Bentley, Jared C.	n
Berbari, Elie F.	n
Berend, Keith R.	1, 3b, 5 – Biomet; 5 – Kinamed, Pacira, Stryker; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Bone and Joint Surgery-American, Orthopedics; 9 – AAOS, American Association of Hip and Knee Surgeons
Berend, Michael E.	1, 3b, 5 – Biomet; 4 – Orthalign; 5 – Johnson & Johnson, Stryker (into our 501c3 research foundation); 8 – Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons, Joint Replacement Surgeons of Indiana Research Foundation, Piedmont Ortho
Berry, Daniel J.	1, 3b, 5 – DePuy, a Johnson & Johnson Company; 7 – Elsevier, Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Journal of Bone and Joint Surgery-American; 9 – Hip Society, Mayo Clinic Board of Governors
Berschback, John C.	n
Bettin, Clayton C.	n
Betzle, Christopher	n
Biggers, Marcus D.	n
Bishop, Julie Y.	n
Bissell, Benjamin T.	n
Blackman, Andrew J.	n
Blaha, J. David	1, 3b – Wright Medical Technology, Inc.; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Bone and Joint Surgery-American, Journal of the American Academy of Orthopaedic Surgeons, Knee; 9 – Michigan Orthopaedic Society
Blazek, Alisa D.	n
Bledsoe, J. Gary	5 – DePuy, a Johnson & Johnson Company
Bohay, Donald R.	1 – Stryker; 2, 3b – BESPA Consulting; 5 – Research and Education Institute at Orthopaedic Associates of Michigan; 8 – Foot and Ankle International
Bohnenkamp, Frank C.	n
Bois, Aaron J.	n
Boivin, Gregory P.	n
Bollier, Matthew J.	2, 3b – Arthrex, Inc.
Bone, Lawrence B.	9 – Society of Military Orthopaedic Surgeons
Bonner, Tara	n
Born, Trevor R.	n
Boudreau, John A.	n
Bouffard, J. Antonio	n
Bowers, Kelly	n

Bozic, Kevin J.	9 – AAOS, American Association of Hip and Knee Surgeons, American Joint Replacement Registry, American Orthopaedic Association, California Joint Replacement Registry Project, California Orthopaedic Association, Orthopaedic Research and Education Foundation
Bracken, Colten D.	n
Brander, Victoria A.	2 – Genzyme; 2, 5 – Sanofi-Aventis; 5 - Calosyn
Bravo, Dalibel M.	n
Bringe, Kariline E.	n
Briski, David	n
Brooks, Peter J.	3b – Smith & Nephew, Stryker
Brower, Richard S.	n
Brown, Alexander M.	n
Brown, Thomas	3b – Smith & Nephew, Winston & Strawn (attorneys), Zimmermann Reed (attorneys); 5 – Musculoskeletal Transplant Foundation; 7 – Journal of Bone and Joint Surgery-American; 8 – Journal of Orthopaedics and Traumatology
Brown, Timothy S.	n
Brunfeldt, Alexander	n
Bryce, Austell	n
Bucholz, Robert W.	7 – Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Journal of Bone and Joint Surgery-American
Buckwalter, Joseph A.	7 – Journal of Orthopaedic Research, Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Journal of Orthopaedic Research
Burge, John R.	n
Burgers, Travis	n
Burnett, R. Stephen J.	3b – Smith & Nephew
Bush-Joseph, Charles	3c – The Foundry; 8 – American Journal of Sports Medicine
Bushmiaer, Marty	4 – Stryker
Butler, Paul D.	n
Byrd, J. W. Thomas	3b,5 – Smith & Nephew; 3c, 4 – A3 Surgical; 7 – Springer; 9 – American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, International Society for Hip Arthroscopy
Cabanela, Miguel E.	9 – International Hip Society, Mid-America Orthopaedic Association
Cain, E. Lyle, Jr.	2, 3b, 5 – Arthrex, Inc., Biomet; 3b – Theralase; 4 – DR7 Innovations; 5 – DePuy/Mitek, Smith & Nephew; 8 – American Journal of Orthopedics; 9 – American Board of Orthopaedic Surgery, Inc., American Orthopaedic Society for Sports Medicine
Callaghan, John J.	1, 3b – DePuy, a Johnson & Johnson Company; 7 – Journal of Arthroplasty (Deputy Editor), Wolters Kluwer Health – Lippincott Williams & Wilkins; 9 – International Hip Society, Knee Society, Orthopaedic Research and Education Foundation
Callanan, Mark C.	n
Camp, Christopher L.	n
Campbell, Andrew B.	n
Campbell, Kevin J.	n

Cannada, Lisa K.	2, 5 – Smith & Nephew; 3b, 5 – Zimmer; 5 – Synthes; 8 – Orthopedics Today; 9 – AAOS, Mid-America Orthopaedic Association, Orthopaedic Trauma Association, Ruth Jackson Orthopaedic Society
Caplan, Arnold I.	2, 3b – Orthofix, Inc.
Carlson, Jon B.	n
Carpenter, Dylan P.	n
Carr, Andrew	7 – Oxford University Press Elsevier; 8 – Journal of Bone and Joint Surgery-British; 9 – Academy of Medical Sciences, Arthritis Research UK, British Elbow and Shoulder Surgery Society, British Orthopaedic Association, European Shoulder and Elbow Surgery Society
Carrillo, Melisa	n
Carrillo-Villamizar, Nazly	n
Carroll, Eben A.	2, 3b, 5, 6 – Smith & Nephew, Synthes; 6 - Zimmer
Carson, Veronica L.	n
Cass, Joseph R.	n
Cavo, Matthew J.	n
Chalmers, Peter N.	n
Chao, John C.	n
Chapel, Ross J.	n
Charters, Michael A.	n
Chase, Steven	n
Chen, Austin W.	n
Chimento, George F.	5 – DePuy, a Johnson & Johnson Company; 9 – AAOS Hip Program Committee, Louisiana Orthopaedic Association
Chmell, Samuel J.	n
Choi, Ho-Rim	n
Chong, Alexander C. M.	n
Chow, Roxanne M.	n
Christophersen, Christy M.	n
Christy, Jonathan M.	n
Chu, Justin	n
Chuinard, Christopher R.	1, 3b, 5 – Tornier; 3b – Mitek; 9 – Association of Clinical Elbow and Shoulder Surgeons
Cien, Adam J.	n
Cip, Johannes	n
Clark, Charles R.	2, 3b, 5 – DePuy, a Johnson & Johnson Company; 6 – Merck, Zimmer; 7, 8 – Journal of Bone and Joint Surgery-American; 9 – American Orthopaedic Association
Clohisy, John C.	3b – Biomet, Pivot Medical; 5 – Wright Medical Technology, Inc., Zimmer; 8 – Journal of Bone and Joint Surgery-American
Coffey, Michael J.	n
Cofield, Robert H.	n
Cohen, Mark S.	1, 5 – Integra; 2, 3b – Mylad; 3b – Acumed, LLC
Colbrunn, Robb	n
Cole, Brian J.	1, 3b – Arthrex, Inc., DJ Orthopaedics; 3b, 4 – Regentis; 3b, 5 – Johnson & Johnson, Zimmer; 4 – Carticept; 5 – Medipost; 7 – Elsevier, Lippincott, Smith & Nephew, WB Saunders; 8 – AAOS,

	American Journal of Orthopedics, American Journal of Sports Medicine, Cartilage, Educational Committee AANA, Elsevier, International Committee AANA, Journal of Bone and Joint Surgery-American, Journal of Shoulder and Elbow Surgery; 9 – Arthroscopy Association of North America
Cole, Peter A.	2, 3b, 5 – Synthes; 4 – BoneFoams Inc, LLC
Collins, Mark S.	n
Connaughton, Alexander	n
Cook, Shane	n
Cote, Derrick O.	n
Cox, Joseph T.	n
Crawford, Brooke M.	n
Crist, Brett D.	2, 5 – Medtronic; 3b – KCI; 4 – Amedica Corporation, Orthopaedic Implant Company; 5 – Sonoma Orthopedics, Synthes, Wound Care Technologies; 6 – Smith & Nephew; 8 – Journal of Orthopaedic Trauma, Journal of the American Academy of Orthopaedic Surgeons, Orthoinfo.org; 9 – International Geriatric Fracture Society, Mid-Central States Orthopaedic Society, Orthopaedic Trauma Association
Crosby, Lynn A.	1, 2, 3b, 5 – Exactech, Inc.; 9 – ACGME Residency Review Committee, AAOS
Cross, Michael B.	n
Cross, William W., III	2 – AO North America, Synthes; 3b – Zimmer, Zyga Tech Inc.; 8 – Clinical Orthopaedics and Related Research, Journal of Orthopaedics and Traumatology
Cui, Shari	n
Cummings, Karen	n
Curry, Madelyn	n
Cutuk, Adnan	n
Czubak, Jaroslaw	n
Dadsetan, Mahrokh	n
Dahl, Brian P.	n
Dahm, Diane L.	1,4 – TENEX health (spouse); 9 – AAOS Arthroscopy and Sports Medicine Program Subcommittee, Arthroscopy Association of North America
Dart, Bradley R.	n
Darwiche, Hussein	n
Davis, Alan	n
Davis, Mark P.	n
Davis, Richard L.	n
De La Rocha, Adriana	n
Dean, Erin M.	n
DeClaire, Jeffrey H.	2, 3b – Biomet; 2 – Zimmer; 3a – Biometric; 5 - Pacira
Deinlein, Donald A.	3b, 5, 6 – K2M; 9 – Adult Spinal Deformity Committee, Scoliosis Research Society
Dekutoski, Mark B.	1 – Mayo Clinic Office of Intellectual Property; 1, 2, 3b – Medtronic; 2 – DePuy, a Johnson & Johnson Company; 9 – North American Spine Society, Scoliosis Research Society
Della Rocca, Gregory J.	2, 3b – Synthes; 3b – Bioventus, Intellectual Ventures, LifeNet

	Health; 4 – Amedica, MergeNet, The Orthopaedic Implant Company; 5 – Eli Lilly, Sonoma Orthopedics, Wound Care Technologies; 8 – Journal of Bone and Joint Surgery-American, Journal of Orthopaedic Trauma, Journal of the American Academy of Orthopaedic Surgeons; 9 – AAOS, American College of Surgeons, Orthopaedic Trauma Association
Della Valle, Craig J.	3b – ConvaTec, DePuy, a Johnson & Johnson Company; 3b, 5 – Biomet, Smith & Nephew; 4,5 – CD Diagnostics; 5 – Stryker; 7 – Journal of Bone and Joint Surgery-American, SLACK Incorporated; 8 – Orthopedics Today, SLACK Incorporated; 9 – American Association of Hip and Knee Surgeons, Arthritis Foundation, Knee Society, Mid-America Orthopaedic Association
Dennis, Douglas A.	1, 2, 3b, 5 – DePuy, a Johnson & Johnson Company; 1 – Innomed; 4 – Joint Vue; 5 – Porter Adventist Hospital; 8 – Journal of Arthroplasty, Journal of Bone and Joint Surgery-American, Clinical Orthopaedics and Related Research, Orthopedics Today; 9 – AAOS, Hip Society, International Congress for Joint Reconstruction, Joint Vue, Operation Walk USA
Dennison, David G.	2 – AO; 5 – DePuy, a Johnson & Johnson Company; 9 – AAOS, American Society for Surgery of the Hand
Dennison, Taylor D.	3a – Eisai Oncology
Dicintio, Martin S.	n
Dilisio, Matthew F.	n
Dirschl, Douglas R.	3b – Amgen, Stryker; 9 – American Orthopaedic Association, Orthopaedic Trauma Association
Dobson, Christopher R.	n
Dockery, John D.	n
Dong, Frank	n
Dornan, Grant J.	5 – Arthrex, Inc., ConMed Linvatec, Opedix, Ossur Americas, Siemens Medical Solutions USA, Small Bone Innovations, Smith & Nephew Endoscopy
Dougherty, Paul J.	8 – Clinical Orthopaedics and Related Research
Doung, Jennifer	n
Dreger, Tina K.	n
Duchman, Kyle R.	n
Duckett, James	n
Dudda, Marcel	n
Duncan, Stephen T.	3b – Mitek, Smith & Nephew
Dunlay, Ryan P.	n
Dunn, Warren R.	n
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Eckerle, Paul	n
Edgington, Jonathan P.	n
Edwards, Gary	n
Edwards, Lindsey H.	n
Edwards, Paul K.	n
Edwards, Peter H., Jr.	1 – DePuy, a Johnson & Johnson Company; 1, 2 – Johnson & Johnson; 1, 3c – Pfizer; 1, 3c, 5 – Eli Lilly

Edwards, Sara L.	n
Eghbal, Azam A.	n
Eilers, Mark A.	n
Elegbede, Adekunle	n
Elhassan, Bassem T.	n
Elia, Chris	n
Elkins, Jacob M.	n
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Engasser, William M.	n
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Erickson, Jill	n
Ertl, William J. J.	n
Esposito, Domenic	n
Estrera, Kenneth A.	n
Eubanks, Timothy	n
Evans, Jason M.	n
Everhart, Joshua S.	n
Fakhouri, George	n
Farrow, Lutul D.	n
Fehring, Thomas K.	1, 2, 3b, 5 – DePuy, a Johnson & Johnson Company; 9 – American Association of Hip and Knee Surgeons, Hip Society, Knee Society
Feldman, John J.	n
Felts, Lara N.	n
Femino, John E.	n
Fening, Stephen D.	n
Fernandez, John J.	1, 4 - Tornier
Ferrara, Lisa	n
Ferrel, Jason R.	n
Fischer, Richard A.	n
Fishman, Matthew P.	n
Fissel, Brian A.	n
Flanigan, David C.	2, 3b – Sanofi; 3b, 6 – Smith & Nephew; 6 – Arthrex, Inc., Biomet, Mitek
Fleissner, Courtney R.	n
Fleissner, Paul R.	2, 3b, 5 – Exactech, Inc.
Flynn, Jeffrey	9 – American Board of Medical Laboratory Immunology, Association of Medical Laboratory Immunology
Fortin, Paul T.	3b – Smith & Nephew, Stryker, Tornier; 5 – Musculoskeletal Transplant Foundation
Fowler, Susan	9 – Interagency Council on Information Resources for Nursing
Fowler, Terry T.	n
Fox, Justin P.	n
Frangiamore, Salvatore J.	n
Frank, Jonathan M.	n
Frank, Rachel M.	n
Franklin, Sarah L.	n
Fras, Andrew R.	n
Fraser, Tyler W.	n

Frassica, Frank J.	3b - Synthes
Frisch, Nicholas B.	n
Froimson, Mark I.	2 – Care Fusion; 3b, 4 – Medical Compression Systems; 8 – American Journal of Orthopedics, Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons, American Orthopaedic Association, Mid-America Orthopaedic Association
Fruth, Kristin	n
Fuller, Eric B.	n
Gad, Bishoy	4 – Advanced Cell Technology Inc., ACTC LabStyle Innovations Corp., DRIO
Gajewski, Timothy	n
Gala, Raj	n
Gao, Xu	n
Gao, Yubo	n
Gardner, Sue	n
Garvin, Kevin L.	1 – Biomet; 8 – Wolters Kluwer Health – Lippincott Williams & Wilkins; 9 – AAOS, American Orthopaedic Association, Hip Society, Knee Society
Geddes, Timothy	n
Gibson, Gary	1 – BioMarin; 8 – Connective Tissue Research
Gil, Karen M.	n
Gilbert, Chan	n
Gilde, Alex K.	n
Gioe, Terence J.	4 – Eli Lilly, Johnson & Johnson; 5 – DePuy, a Johnson & Johnson Company; 9 – American Board of Orthopaedic Surgery, Inc., American Joint Replacement Registry, Mid-America Orthopaedic Association
Goetz, Devon D.	8 – Clinical Orthopaedics and Related Research; 9 – Society for Arthritic Joint Surgery
Goetz, Jessica	n
Goitz, Henry T.	n
Gold, Jonathan	n
Goldberg, Benjamin	1, 2, 3b – Aston Medical; 2, 3b – Acumed, LLC, Allen Medical, Medwest/Arthrex, Stryker; 4 – Biomimetic, MAKO; 8 – European Journal of Orthopaedic Surgery and Traumatology; 9 – AAOS Electronic Skills Pavilion, AAOS Exhibits Committee
Goldstein, Zachary H.	n
Gonzalez, Mark H.	1 – Johnson & Johnson; 3b – Smith & Nephew; 4 – Ortho Sensing Technology; 9 – American Society for Surgery of the Hand
Goodman, Stuart	3c, 4 – Accelalox, Biomimedica, Tibion; 4 – StemCor; 5 – Baxter; 7 – ABJS; 7, 8 – Clinical Orthopaedics and Related Research; 8 – Biomaterials, Journal of Arthroplasty, Journal of Biomed Material Research, Journal of Orthopaedic Research, Open Biomaterials Journal, Open Orthopaedics Journal, Orthopedics; 9 – AAOS Biological Implants Committee
Goodwin, Ryan C.	3b - Stryker
Gordon, Alexander C.	3b – DePuy, a Johnson & Johnson Company; 3b, 4 – OrthoSensor
Gordon, Zachary	n

Gottlieb, Meghan C.	n
Gottschalk, Lionel J., IV	n
Gould, Gregory C.	n
Goulet, James A.	1 – Zimmer; 4 – Pioneer Surgical Technology; 9 – American Orthopaedic Association, Michigan Orthopaedic Society, Orthopaedic Trauma Association
Gourineni, Prasad V.	4 – G2Healthcare
Gower, Kellen H.	n
Goyal, Nitin	n
Gradisar, Ian M.	n
Grady, Mary K.	n
Graham, William C.	n
Grant, David	n
Grant, Kevin D.	n
Grant, Sheila	n
Graves, Christopher M.	n
Graziano, Gregory P.	3c – Medtronic Sofamor Danek; 8 – The Spine Journal; 9 – AAOS, American Board of Orthopaedic Surgery, American Orthopaedic Association, Mid-America Orthopaedic Association
Greber, Eric M.	3a - Stryker
Gregory, James M.	n
Gregory, James R.	n
Greiner, Justin	n
Grenier, Eric S.	n
Griffith, Timothy B.	n
Grosso, Matthew J.	n
Guanciale, Anthony F.	9 – North American Spine Society Patient Care Committee
Guelcher, Scott A.	3b, 5, 6 – Medtronic Sofamor Danek
Guglielmo, Robert	n
Gupta, Anil K.	n
Gurd, David P.	n
Guthrie, S. Trent	9 – Michigan Orthopaedic Society
Guzman, Miguel A.	n
Haddad, Jebran	n
Haider, Hani	2 – Government of Brazil (INMETRO); 3b – AMTI, Inc., Endolab (Germany), Remedy Informatics (UT); 3c, 4, 5 – Trak Surgical, Inc.; 4 – SI-BONE, Softjoint; 5 – Arthrex, Inc., Biomet, Department of Defense, Exponent, Stelkast, Tohoku University (Japan), University of Tokyo; 8 – Advances in Orthopedics, Journal of Engineering in Medicine; 9 – AAOS, International Society of Technology in Arthroplasty, Orthopaedic Research Society
Hakansson, Nils	n
Hakeos, William M.	3b – Synthes; 4 – Sentio MMG
Hakimi, Osnat	n
Halanski, Matthew A.	5 – Biomet, Medtronic, Stryker; 7 – MTDS; 8 – Journal of Bone and Joint Surgery Highlights: Spine, Orthopaedic Knowledge Update
Haleem, Amgad M.	n

Hall, Christine A.	n
Hamilton, Ryan	n
Hannallah, David N.	n
Hanson, George	n
Hanssen, Arlen D.	1, 5 – Stryker; 7 - Elsevier
Hardesty, Christina K.	3b - Medtronic
Hariharan, Arun	n
Harmsen, W. Scott	n
Harper, Benjamin L.	n
Harris, Joshua D.	8 - Athroscopy
Hart, John	n
Hartman, Curtis W.	2, 3b, 5 – Smith & Nephew
Haughom, Bryan D.	n
Hawk, Debbie	n
Haynes, Jacob A.	n
Hedgecock, Jon	n
Heidenreich, Mark J.	n
Heinsch, David J.	n
Hellman, Michael D.	n
Helms, Jonathan R.	n
Hettrich, Carolyn M.	9 – American Orthopaedic Society for Sports Medicine, Iowa Orthopaedic Society, Orthopaedic Research Society
Hetzel, Scott	n
Hewlett, Angela L.	9 – Society for Healthcare Epidemiology of America
Higuera, Carlos A.	n
Hildebrand, Gregory R.	n
Hillis, Stephen	n
Ho, James E.	3a – Neurotherapeutics Pharmaceuticals; 4 – Jazz Pharmaceuticals, Gilead Pharmaceuticals
Hoashi, Jane	n
Hoegler, Joseph J.	n
Hoffmann, Martin F.	n
Holcombe, Sven A.	n
Holmes, James R.	9 – American Orthopaedic Foot and Ankle Society
Honsawek, Sittisak	n
Hooper, Jessica	n
Hopkinson, William J.	4 – Johnson & Johnson, Pfizer, Zimmer; 9 – AAOS
Horn, Brandon J.	n
Hothem, Elijah	n
Houdek, Matthew T.	n
Howard, Krista J.	n
Howe, Benjamin M.	n
Howell, Stephen M.	1, 2, 3b – Biomet Sports Medicine; 1, 2, 3b, 5 – Zimmer; 7 – Saunders/Mosby-Elsevier; 8 – American Journal of Sports Medicine; 9 – AAOS
Hsu, Andrew R.	n
Hsu, Derek	n
Hsu, Joseph R.	2 – Smith & Nephew; 9 – Limb Lengthening Research Society
Huddleston, James I., III	1, 2, 3b – Exactech, Inc., Zimmer; 2, 3b, 5 – Biomet; 2, 3b –

	Stryker; 3b – Smith & Nephew; 3b, 4 – Porosteon; 5 – Robert Wood Johnson Foundation; 8 – Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons
Hudson, Ian L.	n
Hughes, Joy D.	n
Hulst, Jonah B.	n
Hunter, Lindsay R.	n
Huo, Michael H.	2 – Cadence Pharmaceutical, Jassen; 3b – Biomet, DePuy, IMDS; 8 – Current Orthopedic Practice; 9 - AAOS
Hussain, Mohammed	n
Hutchinson, Mark R.	8 – American Journal of Sports Medicine, British Journal of Sports Medicine, The Physician and Sportsmedicine; 9 – AAOS, American Board of Orthopaedic Surgery, Inc., American College of Sports Medicine, American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, Orthopaedic Learning Center
Hyde, Zane B.	n
Iannotti, Joseph P.	1 – Biomet, Musculoskeletal Transplant Foundation; 1, 2, 3b – DePuy Synthes; 1, 3b – Tornier; 1, 2 – Zimmer; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Journal of Shoulder and Elbow Surgery
Ilgenfritz, Ryan M.	9 – Pediatric Orthopaedic Society of North America
Incavo, Stephen J.	1 – Innomed; 1, 3b, 4 - Zimmer; 8 – Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons
Ireland, Philip H.	5 – Stryker
Ishikawa, Susan N.	9 – American Orthopaedic Foot and ankle Society, Campbell Clinic Foundation
Israel, Heidi	n
Jackman, James M.	n
Jacks, Duncan	n
Jackson, Nancy	n
Jackups, Ronald	n
Jacobs, Joshua J.	4 – Implant Protection; 5 – Medtronic Sofamor Danek, Nuvasive, Zimmer
Jacobson, Steven	2, 3b - Lifecell
Jansson, Kyle S.	n
Jarjour, Wael N.	n
Jeffries, James	n
Jenkins, Derek R.	n
Jenkins, Tyler	n
Jew, Mary L.	n
Jew, Nicholas B.	n
Jiang, Jimmy J.	n
Johnson, Anthony E.	3b – Consultant, Orthopaedic Devices Panel, U.S. Food & Drug Administration, Nexus Medical Consulting; 4 – Pfizer; 5 – Bergstrom Pharmaceuticals, Flexion Therapeutics; 8 – Clinical Orthopaedics and Related Research, Foot and Ankle Specialist, Military Medicine, British Journal of Sports Medicine; 9 – Society of Military Orthopaedic Surgeons

Johnson, Jeffrey E.	1, 4 – OrthoHelix Surgical Designs, Inc./Division of Tornier; 3b – Tornier; 4 – Midwest Theapy, LLC; 8 – American Journal of Orthopedics, Foot and Ankle International, Techniques in Foot and Ankle Surgery; 9 – American Orthopaedic Foot and Ankle Society, International Federation of Foot and Ankle Societies, Mid-America Orthopaedic Association
Johnson, Rebecca	n
Johnson, Staci R.	n
Johnson, Steve	n
Jones, Clifford B.	8 – Journal of Bone and Joint-American, Journal of Orthopaedics and Traumatology; 9 – AOA Own the Bone Board, Michigan Orthopaedic Society PAC Secretary, Mid-America Orthopaedic Association Membership Committee, Orthopaedic Trauma Association Membership Chairman; Orthopaedic Trauma Association Health Policy Committee
Jones, David B., Jr.	n
Jones, Grant L.	3c – Arthrotek; 5 – Biomet, Genzyme; 9 – American Orthopaedic Society for Sports Medicine
Jones, Kerwyn C.	3b - Orthopediatrics
Jones, Morgan H.	3b – Allergan; 8 – Orthopaedic Journal of Sports Medicine
Jones, Richard E.	1 – Innomed; 1, 2, 3b – DePuy, a Johnson & Johnson Company, MAKO Surgical; 4 – Amedica, Johnson & Johnson, Kinamed, Omni Scientific, Total Joint Orthopaedics
Jordan, Mark A.	n
Jost, Patrick W.	n
Judd, Matthew	n
Kaar, Scott G.	n
Kaeding, Christopher C.	3b – Biomet; 9 – AAOS, American Orthopaedic Association, American Orthopaedic Society for Sports Medicine, Mid-America Orthopaedic Association
Kakar, Sanjeev	1, 3b, 5 – Arthrex, Inc.; 3b – Skeletal Dynamics
Kamath, Atul F.	8 – BMC Musculoskeletal Disorders; 9 - AAOS
Karam, Matthew D.	n
Karek, Matthew	n
Karges, David E.	n
Kavadi, Niranjan U.	n
Keene, James S.	9 – American Orthopaedic Society for Sports Medicine
Keener, Jay D.	8 – Journal of Shoulder and Elbow Surgery
Keeney, James A.	3b – OrthoSensor; 5 – Stryker; 9 – Society of Military Orthopaedic Surgeons
Keith, Angela D.	n
Keller, Robert A.	n
Kellerman, Heather	n
Kelly, Derek M.	7 – Elsevier Health; 9 – Pediatric Orthopaedic Society of North America
Khoriaty, Justin D.	n
Kim, Brian D.	n
Kim, Young-Jo	n
King, Alexander H.	n

Klaassen, Alison L.	n
Klein, Sandra E.	n
Klika, Alison K.	n
Klosterman, Emma	n
Knapik, Derrick M.	n
Knoll, Peter A.	n
Koh, Jason L.	3b – Aesculap/B. Braun, Arthrex, Inc.; 3b, 4 – Aperion; 9 – American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, Illinois Association of Orthopaedic Surgeons, Patellofemoral Foundation
Kolovich, Gregory P.	n
Konigsberg, Beau S.	n
Konye, Geoffrey	n
Kotwicki, Tomasz	8 – Open Access Biomed Central Journal, Scoliosis; 9 – International Research Society of Spinal Deformities, Society of Scoliosis Orthopedic and Rehabilitation Treatment
Koueiter, Denise	n
Kovacevic, David	n
Kovachevich, Rudy	n
Kraay, Matthew J.	3c – Zimmer; 9 – AAOS, Arthritis Foundation
Kralovec, Michael E.	n
Kraus, Emily A.	n
Krebs, Viktor E.	1 – Shukla Medical (Extract-All); 2, 3b – Stryker Orthopaedics; 8 – Journal of Arthroplasty
Krishnamurthy, Anil B.	n
Krishnan, Varun	n
Krueger, Chad A.	9 – AAOS, Society of Military Orthopaedic Surgeons, Texas Orthopaedic Association
Krummenacher, Tyler R.	n
Kruppa, Christiane G.	n
Krych, Aaron J.	n
Kuivila, Thomas E.	n
Kuzma, Scott A.	n
Kwasny, Mary J.	n
LaFleur, Brett	n
Lahr, Brian D.	n
Laker, Michael W.	n
Lam, Vincent	n
Lammli, John J.	n
Lamplot, Joseph	n
Langfitt, Maxwell K.	n
LaPrade, Robert F.	3b, 5 – Arthrex, Inc.; 5 – Linvatec, Ossur, Smith & Nephew; 8 – American Journal of Sports Medicine, Arthroscopy, Knee Surgery, Sports Traumatology; 9 – American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, ESSKA, International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine
Larson, A. Noelle	9 – Scoliosis Research Society
Larson, Dirk R.	n

Larson, Timothy B.	n
Laughlin, Richard T.	2 – AO North America, Smith & Nephew, Synthes; 3b – World Arthrosis Organization; 3b, 9 – Premier Health Partners Orthopaedic Institute, South Surgery Center, LLC; 3c – Community Tissue Bank; 5 – Grants: AOFAS, Ohio Third Frontier, Orthopaedic Trauma Association; 5, 9 – Wright State University Boonshoft School of Medicine; 9 – Dayton Area Graduate Medical Education Consortium, Mid-America Orthopaedic Association, Wright State Physicians, Inc.
Lavelle, William F.	2 – Stryker; 5 – DePuy, a Johnson & Johnson Company; 8 - SAS
Lawton, Jeffrey N.	3b – Innomed; 5 – Biomet; 6 – AO North America; 9 – American Society for Surgery of the Hand
Ledonio, Charles Gerald T.	5 - Medtronic
Lee, John J.	n
Leighley, Bonnie L.	n
Leland, John M.	n
Lendway, Lisa	n
Lennon, Donald P.	n
Lervick, Gregory N.	2, 3b - Tornier
Les, Clifford M.	n
Levine, Brett R.	3b, 5 – Biomet, Zimmer; 3b – CONMED Linvatec, DePuy, a Johnson & Johnson Company; 8 – Human Kinetics, Orthopedics, SLACK Incorporated; 9 – AAOS, CORD
Levy, Bruce A.	1 – VOT Solutions; 1, 3b, 5 – Arthrex, Inc.; 5 – Biomet; 8 – Arthroscopy, Clinical Orthopaedics and Related Research, Journal of Arthroscopic and Related Surgery, Journal of Knee Surgery, Knee Surgery, Sports Traumatology; 9 – Arthroscopy Association of North America (ISAKOS representative)
Lewallen, David G.	1 – Zimmer; 3b, 4 – Pipeline Biomedical Holdings; 8 – Clinical Orthopaedics and Related Research; 9 – American Joint Replacement Registry, Hip Society, Orthopaedic Research and Education Foundation
Lewallen, Laura W.	1, 5 – Zimmer (family member); 2 – Osteotech (family member); 3b, 4 – Pipeline Biomedical Holdings (family member)
Lewis, Thomas R.	n
Lichstein, Paul M.	n
Licini, David J.	n
Lien, John R.	n
Little, Bryan E.	n
Littleton, Travis W.	n
Liu, Jane	n
Liu, Steve S.	n
Loechler, Youlonda	n
Lograsso, Mary E.	n
Lombardi, Adolph V., Jr.	1, 2, 3b, 5 – Biomet; 1 – Innomed; 3b, 5 – Pacira; 5 – Kinamed, Stryker; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Bone and Joint Surgery-American, Journal of Orthopaedics and Traumatology, Journal of American Academy of Orthopaedic Surgeons, Knee, Surgical

	Technology International; 9 – Hip Society, Knee Society, Operation Walk USA, Orthopaedic Research and Education Foundation
Lostis, Emilie	n
Lovecchio, Francis	n
Lovro, Luke R.	n
Lowe, Walter R.	2 – Arthrex, Inc.; 3b – DJ Orthopaedics, Stryker
Luo, Michael	n
Luo, Tianyi D.	n
Luther, Gaurav A.	n
Luu, Hue H.	n
Ly, Amanda V.	n
Mabry, Tad M.	4 – Elan, Exact Sciences, Norvartis, Pfizer
Macalena, Jeffrey A.	9 – Mid-America Orthopaedic Association
Maerz, Tristan	n
Mageswaran, Prasath	n
Magnussen, Robert A.	8 – BMC Musculoskeletal Disorders, Orthopaedic Journal of Sports Medicine; 9 – American Orthopaedic Society for Sports Medicine
Mahoney, Craig R.	3b, 4 – Trak Surgical, Inc; 5 – Smith & Nephew; 9 – AAOS, Mercy Medical Center, Mid-America Orthopaedic Association, Polk County Medical Society
Malkani, Arthur L.	1, 2, 3b, 5 – Stryker; 5 – Synthes; 8 – Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons
Mall, Nathan A.	7 – Vindico Medical Education
Maloney, Brigid N.	n
Manning, David W.	1, 3b – Biomet; 2, 3b – Medacta; 4 – Iconacy; 9 - AAOS
Manske, M. Claire	n
Maradit-Kremers, Hilal	n
Maratt, Joseph D.	3a, 4 – Alexion Pharmaceuticals, Merck, Momenta Pharmaceuticals; 4 – Abbott Laboratories, Sanofi, Vertex Pharmaceuticals
Marberry, Scott T.	n
Marecek, Geoffrey S.	n
Markel, David C.	1, 2, 3b, 4, 5 – Stryker; 4 – Arbotetum Ventures, Novi Bone and Joint Center; 8 – Clinical Orthopaedics and Related Research, Journal of Arthroplasty, Journal of Bone and Joint Surgery-American, Osteoarthritis and Cartilage; 9 – American Association of Hip and Knee Surgeons, Michigan Orthopaedic Society, Mid-America Orthopaedic Association
Markert, Ronald J.	n
Markiewitz, Andrew D.	7 – American Board of Orthopaedic Surgery, Inc., CRC Press; 8 – Hand, Journal of Bone and Joint Surgery-American, Journal of Hand Surgery-American; 9 – Academy of Medicine of Cincinnati, AAOS, Mid-America Orthopaedic Association, Ohio State Medical Association
Marra, Guido	3b – Zimmer; 9 – AAOS, American Shoulder and Elbow Surgeons, Association of Bone and Joint Surgeons
Marsh, J. Lawrence	1 – Biomet; 4 – FxRedux; 7 – Oxford Press; 9 – ACGME Residency Review Committee, American Board of Orthopaedic

	Surgery, Inc., American Orthopaedic Association, Mid-America Orthopaedic Association, National Board of Medical Examiners
Marshall, Nathan E.	n
Martell, John M.	1 – UCTech patent from University of Chicago; 3b – Biomet, StelKast, Inc.
Martin, Christopher T.	9 – AAOS, Musculoskeletal Transplant Foundation
Martin, John R.	n
Martin, William	n
Martusiewicz, Alexander	n
Maskill, John D.	n
Mason, James	9 – Orthopaedic Trauma Association
Matic, George T.	n
Matthews, Joshua M.	n
Mauck, Benjamin M.	n
Mayerson, Joel L.	5 – Millenium Pharmaceuticals; 8 – Conference Papers in Oncology, Journal of Surgical Oncology; 9 – AOA, Musculoskeletal Tumor Society, National Comprehensive Cancer Network, Ohio Orthopaedic Society
McAllister, Megan	n
McAndrew, Christopher M.	2 – Synthes; 7 – Journal of Bone and Joint Surgery-American
McArthur, Benjamin A.	n
McCarthy, Mark A.	n
McCormick, Frank	n
McCormick, Jeremy J.	2 – Synthes Integra; 5, 6 – Midwest Stone Institute, Wright Medical Technology, Inc.; 6 – Arthrex, Inc.; 8 – Foot and Ankle International, Techniques in Foot and Ankle Surgery; 9 – American Orthopaedic Foot and Ankle Society
McCormick, Kelly R.	1 - Innomed
McDonald, Douglas J.	9 – Musculoskeletal Tumor Society
McFarlin, Jared	n
McGwin, Gerald	n
McIntosh, Amy L.	3b – Synthes; 9 – Mid-America Orthopaedic Association
McKeon, Kathleen E.	n
McLain, Robert F.	9 – Mid-America Orthopaedic Association
McLaughlin, Jeffrey R.	1, 2, 3b, 5 – Biomet; 9 – Mid-America Orthopaedic Association
McNamara, Andrew R.	n
McQueen, David A.	n
Mednick, Rachel E.	n
Meftah, Morteza	n
Mehle, Susan	n
Mehran, Nima	n
Mejia, Alfonso	n
Mendoza-Lattes, Sergio A.	2, 3b – Globus Medical; 2, 3b, 5 – Medtronic Sofamor Danek; 3b – Synthes; 5 – Stryker; 8 – Journal of Bone and Joint Surgery-American, Clinical Orthopaedics and Related Research, Journal of Orthopaedic Research, Spine; 9 – AAOS, Scoliosis Research Society
Meneghini, R. Michael	1, 2, 3b, 5 – Stryker; 8 – Journal of Arthroplasty
Meschbach, Nicole T.	n

Mesko, Nathan W.	3c – DePuy, a Johnson & Johnson Company, Stryker; 9 – AAOS, American Association of Hip and Knee Surgeons
Meyer, Frederick N.	2 – Auxilium; 8 – Journal of Bone and Joint Surgery-American, Journal of Hand Surgery-American; 9 – AAOS, American Orthopaedic Association, Clinical Orthopaedic Society, Mid-America Orthopaedic Association
Meyer, Mark S.	n
Micev, Alan J.	n
Michienzi, Avery E.	n
Mihalko, William M.	1, 2, 3b, 5 – Aesculap/B. Braun; 3b – Medtronic; 5 – Smith & Nephew, Stryker; 7 – Saunders/Mosby-Elsevier, Springer; 8 – Journal of Arthroplasty, Reconstructive Review; 9 – American Orthopaedic Association, ASTM International
Miller, Benjamin J.	9 – Mid-America Orthopaedic Association, Musculoskeletal Tumor Society
Miller, Robert H., III	7 – Saunders/Mosby-Elsevier; 8 – American Journal of Sports Medicine
Miller, Ryan E.	n
Millis, Michael M.	7, 8 – Saunders/Mosby-Elsevier; 8 - Springer
Miniaci, Anthony	1, 2, 3b, 4, 6 – Arthrosurface; 1, 3b, 4 – Zimmer; 2, 3b – CONMED Linvatec, Smith & Nephew; 3b, 4, 6 – Stryker; 4 – DePuy, a Johnson & Johnson Company, Medtronic; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins; 8 – Wolters Kluwer Health – Lippincott Williams & Wilkins; 9 – American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America, International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine
Miotin, Lauren	n
Mir, Hassan R.	3b – Smith & Nephew; 8 – Journal of Orthopaedic Trauma, Journal of the American Academy of Orthopaedic Surgeons, Journal of Bone and Joint Surgery, Orthopaedic Trauma Association Newsletter Editor; 9 – AAOS, Foundation of Orthopaedic Trauma, Orthopaedic Trauma Association
Mitchell, W. Ryan	n
Moed, Berton R.	1 – Biomet; 9 – AO Foundation, AO North America
Molina, Cesar S.	n
Molligan, Jeremy	n
Molloy, Robert M.	2, 3b, 5 – Stryker; 5 - Zimmer
Moore, Drew D.	n
Moore, Thomas J., Jr.	3b – Smith & Nephew
Moran, Steven L.	1, 2, 3b – Integra; 4 – Axogen, Conventus; 8 - Hand
Moretti, Vincent M.	n
Moric, Mario M.	n
Mormino, Matthew A.	3b – Cardinal Health; 8 – Journal of the American Academy of Orthopaedic Surgeons, Journal of Surgical Education
Morrey, Mark E.	4 - Tenex
Morris, Kelly A.	n
Morris, Michael R.	n
Morscher, Melanie A.	n

Moskowitz, Alan	n
Mott, Michael P.	n
Mouthuy, Pierre-Alexis	n
Moutzouros, Vasilios	n
Mroz, Thomas E.	2 – AO Spine; 3b – Globus Medical; 4 – Pearl Diver, Inc.; 8 – Global Spine Journal, SpineLine; 9 – AO Spine, North American Spine Society
Murphy, G. Andrew	3c – Wright Medical Technology, Inc.; 5 – Allostem, Arthrex, Inc., Biomimetic, Smith & Nephew; 7 – Saunders/Mosby-Elsevier; 8 – Foot and Ankle International; 9 - AAOS
Murphy, Joshua M.	n
Murphy, Robert F.	9 - AAOS
Murray, Trevor G.	3b – Pacira Pharmaceuticals, Smith & Nephew, Zimmer; 5 – Stryker
Murtha, Yvonne M.	9 – AAOS
Mutnal, Amar	4 - Genentech
Nair, Rajesh	n
Nam, Denis	4 – OrthAlign, Inc.
Naranje, Sameer M.	6 - OREF
Nash, Cassie	n
Natoli, Roman	n
Neckrysh, Sergey	2, 3b, 6 – DePuy, a Johnson & Johnson Company, Medtronic Sofamor Danek; 2 – Globus Medical; 3b – K2M; 3b, 4 – Qualgenix;
Nelson, Bradley J.	5 – DePuy, a Johnson & Johnson Company, Histogenics, Omeros; 9 – American Orthopaedic Society for Sports Medicine
Nemeth, Blaise A.	6 - Biomet
Nepple, Jeffrey J.	n
Ness, Shane R.	n
Nessler, Joseph P.	1, 2, 3b, 4, 6 – Stryker
Newbern, D. Gordon	n
Nho, Shane J.	3b – Ossur; 3b, 4, 5 – Pivot Medical; 3b, 5 – Stryker; 5 – Allosource, Arthrex, Inc., Athletico, DJ Orthopaedics, Linvatec, Miomed, Smith & Nephew; 8 – Journal of Bone and Joint Surgery
Nicholson, Nathan A.	n
Nickerson, Terry P.	n
Nies, Matthew S.	n
Noble, Philip	1 – Stryker; 1, 2, 3b, 5 – Zimmer; 1, 3b – Omni Sciences, Inc.; 1, 7 – Springer; 3b – DePuy, a Johnson & Johnson Company, Johnson & Johnson; 5 – Synthes; 8 – Journal of Arthroplasty; 9 – Hip Society
Noiseux, Nicolas O.	3b – Wright Medical Technology, Inc.; 5 – DePuy, a Johnson & Johnson Company, Zimmer
North, W. Trevor	n
Norton, Adam	n
Nuckley, David J.	3a – Zimmer; 3b – Zyga Technologies
Nunley, Ryan M.	3b – CardioMEMS, Integra Sciences, Medtronic, 3b, 5 - Smith &

	Nephew, Wright Medical Technology, Inc.; 5 – Biomet, DePuy Synthes, Medical Compression Systems, Inc., Stryker; 9 – Missouri State Orthopaedic Association, Southern Orthopaedic Association
Nwagwu, Chimnoya	n
Nyazee, Humaa A.	n
Nypaver, Christina	n
Oak, Nikhil R.	n
Ochsner, John L.	n
Odeh, Khalid I.	n
Odland, Andrew N.	n
O'Guinn, Justin D.	n
Oliphant, Bryant W.	2 - Synthes
Olson, Stephen T.	n
O'Malley, Natasha T.	n
Onwudiwe, Ndidi	n
O'Rourke, Colin	n
Osmon, Douglas R.	9 – Musculoskeletal Infection Society
Otero, Jesse E.	n
Otterberg, Erik T.	9 – Lakeside Hospital, Mid-America Orthopaedic Association
Ozer, Kagan	n
Padley, Michelle A.	n
Pagnano, Mark W.	1 – DePuy, a Johnson & Johnson Company, MAKO, Stryker; 5 – Zimmer; 7, 8 – Clinical Orthopaedics and Related Research; 9 – AAOS, Knee Society
Paik, Ronald S.	n
Paletta, George A., Jr.	2 – Arthrex, Genzyme
Paliwal, Monica	n
Panas, Kenton B.	n
Pancholi, Neel	n
Pangrazzi, Garett J.	n
Paprosky, Wayne G.	1, 2, 3b – Zimmer; 2, 3b – DePuy, a Johnson & Johnson Company, Medtronic, Stryker; 7 – Lippincott; 8 – Journal of Arthroplasty; 9 – Hip Society
Park, Daniel K.	3b – Baxano, DePuy, a Johnson & Johnson Company, K2M, Stryker; 4 – Johnson & Johnson
Parks, Christopher T.	n
Parry, Joshua A.	n
Parsons, Theodore W., III	9 – AAOS, American Orthopaedic Association, Henry Ford Medical Group, Michigan Orthopaedic Society, Musculoskeletal Tumor Society, Orthopaedic RRC, Society of Military Orthopaedic Surgeons
Parvizi, Javad	3b – Cadence; 3b, 5 – 3M, Smith & Nephew, Zimmer; 3b – CeramTec, Pfizer, TissueGene; 5 – Baxter, DePuy, a Johnson & Johnson Company, National Institutes of Health (NIAMS & NICHD), Stryker; 7 – jaypee, Journal of Arthroplasty, Journal of Bone and Joint Surgery – American, Wolters Kluwer Health – Lippincott Williams & Wilkins; 7, 8 – SLACK Incorporated; 8 – American Journal of Orthopedics, Current Opinion in

	Orthopaedics, International Orthopaedics, Journal of Arthroplasty, Journal of Bone & Joint Surgery – American, Journal of Bone and Joint Surgery – British, Journal of the AAOS, Magnifi Group, Orthopedics Today; 9 – American Association of Hip and Knee Surgeons, American Board of Orthopaedic Surgery, Inc., British Orthopaedic Association, CD Diagnostics, Eastern Orthopaedic Association, Hip Society, Orthopaedic Research and Education Foundation, Orthopaedic Research Society, Philadelphia Orthopedic Society, Smartech, United Healthcare
Pashos, Gail	4 - GlaxoSmithKline
Patel, Anay R.	n
Patel, Jay N.	n
Patel, Kushal R.	n
Patel, Raj M.	n
Patel, Rakesh D.	2 – Stryker Spine
Patzkowski, Jeanne C.	n
Pavey, Emily S.	n
Pearson, Claire	n
Penny, Phillip C.	n
Perera, Priyangi	n
Perry, Kevin I.	n
Perry, Tiffany	n
Peters, Christopher L.	1, 2, 3b – Biomet; 8 – Journal of Arthroplasty; 9 – AAOS, American Association of Hip and Knee Surgeons
Peterson, Ham	7 – Springer; 8 – Journal of Pediatric Orthopaedics B (European)
Peterson, Jonathan B.	n
Peterson, Todd	n
Petrus, Cara L.	n
Pfefferle, Kiel J.	n
Philippon, Marc J.	1 - Bledsoe, CONMED Linvatec, Donjoy; 1, 3b, 5, 6 – Smith & Nephew; 1, 4 – Arthrosurface; 3b, 4 – MIS; 4 – Hipco; 5 – Ossur, Siemens, Vail Valley Medical Center; 7 – SLACK Incorporated, Elsevier; 9 – AOSSM, International Society for Hip Arthroscopy, Steadman Philippon Research Institute
Phillips, Dylan	n
Phisitkul, Phinit	3b – Arthrex, Inc.; 4 – MTP Solutions; 9 – American Orthopaedic Foot and ankle Society
Pichetsurnthorn, Pie	n
Pitts, Todd	n
Podeszwa, David A.	9 – AAOS, Pediatric Orthopaedic Society of North America
Poehling-Monaghan, Kirsten L.	n
Poe-Kochert, Connie	n
Politi, Joel R.	1, 2, 3b – DePuy, a Johnson & Johnson Company
Polly, David W., Jr.	9 – Scoliosis Research Society
Pomajzl, Ryan J.	n
Ponce, Brent A.	2, 3b – Tornier; 3b – Accumed, LLC; 5 - Arthrocare
Popovich, John M., Jr.	n
Potts, Christopher A.	n

Prieto, Edna M.	n
Prieto, Hernan A.	n
Pugely, Andrew J.	9 - AAOS
Pugh, Lucas	n
Pulido, Luis	n
Pulley, Benjamin R.	n
Rakel, Barbara A.	n
Ramaesh, Rishikesan	n
Ramaseshan, Karthik	n
Ramme, Austin J.	n
Ramsey, Trevor D.	n
Razzano, Andrew J.	n
Rees, Harold W.	8 – Orthopedics; 9 - AAOS
Ren, Weiping	n
Rhee, Peter C.	n
Rhodes, Leslie	n
Ricchetti, Eric T.	5 – DePuy, a Johnson & Johnson Company, Tornier
Richardson, David R.	n
Ridley, T. J.	n
Ries, Zachary G.	n
Riley, Patrick M., Jr.	n
Ringnes, Andrew P.	n
Ritzman, Todd F.	3c – Austin Bioinnovation Institute of Akron; 3c, 4 – Apto Orthopaedics
Riyad, Gargoum	n
Rizzo, Marco	5 – SBI, TriMed; 8 – Elsevier, Journal of Wrist Surgery; 9 – AAOS, American Association for Hand Surgery, American Society for Surgery of the Hand
Roberson, Troy A.	n
Roberts, Craig S.	7 – Elsevier; 8 – Injury, Journal of Orthopaedic Trauma, 9 – Kentucky Orthopaedic Society, Mid-America Orthopaedic Association, Orthopaedic Trauma Association
Robertson, Daniel S.	n
Robinson, Luke	n
Roc, Gilbert C.	n
Rockwood, Charles A., Jr.	1, 4 – DePuy, a Johnson & Johnson Company; 7 – Saunders/Mosby-Elsevier, Wolters Kluwer Health – Lippincott Williams & Wilkins
Rogers, Mark E.	n
Romano, Desiree R.	n
Romeo, Anthony A.	1, 2, 3b, 5, 6 – Arthrex, Inc.; 5 – Ossur, Smith & Nephew; 5, 6 – DJO Surgical; 7 – Saunders/Mosby-Elsevier; 8 – Journal of Shoulder and Elbow Surgery, Operative Techniques in Sports Medicine, Orthopaedic Journal of Sports Medicine, Orthopedics, Orthopedics Today, SLACK Incorporated, Sports Health, Techniques in Shoulder and Elbow Surgery; 9 – American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America
Romness, David W.	3b, 5 – Tissuegene; 9 – AAOS, Eastern Orthopaedic

	Association, Virginia Orthopaedic Society
Rose, Chris	n
Rose, Peter S.	8 – Journal of the AAOS, Journal of Surgical Oncology, Yearbook of Orthopedics; 9 – Collaborative Spine Research Foundation, Minnesota Orthopaedic Society
Rosenbaum, Samuel L.	n
Rosenstein, Benjamin	n
Rothermich, Marcus A.	n
Rosenthal, Brett D.	n
Ruh, Erin L.	n
Rungprai, Chamnanni	7 – EOS imaging
Russ, Samuel D.	n
Russell, Robert D.	n
Ruta, David	n
Rutt, Brian D.	n
Ryssman, Daniel B.	n
Saad, Mohamed	n
Sabesan, Vani J.	5 – Tornier; 9 – Kalamazoo Academy of Medicine
Salari, Pooria	n
Salata, Michael J.	3b – Linvatec, Smith & Nephew
Saleh, Anas	n
Salisbury, Meagan	n
Saltzman, Bryan M.	n
Saltzman, Matthew D.	2 – CareFusion; 3b – DJ Orthopaedics, Tornier
Samona, Jason S.	n
Sanchez, Carlos J., Jr.	n
Sanchez, Hugo B.	5 - Biomet
Sanchez-Sotelo, Joaquin	1, 5 – Stryker; 5 – Biomet, DePuy, Zimmer; 8 – Journal of Shoulder and Elbow Surgery; 9 - AAOS
Sanders, Thomas J.	n
SanJuan, Angielyn M.	n
Santos, Edward Ranier G.	5 – SI-Bone, Inc.
Sardesai, Neil	4 – Avanir Pharmaceuticals, Boston Scientific, GTx, Medtronic
Sarfani, Shumaila	n
Sathy, Ashoke K.	n
Savich, Tatjana T.	n
Sawyer, Jeffrey R.	7 – Mosby, Wolters Kluwer Health-Lippincott Williams & Wilkins; 9 – AAOS, Campbell Foundation, Pediatric Orthopaedic Society of North America
Schick, Cameron W.	n
Schiff, Adam P.	n
Schleck, Cathy D.	n
Schoch, Bradley S.	n
Schoenecker, Perry L.	8 – Journal of Children's Orthopaedics, Journal of Pediatric Orthopedics; 9 – Pediatric Orthopaedic Society of North America
Schon, Lew C.	1 – Darco, DJ Orthopaedics; 1, 2, 3b, 4, 5 – Tornier; 1, 2, 3b, 5 – Zimmer; 1, 5 – Arthrex, Inc.; 2, 3b, 5 – Biomet, Biomimetics; 3b – Guidepoint Global, Gerson Lehrman Group, Wright Medical Technology, Inc.; 3c – Carestream Health; 3c, 4, 5 – Royer

	Biomedical, Inc.; 4 – Healthpoint Capital; 4, 6 – Bioactive Surgical, Inc.; 5 – Spinesmith Holdings; 6 – Chesapeake Surgical Biocomposites, Concepts in Medicine LLC, Olympus, OMEGA, OrthoHelix, Smith & Nephew Endoscopy; 7 – Elsevier; 9 – American Orthopaedic Foot and Ankle Society
Schraut, Nicholas B.	n
Schueler, Beth A.	n
Schwindel, Leslie E.	n
Scott, Donna	n
Sebastian, Arjun S.	n
Sekiya, Jon K.	1, 3b – Arthrex, Inc.; 7 – Elsevier; 8 – Orthopaedic Journal of Sports Medicine, Sports Medicine and Arthroscopy Review; 9 – American Orthopaedic Society for Sports Medicine
Selley, Ryan	n
Sembrano, Jonathan N.	5 – Nuvasive; 9 – North American Spine Society, Philippine-Minnesota Medical Association, Society of Lateral Access Surgery
Sems, S. Andrew	1, 3b - Biomet
Severson, Erik P.	n
Shah, Apurva S.	9 – American Society for Surgery of the Hand, Pediatric Orthopaedic Society of North America
Shah, Jay P.	n
Shah, Ritesh R.	n
Shaheen, Michael B.	n
Shaheen, Philip	n
Sharma, Vinay K.	n
Shaughnessy, William J.	8 – Journal of the American Academy of Orthopaedic Surgeons
Shelby, Marcus A.	n
Shemory, Scott T.	n
Sher, Soa-Yih	n
Shi, Lewis L.	n
Shin, Alexander Y.	1 – Trimed; 3b – Acumed, LLC, LMT Orthopedics; 5 – Musculoskeletal Transplant Foundation; 8 – Journal of Bone and Joint Surgery- American, Journal of Hand Surgery-American, Techniques in Hand and Upper Extremity Surgery; 9 – American Society for Surgery of the Hand
Shives, Thomas C.	1- DJ Orthopaedics
Shorten, Peter L.	n
Shybut, Theodore	n
Siemionow, Krzysztof B.	1, 3B- Amedica; 2, 3b – DePuy, a Johnson & Johnson Company; 3b LifeSpine; 4 – Qualgenix; 4, 5, 6 – Tolera Theapeutics; 5 – Musculoskeletal Transplant Foundation; 9 – Composite Tissue Allograft Society
Sierra, Rafael J.	1, 2, 3b, 5 – Biomet; 5 – DePuy, a Johnson & Johnson Company, Stryker, Zimmer; 8 – Journal of Arthroplasty; 9 – American Association of Hip and Knee Surgeons, Maurice Mueller Foundation, Mid-America Orthopaedic Association
Sierzant, Charles G.	n
Sietsema, Debra L.	2, 3b – Eli Lilly; 9 – American Orthopaedic Association Own the Bone, Bone and Joint Initiative, NAON Evidence Base Practice

	and Research Committee, NOF Nursing Advisory Council, Orthopaedic Trauma Association Coding and Classification Committee
Sikora-Klak, Jakub	n
Silverton, Craig D.	1, 3b – Biomet; 9 - MOAOS
Sim, Franklin H.	7 – Saunders/Mosby-Elsevier
Siman, Homayoun	n
Sink, Ernest L.	3b - Pivot
Sivasubramaniam, Priya G.	n
Slikker, William, III	n
Sluka, Kathleen A.	3b – Abbott, Regeneration Technologies, Inc.; 4 – Eli Lilly; 5 – Gruenenthal, Medtronic; 7 – IASP Press, Physical Therapy Journal; 8 – Journal of Pain, Physical Therapy Journal; 9 – American Pain Society
Smith, Hugh M.	n
Smith, Langan S.	n
Smith, Richard A.	n
Smith, Sarah E.	n
Smits, Shelly	n
Smyth, Mark P.	n
Snoap, Tyler	n
Snook, Derek L.	2 – Medtronic Sofamor Danek; 3b – Globus Medical, Integra
Song, Wei	n
Son-Hing, Jochen P.	9 – Pediatric Orthopaedic Society of North America, Scoliosis Research Society
Sonn, Kevin	n
Sorkin, Anthony T.	2 – Synthes; 3b – Stryker; 4 – Johnson & Johnson
Spanyer, Jonathon	n
Spencer-Gardner, Luke	n
Sperling, John W.	1 – Biomet, DJ Orthopaedics; 3b – Tornier; 4 – Emerge Medical; 8 – Journal of Shoulder and Elbow Surgery, SLACK Incorporated
Sporer, Scott M.	3b – Smith & Nephew; 3b, 5 – Zimmer; 5 – Central Dupage Hospital; 7 – SLACK Incorporated; 9 – Hip Society
Sproul, Robert C.	n
Stambough, Jeffrey B.	n
Stanga, Daryl	n
Stannard, James P.	2 – AOSSM/AAOS, Medtronic (Kyphon Products), RTI; 2, 3b – Smith & Nephew, Sonoma Orthopedics; 3b – DePuy, a Johnson & Johnson Company, Medtronic Sofamor Danek, Synthes; 5 – Kinetic Concepts, Inc.; 7 – Theime; 8 – Journal of Knee Surgery; 9 – Mid-America Orthopaedic Association, Orthopaedic Trauma Association
Stans, Anthony A.	9 – Pediatric Orthopaedic Society of North America
Starr, Adam J.	1 – Starrframe, LLC; 2 – Smith & Nephew; 8 – Journal of Orthopaedic Trauma
Steckelberg, James M.	n
Steensen, Robert N.	n
Steiner, Richard P.	n

Stern, Peter J.	8 – Journal of Bone and Joint Surgery-American
Stewart, Cory M.	n
Stoner, Julie A.	n
Stover, Matthew	n
Strnad, Gregory J.	n
Stuart, Michael J.	1, 3b – Arthrex, Inc.; 5 – Stryker; 8 – American Journal of Sports Medicine; 9 - AAOS
Stulberg, Bernard N.	1, 3b – Exactech, Inc.; 2 – Medtronic; 2, 5 – Corin U.S.A.; 3 – Stryker; 5 – Zimmer; 8 – Journal of Arthroplasty; 9 – Mid-America Orthopaedic Association
Stulberg, S. David	1 – Biomet, Innomed; 1, 2, 3b – Aesculap/B. Braun; 2, 3b, 4 – Stryker, 2, 3b – Zimmer; 4 – Blue Belt Technologies, Johnson & Johnson; 7 – Peachtree Publishers
Styron, Joseph F.	n
Sucato, Daniel J.	3c – Orthopaediatrics; 7 – Saunders/Mosby-Elsevier; 9 – AAOS, Pediatric Orthopaedic Society of North America, Scoliosis Research Society
Sullivan, Jaron P.	n
Sunderland, Adam M.	n
Swann, R. Presley	n
Sweeney, Patrick	n
Swiontkowski, Marc F.	2 – Pfizer China; 3b – Eli Lilly; 7 – Saunders/Mosby-Elsevier, Wolters Kluwer Health - Lippincott Williams & Wilkins; 8 – Journal of Bone and Joint Surgery-American; 9 – American Orthopaedic Association, Mid-America Orthopaedic Association
Switzer, Julie A.	9 – AAOS Women's Health Issues Advisory Board
Sybrowsky, Christian L.	n
Sykes, Joshua B.	n
Szczodry, Michal	n
Szubski, Caleb	n
Tabaie, Sean A.	n
Tait, Mark A.	n
Talati, Rushi	n
Tanavalee, Aree	9 – Royal College of Orthopaedic Surgeons of Thailand, Thai Hip and Knee Society
Tantavisut, Saran	n
Taunt, Charles J.	n
Taunton, Michael J.	3b – DJ Orthopaedics; 5 - Stryker
Techy, Fernando	2 – DePuy, a Johnson & Johnson Company; 3b – Amedica, Grafton Medical Alliance
Tellini, Allesandra	n
Tennent, David J.	n
Tetreault, Matthew W.	n
Thames, Claudia	n
Theiss, Steven M.	1, 2, 3b – Biomet; 2, 3b, 5 – Synthes; 9 – American Orthopaedic Association
Thompson, George H.	3a, 6 – NuSpine Medical Technologies (son); 3c – OrthoPediatrics, SpineForm; 7 – Lippincott; 8 – Journal of Pediatric Orthopedics; 9 – Societe Internationale de Chirurgie

	Orthopedique et de Traumatologie
Thompson, Kevin T.	n
Thormeyer, Jeffrey R.	n
Throckmorton, Thomas W.	2, 3b, 5 – Biomet; 3b – Zimmer; 7 – Saunders/Mosby-Elsevier; 8 – American Journal of Orthopedics; 9 – AAOS, Mid-America Orthopaedic Association
Tolhurst, Stephen R.	3b – Exactech, Inc.
Tompkins, Marc	7 – Journal of Bone and Joint Surgery Sports Highlights
Toohey, John S.	n
Toolan, Brian C.	4 – Pfizer; 8 – Foot and Ankle International; 9 – AAOS, American Board of Orthopaedic Surgery, Inc., American Council of Graduate Medical Education, American Orthopaedic Association, American Orthopaedic Foot and Ankle Society
Toor, Aneet S.	n
Tran, Nho	n
Traver, Jessica L.	n
Trinh, Thai Q.	n
Trombley, Robert	n
Trousdale, Robert T.	1, 3b – DePuy, a Johnson & Johnson Company, MAKO, Wright Medical Technology; 9 – Mid-America Orthopaedic Association
Turner, Norman S.	n
Tyrakowski, Marcin	n
Vaidya, Rahul	1, 2, 3b, 3c – Stryker; 2, 5, 6 – Synthes; 8 – European Spine Journal
Vaksha, Vedant	n
Van Demark, Robert E., III	n
Vang, Sandy	n
Vann, Elliott R.	n
Vega, Charles	n
Vekaria, Shyam K.	n
Velazquez, Ana I.	n
Verma, Nikhil N.	1, 3b, 5 – Smith & Nephew; 2, 5 – Arthrosurface; 3b – Minivasive; 4 – Omeros; 5 – Arthrex, Inc., Athletico, ConMed Linvatec, Miomed, Mitek; 7 – Arthroscopy, Vindico Medical-Orthopedics Hyperguide; 8 – Arthroscopy, Journal of Knee Surgery, SLACK Incorporated; 9 – Arthroscopy Association Learning Center Committee
Volgas, David A.	5 – Twinn Star Medical
Voor, Michael J.	1 – DePuy, a Johnson & Johnson Company; 3b, 4 – Vivorte Inc.
Wagner, Eric R.	n
Wagner, Russell A.	5 – Biomet; 9 – American Orthopaedic Association
Walsh, Christopher P.	n
Walton, David M.	n
Wang, Olivia	n
Wang, Stewart C.	n
Wangroongsub, Yongsak	n
Ward, Christina M.	n
Ward, Michael	n
Warner, William C., Jr.	3c – Medtronic Sofamor Danek; 7 – Saunders/Mosby-Elsevier; 9

	– Clinical Orthopaedic Society
Warth, Lucian C.	n
Watson, J. Tracy	1 – Biomet, DePuy, a Johnson & Johnson Company; 1, 3b – Smith & Nephew; 2 – Medtronic; 3b – Advanced Orthopedic Solutions, Bioventus; 3c – Accelalox, Acumed, LLC, Ellipse; 8 – Orthopaedic Knowledge Online; 9 – Orthopaedic Trauma Association
Watts, Chad D.	n
Weatherford, Brian M.	n
Weaver, Kevin	n
Webb, Jonathan E.	n
Weber, Alexander E.	n
Weiner, Dennis S.	n
Weiner, Scott D.	9 – American Orthopaedic Association, Musculoskeletal Tumor Society
Weinlein, John C.	7 – Saunders/Mosby-Elsevier
Weinstein, Stuart L.	7 – Wolters Kluwer Health-Lippincott Williams & Wilkins; 8 – Journal of Bone and Joint Surgery-American
Wenke, Joseph C.	8 – Journal of Surgical Orthopaedic Advances, Tissue Engineering
Wera, Glenn D.	n
Wessell, Nolan M.	n
Westerlind, Brian O.	n
Westermann, Robert W.	n
Whitaker, M. Camden	3b – Innovasis, Inc.
White, Richard A.	3b – Biomet; 4 – Amedica, Orthopediatrics
Widmer, Steven A.	n
Wijdicks, Coen A.	5 – Acumed, LLC, AlloSource, Arthrex, Inc., Biomet, Ceterix Orthopaedics, ConMed Linvatec, DePuy Synthes, OREF, Ossur, Smith & Nephew, Sonoma Orthopedics; 8 – Arthroscopy, Knee Surgery, Sports Traumatology
Wilke, Benjamin K.	n
Williams, Brandon M.	n
Wilson, Becky	3a, 4 - Synthes
Wiltfong, Roger E.	n
Wimmer, Marcus	n
Wingerter, Scott A.	n
Wojtera-Tyrakowska, Dominika	n
Wojtys, Edward M.	7, 8 - SportsHealth
Wolf, Brian R.	8 – Orthopaedic Journal of Sports Medicine; 9 – American Orthopaedic Society for Sports Medicine, Mid-America Orthopaedic Association
Wood, Meredith	n
Wooley, Paul H.	3b – DePuy, a Johnson & Johnson Company; 3c, 5 – Stryker; 5 – Smith & Nephew; 9 – Orthopaedic Research Society
Wooten, Clint J.	n
Worden, Alicia F.	n
Wozniczka, Jennifer K.	n
Wright, David M.	n

Wright, Jonathan W.	3a – Warner Chilcott
Wu, Karen	2 – Penumbra; 9 – Association of VA Orthopaedic Surgeons Society for Neurointerventional Surgery
Wu, Lai-Chu	n
Wyles, Cody C.	n
Wysocki, Robert W., Jr.	8 – Operative Techniques in Sports Medicine
Yack, H. John	8 – Journal of Applied Biomechanics
Yaffe, Mark A.	n
Yager, Craig	n
Yakkanti, Madhusudhan	6 - Synthes
Yaszemski, Michael J.	3b – Medtronic; 8 – Journal of Biomedical Materials Research-J. Wiley, Inc.; 9 – AAOS, Minnesota Orthopaedic Society, Society of Military Orthopaedic Surgeons
Yau, Paul F.	n
Yengle, Patricia	n
Yi, Paul H.	n
Yi, Seung J.	n
Yin, Jonathan	n
Youlo, Sylvester T.	n
Young, Nicholas A.	n
Yson, Sharon C.	n
Yu, Michael	n
Yu, Stephen	n
Yuan, Brandon J.	n
Zadzilka, Jayson D.	n
Zaltz, Ira	3b – Pivot Medical; 5 – DePuy, a Johnson & Johnson Company
Zekaj, Mark	n
Zhang, Zijun	n
Zielinski, Martin D.	n
Zienkiewicz, Katarzyna	n
Zimel, Melissa N.	n