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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 23, 2015

Irrigation and Debridement Prior to a Two-Stage Revision TKA Does Not Increase Risk of Failure

Abstract ID: Paper 001

Olubusola Brimmo, M.D.
Nicholas Schlitz, Ph.D.
Aiswarya Pillai Chandran, M.S.
Siran Koroukian, Ph.D.
*Alison K. Klika, M.S.
Carlos A. Higuera, M.D.
Wael K. Barsoum, M.D.
Cleveland, OH

INTRODUCTION: Studies have shown an increased rate of failure of two-stage revision total knee arthroplasty (rTKA) after a failed irrigation and debridement (I&D) for prosthetic joint infections (PJI) of the knee. The objective of this study was to compare failure rates of patients following two-stage rTKA with and without a previous I&D.

METHODS: The 2005-2011 State Inpatient Database (SID) from 2 states (CA and NY) was used to identify patients who underwent two-stage rTKA for PJI between 2007-2009 (using ICD-9-CM procedure and diagnosis codes). The main exposure was I&D. A two-year look back period was used to detect those patients who had an I&D prior to two-stage rTKA, and the outcomes of the two groups (with and without prior I&D) were compared. The primary outcome was failure of the two-stage rTKA (i.e., defined as the need for subsequent surgery due to infection, including ICD-9 diagnosis code 996.66). Follow-up time ranged from 2 - 4 years. Bootstrapping analysis and Kaplan-Meier curves were used to compare failure for groups treated with and without I&D prior to two-stage rTKA.

RESULTS: A total of 628 two-stage rTKA patients were included, with n=45 (7.2%) who had an I&D prior to revision, and n=583 who did not. Overall rTKA failure rate was 74/628 (11.8%). Estimated failures by year two, was 9.0% (95% CI: 2.0% - 18.3%) for patients with a prior I&D, and 12.1% (9.3% - 14.8%) for patients with no I&D, which rose to 15.2% by four years postoperative. The mean time to failure was 119 days (standard deviation[SD]: 38) and 398

(SD: 46) days for patients with and without prior I&D, respectively (p=<.001).

CONCLUSION: Patients who had an I&D prior to two-stage rTKA for infection did not have an increased need for surgery following the revision for infection-related reasons, although the time to failure was significantly shorter.

Periarticular Injection Following TKA Using Liposomal Bupivacaine vs. a Modified Ranawat Suspension. A Prospective, Randomized Study

Abstract ID: Paper 002

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*Philip N. Collis, M.D.
Allison Hunter, B.S.
Derek Vaughn, M.D.
Langan Smith, B.S.
Leah Carreon, M.D.
Jiapeng Huang, M.D.
Jeffrey Stimac, M.D.
Arthur L. Malkani, M.D.
Louisville, KY

INTRODUCTION: Many advancements have been made in an effort to decrease narcotic consumption while improve pain relief, including multimodal drug therapies, regional nerve blocks, and local periarticular injections following TKA. Liposomal bupivacaine has recently been introduced as a long acting local anesthetic. The purpose of this study is to compare liposomal bupivacaine to a modified (Ranawat's) local injection for TKA.

METHODS: This is a prospective, randomized study of 85 consecutive patients undergoing primary TKA. Group A patients received a periarticular injection with liposomal bupivacaine ($285) and Group B with a mixture of ropivacaine, epinephrine, ketorolac, and clonidine ($40). Both groups received the same preoperative teaching, implant type, and postoperative management. Outcome measures included knee pain at rest and with activity, amount of narcotics, knee range of motion, and walking distance. Measures were recorded at intervals of 24 hours, 48 hours, 72 hours, two weeks and four to eight weeks postoperatively.

RESULTS: There were 44 patients in the Group A (liposomal bupivacaine) and 41 in group B. There were no differences in the groups with respect to age, sex, and preoperative knee scores. Pain levels at rest and activity showed no differences between groups at all time intervals. There were no differences with respect to narcotic usage and knee ROM. Liposomal bupivacaine group had a greater walking distance at 24, 48, and 72 hours, but only significant at 24 hours ($p = 0.034$). There was a trend towards increased discharge to home vs. rehabilitation in the liposomal bupivacaine group, but this was not significant.

CONCLUSION: Liposomal bupivacaine as a periarticular injection following TKA demonstrated similar pain levels, narcotic usage, and ROM compared to a modified Ranawat suspension, but improved walking distance and a trend towards home discharge.

What Safe Zone? The Majority of 224 Dislocated THA were within the Lewinnek Zone

Abstract ID: Paper 003

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*Matthew P. Abdel, M.D.
Philipp von Roth, M.D.
Matthew T. Jennings, B.S.
Arlen D. Hanssen, M.D.
Mark W. Pagnano, M.D
Rochester, MN

INTRODUCTION: One long held tenet is that cup inclination and anteversion should be 40±10° and 15±10°, respectively, to minimize dislocations after primary total hip arthroplasty (THA). Recent interest in navigation, robotics, and advanced 3-D imaging has focused on those classic targets defined by Lewinnek in 1978. In contemporary THA practice (characterized by multiple femoral heads size options, multiple liner options, and the predominance of uncemented femoral fixation), we questioned whether those target values accurately predict dislocation remains poorly understood.

METHODS: From a consecutive cohort of 11,246 primary THAs done at our institution between 2003 and 2012, we retrospectively identified 224 THAs (1.9%) which subsequently dislocated. Clinical demographics including age, gender, and BMI, as well as radiographic parameters including inclination, anteversion, center of rotation, and limb length discrepancy were analyzed. The mean age was 64 years, mean was BMI 29 kg/m^2, and mean time to first dislocation was 18 months. Minimum follow-up was 2 years.

RESULTS: The majority (58%) of these dislocated THAs had an acetabular socket position that was within the Lewinnek safe-zone. Mean cup inclination was 44 ± 8° (95% CI = 42-45°), with 84% within the safe zone. The mean anteversion was 15 ± 9° (95% CI = 13-16°), with 69% within the safe zone. The mean lateralization of the center of rotation was 6 ± 4 mm from the native center of rotation, and the mean limb length difference was 4 ± 7 mm longer.

CONCLUSION: The historical target values for cup inclination and anteversion defined by Lewinnek may be useful, but should not be considered a safe-zone given that the majority of these contemporary THAs which dislocated were in fact within those target values. It is likely that the ideal cup position for some patients lies outside the Lewinnek zone and that more advanced analysis is required to identify the right target in that subgroup.

Does Prior Cartilage Restoration Negatively Impact Outcomes of Knee Arthroplasty?

Abstract ID: Paper 004

Rachel M. Frank, M.D. / Chicago, IL
*Darren Plummer, M.S. / Chicago, IL
Peter N. Chalmers, M.D. / Chicago, IL
Scott M. Sporer, M.D. / Winfield, IL
Brett R. Levine, M.D. / Chicago, IL
Brian J. Cole, M.D. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

INTRODUCTION: Cartilage restoration procedures are being performed with increasing frequency and if these procedures fail, patients may require unicompartmental (UKA) or total knee arthroplasty (TKA) to alleviate their symptoms. The purpose of this study was to compare patients who failed a cartilage restoration procedure to matched-controls undergoing primary knee arthroplasty.

METHODS: A retrospective review of prospectively collected data on patients who underwent cartilage restoration by a single surgeon and subsequently progressed to arthroplasty was performed. Patients were matched to primary UKA/TKA controls based on gender, age ± 5 years, body mass index (BMI) ± 5, smoking status, and arthroplasty type and were followed for a minimum of 2 years (mean, 3.7; range, 2.0-7.2). The primary outcome was the Knee Society Score (KSS). Secondary outcomes were range of motion (ROM) and revision rate. Appropriate statistical analysis was performed for continuous data with between and within group comparisons.

RESULTS: A total of 26 patients (13 per group: 8 TKAs and 5 UKAs) were included. There were no significant differences in age, gender, BMI, smoking status, worker's compensation status, preoperative ROM, postoperative ROM, or preoperative KSS scores between groups ($P>0.05$ in all cases), suggesting adequate matching. Patients in the cartilage group had a significantly lower pre-arthroplasty (post-cartilage) Kellgren and Lawrence grade (average 2.6±0.9) compared to matched controls (average 3.7 ± 0.5, $P=0.004$). There were no significant differences in pre-cartilage to post-cartilage (pre-arthroplasty) Tegner (2.4 ± 2.4 to 2.3 ± 0.8, $P=0.729$), Lysholm (30.8 ± 17.1 to 38.2 ± 20.0, $P=0.474$), IKDC (26.4 ± 10.3 to 33.0 ± 10.3, $P=0.847$), or KOOS-pain (41.7 ± 19.4 to 59.0 ± 19.9, $P=0.672$) scores. Patients in the cartilage group had significantly lower postoperative KSS scores (78 ± 13 vs. 91 ± 5, $P=0.005$) and experienced significantly less improvement in KSS scores (30 ± 10 vs. 46 ± 10, $P<0.001$). Two patients (15%) in the cartilage group required revision TKA at 1.9 years (for pain) and 4.7 years (for infection) following the index TKA.

DISCUSSION AND CONCLUSION: While patients with a failed cartilage procedure do still derive benefit from knee arthroplasty, the magnitude of improvement and final scores are lower than matched controls. However, these patients also experienced little to no benefit from cartilage restoration, suggesting that unmeasured shared patient characteristics may play a role. This information can be used to counsel this difficult patient population on expected outcomes following arthroplasty procedures.

MAOA BREAKOUT SESSION #1
HAND/ELBOW
April 23, 2015

An Analysis of Capitate and Lunate Morphology to Predict Long-Term Outcomes in Proximal Row Carpectomy

Abstract ID: Paper 005

Eric R. Wagner, M.D. / Rochester, MN
*Dalibel Bravo, M.D. / New York, NY
Bassem T. Elhassan, M.D. / Rochester, MN
Steven L. Moran, M.D. / Rochester, MN

PURPOSE: Although proximal row carpectomy (PRC) has been established as a successful option for radiocarpal arthritis, many patients experience long-term pain and radiocapitate degenerative changes. The purpose of this study was to elicit radiographic parameters that might help predict the long-term success of PRCs.

METHODS: Review of all patients who underwent proximal row carpectomy (PRC) from 1967 to 2010 for the diagnosis of wrist arthritis. Inclusion criteria were radiographic follow-up beyond 1 year postoperatively. Capitate morphology was described as type I (flat), type II (spherical), or type III (V-shaped). Lunate morphology was classified according to the presence (type II) or absence (type I) of a hamate facet. Radiocapitate arthritis was classified as grade I (mild), grade II (moderate), or grade III (severe).

RESULTS: There were 76 patients who fit the inclusion criteria. Capitate morphology included 55% with a type I, 41% with a type II, and 4% had a type III capitate. 59% of patients had a type I lunate, while 41% had a type II lunate. At an average radiographic follow-up of 6.5 (1.0-29.0) years, 45% of patients had grade II (moderate) or grade III (severe) radiocapitate arthritis. Grade III arthritis of the radiocapitate articulation was seen in 24% of wrists. Type II and type III capitates had a significantly higher rate of grade III arthritis ($p<0.03$) and moderate or severe radiocapitate arthritis ($p<0.05$) when compared to type I capitates. Furthermore, patients with a preoperative type II lunate had a significantly increased risk of grade III arthritis ($p<0.05$) and moderate or severe radiocapitate arthritis ($p<0.02$) than type I lunates. However, these radiographic signs did not correlate with clinical outcomes or risk of revision surgery. Neither the shape of the lunate nor the shape of the capitate had a significant influence on the rate of revision surgery, pain scores, DASH, or PRWE scores ($p>0.10$).

SUMMARY POINTS: Capitate and lunate morphology is correlated with the development of radiocapitate arthritis after proximal row carpectomy. Type I (round) capitates and type I (no hamate facet) lunates decrease the risk of radiocapitate arthritis. However, radiographic signs of radiocapitate arthritis did not correlate with pain or clinical outcomes.

Anatomic Study of the Lunate Fossa, Proximal Lunate, and Proximal Capitate as it Relates to Proximal Row Carpectomy

Abstract ID: Paper 006

Eugene Y. Tsai, M.D.
*Rodrigo A. Iglesias, M.S.
William Z. Morris, M.D.
James R. Anderson, M.D.
Cleveland, OH

BACKGROUND: Studies have previously demonstrated generally good outcomes following proximal row carpectomy (PRC); however, in the minority of patients in which PRC fails, no intrinsic factors have been identified that predisposed them to failure. Recent theories have hypothesized that mismatch in the morphology between the lunate facet of the distal radius and the proximal capitate may contribute to PRC failure secondary to increased contact forces across the radiocapitate articulation.

METHODS: We made direct measurements of 288 cadaveric samples to assess articular morphology of the lunate facet, proximal lunate, and proximal capitate. The radius of curvature (ROC) of each articular facet was then calculated from these measurements. Multiple regression was utilized to identify the impact of gender, ethnicity, age, height, and weight with the goal of identifying subgroups that might be anatomically predisposed to poorer outcomes after PRC based on articular mismatch.

RESULTS: Height was found to be a significant predictor of the radius of curvature ratio of the lunate and capitate in the AP plane ($p=0.044$). Males were found to have a significantly larger ROC of the lunate fossa by a mean of 0.80 mm ($p=0.005$) in the AP plane. They also had a significantly larger proximal lunate ROC by a mean of 1.69 mm ($p=0.002$) in the transverse plane, a significantly larger proximal capitate ROC by a mean of 0.44 mm ($p=0.0012$) in the AP plane, and a significantly larger proximal capitate ROC by a mean of 2.60 mm ($p=0.004$) in the transverse plane. Compared to African-Americans, Caucasians had a significantly smaller proximal lunate ROC by a mean of -1.74 mm ($p=0.022$) in the transverse plane. Caucasians also had a smaller proximal capitate ROC by a mean of -1.79 mm ($p=0.006$) in the transverse plane. In taller individuals, the lunate facet ROC was significantly larger by a mean of 0.044 mm per cm of height ($p=0.001$) in the AP plane. Their proximal capitate ROC was significantly larger by 0.028 mm per cm of height ($p<0.001$) in the AP plane.

CONCLUSIONS: A larger ROC of the proximal lunate and proximal capitate was associated with male gender, African American ethnicity, and increased height. A larger ROC of the lunate facet was associated with male sex and increased height. Only decreasing height was a significant predictor of the ROC ratio between the lunate and capitate. Further study is required to determine the relationship of articular mismatch with PRC failure.

Long-Term Results of Radioscapholunate Wrist Fusion

Abstract ID: Paper 007

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*Maureen A. O'Shaughnessy, M.D.
Steven L. Moran, M.D.
Eric R. Wagner, M.D.
Bassem T. Elhassan, M.D.
Rochester, MN

Radioscapholunate (RSL) fusion has been shown to be a good option for patients with advanced wrist degeneration or chronic instability. It leads to pain relief, high patient satisfaction, and preservation of strength. However, the creation of incongruous radiocarpal articulation limits motion, may lead to future degenerative changes and potential revision procedures. We examined the indications for RSL fusion and the long-term clinical outcomes.

The study is an IRB-approved retrospective chart review for the time period of 1988-2008 in patients undergoing RSL fusion at a single institution. Range of motion of operative and contralateral side was measured by clinicians at follow-up visits. Latest radiographs were evaluated and recorded. Pain and satisfaction were recorded.

The series includes 96 patients (42 male, 54 female) with an average age at surgery of 47 years (range 26 to 82). Average follow-up was 15.1 years (range 4-24). Surgical intervention consisted primarily of fixation using Kirschner wires, staples, and headless compression screws. Also utilized were locking and nonlocking dorsal circular plates. Bone graft was utilized in 64 (67%) of cases. PIN and/or AIN neurectomy was performed in 68% of cases.

Fifteen patients (16%) required revision to total wrist fusion at an average of 28 months postoperatively. Eighteen complications occurred (19%) including pin site infections, delayed union, extensor tendon rupture, pseudarthrosis, and hardware prominence requiring removal. Overall, patients were satisfied with the results (87%).

Average flexion/extension arc was 53° on the operative extremity compared to 97° of the contralateral extremity; resulting in 54% of motion. The radial/ulnar deviation arc was 29° vs. 49° on the unaffected side, resulting in 59% of motion. Grip strength was 20 kg vs. 29 kg on the contralateral side, giving average grip strength of 71% of unaffected extremity.

RSL fusion is a reliable operation for management of chronic wrist pain and/or instability. As a partial fusion, it maintains more motion than a total wrist fusion. A total wrist fusion is always a salvage option, and in our series 16% went on to require conversion to total wrist fusion. The remaining 84% had good outcomes with adequate pain relief, motion, and function at an average of 15 years. Complication rates were modest at 19%. RSL fusion should be considered as a reliable option to relieve pain and restore function for patients not candidates for or are not desirous of total wrist fusion.

Pyrocarbon in Proximal Interphalangeal Arthroplasty: A Longitudinal Analysis of 193 Cases

Abstract ID: Paper 008

Eric R. Wagner, M.D.
T. David Luo, M.D.
Matthew T. Houdek, M.D.
Steven L. Moran, M.D.
*Marco Rizzo, M.D.
Rochester, MN

PURPOSE: Pyrocarbon proximal interphalangeal (PIP) arthroplasty has been utilized over the last 15 years in the treatment of arthritis with variable outcomes being reported. The objective of this study was to examine the outcomes and factors that influence the results of PIP arthroplasty utilizing a pyrocarbon prosthesis.

METHODS: An analysis of 193 consecutive PIP arthroplasties in 113 patients was prospectively collected over a 14-year time period from 1998 to 2012. Demographics included average age of 59 years, BMI 25.5 kg/m^2, 74% females, 10% smokers, 9% with diabetes mellitus (DM), and with 52% of arthroplasties performed on the dominant extremity. 45 patients had inflammatory arthritis, 40 had post-traumatic arthritis, and 108 had osteoarthritis. Of the 45 with inflammatory arthritis, 12 were on prednisone and 9 on methotrexate at the time of surgery. 23 (12%) implants were augmented with bone graft. Univariate logistic regression and Kaplan-Meier survival analyses were performed.

RESULTS: At 4.2 years of average follow-up, 38 (20%) patients underwent revision surgery. Revision surgeries were performed for infection, instability, flexion contracture, and heterotopic ossification. Overall pain relief was excellent. The 2-, 5- and 10-year survival rates were 84%, 78%, and 78%, respectively. The risk for revision surgery was lower in patients with osteoarthritis (HR 0.52, $p<0.04$) and younger patients (HR 0.97, $p<0.01$). When comparing those with osteoarthritis to those with either inflammatory arthritis or post-traumatic arthritis, the 2- and 5-year survival for OA was 89% and 85% compared to 77% and 71%, respectively. Sixteen operations were complicated by intraoperative fractures. 9% of patients experienced a postoperative complication, including 3 infections, 1 postoperative fracture, 13 cases of heterotopic ossification (HO), and 13 PIP dislocations. Patients with inflammatory arthritis requiring prednisone at the time of surgery had higher rates of dislocations ($p<0.01$). Patients had significant improvements in their preoperative to postoperative pain levels ($p<0.01$).

SUMMARY POINTS: PIP arthroplasty with a pyrocarbon implant demonstrates over 80% 2-year and nearly 80% 5-year survival rates with a relatively low overall rate of complications. Patients treated for OA and younger patients tended to have lower risk for revision surgery. Overall, pain relief was very predictable.

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Revision Metacarpophalangeal Arthroplasty: 128 Consecutive Cases

Abstract ID: Paper 009

Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
*Robert E. Van Demark, III, M.D.
Steven L. Moran, M.D.
Marco Rizzo, M.D.
Rochester, MN

PURPOSE: Primary metacarpophalangeal (MCP) arthroplasty is an established treatment for MCP arthritis, and as with all total joint replacements, it is not unusual to require revision arthroplasty. There is a paucity of literature examining incidence, prognosis, and outcomes following MCP revision arthroplasty. The objective of this study was to assess the results revision MCP arthroplasty, identifying factors associated with improved outcomes.

METHODS: Utilizing the institutional Joint Registry Database, 128 revision MCP arthroplasties were performed in 64 patients at our institution from 1998 to 2012. The average age at surgery was 62.2 years, average BMI 31.5, with 84% females, 8% smokers, and 8% with diabetes mellitus (DM). There were 83 with patient's rheumatoid arthritis (RA) and 6 with Juvenile RA, while 46 patients were using prednisone and 31 MTX at surgery. There were 50 non-constrained (30 pyrocarbon and 19 metal-plastic) and 78 constrained silicone implants.

RESULTS: At an average 5.1 years of follow-up, there were 19 (15%) repeat revision surgeries performed. Reasons for revision surgery included: dislocation (11), pain with limited motion (4), silicone synovitis and bone resorption (2), infection (1), and metacarpal component loosening (1). The 2-, 5-, and 10-year survival rates were 89%, 80%, and 78%, respectively (Table 1). Patients that had a history of DM and prior instability had an increased risk of implant failure ($p<0.01$). There were 3 intraoperative complications involving periprosthetic fractures, including 2 in the proximal phalanx and 1 in the metacarpal. Only 1 of the fractures required circumferential suture stabilization. There were 11 (9%) postoperative complications, including 8 MCP dislocations, 1 heterotopic ossification, 1 postoperative fracture, and 1 infection. Furthermore, 31 (24%) developed flexion contractures. SRA implants ($p<0.05$) and instability ($p<0.02$) were associated with increased rates of infection, while implants in the dominant extremity ($p<0.04$) were associated with increased rates of flexion contractures. The rates of postoperative dislocation were higher in female patients ($p<0.04$), smokers ($p<0.02$), and SRA implants ($p<0.03$).

SUMMARY POINTS: Revision MCP arthroplasty is a challenging procedure with a 5-year survival of 80% and a relatively high rate of complications and flexion contractures. Worse outcomes are seen in in patients with a history of MCP dislocations, smokers, and SRA implants. With increasing use of MCP arthroplasty, there is a need for innovative strategies to optimize long-term outcomes in revision MCP arthroplasty.

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An Outcome Analysis of 75 Consecutive Cases of Revision Proximal Interphalangeal Arthroplasty

Abstract ID: Paper 010

Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
*John T. Weston, M.D.
Steven L. Moran, M.D.
Marco Rizzo, M.D.
Rochester, MN

PURPOSE: Proximal interphalangeal (PIP) arthroplasty is an motion preserving alternative to arthrodesis in the management of arthritis. Unfortunately, reoperation rates are not inconsequential. The objective of this study was to examine the outcomes and factors that improve the results of revision PIP arthroplasty.

METHODS: An analysis of 75 consecutive revision PIP arthroplasties in 49 patients was performed using our institution's Joint Registry Database from 1998 to 2012. There were 61 (81%) females, 3 (4%) smokers, 9 (12%) with diabetes mellitus (DM), and with 43 (57%) arthroplasties performed on the dominant extremity. The average age was 58.1 years and average BMI was 27.5. 16 (21%) patients had rheumatoid arthritis (RA) with 14 on prednisone and 7 on methotrexate at the time of surgery. 34 (45%) had a history of prior MCP trauma. There were 12 (16%) constrained (silicone) implants and 63 (84%) non-constrained implants (34 pyrocarbon and 29 metal-plastic). 25 (33%) implants were cemented, while 14 (19%) were augmented with bone graft. Preoperatively, there were 2 (3%) patients with flexion contractures and 6 (8%) had MCP instability. Univariate logistic regression and Kaplan-Meier survival analyses were performed.

RESULTS: At a median of 3.5 years of follow-up, 19 (25%) patients underwent re-revision surgery. Re-revision surgeries were performed for infection, instability, flexion contracture, and heterotopic ossification. The 2-, 5-, and 10-year survival rates were 77%, 64%, and 64%, respectively). Factors that had a significant influence on revision surgery were postoperative dislocations, pyrocarbon implants, and use of bone graft during the initial surgery (Table 1). Two operations were complicated by intraoperative fractures occurring during broaching of the proximal phalanx. Neither of these fractures required stabilization. 20% of patients experienced a postoperative complication, including 2 infections, 1 postoperative fracture, 3 cases of heterotopic ossification, and 9 MCP dislocations, while another 30 (40%) experienced postoperative flexion contractures. Increasing BMI was linked to higher rates of flexion contractures ($p<0.007$) and use of a pyrocarbon implant was associated with increased rates of heterotopic ossification ($p<0.02$).

SUMMARY POINTS: PIP arthroplasty in the revision setting represents a complex challenge for surgeons. With only a 77% 5-year survival and a high rate of complications, there is a need to continue to search for innovative techniques to improve PIP outcomes in the revision setting. In this series, silicone implants had lower rates of implant failure and other complications.

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Dorsal Screw Penetration with the Use of Volar Plating of Distal Radius Fractures: How Can You Best Detect?

Abstract ID: Paper 011

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*Brian W. Hill, M.D.
Irshad A. Shakir, M.D.
Lisa K. Cannada, M.D.
St. Louis, MO

PURPOSE: The valley between the sigmoid notch and Listers' tubercle make evaluation of screw prominence difficult with conventional fluoroscopic images. Various projections have been described to detect dorsal cortex screw penetration. This cadaveric study is designed to evaluate which described fluoroscopic images are useful to detect dorsal cortex penetration with the use of volar locking plates.

METHODS: Twenty-one embalmed forearm cadaveric specimens were used. Volar locking plates were secured in position proximally. Four 2.5 mm locking screws were inserted distally using 18 mm, 20 mm, and 22 mm screws in 7 specimens for each length. The specimen was evaluated to count the number of screws breaching the dorsal cortex. Four fluoroscopic images (lateral, 45° supination, 45° pronation, dorsal tangential view) were taken of each wrist. A group of 63 orthopedic surgeons with different levels of experience were then asked to evaluate if the screws penetrated the dorsal cortex after viewing each image. The data was analyzed for sensitivity and specificity in the evaluation of dorsal screw penetration and interobserver reliability using the interclass correlation coefficient.

RESULTS: The 21 cadaveric specimens had an average age of 78 (range, 25-91 years). Dorsal cortex screw penetration of at least one screw occurred in 14% (1/7) of specimens with 18 mm screw, 57% (4/7) of specimens with 20 mm screw, and 86% (6/7) specimens with 22 mm screws. The sensitivity of the lateral view was 64.1%, 90.3% on the 45° supination view, 63.9% on the 45° pronation view, and 73.2% on the dorsal tangential view. An increase in the number of years of orthopedic experience demonstrated an inverse relationship with respect to sensitivity/specificity (Table 1).

CONCLUSION: Dorsal cortex screw penetration can lead to tendon irritation and rupture. This can occur especially with penetration of the third dorsal compartment due to its relationship to Lister's tubercle. This cadaveric study gave us direct visualization of screw penetration to accurately determine which fluoroscopic images detected this breach. The lateral and 45° pronation views detected screw penetration about two-thirds of the time. The sensitivity increased with dorsal tangential views to 73% and the 45° supination view to 90%. Clinicians should consider use of these views to diagnose dorsal screw penetration after volar plating.

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Characterizing Bone Mineral Density Using CT Attenuation Following Distal Radius Fractures

Abstract ID: Paper 012

Mark Arnold / Minneapolis, MN
Osa Emohare, Ph.D. / Minneapolis, MN
*Christina M. Ward, M.D. / St. Paul, MN

Distal radius fractures are commonly associated with an underlying reduction in bone mineral density (BMD), as occurs in osteoporosis. Recent data has shown that CT attenuation in images of the L1 vertebra can be used to generate estimates of bone mineral density, in Hounsfield units (HU), to a greater sensitivity and specificity than DXA. The aim of this study is thus to evaluate the utility of CT attenuation in characterizing BMD in patients presenting acutely with distal radius fractures.

Following institutional review board approval, 377 patients aged 18 years and over presented between 2008 and 2012 to a level I trauma center and had a CT scan including the L1 vertebrae in the 6 months before or after their admission. To measure CT attenuation, a region of interest (ROI) was selected over the L1 vertebrae on the axial plane of a CT scan, and mean attenuation was then derived. The data were also compared against predefined thresholds for the diagnosis of osteoporosis.

175 met the inclusion criteria; 128 were aged less than 65, and 47 were 65 years and older. In the younger cohort, 3/128 (2%) sustained their fracture through a low velocity mechanism, while this comprised 29/47 (62%) of those older than age 65 (P=1 x10-17). In the older cohort, 8/47 (17%) had a DXA scan before or after their injury while this was 4/128 (3%) in the younger cohort. Mean CT attenuation in the younger cohort was 190HU and only 93.5HU in the older cohort (P=5.3 x10-23). Regression demonstrated a strong correlation between aging and bone density r= -0.79.

Seven patients (5%) of the younger cohort were osteoporotic compared with 30 patients (63%) at the 110HU threshold for 90% specificity. Thirty-eight patients (29.7%) in the younger cohort and 45 patients (95.7%) in the older cohort were osteoporotic at the 160HU threshold for 90% sensitivity. All differences were strongly significant (P<0.0001).

This study demonstrated the utility of CT attenuation in assessing bone density by opportunistically harnessing CT scans ordered for other reasons. CT attenuation as a technique is more sensitive and specific than DXA. This information may also be valuable in deciding the type of surgical fixation employed, as a profoundly osteoporotic fracture may require modifications in fixation. In addition, although the majority of older patients in this cohort should have had a DXA scan, less than 20% have done so. This may ensure broader access to ‘bone health'.

Epidemiologic Dynamics Contributing to U.S. Pediatric Wrist Fractures

Abstract ID: Paper 013

Neil S. Shah, M.D.
*David Buzas, M.D.
Ephraim M. Zinberg, M.D.
Detroit, MI

INTRODUCTION: In childhood, trauma to the distal upper extremity is frequent, and pediatric wrist fractures are commonly seen in the emergency department (ED). The purpose of this study was to explore and evaluate national epidemiologic trends and factors contributing to wrist fractures in children.

METHODS: Over a 16-year period from January 1998 to December 2013, patients aged 0-17 years old with primary diagnosis of wrist fracture were identified and reviewed, as evaluated in U.S. EDs and chronicled by the National Electronic Injury Surveillance System (NEISS) database of the U.S. Consumer Product Safety Commission. Descriptive epidemiologic, bivariate, and chi-square analyses were conducted. Patients were categorized into age-defined subgroups (0-12 months, 13-36 months, 3-5 years, 6-10 years, and 11-17 years) and further stratified with regards to gender, race, location, and consumer product/activity associated with injury.

RESULTS: There were 53,265 children evaluated in NEISS EDs (national estimate, 1,908,904) with wrist fractures from 1998-2013. Mean age was 10.9 (SD 3.8) years, with 64% male and 36% female. Most common locations of injury were place of recreation or sports (28%), home (23%), and school (13%). The top five consumer-product related injuries were associated with bicycles (10%), football (8%), playground activities (8%), basketball (6%), and soccer (5%). The highest associations were with bedsprings (19% of 0-12 months), stairs or steps (14% of 13-36 months), playgrounds (25% of 3-5 years and 15% of 6-10 years), and football (14% of 11-17 years). The greatest increase in fractures occurred between ages 0-12 and 13-36 months (1:3.8), with second-largest increase between ages 3-5 and 6-10 (1:2.2). Over the past 16 years, there has been a decline in number of bicycle- and basketball-related injuries, while there has been an increase in soccer-related wrist fractures. Football-related fractures have declined in recent years, while playground wrist fractures have remained relatively unchanged. There was a disproportionately higher number of females sustaining fractures in all groups under age 11, with increased males in the 11-17 group (18%, $p<0.05$). Race and injury location appeared consistent throughout stratified groups.

CONCLUSIONS: It is essential to develop injury prevention and safety strategies as well as identify individual risk factors for fracture, including activity, gender, and key age transitions. Surveillance is imperative to advance our understanding of the epidemiologic basis for pediatric wrist fractures, and in the future may facilitate development of research prediction tools to anticipate or prevent injury.

The Use of an iPad to Evaluate Patient-Reported Functional Outcome Measures in Hand Surgery

Abstract ID: Paper 014

Mark A. Yaffe, M.D. / Indianapolis, IN
*Nitin Goyal, B.S. / Chicago, IL
Daniel Kokmeyer, M.D. / Indianapolis, IN
Gregory A. Merrell, M.D. / Indianapolis, IN

INTRODUCTION: Accurate and efficient patient-reported outcome data collection is critical for assessment of surgical outcomes. Traditional pen and paper data collection is time, labor, and resource intensive, and possibly even more strenuous for patients presenting with hand and upper extremity ailments. An iPad-based system offers potential for improved usability and thus fewer omissions compared to a traditional pen and paper system. Our purpose was to evaluate the feasibility of collecting patient-reported outcome measures using an iPad for two different questionnaires.

METHODS: 200 total patients were randomized to complete one of two questionnaires using either an iPad or pen and paper. The Michigan Hand Questionnaire (MHQ) and QuickDASH questionnaires were administered using either an iPad or pen and paper with 50 patients in each group. Identical content and verbal/written instructions were given. Questionnaires were analyzed to identify differences in patient preference for future questionnaire format, questionnaire completion, number of omissions, ease of use, and time to completion between iPad and pen and paper groups for both questionnaires.

RESULTS: The proportion of patients who preferred the given questionnaire delivery method again was significantly higher in the iPad group compared to the pen and paper group for the MHQ (93.9% vs. 47.9%; $p<0.001$) and QuickDASH (90.0% vs. 58.3%; $p<0.001$) questionnaires. A higher proportion of the iPad group found questionnaires physically “very easy” to complete compared to pen and paper for the MHQ (72% vs. 56%; $p=0.098$), though not for the QuickDASH (76% vs. 70%;$p=0.504$). The iPad group was associated with fewer omissions compared to pen and paper for the MHQ (0.4 vs. 2.0;$p=0.124$) and QuickDASH (0.0 vs. 0.2;$p=0.025$). The iPad group was associated with a higher proportion of scorable questionnaires using the MHQ (98% vs. 90%; $p=0.095$) and QuickDASH (100% vs. 94%; $p=0.083$) questionnaires. Time to completion was similar for the MHQ questionnaire, but was significantly longer for the QuickDASH questionnaire using the iPad compared to pen and paper (3.3 vs. 2.5 minutes;$p=0.012$).

DISCUSSION: iPad users overwhelmingly preferred to use an iPad again compared to pen and paper users preferring to use pen and paper again. The longer questionnaire (MHQ) resulted in appreciable ease of use differences in favor of the iPad with a similar time to completion. The iPad was associated with lower number of omissions and more scorable questionnaires. The use of an iPad is an efficient and preferable questionnaire format for longer patient-reported outcomes questionnaires in a high-volume hand and upper extremity practice setting.

The Risk of Revision Surgery After Primary Total Elbow Arthroplasty: A Review of 1,261 Elbows Over 4 Decades

Abstract ID: Paper 015

Suenghwan Jo, M.D.
Bernard F. Morrey, M.D.
Joaquin Sanchez-Sotelo, M.D.
*Mark E. Morrey, M.D.
Rochester, MN

Total elbow arthroplasty (TEA) can address a broad spectrum of pathology and provide excellent outcomes. Unfortunately, a certain number of implants will require revision based on mechanical failure, infection, fracture, and instability. The long-term cumulative risk of revision after primary TEA has not been thoroughly investigated. The aim of this study is (1) to report the long-term cumulative risk of revision in a large series of primary TEAs, and (2) to identify demographic and surgical risk factors leading to failure.

METHODS: A retrospective analysis was performed on 1,261 consecutive primary TEAs in 1,108 patients between 1972 and 2009 using our institution's total joint database. All operations were performed in one institution and patients were followed up in routine time intervals up to 2013 with mean follow-up of 9.5 years (range 0-37 years). The patient cohort includes 297 males and 811 females with mean age of 60 years (range, 16 - 93 years) at the time of the surgery. Patient demographics (age, gender, body mass index [BMI], side, height, bilateral involvement, diagnosis) and implant type (linked vs. unlinked, use of cement) were identified and compared between revised and non-revised groups. Cumulative risk of revision was calculated with the Kaplan-Meier method. Multiple variable analysis using Cox proportional hazard model was performed to identify risk factors.

RESULTS: Overall, 260 (20.6%) patients experienced revision surgery at the mean of 6.9 years from the primary arthroplasty. The cumulative risk of revision surgery was 2.5%, 10.9%, and 19.4% at 1 year, 5 years, and 10 years respectively, and the risk rose in a linear fashion reaching 41.5% at 25 years. In the multiple variable analysis, age less than 60 (HR 2.67, as compared to age >60), male gender (HR 1.85, as compared to female), increased BMI (HR 1.16, per 5kg/m^2 increment), unlinked implants (HR 3.95, as compared to linked), and post-traumatic arthritis (HR 2.70, as compared to rheumatoid arthritis) were risk factors for revision. The most common reason necessitating revision arthroplasty was mechanical failure (53%) followed by infection (24%), periprosthetic fracture (17%), and instability (4%).

DISCUSSION AND CONCLUSION: The cumulative risk for requiring revision after primary total elbow arthroplasty increases at a constant rate starting from the first year to a rate of almost 42% at 25 years. Our data suggest that young, male patients with a diagnosis of post-traumatic osteoarthritis and the use of unlinked type implants represent the largest risk factors for revision surgery.

Total Elbow Arthroplasty in Patients Under Age 50: A 15-Year Mean Follow-Up Study

Abstract ID: Paper 016

Peter L. Kok, M.D.
Mark E. Morrey, M.D.
Bernard F. Morrey, M.D.
*Joaquin Sanchez-Sotelo, M.D.
Rochester, MN

INTRODUCTION: Young age is generally considered a relative contraindication for total elbow arthroplasty (TEA) due to concerns related to implant durability. However, TEA may represent the most reliable surgical option for selected patients with severe joint destruction at a young age. Few studies have analyzed the long-term outcome of TEA in younger patients. The purpose of this study was to determine the outcome of TEA in patients under the age of 50-years-old.

METHODS: Between 1983 and 2003, 165 consecutive primary TEAs were performed in our institution in patients under the age of 50. Patients with an underlying bleeding diathesis or a neoplasm were excluded. One patient died and 12 had incomplete follow-up, leaving 135 elbows (122 patients) followed until revision or for a minimum of 5 years (mean follow-up time, 14.9 ± 6.3 years). Mean age at time of surgery was 40 ± 7.3 years. The preoperative diagnosis was rheumatoid arthritis (RA) in 62 patients, post-traumatic arthritis (PTA) in 50 patients, and juvenile rheumatoid arthritis (JRA) in 23 patients. We analyzed preoperative and postoperative pain, range of motion, and postoperative Mayo Elbow Performance Scores (MEPS). All 148 patients were included in the survivorship analysis.

RESULTS: The mean pain score component of the MEPS improved from 8.3 to 37.9 ($p < 0.0001$), mean arc of motion improved from 65° to 90° ($p < 0.0001$), and the mean postoperative MEPS was 74 ± 16 points. 17 patients were graded as having a poor outcome, 41 fair, 47 good, and 30 excellent outcomes. Implant survival was 87% at 5 years, 77% at 10 years, and 54% at 20 years, with 47 patients (31%) ultimately undergoing revision. Median survival time was 21.25 years. There was a significant difference in outcomes and survival based on diagnosis. The MEPS in patients with PTA (66.5) was significantly worse than in patients with RA and JRA (75 and 79; $p=0.02$ and $p< 0.001$ respectively). Patients with PTA also had significantly higher rates of implant failure than patients with RA or JRA ($p=0.004$ and 0.023 respectively). There was no difference in MEPS ($p=0.32$) or survival ($p=0.96$) between RA and JRA.

CONCLUSIONS: TEA consistently improves pain, motion, and function in patients under the age of 50. Revision-free survivorship drops to approximately 75% at 10 years and 50% at 20 years. In patients under 50, inflammatory conditions are associated with better functional scores and survival compared to post-traumatic arthritis.

Single-Stage Bilateral Total Elbow Arthroplasty is Safe, Reliable, and Cost-Effective in Rheumatoid Arthritis

Abstract ID: Paper 017

Suenghwan Jo, M.D. / Rochester, MN
*Akin Cil, M.D. / Kansas City, MO
J. Michael Wiater, M.D. / Royal Oak, MI
Shawn W. O'Driscoll, M.D. / Rochester, MN
Bernard F. Morrey, M.D. / Rochester, MN
Mark E. Morrey, M.D. / Rochester, MN
Joaquin Sanchez-Sotelo, M.D. / Rochester, MN

INTRODUCTION: In the elbow, severe bilateral involvement is particularly common in rheumatoid arthritis, making single-stage bilateral elbow arthroplasty an attractive alternative to reduce duration of disability, episodes of anesthesia and admissions, and potentially cost. The purpose of this study was to determine the outcome of single-stage bilateral total elbow arthroplasty (TEA) in selected patients with severe involvement of both elbows.

METHODS: Between 1991 and 2011, 20 patients underwent single stage bilateral TEA at our institution. Two patients were lost to follow-up before 2 years and one patient was excluded due to diagnosis of post-traumatic osteoarthritis; the remaining 17 patients (34 elbows) with diagnosis of inflammatory arthritis form the basis of this study (Group 1). There were 12 females and 5 males with a mean age of 63.4 (range, 44-86) years. These patients were matched by age, gender, and, body mass index with 17 patients (34 elbows) who had undergone staged bilateral TEA (Group 2). These two study groups were compared for surgical complications, clinical outcome, revision surgery, and cost.

RESULTS: The mean duration of follow-up for groups 1 and 2 was 8.9 (2-18.7) years and 10.2 (2-20.2) years respectively. Single-stage bilateral TEA was associated with a shorter overall hospital stay (5.4 vs. 9.5 days), shorter overall anesthesia time (4.1 vs. 5.3 hours), and no increase in medical complications or transfusion rates. At most recent follow-up, both groups showed similar outcomes using Mayo Elbow Performance Score (85 vs. 80 points) and subjective satisfaction (90.6% vs. 91.1%). There was one periprosthetic infection in one elbow in group 1. The revision rate for mechanical failure was higher in group 1 (17.6% vs. 5.8%); this may have been partly related to the more common use of the Coonrad-Morrey precoated ulnar component in this group (18/34 vs. 6/34). Single-stage bilateral TEA led to overall savings of 39%.

DISCUSSION AND CONCLUSION: Single-stage bilateral TEA does not seem to be associated with a higher rate of perioperative adverse events. End-stage outcomes seem to be similar to those obtained when both elbows are replaced sequentially. Single-stage bilateral TEA compares favorably with staged bilateral TEA in terms of cost. However, in our study groups, a higher rate of mechanical failure was noted in the single-stage group, likely related to differences in implant selection.

Total Elbow Arthroplasty for Primary Osteoarthritis

Abstract ID: Paper 018

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*Bradley S. Schoch, M.D.
Jean David Werthel, M.D.
Joaquin Sanchez-Sotelo, M.D.
Bernard F. Morrey, M.D.
Mark E. Morrey, M.D.
Rochester, MN

BACKGROUND: Primary osteoarthritis of the elbow can be treated successfully in a large number of patients with osteophyte removal and capsulectomy. However, a subset of patients with more advanced cartilage loss and pain through the mid arc of motion do not respond well to joint debridement alone. Total elbow arthroplasty (TEA) provides a more reliable short-term solution, but may be associated with a high complication rate in active patients. The purpose of this study was to determine the outcome and complications of TEA in patients with primary elbow osteoarthritis.

METHODS: Between 1984 and 2012, 21 consecutive TEA were performed in 21 patients with primary elbow osteoarthritis. Two patients died and one was lost to follow-up prior to 2 year follow-up, leaving 8 men and 10 females with a mean age at the time of surgery of 67.6 years (range, 51-85). Implants used included Coonrad-Morrey (14 elbows), Latitude (3 elbows), and other (1 elbow). Outcome measures included pain, motion, MEPS, complications, and reoperations. The mean follow-up time was 8.3 years (range, 2-20).

RESULTS: Total elbow arthroplasty resulted in substantial pain relief (3.7 preoperatively, 1.9 at most recent follow-up, $p<0.001$). However, range of motion remained largely unchanged ($p>0.05$). Patients maintained their preoperative flexion, but flexion contractures did not improve. At most recent follow-up, the mean MEPS was 77.3 points (range, 55 – 100); MEPS were fair or poor in 46% of the elbows. Reasons for unsatisfactory results included persistent pain in 7 elbows with concurrent decreased motion in 6 elbow. Despite the high rate of unsatisfactory MEPS, 92% of patients were satisfied with their elbow. Complications were classified as minor in 4 (22%) and major in 3 elbows (18%). Reoperations included debridement for infection (1), humeral revision (1), and removal of a loose radial head component (1).

CONCLUSION: Total elbow arthroplasty represents a reliable surgical option for pain relief in patients with primary elbow osteoarthritis. However, restoration of extension is not always obtained, indicating that more aggressive soft tissue releases or humeral shortening may need consideration at the time of arthroplasty. Objective unsatisfactory results were documented in approximately half of the elbows included in this study, which is at least partially due to persistent loss of motion. Further research is warranted to further delineate the indications of TEA for this condition and improve surgical techniques and postoperative management.

MAOA BREAKOUT SESSION #2
SPORTS
April 23, 2015

Conventional Plate Fixation vs. PEEK Intraosseous Implant in Proximal Tibial Osteotomy

Abstract ID: Paper 019

*****Mario Hevesi, B.S.
Elizabeth A. Arendt, M.D.
Jeffrey A. Macalena, M.D.
Minneapolis, MN

INTRODUCTION: Proximal tibial osteotomy (PTO) has been shown to be safe and effective for varus correction of medial compartment degenerative disease. PTO is also used in the setting of cartilage and ligament surgery when correcting concurrent varus malalignment. This retrospective cohort study is the first direct quantitative comparison of osteotomies fixated with conventional plate and screw (CPS) vs. a PEEK (polyether ether ketone) intraosseus implant (PII).

METHODS: After IRB approval, 44 proximal PTO cases—22 CPS, 22 PII—were retrospectively reviewed from a preoperative baseline to a mean of 12 months follow-up (range: 1, 26 months). Angle of varus deformity, location of the weight-bearing line along the diameter of the tibial plateau (WBL), femoral axis-femoral condyle angle (FAFC), tibial plateau-tibial shaft angle (TPTS), tibial slope, Insall-Salvati ratio (ISR), and Caton Deschamps index (CDI) were recorded alongside significant comorbidities. Implant retention rates were also calculated.

RESULTS: Both cohorts showed significant improvements in varus deformity, WBL, and TSTP in the first 6 months postoperative. The CPS cohort was surgically corrected from a mean deformity of 5.5° to -0.5° ($p < 0.0001$) whereas the PII cohort improved from 6.6° to -1.6° ($p < 0.0001$).

CPS implant selection did not initially alter ISR and CDI at 0-6 months post-PTO, but significantly affected the two measures at 6-12 months and 12-26 months ($p < 0.01$). PII affected ISR throughout follow-up ($p < 0.05$ at 0-12 months) and did not significantly affect CDI at any time. Neither implant significantly affected FAFC or tibial plateau slope at any point 0 to 26 months.

Patients remaining in the study at 12-26 months had axial deformities of 1.45° (CPS) and -1.60° (PII), respectively. At the conclusion of follow-up at 26 months, all 22 PII implants were in place whereas 8 CPS implants had been removed (4 due to pain +/- instability, 4 due to further reconstruction) suggesting PII retention is significantly greater ($p = 0.006$).

CONCLUSIONS: PII implant selection was found to be effective at correcting genu varum while concurrently causing less significant perturbation to patellar height and demonstrating increased implant retention compared to CPS in this retrospective cohort study.

SUMMARY: This retrospective review quantitatively compares radiographic outcome and

retention rate of conventional plate fixation vs. PEEK intraosseous implants in proximal tibial osteotomy for 44 patients.

Surgical Treatment of Multiligament Knee Injuries

Abstract ID: Paper 020

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*Shane Cook, M.D.
T. J. Ridley, M.D.
Matthew J. Bollier, M.D.
Mark A. McCarthy, M.D.
Yubo Gao, Ph.D.
Brian R. Wolf, M.D., M.S.
Annunziato Amendola, M.D.
Iowa City, IA

PURPOSE: To analyze one institution's experience with multiligament knee injuries (MLKI).

METHODS: Over 10 years (June 2003 to May 2013), 133 MLKI including 130 patients were included in the study. Inclusion criteria included: (1) injury to two or more knee ligaments and (2) multiligament knee repair/reconstructive surgery. A chart review was performed at least one year after surgery to collect data.

RESULTS: Seventy-six percent of the MLKI were male patients. The average age at time of injury was 26 years old. Forty-three (33%) patients were obese (BMI≥30kg/m²). Fifty-one (38.3%) MLKI were bi-cruciate and an associated medial and/or lateral sided injury and the remaining 82 were 2 ligament knee injuries. Peroneal injuries occurred in 26 MLKI (19.5%) and 4 (3%) had associated vascular injuries. A high-energy mechanism of injury was noted in 39.1% of knee injuries. Thirty-three (24.8%) patients suffered from another orthopedic injury in addition to their MLKI and 15 patients (11.5%) suffered additional non-orthopedic injuries. Surgery was performed acutely (<3 weeks) in 63 (47.4%) of the MLKI. Primary repair alone was reported in 12 cases and reconstruction with or without repair was performed in the remaining 121 patients.

Forty-three postoperative complications were documented in 37 patients (28.5%). Twelve patients (9%) required revision surgery, 18 patients (13.8%) underwent manipulation under anesthesia (MUA), 6 patients (4.6%) underwent operative hardware/suture removal, and 5 patients (3.8%) developed postoperative infection. One developed a DVT with a subsequent PE.

Patients that had a >2 ligament injury or had surgery acutely were at a significant increased risk for knee stiffness requiring MUA (p=.0163 and p=.0471, respectively). Knees with >2 ligaments injured were associated with a higher postoperative overall complication risk (P=.007). Knees with 4 ligaments injured were at increased risk to undergo revision surgery (p=.041). Obese patients were more likely to have a postoperative infection (p=.038).

CONCLUSIONS: This is one of the largest series of surgically-treated MLKI patients at one institution. Overall complications were higher in patients with >2 ligaments injured. Knee stiffness requiring MUA were more common in patients who had 3 or more ligaments ruptured and those treated within 3 weeks of the injury. Repair, reconstruction, or type of graft used had no impact on need for revision surgery. Knees with all four ligaments injured were more likely to undergo revision surgery.

Peroneal Neuropathy After Posterolateral Knee Injury

Abstract ID: Paper 021

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*Mark A. McCarthy, M.D.
Taylor J. Ridley, M.D.
Matthew J. Bollier, M.D.
Brian R. Wolf, M.D., M.S.
Annunziato Amendola, M.D.
Iowa City, IA

BACKGROUND: Peroneal nerve injuries occur in 16-40% of patients with multiligament knee injury, with spontaneous recovery occurring in 14-56% of cases. No studies have specifically evaluated peroneal nerve injuries in the setting of posterolateral corner (PLC) damage.

OBJECTIVES: Our purpose was to report on the incidence of peroneal nerve injuries in our cohort of posterolateral knee injured patients. We also present our recommended treatment algorithm.

METHODS: A retrospective chart review was performed to identify patients that underwent posterolateral corner (PLC) reconstruction or repair from January 1, 2000, to March 1, 2012, with minimum 6-month clinical follow-up. Peroneal nerve injuries were identified, and treatment and outcomes were analyzed.

RESULTS: There were 61 PLC injuries in 60 patients. 16 of the 61 knees (26.2%) had a peroneal nerve injury at the time of initial presentation. There were 13 complete and 3 partial nerve injuries. All 13 complete injuries underwent neurolysis. Three were complete transections, and 10 were stretch injuries. Of the 10 stretch injuries, 4 (40%) spontaneously recovered full nerve function at final follow-up. The remaining six patients were offered posterior tibialis transfer (PTT), but chose definitive treatment with ankle-foot orthoses (AFO). Two of the three transected nerve patients underwent successful PTT, and one chose AFO as definitive treatment. All three partial nerve injuries underwent neurolysis and had complete nerve recovery at final follow-up.

IKDC averages in the nerve injury group and the non-nerve injury group were 63.8 and 70.5 ($p = 0.54$), respectively. Lysholm averages in these two groups were 86.2 and 82.5 ($p = 0.55$), respectively. Higher rates of high-energy mechanisms were present in the peroneal nerve injury group (9/16, or 56.3%, vs. 14/45, or 31.1%). Rates of other major orthopedic injuries were similar among the two cohorts, 4/16 (25%) in the nerve palsy group and 11/45 (24.4%) in those without nerve injury. Non-orthopedic injuries were higher in the nerve palsy group than the non-injured group (4/16, or 25% vs. 5/45, or 11.1%, respectively).

CONCLUSION: Our cohort showed similar rates of peroneal nerve injuries (26.2%) and high rates of spontaneous recovery in complete palsies with nerve stretch injury (40%). Outcomes scores were relatively similar among the two groups. High energy mechanism of injury was higher in the nerve palsy cohort. We recommend a period of up to one year in monitoring for recovery and neurolysis at the time of posterolateral knee surgery.

Drilling the Femoral Tunnel from a Posteromedial Portal – A Comparison of Four Drilling Techniques and the Distance from the Guidewire to Important Structures in the Knee

Abstract ID: Paper 022

Micah E. Lissy, M.D.
Patrick M. Keating, B.S.
*Stephen E. Lemos, M.D., Ph.D.
Warren, MI

The purpose of this study was to compare the distance from the guidewire to important neurovascular structures between a posteromedial portal drilling technique and three other drilling techniques in anatomic ACL reconstructions.

METHODS: Eight fresh-frozen cadaver knees were used, and all four drilling techniques (drilling from an accessory anteromedial portal [AAMP], drilling with the knee in a figure of four, drilling with a transtibial technique [TT], and drilling from a posteromedial portal [PMP]) were performed on each knee in random order, leaving the guide pin in the condyle after it was placed. Once the guide pins were placed and the structures of interest were located, the distance from the pin to to the structure was measured with digital calipers.

RESULTS: There was a significant difference in proximity to the ACL footprint among the four drilling techniques ($p = 0.001$). A post-hoc analysis was performed using Wilcoxon signed-rank tests to evaluate the differences among the groups. The guide pin for the posteromedial portal technique was significantly closer to the ACL footprint (1.03 +/- 0.98 mm) than the guide pins for the figure of four technique (2.81 +/- 2.17 mm) ($p = 0.049$) and the transtibial technique (6.56 +/- 3.03 mm) ($p = 0.011$). Also, the mean distance from the guide pin for the posteromedial portal technique to the anterior articular cartilage was 5.24 +/- 2.23 mm, which is a significantly larger distance than that of the figure of four technique (3.48 +/- 0.98 mm) ($p = 0.041$) and a larger distance than that of the accessory anteromedial portal technique (3.68 +/- 2.01 mm), though the difference was not significant at the 0.05 level ($p = 0.068$). Additionally, the guide pin for the posteromedial portal technique was significantly farther away from the common peroneal nerve (68.23 +/- 10.15 mm) than the guide pin for the accessory anteromedial portal technique (57.80 +/- 9.46 mm) ($p = 0.017$) and the figure of four technique (50.53 +/- 8.90 mm) ($p = 0.018$).

CONCLUSIONS: All-epiphyseal ACL reconstruction in skeletally immature patients ulitizing the posteriomedial portal has several advantages. The posteromedial portal drilling technique places the femoral tunnel closer to the native ACL footprint than most standard adult techniques. It does not cross the physis. It is farther from the anterior articular cartilage than most standard adult techniques. It is farther from the common peroneal nerve than most standard adult femoral tunnel drilling techniques.

The Use of Bone Marrow Concentrate and Demineralized Bone Matrix in the Treatment of Osteochondritis Dissecans

Abstract ID: Paper 023

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*Paul R. Fleissner, Jr., M.D. / Akron, OH

INTRODUCTION: The treatment of osteochondritis dissecans remains controversial and unproven in the current literature. Recent work done by an academy committee resulted in 17 recommendations without strong scientific evidence to support any of them. The current research investigates a minimally invasive method utilizing biologics to enhance healing in osteochondritis dissecans (OCD).

METHODS: This is an IRB-approved, prospective, one arm pilot study. Twenty-nine patients who had symptoms for at least 5 months and failed non-operative treatment underwent diagnostic arthroscopy and ante grade drilling with grafting of the OCD using bone marrow concentrate and demineralized bone matrix. All patients had their articular cartilage intact at arthroscopy. Each patient was followed with serial radiographs: AP, lateral and tunnel views at 6 weeks, 3, 6, 12, and 24 months, and MRI at 1 year postoperatively. All patients had preoperative Lysholm and IKDC knee scores and at final follow-up. Patients were also evaluated for location and size of the lesion, length of non-operative treatment, and status of growth plate at treatment.

RESULTS: The average patient age was 14 (range 11-17). There were 16 right knees and 13 left. Twenty-four lesions were on the medial femoral condyle and five on the lateral femoral condyle. The average length of symptoms preoperatively was 13 months (range 5-48). Twelve patients had closed growth plates at the time of surgery, and 17 had open growth plates. Twenty-eight patients were considered healed based on clinical symptoms, MRI, x-ray, and IKDC and Lysholm scores. One patient failed this treatment and required subsequent osteochondral transplant. This was the only patient who demonstrated undermining fluid signal on MRI. All other patients demonstrated either partial or complete revascularization of the lesion and resolution of preoperative bony edema on the MRI. Serial plain radiographs revealed increasing bony incorporation of the lesion in all cases. No case was exuded in the joint as a loose body. The average Lysholm score improved from 56 to 93 and the IKDC score from 51 to 91.

DISCUSSION AND CONCLUSION: Definitive treatment modalities for OCD are still evolving. Current literature reveals a healing rate of 50-60% in patients with open growth plates treated non-operatively. It is generally believed that patients with closed growth plates do not heal unless treated operatively. Providing a method utilizing biologics and a minimally invasive technique that routinely stimulates healing without articular cartilage violation is beneficial in the management of OCD. This technique realizes that goal and could provide direction for future treatment of osteochondritis dissecans.

Medial Femoral Condyle Cartilage Defect Biomechanics: Effect of Obesity, Defect Size, and Cartilage Thickness

Abstract ID: Paper 024

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*Kyle W. Lacy, M.D., M.S. / Detroit, MI
Allison Cracchiolo, B.S. / Detroit, MI
Stephen Yu, M.D. / Detroit, MI
Henry T. Goitz, M.D. / Warren, MI

INTRODUCTION: Full-thickness cartilage defects of the medial femoral condyle (MFC) are a common source of knee pain; microfracture is a commonly implemented treatment. Containment, the ability of rim cartilage to protect the base of the defect from load, is favorable in microfracture, as the superclot is shielded from force. Postoperative weight-bearing protocols, as well as indications for microfracture in the obese patient, are controversial. The force sustained at the base of full-thickness cartilage defects during weight-bearing loads, and the influence of obesity, defect size, and cartilage thickness on these forces remains yet unknown.

METHODS: Eight human cadaver knees were loaded in 15° of flexion to simulate 20, 30, and 40 BMI single-stance weight bearing. Full-thickness cartilage defects of diameters 6, 8, 10, 12, 14, 16, 18, and 20 mm were made on the MFC at the point of maximum contact force. A medial compartment sensor measured force transmission and area of containment. For defects 14, 16, 18, and 20 mm in diameter, a sensor quantified force at the subchondral bone. Surrounding rim cartilage thickness was quantified for each size defect using digital calipers. Area of containment and base of defect forces were compared between BMI groups using a repeated measures ANOVA.

RESULTS: Larger BMI loads (BMI ≥ 30) led to significant decreases in the area of containment for all defects ≥ 14 mm diameter ($p \leq 0.038$). Base of defect force increase was significant for defects ≥ 16 mm diameter (2 cm^2 in area) between loaded and unloaded states ($p \leq 0.042$), and for BMI ≥ 30 loads ($p \leq 0.045$). Cartilage rim thickness < 2 mm resulted in significantly higher force at the base of the defect than for cartilage thickness ≥ 2 mm, for all BMI groups ($p \leq 0.025$).

CONCLUSION: Biomechanically unfavorable environments were observed for MFC cartilage defects in the setting of BMI ≥ 30, size ≥ 2 cm, and rim thickness < 2 mm. The resultant decrease in area of containment, and increase in force sustained at the base of the defect, expose the superclot to potentially detrimental forces in the setting of microfracture. Our findings correlate with clinical studies showing decreased cartilage fill rates, and poorer knee function, after microfracture in patients with BMI ≥ 30. Clinical studies are needed to compare microfracture with other more structurally stable treatments (OATS, osteochondral allograft) for femoral condyle cartilage defects in the obese patient population.

Does Excellent Six-Month Strength and Function Following ACL Reconstruction Predict Mid-Term Outcomes?

Abstract ID: Paper 025

Paul L. Sousa, B.S.
Robert A. Cates, D.O.
Aaron J. Krych, M.D.
*Bruce A. Levy, M.D.
Michael J. Stuart, M.D.
Diane L. Dahm, M.D.
Rochester, MN

INTRODUCTION: Functional and isokinetic testing are commonly performed to evaluate patients after anterior cruciate ligament (ACL) reconstruction. While this data is often used as criteria for return to sport, correlation of the test results at six months following surgery with subsequent outcome is lacking. We sought to determine if patients with excellent functional and isokinetic at six months had (1) a lower risk of subsequent ACL tears, (2) superior knee function, and (3) increased activity levels at mid-term follow-up.

METHODS: We identified 223 patients who underwent primary ACL reconstruction by a single surgeon and had functional and isokinetic testing performed six months postoperatively. Patients were placed into two groups based on specific criteria from their performance data. An 'excellent' outcome was defined as having a satisfactory result in 6 of 7 isokinetic-strength and functional-testing categories. A satisfactory result was defined as 85% or greater performance in isokinetic strength and 90% or greater performance in functional testing compared to the contralateral knee. The excellent group was representative of patients that were allowed to return to full activities at six months after surgery. Of the 223 patients, 52 (23.3%) met criteria for the early return-to-sport group, and the remaining 171 (76.7%) constituted the delayed return-to-sport group. We then compared the incidence of ACL-graft tear (ipsilateral) and native-ACL tear (contralateral) between the two groups. In addition, we compared International Knee Documentation Committee (IKDC) and Tegner scores at a minimum two-year follow-up between the two groups.

RESULTS: Ten (4.5%) patients had an ipsilateral graft rupture, and 17 (7.6%) had a contralateral ACL tear after mean follow-up of 44 months (range 22-123). The graft rupture rate was similar in the early return-to-sport group (3.8%, n=2) compared to the delayed return-to-sport group (4.7%, n=8; p=0.30). However, there was a higher rate of contralateral ACL tear in the early return-to-sport group (15.4%, n=8) compared to the delayed return-to-sport group (5.3%, n=9; p=0.003; Figure 1). The early return-to-sport group had superior IKDC scores 94.3 + 6.4 vs. 90.9 + 9.7; p=0.04 and Tegner scores 6.6 + 1.8 vs. 5.7 + 1.6; p=0.01 (Table 1).

DISCUSSION AND CONCLUSION: Patients with an excellent performance on their isokinetic-strength and functional testing at six months after ACL reconstruction have superior knee function and higher activity levels at mid-term follow-up. However, these patients appear to be at greater risk of contralateral ACL injury, which may be related to their increased activity level.

Keywords: ACL reconstruction, Isokinetic strength, Functional testing, Predictive factors, Outcomes

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Meniscal Tears Left In Situ at the Time of Anterior Cruciate Ligament Reconstruction

Abstract ID: Paper 026

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*Marcus A. Rothermich, M.D.
Rick W. Wright, M.D.
St. Louis, MO

INTRODUCTION: Meniscal tears can be incidentally encountered at the time of anterior cruciate ligament (ACL) reconstruction. In these cases, the surgeon has several treatment options including benign neglect, debridement, trephination, or repair. This systematic review addresses outcomes following benign neglect in patients with a meniscus injury discovered at the time of ACL reconstruction. We hypothesized that there would be no significant difference in patient outcomes following benign neglect compared with patients who had operative intervention.

METHODS: We searched Medline and Embase for articles published between 1980-current. We also searched the Cochrane Database and bibliographies of identified articles to augment our cache. Inclusion criteria included English language, randomized controlled trials, retrospective studies, and prospective cohort studies regarding meniscal tears with concomitant ACL reconstruction. Exclusion criteria included non-English language, narrative review articles, and lack of outcome data.

RESULTS: Our initial search identified 97 total studies. These underwent full text review resulting in eight studies that met our inclusion and exclusion criteria. The data from each study, including medial vs. lateral reoperation rate, was extracted and analyzed. The combined data resulted in a total of 646 meniscal tears left in situ in 628 patients. Of these 646 tears, a total of 35 required reoperation (5.4%). The majority of the meniscal tears left in situ were isolated to the lateral meniscus (62.5%). Of these 404 lateral meniscal tears, 12 required reoperation (3.0%). Of the 242 isolated medial meniscal tears left in situ, 23 required reoperation (9.5%).

CONCLUSION: This systematic review analyzed patient outcomes following benign neglect of stable meniscal tears discovered at the time of ACL reconstruction. Our hypothesis that there would be no significant difference in patient outcomes compared with patients who had operative intervention is supported by the eight studies. For stable vertical tears, meniscal repair is often successful if the tear extends more than 1 centimeter anterior to the popliteus in the lateral meniscus. For vertical tears in the medial meniscus or posterolateral meniscus, benign neglect is often a successful and appropriate option. These injuries, when encountered at the time of arthroscopy, can be left in situ to achieve statistically similar subjective and objective outcomes when compared with those treated with surgical intervention.

Comparison of ACL Strain in the MCL Deficient and MCL Reconstructed Knee During Simulated Landing in a Cadaveric Model

Abstract ID: Paper 027

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*Eric J. Mancini, M.D. / Detroit, MI
Stephen E. Lemos, M.D., Ph.D. / Warren, MI
Robert B. Kohen, M.D. / Detroit, MI
Amanda O. Esquivel, M.D. / Detroit, MI
Allison Cracchiolo, B.S. / Detroit, MI

OBJECTIVES: To determine the role an incompetent MCL plays in ACL strain during simulated landing at various degrees of flexion and valgus. Also, whether a reconstruction of the MCL could restore baseline ACL strain.

METHODS: Eight fresh, frozen human cadaveric knees were used in this study. Under arthroscopic assistance, a 3.0 mm stroke micro-miniature Differential Variable Reluctance Transducer was attached to the anteriomedial bundle of the ACL to measure strain. The tibia was attached to the actuator of an electromechanical materials testing machine (Instron, Canton, MA) and the femur was rigidly fixed to the base of the Instron. The quadriceps was pretensioned with 150 N of force, both medial and lateral gastrocnemius, semimembranous, biceps femoris were pretensioned with 75 N. The Instron applied a force of 2x body weight (BW) over 60 msec to simulate landing after a jump. The knees were tested in 12 loading conditions, consisting of full extension or 15° flexion combined with 7° valgus or neutral alignment while the tibia was either in external rotation, neutral rotation, or internal rotation. This test procedure was repeated on each specimen with the MCL resected and reconstructed.

RESULTS: At full extension, 7° valgus and 10° internal rotation of the tibia, the MCL deficient group had significantly higher strain on the ACL than the intact MCL group ($p = 0.018$). The MCL reconstruction group decreased the ACL strain significantly ($p = 0.028$) and ACL strain with reconstruction was not different than the intact knee. ($p = 0.715$). At full extension, 7° valgus and neutral rotation, the reconstruction group had significantly lower strain compared to the MCL deficient group ($p = 0.017$). In 15° flexion, 7° valgus and neutral rotation, the MCL deficient group had significantly higher strain on the ACL than the intact group ($p = 0.023$) while the reconstruction group was not significantly different from the intact group ($p=0.595$).

CONCLUSIONS: During valgus landing, a knee with an incompetent MCL puts the ACL under increased strain. While we do not know if this puts the ACL at increased risk of rupture, it is subjected to higher strain. Concomitant ACL/MCL tears are a common injury pattern. These findings give support to fixing an unhealed or elongated MCL tear with a concomitant ACL tear. When a MCL injury is untreated and/or heals in an elongated position, it shows that a reconstruction can lead to similar ACL strain as in the intact knee.

Reliability of a Simple Method of Measuring Tibial Tubercle to Trochlear Groove Distance on MRI without Advanced Radiologic Software

Abstract ID: Paper 028

Christopher L. Camp, M.D.
Mark J. Heidenreich, B.S.
Diane L. Dahm, M.D.
Jeffrey R. Bond, M.D.
Mark S. Collins, M.D.
*Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: Tibial tubercle-trochlear groove (TT-TG) distance is a variable that guides surgical decision making in patients with patellar instability. The purpose of our study was to compare the accuracy and reliability of an MRI TT-TG measuring technique using a simple external alignment method to a previously validated gold standard technique that requires advanced software read by radiologists.

METHODS: TT-TG was calculated by MRI on 59 knees with a clinical diagnosis of patellar instability in a blinded and randomized fashion by two musculoskeletal radiologists using advanced software and by two orthopedists using the study technique which utilizes measurements taken on a simple electronic imaging platform. This technique utilizes a small reusable strip of adhesive paper to serve as an external alignment guide, and measurements are taken on a standard electronic imaging platform. The adhesive strip is applied to the computer monitor and remains stationary as the user scrolls through multiple axial images. Inter-rater reliability between the two radiologists and the two orthopedists and intermethods reliability between the two techniques were calculated using interclass correlation coefficients (ICC) and concordance correlation coefficients (CCC). ICC and CCC values greater than 0.75 were considered to represent excellent agreement.

RESULTS: The mean TT-TG distance was 14.7 mm (Standard Deviation [S.D.]: 4.87 mm) and 15.4 mm (S.D.: 5.41) as measured by the radiologists and orthopedists, respectively. Excellent interobserver agreement was noted between the radiologists (ICC 0.941; CCC 0.941), the orthopedists (ICC 0.978; CCC 0.976), and the two techniques (ICC 0.941; CCC 0.933).

CONCLUSIONS: The Simple TT-TG Distance Measurement technique analyzed in this study resulted in excellent agreement and reliability as compared to the gold standard technique. This method can predictably be performed by orthopedic surgeons without advanced radiologic software.

Patellar Instability Ratios: Relating Tibial Tubercle-Trochlear Groove Distance to Patient Specific Anatomy

Abstract ID: Paper 029

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*Mark J. Heidenreich, B.S.
Christopher L. Camp, M.D.
Diane L. Dahm, M.D.
Michael J. Stuart, M.D.
Bruce A. Levy, M.D.
Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: Patients with patellar instability and tibial tubercle to trochlear groove (TT-TG) distances ≥ 20 mm are considered to have pathologic lateralization of the tibial tubercle (TT) and may be candidates for TT realignment surgery. Although this variable has proven valuable in predicting risk of recurrent dislocations, uniform application is not feasible given lack of consideration for patient size, bony morphology, and patellofemoral mechanics. We sought to develop a Patellar Instability Ratio (PIR) that predicts the risk of recurrent instability based on the TT-TG distance relative to patient specific anatomy.

METHODS: Fifty-nine patients with a clinical diagnosis of patellar instability were included in the study. A number of measures were calculated on MRI by two observers in a blinded and randomized fashion. Variables analyzed included: TT-TG, tibial tubercle to posterior cruciate ligament distance (TT-PCL), sagittal patellar length (PL), sagittal trochlear length (TL), axial patellar width (PW), axial trochlear width (TW), sagittal patellofemoral engagement (SPE; SPE=TL/PL), and axial patellofemoral engagement (APE; APE=PW/TW). Patients were divided into two groups: those with ≤ 1 dislocation and those with ≥ 2 dislocations. Using these groups, the ability of TT-TG, TT-PCL, and 12 different ratios to predict recurrent instability was assessed by calculating odds ratios (OR), C-statistics, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for each of the ratios. P values < 0.05 were considered significant.

RESULTS: Mean follow-up was 6.6 years. Twelve patients (20%) experienced one dislocation, while 47 (80%) sustained two or more dislocations. The highest ORs for recurrent instability were noted for TT-TG/PW (OR >100, p=0.03) and TT-TG/TW (OR 37.22, p=0.02) (Table 1). PW was defined as the largest medial to lateral width of the patella articular surface. TW is defined as the largest articular width of the trochlea that is articulating with the patella and can be conceptualized as the “jump distance” that must be overcome for the patella to dislocate. The sensitivity and specificity of TT-TG/PW ratio ≥ 0.40 was 67% and 83% and that of TT-TG/TW ≥ 0.49 was 59% and 92%, respectively. PPV for TT-TG/PW ≥ 0.40 was 94% while that of TT-TG/TW ≥ 0.49 was 97%.

CONCLUSION: Two distinct PIR (TT-TG/PW and TT-TG/TW) have been identified that predict recurrent patellar instability greater than TT-TG alone with PPVs ≥ 94% and ORs > 37 for both measures. These ratios take into consideration the TT-TG relative to patient specific size and anatomy.

Click here to view Table

The Prevalence and Combined Prevalences of Anatomic Factors Associated with Recurrent Patellar Dislocation: An MRI Study

Abstract ID: Paper 030

Robert N. Steensen, M.D.
Jared C. Bentley, M.D.
*Thai Q. Trinh, M.D.
Jeffrey R. Backes, M.D.
Roger E. Wiltfong, M.D.
Columbus, OH

BACKGROUND: Anatomic factors are associated with dislocation of the patella. Among these factors are patella alta, increased quadriceps angle (Q-angle), rotational deformities, and trochlear dysplasia. Identifying the presence of these anatomic factors both in isolation and in combination may influence treatment in patients presenting with patellar dislocation.

PURPOSE: The purpose of this study was to compare the prevalence and combined prevalences of these anatomic factors utilizing MRI in a group of patients with and without a history of recurrent dislocation of the patella.

METHODS: The prevalence and combined prevalences of patella alta, increased quadriceps angle (TT-TG distance), rotational deformities, and trochlear dysplasia were reported and compared utilizing MRI in patients with (60 patients, 60 knees) and without (120 patients, 120 knees) a history of recurrent patellar dislocation.

RESULTS: Patients with recurrent patellar dislocation possessed a higher rate of patella alta (60.0% vs. 20.8%), increased quadriceps angle (42.0% vs. 3.2%), rotational deformity (26.7% vs. 2.5%), and trochlear dysplasia (68.3% vs. 5.8%) than patients without a history of patellar dislocation. Multiple anatomic factors were identified in 58.3% (35/60) of patients with recurrent dislocation compared to 1.7% (2/120) of controls.

CONCLUSIONS: Recurrent patellar dislocation is associated with an increased prevalence of patella alta, increased quadriceps angle, rotational deformities, and trochlear dysplasia compared to patients with no history of patellar dislocation. Multiple anatomic factors were identified in the majority of patients presenting with recurrent dislocation. Further research may identify which factors play a greater role in patellar stability and may allow physicians to predict which first time dislocation patients are more likely to sustain a recurrence.

Key terms: Patellofemoral, patellofemoral instability, patellar dislocation, MRI, knee

TT-TG vs. Modified LPE for Determination of Tibial Tubercle Transfer Distance in Fulkerson Osteotomy Procedures

Abstract ID: Paper 031

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*Alan D. Edwards
Evan P. Larson
Nikhil K. Sahai
John P. Albright, M.D.
Iowa City, IA

BACKGROUND: Tibial tubercle-trochlear groove (TT-TG) distance is currently accepted for the determination of tibial tubercle medialization distance required in Fulkerson osteotomy procedures. Previous work by our group suggests that a correlation also exists between transfer distance and a modified LPE described by McDermott et al. If the correlation between modified LPE and the transfer distance was found to be stronger than it's correlation with TT-TG, it would suggest that the best measurement to use when preoperatively calculating necessary medialization is actually modified LPE. McDermott's group found that transfer prediction by TT-TG varied based on the patella's location relative to the trochlear groove at 30° of flexion.

METHODS: The electronic medical records of 32 patients who underwent Fulkerson Osteotomy procedures with femoral nerve stimulation were reviewed and measurements taken. To achieve inter- and intra-rater reliability, all measurements were performed twice each by two investigators, and the average of the 4 values was used in the final analysis. Only patients who were deemed to have a good volitional quadriceps active hyperextension MRI scans were included in the study. For each patient, modified LPE was measured on quadriceps active hyperextension MRI, and TT-TG was measured on passive extension MRI. Correlation between TT-TG vs. actual tibial tubercle transfer distance and modified LPE vs. actual tibial tubercle transfer distance were then determined and analyzed.

RESULTS: The correlation between TT-TG and actual intraoperative tibial tubercle transfer distance in Fulkerson Osteotomy procedures with intraoperative femoral nerve stimulation was found to be weak at 0.430 ($p < 0.05$). The correlation between modified LPE and actual intraoperative tibial tubercle transfer distance was found strong at 0.677 ($p < 0.001$).

CONCLUSIONS: The correlation between modified LPE and actual intraoperative tibial tubercle transfer distance was stronger than the correlation between TT-TG and tibial tubercle transfer distance. This suggests that the modified LPE as described by McDermott et al. may actually be a better preoperative determinant than the currently-utilized TT-TG of the transfer distance required to achieve maximum patellofemoral congruency intraoperatively, regardless of patellar location at 30° of knee flexion.

MAOA BREAKOUT SESSION #3
TRAUMA
April 23, 2015

Vascular Thoracic Outlet Syndrome Following Clavicle Fractures and Adjacent Joint Trauma

Abstract ID: Paper 033

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*Alexander E. Weber, M.D.
Enrique Criado, M.D.
Ann Arbor, MI

Thoracic outlet syndrome (TOS) as a complication of clavicular malunion is rare. The vast majority of those cases are associated with neurogenic compression following clavicle malunion. There is a paucity of data regarding vascular TOS following clavicular trauma, which is of great concern given the high rate of morbidity associated with arterial or venous complications. The purpose of this study is to describe a series of vascular TOS associated with clavicular malunion, clavicular nonunion, sternoclavicular (SC) or acromioclavicular (AC) dislocations, and malpositioned hardware.

A retrospective chart review of the clinical records and imaging studies of all patients surgically treated at our institution for TOS from 1991 to 2013 was conducted. A descriptive analysis of the cohort of patients with associated clavicle or adjacent joint trauma was performed.

During the study period, 500 patients were operated upon for TOS. Of the total, 28 were associated with post-traumatic deformity of the clavicle or SC/AC joints. Fourteen of the 26 post-traumatic patients manifested with vascular TOS (11 arterial TOS and 3 venous TOS). Six of the 14 were due to clavicle malunion, 4 were due to SC dislocations, 2 were due to malpositioned clavicular screws, 1 was due to combined AC and clavicular pathology, and 1 was secondary to clavicle nonunion. The patient cohort was 50% male, and the average patient age was 33 years. The time from initial clavicle or SC/AC trauma to TOS symptoms was frequently prolonged. The median time between vascular TOS symptom onset to surgical intervention for vascular TOS was 1 month (range 0.25 – 324 months). The underlying pathology was confirmed with computed tomography angiogram or Doppler studies. The offending osseous and articular pathology was surgically addressed with partial claviculectomy (in all 14 cases), first rib resection in 3 cases, and hardware removal in 2 cases. The vascular injury was addressed with anuersymal resection and grafting in arterial cases and thrombolysis in venous cases. One of 14 patients had recurrence of venous TOS symptoms without evidence of venous occlusion. Thirteen of 14 were without symptoms and discharged from clinic at 6 months following surgery.

This case series is the largest to-date of vascular TOS associated with previous clavicle or AC/SC trauma. Although vascular TOS following trauma to the clavicle or the adjacent joints is a rare phenomenon, the treating orthopedic surgeon should be aware of its existence as a delayed or improper diagnosis can lead to severe vascular complications.

Incidence of Iatrogenic Radial Nerve Palsy Following ORIF of Humeral Shaft Nonunion

Abstract ID: Paper 034

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*Rafael Kakazu, M.D.
Steven K. Dailey, M.D.
John D. Wyrick, M.D.
Michael T. Archdeacon, M.D.
Cincinnati, OH

INTRODUCTION: The rate of iatrogenic radial nerve palsy following ORIF of acute humeral shaft fractures is approximately 6.5%. To our knowledge, no study has investigated the rate of occurrence of iatrogenic radial nerve palsy following surgical fixation of established humeral shaft nonunion (HSNU). We hypothesize that the incidence of radial nerve palsy is higher following ORIF of an established HSNU when compared to historical rates reported for ORIF of acute humeral shaft fractures.

METHODS: This study was conducted at an academic Level I trauma center following IRB approval. All patients who underwent operative treatment of a HSNU by the senior authors were identified from a fracture treatment database. Inclusion criteria were a HSNU confirmed both clinically and radiographically, absence of a preoperative radial nerve palsy, and postoperative clinical follow-up documenting radial nerve function. Sixty surgically managed HSNU cases were identified, of which 51 patients had adequate postoperative neurologic examination for inclusion in the study. The main outcome was diagnosis of postoperative iatrogenic radial nerve palsy.

RESULTS: Fifty-one patients were included in the cohort. Average age was 54 years (range, 21-85 years) with 20 males and 31 females. Eleven (22%) patients developed iatrogenic radial nerve palsies: three experienced complete resolution (mean, 3.6 months), two experienced partial resolution, and six had persistent dense radial nerve palsies. There were no statistical differences between patients who developed nerve palsy and those that did not in regards to age, gender, laterality, tobacco use, diabetes status, initial management (operative vs. non-operative), surgical approach, presence of infection, or operative time ($p > 0.05$).

CONCLUSIONS: The incidence of iatrogenic radial nerve palsy for patients undergoing surgical fixation of a HSNU was 22%. According to historical data, this rate is approximately three times higher than for those undergoing ORIF of acute humeral shaft fractures.

Definitive External Fixation for Fractures of the Humerus Shaft: A Systematic Review

Abstract ID: Paper 035

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*George C. Balazs, M.D.
Michael A. Donohue, M.D.
Jared A. Wolfe, M.D.
Mark E. Fleming, D.O.
Bethesda, MD

BACKGROUND: Humerus shaft fractures account for 3-5% of all fractures, occurring with an overall incidence rate of 19 per 100,000 annually in the United States. Commonly accepted indications for operative treatment include open fractures, neurovascular injury, polytrauma, highly comminuted or segmental fractures, and clinically unacceptable alignment. Plating and intramedullary nailing are the most common operative treatment methods, with generally good functional results (87 - 90.9%) but also high complication rates (20.6 - 42%). External fixation is less commonly utilized, but holds theoretical benefits of decreased operative times and reduced complications. We sought to systematically review available literature on the results of definitive external fixation for humerus shaft fractures.

METHODS: Two independent examiners searched PubMed for all English-language studies since January 1, 1980, examining the complications and results of external fixation for humerus shaft fractures. Exclusion criteria included treatment for nonunion/malunion after failed operative or nonoperative treatment, failure to report complications by type, use of hybrid constructs with internal and external fixation, and case reports.

RESULTS: 82 candidate studies were identified, of which 11 met all inclusion criteria. A total of 275 humerus shaft fractures (128 open, 147 closed) were treated with external fixation (264 uniplanar lateral fixators, 11 Ilizarov fixators). Average treatment time was 110.2 days, and 251 (91.3%) achieved union. Complications included iatrogenic nerve injury (1.1%), nonunion (8.7%), and loss of reduction requiring reoperation (1.8%). 52 patients (18.9%) experienced pin site problems, most commonly infection, and the majority were successfully treated with local wound care and oral antibiotics. Fixtors were well-tolerated, with only one patient requiring removal due to discomfort. The overall complication rate was 37.1%. Among studies reporting overall results of treatment, 85.1% were rated as good-to-excellent.

CONCLUSIONS: Definitive external fixation of humerus shaft fractures is a viable treatment strategy with complications and results similar to those of plate fixation and intramedullary nailing. External fixation is a reasonable alternative to consider in high-risk patients with humerus shaft fractures.

Total Elbow Arthroplasty for Early Loss of Fixation After Distal Humerus Fractures

Abstract ID: Paper 036

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*Matthew C. Kergosien, M.D. / Beaumont, TX
Mark E. Morrey, M.D. / Rochester, MN
Joaquin Sanchez-Sotelo, M.D. / Rochester, MN
Bernard F. Morrey, M.D. / Rochester, MN

BACKGROUND: Early loss of fixation of distal humerus fractures represents a challenging problem. Revision internal fixation to a stronger construct may be limited by the presence of hardware, damage to the articular surface, stiffness, and poor bone stock. Conversion to an elbow arthroplasty is an attractive alternative, but may be technically challenging and prone to complications. The purpose of this study was to determine the technical challenges, outcome, and complications of total elbow arthroplasty when used for the salvage of early loss of fixation of distal humerus fractures.

METHODS: Between 1998 and 2013, 22 linked semiconstrained elbow arthroplasties were performed at our institution for loss of fixation within 12 months of the index osteosynthesis procedure. One patient died; the remaining 21 elbows were followed for a mean of 5.8 years. There were 18 female and 3 male patients with a mean age of 63 years (range, 30 – 84 years). The average time between distal humerus fracture fixation and elbow arthroplasty was 8 months. The average number of procedures prior to elbow arthroplasty was 1.45 (range, 1 to 4).

RESULTS: At most recent follow-up, 6 elbows had required a reoperation, including implant revision or removal in 4 elbows (19%). These six patients required a total of 14 reoperations, 9 of which involved revision or removal of implants. For patients with surviving implants, the mean MEPS score was 85.5 points, 89% reported no or mild pain, and 78% considered their elbow much better. Flexion increased from 94° to 138° and extension increased from 43° to 18°. The overall infection rate was 5%.

CONCLUSIONS: Elbow arthroplasty may improve pain, motion, and overall elbow function when internal fixation fails within the first 12 months after osteosynthesis. However, implant revision or removal remains relatively high at mid-term follow-up, and the overall results seem to be inferior to patients treated acutely with an elbow arthroplasty.

Patients Undergoing Total Elbow Arthroplasty for Elbow Fracture Have Higher Perioperative Complications: A Nationwide Analysis of 3,797 Cases

Abstract ID: Paper 037

Jimmy J. Jiang, M.D. / Chicago, IL
*Aneet S. Toor, M.D. / Chicago, IL
Lewis L. Shi, M.D. / Chicago, IL
Jason L. Koh, M.D. / Evanston, IL

Abstract:

INTRODUCTION: Total elbow arthroplasty (TEA) is increasingly used for patients who sustain an elbow fracture. We investigate the immediate perioperative outcomes and complications of patients who underwent a TEA for a preoperative fracture vs. nonfracture diagnosis (osteoarthritis or rheumatoid arthritis).

METHODS: The Nationwide Inpatient Sample (NIS) database was queried from 2005-2011 for all patients who underwent a TEA (ICD-9 procedure code = 81.84). The NIS is a statistically representative sample of hospitals from across the United States that includes data on approximately 8 million inpatient admissions per year or roughly 20% of all admissions. A total of 3,797 patients were included in this retrospective study, and fracture patients were identified based on ICD-9 coding (812.4x-812.5x and 813.0x-813.1x). The demographic data, comorbidities, complications, and perioperative inpatient data were compared between the patients with and without a fracture diagnosis.

RESULTS: Fracture was the most common indication for TEA (n=2571 [67.6%] vs. nonfracture, n=1226 [32.3%]). The overall short-term perioperative complication rates following TEA were 9.6% in the fracture group and 6.4% in the nonfracture group. Patients with a fracture had significantly increased rates of urinary tract infection (odds ratio [OR] =2.6, p<0.001), non-routine discharge (OR=2.2, p<0.001), and overall perioperative complications (OR=1.6, p=0.001). They also had a statistically significant longer hospitalization stay (4.2 vs. 2.7 days, p<0.001) and incurred higher hospital charge ($58,428 vs. $54,101, p<0.001). Patients with fractures had significantly increased rates of comorbidities including alcoholism (OR=2.8, p=0.003), congestive heart failure (OR=1.5, p=0.02), diabetes (OR=1.4, p=0.001), neurologic disorder (OR=3.5, p<0.001), and pulmonary circulation disorder (OR=2.0, p=0.004). Multivariate analyses, which adjusted for significant differences in preoperative variables and comorbidities, showed that having a fracture was independently associated with increased risk of overall perioperative complications (relative risk [RR] =1.7, p=0.001), pneumonia (RR=2.7, p=0.05), and UTI (RR=2.9, p<0.001). Having an elbow fracture was also independently associated with increased length of stay (difference = 1.1 days, p<0.001) and a higher proportion of non-routine hospital discharge (RR=2.6, p<0.001).

DISCUSSION AND CONCLUSION: Fracture patients had a higher overall complication rate (9.6%) compared to nonfracture patients (6.4%) following TEA. After adjustment of differences in preoperative variables, fracture patients were still independently associated with a significantly longer hospital stay and perioperative complication rate.

Too Hot for Trauma

Abstract ID: Paper 038

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*Gregg M. Ebersole, M.D.
Melissa Meister, M.D.
Lisa K. Cannada, M.D.
J. Tracy Watson, M.D.
St. Louis, MO

PURPOSE: This study focuses on the occurrence of orthopedic trauma admissions in concordance with local weather variations. We hypothesize that the rate of orthopedic trauma will be altered with extreme weather, with daily temperature maximums (Tmax) that exceed 90°F, and with Tmax below 32°C.

METHOD: Data was obtained from two Level I trauma centers located in the Midwest, with seasonal weather variability from 1/1/09-12/31/12. Inclusion criteria was >18 years of age, orthopedic injury with AIS-extremity >1. The data collected from the National Weather Service was: Tmax, Tmin, Tdev, and precipitation.

RESULTS: There were 5,879 trauma admissions that occurred over 48 months (1,461 days) with an average of 4.0 traumas per day. There was a total of 583 days without traumas between the two hospitals. The etiology of injury was motor vehicle collision 2,062 (35%), motorcycle collision 631 (11%), pedestrian vs. auto 276 (5%), fall 1,845 (31%), gunshot wound (GSW) 412 (7%), and other 653 (11%). 1,901 occurred during 488 days with precipitation to give an average of 3.9 per day vs. an average of 4.1 traumas per day without precipitation, which was not significant. With Tmax 80-89°F there was 1,401 traumas (296 days), with an average of 4.7 traumas per day. With Tmax 90-99°F there was 949 traumas (193 days), with an average of 4.9 traumas per day. When Tmax was >100°F, the rate dropped to 3.9 traumas per day with 156 traumas (40 days), which was a significant decrease.

CONCLUSION: The occurrence of orthopedic trauma does increase during warmer seasons and months with the peak occurring in August. Precipitation had no overall effect on trauma rate. The incidence of trauma did increase as temperatures increased from 80-89°F to 90-99°F, but once the Tmax exceeded 100°F, the rate dropped significantly.

SIGNIFICANCE: High temperatures are “too hot for orthopedic trauma” once extreme temperatures of Tmax >100°F are reached with a significant decrease in admissions.

Effects of Reamer-Irrigator-Aspirator Wastewater on Bone Regeneration

Abstract ID: Paper 039

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*Derek J. Klaus, M.D. / Akron, OH
Douglas Crowder / Akron, OH
Ethan Scott, B.S. / Rootstown, OH
Stephen D. Fening, Ph.D. / Cleveland, OH
Fayez Safadi, Ph.D. / Rootstown, OH
Eric T. Miller, M.D. / Akron, OH

BACKGROUND/PURPOSE: The Reamer-Irrigator-Aspirator (RIA) device is capable of obtaining large quantities of autologous bone graft with significantly less donor site morbidity compared to iliac crest bone graft. The reamed femoral contents are aspirated and passed through a filter to separate the desired bone graft from the remaining wastewater (WW). The first aim of this study was to describe a method to concentrate osteogenic growth factors and viable mesenchymal stem cells (MSCs) from RIA WW. The second aim was to examine the effects of WW-derived growth factors on human MSCs in vitro as well as in a mouse calvarium critical-size defect (CSD) model in vivo.

METHODS: Twelve consecutive patients scheduled for femoral RIA bone grafting procedures were enrolled. RIA WW and 50 cc of peripheral blood were collected from each patient. Peripheral blood was centrifuged to obtain platelet rich plasma (PRP). MSCs were extracted from the WW and the remaining aspirate was concentrated. MSCs were incubated in the presence of PRP or concentrated WW to assess cell proliferation, survival, and mineralization in vitro. 5 mm CSDs were made in the calvaria of immunodefficient mice and packed with a collagen sponge alone or a collagen sponge soak-loaded with PRP or WW. Four weeks post-surgery, the calvaria were harvested and examined using micro-CT to determine percent bone ingrowth.

RESULTS: All patients were male (mean age 48, range 21 to 63). MSCs extracted from RIA WW remain viable after processing and retain multipotency. Concentrated WW yields comparable concentrations of osteogenic growth factors when compared to PRP. Concentrated WW significantly improved MSC proliferation by 4 times ($p<0.0001$) and survival by 3 times ($p<0.0001$) when compared to MSCs treated with PRP in vitro. MSCs treated with WW showed a 500-fold increase in mineralization after two weeks when compared to PRP ($p<0.001$). Significantly higher rates of bone ingrowth were observed in CSDs treated with WW (26%) compared to PRP (20%), $p<0.01$.

CONCLUSION: When compared to PRP, concentrated WW was shown to (1) accelerate MSC proliferation, survival, and mineralization in vitro by 4, 3, and 500-fold, respectively and (2) accelerate osteogenesis in a mouse calvarium CSD model in vivo.

Does BMI Affect Low Energy Trauma Fracture Site?

Abstract ID: Paper 040

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*Thomas S. Wenzlick, B.S.
Debra L. Sietsema, Ph.D., R.N.
Steven P. Lewis, B.S.
Clifford B. Jones, M.D.
Grand Rapids, MI

PURPOSE: The purpose of this study was to determine the fracture site based on body mass index in low energy trauma fractures.

METHODS: From 2011-2012, 1400 consecutive adults, 50 years and older with low energy trauma fractures who received care in a Level I trauma center, were seen in an outpatient clinic for bone health, and retrospectively evaluated.

RESULTS: There were 942 (75%) females and 322 (25%) males with a mean age at injury of 72 years (50-101) and mean BMI of 27.8 (10.2-84.4). There were 53 (4.2%) underweight, 418 (33.1%) normal weight, 387 (30.6%) overweight, 216 (17.1%) obese I, 99 (7.8%) obese II, and 69 (5.5%) obese III patients. There were 145 (11.5%) current and 308 (24.4%) former smokers. Comorbidities included diabetes (241, 19.1%), hypothyroidism (220, 17.4%), COPD (129, 10.2%), chronic renal disease (87, 6.9%), rheumatoid arthritis (73, 5.8%), dementia (69, 5.5%), and 45 (3.6%) had a previous diagnosis of osteoporosis with prescriptive treatment. Previous fractures after age 50 occurred in 364 (28.8%). The T-score mean was -2.2 (0.9 to -6.3). The fracture sites were spine (214, 16.9%), radius/ulna (186, 14.7%), hip (184, 14.6%), humerus/shoulder girdle (168, 13.3%), femur (150, 11.9%), tibia/fibula/patella (149, 11.8%), ankle/foot (142, 11.2%), and pelvis/sacrum (71, 5.6%). Humerus/ shoulder girdle fractures increased as BMI increased (3, 5.7%; 51, 12.2%; 38, 9.8%, 34, 15.7%; 22, 22.2%; 18, 26.1%) ($x^2<.001$). Ankle/foot fractures occurred more in overweight (51, 13.2%), obese I (41, 19.0%), obese II (12, 12.1%), and obese III (10, 14.5%) ($x^2<.001$). Pelvis/sacral fractures occurred most in the normal (35, 8.4%) and overweight (22, 5.7%) ($x^2=.031$). Tibia/fibula/patella fractures occurred more often in the obese I (33, 15.3%), obese II (15, 15.2%), and obese III (11, 15.9%) ($x^2=.239$). Hip fracture rate decreased as BMI increased (19, 35.8%; 75, 17.9%; 56, 14.5%, 19, 8.8%; 8, 8.1%; 4, 5.8%) ($x^2<.001$). Spine fractures occurred primarily in the normal (72, 17.2%) and obese I (79, 20.4%) groups. Femur fracture rate was most frequent in the underweight (12, 22.6%), but equitable across the remaining BMI categories ($x^2=.146$). Radius/ulna fractures were similar across BMI categories ($x^2=.721$).

CONCLUSIONS: A substantial number of low trauma fractures occurred in patients that are obese. The fracture type varied across BMI categories. Bone health care should be integral for the elderly with lower BMI to decrease the risk of hip, pelvis, and spine fractures. Weight loss interventions that also promote bone and muscle strength should be implemented for overweight and obese patients to reduce risk of other low trauma fractures.

What is the Bone Metabolic State of Patients with High Energy Trauma Fractures?

Abstract ID: Paper 041

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*Debra L. Sietsema, Ph.D., R.N. / Grand Rapids, MI
Michael D. Koets, B.S. / Detroit, MI
Clifford B. Jones, M.D. / Grand Rapids, MI

PURPOSE: Osteoporosis is a metabolic bone disorder affecting 9 million adults in the United States, resulting in nearly 2 million fractures annually from low energy falls. This disease causes low skeletal mass and a decrease in bone remodeling leading to fragility and fracture. The cause of this decline in bone strength is a physiological imbalance of metabolites, most importantly calcium and Vitamin D. The purpose of this study was to determine the bone metabolic health of patients with a high-energy trauma fractures.

METHODS: From 2011 through 2012, 522 consecutive adults with high-energy trauma fractures were initially treated at a Level I Trauma Center, were seen in an outpatient clinic for bone health, and retrospectively evaluated. 96 patients were excluded due to insufficient chart data, resulting in 426 patients in the study. Patients had a full work-up consisting of mechanism of traumatic fracture(s), health and medication history, physical examination, bone health laboratory values, and DXA.

RESULTS: There were 231 (54%) males and 195 (46%) females with a mean age of 54 (18-90) and BMI of 27.7 (15.3-70.6) and predominance of Caucasians (405, 95%). Mechanism of injury was MVA (149, 35%), fall from height (106, 25%), MCA (53, 12%), and other (118, 28%). 19/426 (5%) had previous fracture(s) after age 50. Comorbidities included: diabetes (45, 11%), hypothyroidism (45, 11%), COPD (23, 5%), and RA (17, 4%). 92/426 (22%) were smokers and 67 (16%) were past smokers. Medication history included: bisphosphonate (10, 2%), PPI (64, 15%), Estrogen (52, 12%), Glucocorticoids (7, 2%). Lab values included: Calcium 8.9 (6.5-11.1), Vitamin D 25 (OH) 27.5 (3-65) with 262 (62%) less than 30 ng/ml. Bone turnover markers were: P1NP 52 (1-231) and CTX 0.5 (0.09-1.77). DXA T-score was -1.7 (0.4 to -4.8). Decreased T-score was related to increased age ($r=-0.318$, $p<0.001$).

CONCLUSIONS: Despite having a high-energy mechanism, patients presenting with fractures at a Level I Trauma Center were found to have risk factors for poor bone health similar to patients presenting with low energy fractures. Vitamin D insufficiency occurred in a majority and bone turnover markers demonstrated poor bone remodeling. Previously undiagnosed osteoporosis was noted, especially with increased age. Consistent screening criteria should be implemented for all patients presenting with fractures to improve the bone-healing environment.

Early Appropriate Care of Orthopedic Injuries in Elderly Multiple-Trauma Patients

Abstract ID: Paper 042

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*Michael S. Reich, M.D.
Andrea J. Dolenc, B.S.
Timothy A. Moore, M.D.
Heather A. Vallier, M.D.
Cleveland, OH

PURPOSE: Previous work from our institution established resuscitation parameters that minimize complications with early fracture management. Recommendations included definitive management of mechanically unstable fractures of the pelvis, acetabulum, spine, and femur within 36 hours, provided the patient demonstrated a positive response to resuscitative efforts, including lactate <4.0, pH ≥7.25, or base excess (BE) ≥-5.5 mmol/L. This protocol has been applied to all skeletally mature patients, but patients with advanced age or pre-existing medical issues may require unique parameters to mitigate risk of complications and mortality.

METHODS: Between October 2010 to March 2013, 376 skeletally mature patients with 426 unstable fractures of the pelvis (n=73), acetabulum (n=58), spine (n=112), and/or proximal or diaphyseal femur fractures (n=183) were treated at a Level I trauma center and were prospectively studied. Subgroups of patients age ≤30 years old (n=114) and ≥60 years old (n=37), treated within 36 hours of injury were compared. The Injury Severity Score (ISS), Glasgow Coma Score (GCS), and American Society of Anesthesiologists (ASA) classification were determined. Lactate, pH, and BE were measured at eight-hour intervals and perioperatively. Complications included pneumonia, pulmonary embolism (PE), acute renal failure (ARF), acute respiratory distress syndrome (ARDS), multiple organ failure (MOF), deep vein thrombosis (DVT), infection, sepsis, and death.

RESULTS: Patients ≤30 years old (y/o) were more likely to sustain gunshot wounds (p=0.039), while those ≥60 y/o were more likely to fall from a height (p=0.002). In patients who underwent definitive fixation within 36 hours, younger patients had lower GCS (12.3 ± 4.32 vs. 14.2 ± 2.77, p=0.003), and lower ASA (2.58 ± 0.86 vs. 3.03 ± 0.76, p=0.004), with no difference in ISS (25.0 ± 9.64 vs. 24.6 ± 8.99). At least one complication occurred at similar rates for patients ≤30 y/o (15.8%) and ≥60 y/o (16.2%) At the time of fixation for patients ≤30 y/o and ≥60 y/o, there were no differences in lactate (2.09 ± 0.95 vs. 1.86 ± 0.81), pH (7.32 ± 0.07 vs. 7.32 ± 0.09), or BE (-3.79 ± 3.73 vs. -3.42 ± 4.30). Subgroup analysis evaluating the severity of acidosis incrementally within patients ≤30 y/o showed increased overall complications if pH was <7.30 (p=0.042) or BE <-6.0 (p=0.049). Patients ≥ 60 y/o demonstrated more sepsis if BE was <-6.0 (p=0.046). Higher ASA was associated with a greater incidence of any complication, pulmonary complication, pneumonia, ARDS, MOF, sepsis, and death, irrespective of patient age.

CONCLUSIONS: Further study is needed in a larger sample to determine whether previous resuscitation parameters guiding timing of definitive fixation in elderly patients should be more conservative to decrease their risk of complications.

Does Timing from Injury to Surgical Reduction of Talar Fracture-Dislocations Matter?

Abstract ID: Paper 043

Robert W. Westermann, M.D.
*Joseph A. Buckwalter, V, M.D.
Matthew D. Karam, M.D.
Brian Mooers, M.D.
Brian R. Wolf, M.D., M.S.
Iowa City, IA

INTRODUCTION: Fractures of the talus with associated dislocations are rare, and are associated with high rates of complications including avascular necrosis (AVN). The purpose of this study is to evaluate the influence of time to reduction of OTA/AO 81-B3 talus fractures and complete extrusions without talar neck fracture on the rate of AVN.

METHODS: A 10-year (2003-2013) retrospective review at a Level I trauma center was conducted identifying all patients managed operatively with talus fractures. Operative reports were obtained and reviewed. Three independent reviewers classified injury plain films according to the OTA/AO classification. Radiographs obtained at final follow-up were evaluated by musculoskeletal radiologists. Analysis of OTA/AO 81-B3 fractures and complete talar extrusions (tibiotalar, subtalar, and talonavicular dislocation without a talar neck fracture) was performed. The primary outcomes were defined as presence of AVN and/or arthrodesis of the tibiotalar or subtalar joints.

RESULTS: Our review identified 100 operatively managed fractures of the talus. 11% were OTA/AO 81-B1 fractures, 29% were OTA/AO 81-B2 fractures, and 29% were OTA/AO 81-B3 fractures. Talar body fractures (81-C) made up 22% of cases, while complete extrusions (1%), lateral process fractures (81-A2) (4%), and talar head fractures (81-A3) (1%) were less commonly managed operatively. OTA/AO 81-B3 fractures and completely extruded tali were considered.

Mean time to reduction of OTA/AO 81-B3 fractures and completely extruded tali was 16.7 hours for patients without AVN or arthrodesis, and 18.7 hours for patients who developed AVN or subsequently underwent arthrodesis (p=0.80). The follow-up was significantly longer for patients who did not develop AVN or undergo an arthrodesis (120 weeks vs. 53 weeks p=0.03), indicating an adequate time for surveillance of complications. There was no difference in age (p=0.61), sex (p=0.89), BMI (p=0.38), and the rate of open fracture (p=0.93), between patients who developed AVN and those who did not. Patients who developed AVN had a higher incidence of associated extremity and polytrauma; however, this did not reach statistical significance (p=0.06).

DISCUSSION AND CONCLUSION: Fracture-dislocations to the talar neck are devastating injuries with high rates of complications. Urgent operative reduction of these injuries is considered important in preservation of blood supply and thereby decreasing the risks of AVN. These data suggest the time from injury to surgical reduction of OTA/AO 81-B3 fractures and talar extrusions was no different between patients who went on to AVN and/or arthrodesis and those who did not.

Clinical Outcomes of Talus Fractures

Abstract ID: Paper 044

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*Brandee S. Black, M.D.
Yelena Levina, B.S.
Brett D. Crist, M.D., FACS
David A. Volgas, M.D.
James P. Stannard, M.D.
Gregory J. Della Rocca, M.D.
Columbia, MO

PURPOSE: Talus fractures often result from high-energy trauma. Post-traumatic problems include fracture nonunion, post-traumatic arthrosis, and osteonecrosis. Chronic pain and abnormal hindfoot mechanics also plague patients, even those in whom uneventful healing has occurred. Little is known about long-term outcomes after talus fracture. We evaluated patients presenting for operative management of talus fractures and reviewed their long-term radiographic and clinical outcomes.

METHODS: After IRB approval, we undertook a retrospective review of all operatively-managed talus fractures at our Level I trauma center between 9/1/2005 and 4/30/2012. Demographic information was extracted via chart abstraction. Radiographs were assessed to determine fracture type, time to healing, arthrosis, and/or osteonecrosis. Patients were prospectively contacted to assess pain and employment status. Short Form-12 version 1 (SF-12v1) and AAOS Foot and Ankle Outcomes Questionnaire (FAOQ) were completed.

RESULTS: Seventy-five fractures (73 patients) underwent talus fracture reconstruction. The mean patient age was 40.65 years. Mean body mass index was 28.63 (median 26.9, range 17-46). Most injuries were high-energy, with motor vehicle crashes representing the bulk of injury mechanisms (68%). Fractures of the talar body were more common than of the talar neck. Incidence of open talus fractures, other ipsilateral lower extremity or pelvic injuries, and contralateral lower extremity or pelvic injuries were 32%, 71%, and 32%, respectively. Forty-six patients had 12-month radiographic follow-up; the incidences of radiographic nonunion, osteonecrosis, and arthrosis were 10.2%, 20%, and 46%, respectively. Twenty-six of 73 patients were contacted successfully at least 12 months postoperatively. None of these patients was pain-free, and the average pain score was 6.0 (σ=2.5) on a scale of 1-10. Of the 26, 7 patients (27%) were unable to return to gainful employment. Patients with open fractures were significantly (p=0.019) less likely to return to work and/or activities of daily living. Average SF12v1 Physical Component Summary (PCS) score was 36.8 (σ=9.7), lower than the United States population norm of 50.0 (σ=10). Average SF12v1 Mental Component Summary (MCS) score was 54.0 (σ=10.2), similar to that of the United States population norm of 50.0 (σ=10). Average FAOQ score was 62.5 (σ=21.1), lower than the United States population norm of 93.2 (σ=12.3).

DISCUSSION: Talus fractures are associated with high-energy mechanisms and many talus fracture patients sustain multiple other injuries. Although reliable talus fracture union generally occurs after surgical care, osteonecrosis, arthrosis, and long-term pain can also be expected with residual physical dysfunction. Talus fractures may represent life-altering events for young patients.

Correlation Between CT Measurement of Intra-Articular Calcaneus Fracture and Clinical Results, Complications, and Contact Stress Analysis

Abstract ID: Paper 045

Saran Tantavisut, M.D.
Kevin Dibbern, M.D.
Donald D. Anderson, Ph.D.
Phinit Phisitkul, M.D.
Matthew D. Karam, M.D.
Yubo Gao, Ph.D.
Brian O. Westerlind
*J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: A quality of intra-articular reduction is one of the main factors which influence to both short- and long-term results. This study retrospectively reviewed patients with intra-articular calcaneal fractures who were treated with percutaneous reduction and fixation with screws alone and assessed the correlation between Sander classification, preoperative articular displacement, and postoperative quality of articular reduction in CT scan using novel measurement technique with mid-term clinical outcomes, VAS score, and complications. We also analyzed the correlation between postoperative quality of articular reduction and pressure area analysis by computerized discrete element analysis (DEA).

MATERIALS AND METHODS: We included calcaneus fracture patients between 2000 and 2011. All patients had complete preoperative and postoperative CT scans. The articular reduction was quantitatively analyzed by measuring the widest posterior talocalcaneal joint displacement in 3 CT scanning planes then summarized 3 widest displacement to achieve a final score. All data were reviewed from the time of injury to the most updated follow-up. We recorded postoperative activity, pain and stiffness, ability to return to work, VAS score, and complication. In 30 cases, contact stress was measured using discrete element analysis.

RESULTS: Sixty-one patients (67 feet) with an average follow-up time of 1.3 ± 0.9 years were included in this study. We found Sander type 2 in 47.7%, type 3 in 41.8%, and type 4 in 10.4%. Postoperative activity, pain, and stiffness were reported as good to excellent in 56.5%, 55.2%, and 68.7%, respectively.

We found 7.4% of calcaneus fractures had late arthritis or required subtalar fusion and 1.5% had deep infection. The average VAS score was 3.5. The average preoperative CT was 33.6 ± 2.5 mm and postoperative score was 12.9 ± 1.4 ($p < 0.0001$).

Sander classification didn't demonstrate correlation to any clinical results or complications. Of the patients with either subtalar fusion or late stage arthritis, there was significant correlation between both the preoperative and postoperative CT composite scores ($p = 0.05$ and 0.03 respectively). The VAS scores did not correlate with the preoperative CT scores ($p=0.4$), although they showed strong trend to correlate with postoperative scores ($p=0.06$). The measurement of articular reduction and outcomes were correlated with contact stress analysis in the 30 cases that were investigated.

CONCLUSION: This study demonstrated that both preoperative displacement and postoperative quality of articular reduction in CT scan were significantly correlated with subtalar fusion or late stage arthritis.

Outcome of Interprosthetic Femoral Fractures with Retained Knee and Hip Arthroplasty Treated with a Polyaxial Locking Plate

Abstract ID: Paper 046

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*Martin F. Hoffmann, M.D.
Sebastian Lotzien, M.D.
Thomas A. Schildhauer, M.D.
Bochum, Germany

Interprosthetic femoral fractures associated with well-fixed total hip and total knee prostheses are rare. Demographic trends combined with a greater number of hip and knee replacements being performed may lead to an increase of these fractures. ORIF utilizing locked plates have been successfully performed in fractures associated with well-fixed components. Fixation often remains challenging in periprosthetic fractures due to osteoporosis, reduced bone stock, and the vicinity of hardware components. Due to the presence of prosthetic implants proximal and distal of the fracture, interprosthetic femur fractures provide even less bone for fixation in combination with unfavorable local mechanical conditions. Limited studies focus on locking plates in interprosthetic femur fractures. The purpose of this study was to evaluate a series of polyaxial locking plate treatment of interprosthetic femoral fractures.

METHODS: Over an 8-year period, 2005-2012, 26 consecutive interprosthetic femoral fractures (AO/OTA 32) from one academic trauma center were retrospectively identified as having been treated with polyaxial locked plate fixation. Of these, 24 fractures in 24 patients (91.7% female) met the inclusion criteria. Patients had an average age of 80.7 years (65-93 years) and a BMI of 28.8 kg/m^2 (20.2-44.1 kg/m^2). Two patients (8.3%) previously had a revision THA. Fixation constructs for plate length and working length were delineated. Demographics were assessed. Nonunion, infection, and implant failure were used as independent complication variables.

RESULTS: All patients were treated operatively. 22 fractures (91.7%) healed after the index procedure. No wound complications occurred in this study population. 3/24 (12.5%) needed revision surgery by developing a nonunion with 2 fractures (8.3%) leading to hardware failure. Additional surgeries for nonunion were performed after 3 months. One obese patient (BMI 44.1kg/m^2) needed redo-surgery after 1 month due to hardware failure. Hospital stay was 15.5 days. Operative time was 117 minutes (50–210 minutes). For technical aspects, 19 patients (79.2%) were treated with distal femur plates (NCB-DF) and in 5 patients (20.8%), periprosthetic plates (NCB-PP) were utilized. Plate length was 259.6 mm (167-324 mm, 5 to 13 holes). No difference was found in nonunion formation regarding plate length or number of screws.

CONCLUSION: Fixation of interprosthetic femoral fractures after total knee and hip arthroplasty continues to be challenging. The use of a single locked plate with variably angled screws is an attractive option for managing interprosthetic fractures. In our series, this technique was associated with a high rate of fracture union in an elderly patient population.

MAOA BREAKOUT SESSION #4
REVISION HIP AND KNEE ARTHROPLASTY
April 23, 2015

Constrained Cemented Liners in Revision Total Hip Arthroplasty: 10-Year Outcomes

Abstract ID: Paper 047

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*Diren Arsoy, M.D.
Matthew P. Abdel, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Cementation of constrained liners remains an option to treat recurrent dislocation in revision total hip arthroplasty, but concerns remain for mechanical failure and instability with long-term follow-up. The aim of this study was to define long-term failure modes of previously cemented constrained polyethylene liners at the time of revision total hip arthroplasty (THA).

METHODS: We retrospectively reviewed 162 revision THAs (157 patients) where cementation of a constrained polyethylene liner at the time of revision THA was performed. Survivorship, radiographic outcomes, and rate of instability were analyzed. We sought to identify risk factors for re-revision and recurrent instability. The median age was 72 years. Median follow-up was 10 years.

RESULTS: In 87 cases, constrained liners were cemented into a new cementless acetabular shell. In the remainder of cases, the liner was cemented into an existing well-fixed acetabular component. At 10 years, survivorship free of acetabular revision for any reason excluding infection was 78%. 10-year survivorship free of acetabular revision for any reason was 68%. Survivorship free of acetabular liner revision for aseptic and catastrophic mechanical failure (aseptic loosening at the cement-liner interface, polyethylene wear, polyethylene liner spin-out or fracture) was 89% at 10-year follow-up. The overall dislocation rate at 10 years was 15%, but was 27% for patients that underwent isolated constrained liner cementation at the time of revision THA. Constrained liner cementation into an existing cup was associated with a more than 6x higher risk for postoperative instability (HR= 6.3; p=0.04). In contrast, patients that underwent combined shell revision with liner cementation had a 4% dislocation rate at 10-year follow-up.

CONCLUSIONS: Cementation of constrained liners show a mechanical failure rate of 11% at 10-year follow-up as reported in other series. Recurrent instability remains high in patients where isolated liner cementation was performed and should be used with caution to treat instability.

SUMMARY: Cementation of a highly crosslinked polyethylene constrained liner into a cementless acetabular shell was associated with an 11% mechanical failure rate at 10 years.

Revision THA Utilizing the Cement-in-Cement Technique

Abstract ID: Paper 048

Derek F. Amanatullah, M.D.
*Lorena V. Floccari, M.D.
Georgios I. Vasileiadis, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

The cement-in-cement technique is powerful in the setting of revision THA, especially to gain acetabular exposure, change a damaged or loose femoral component, change the version, offset, or length of a fixed femoral component, or repair a Vancouver B1 periprosthetic fracture with an intact cement mantle. The goal of this retrospective study is to assess the clinical and radiographic characteristics of revision THA utilizing the cement-in-cement technique in the United States of America. Between 1971 to 2013, 63 revision THAs at our institution utilized the cement-in-cement technique with an Omnifit or Exeter stem. Aseptic loosening (74%) was the predominant preoperative diagnosis followed by periprosthetic fracture (14%), instability (8%), and implant fracture (6%). The mean clinical follow-up was 5.5 ± 3.8 years. There was a statistically significant increase of 18.5 points in Harris hip score ($p < 0.001$) after revision THA with utilizing the cement-in-cement technique. There were 13 returns to the operating room resulting in an overall failure rate of 20.6%. Eleven cases required revision THA (17.5%), but only one revision THA was for aseptic removal of the femoral component (1.6%). This implant demonstrated radiographic evidence of radiographic loosening, stem migration, cortical remodeling, and cement mantle fracture. All of the other femoral implants had no evidence of component migration, cement mantle fracture, or circumferential lucent lines at final follow-up. The patients that underwent cement-in-cement revision THA at our institution had good restoration of function, but cement-in-cement revision THA in general has a high complication rate that is not associated with aseptic loosening of the femoral stem.

Dual Mobility Articulations Outperform Constrained Liners for Patients at High Risk for Instability

Abstract ID: Paper 049

Darren R. Plummer, M.S. / Chicago, IL
*Jonathan M. Christy, M.D. / Chicago, IL
Mario Moric, M.S. / Chicago, IL
Scott M. Sporer, M.D. / Winfield, IL
Wayne G. Paprosky, M.D. / Winfield, IL
Craig J. Della Valle, M.D. / Chicago, IL

INTRODUCTION: Patients at highest risk for instability are often times treated with a constrained liner. Constrained liners, however, typically require an open reduction, reduce range of motion, and can increase forces at the prosthetic interfaces. Dual-mobility articulations are a potential alternative although little data is available on their use in the most challenging situations. The purpose of this study was to compare constrained liners to dual-mobility articulations in patients at high risk for dislocation following revision total hip arthroplasty (THA).

MATERIALS AND METHODS: A consecutive series of revision THA that were at high risk for instability were compared retrospectively. Indications for both groups included abductor insufficiency, revision for instability, or inadequate intraoperative stability when trialing. Forty-three hips were reviewed in the constrained group (mean follow-up 3.4 years) and 36 in the dual-mobility group (mean follow-up 2.4 years). The rate of failure was compared using a Fisher's exact test with a p-value of < 0.05 considered significant.

RESULTS: At a minimum of two years, there were ten dislocations in the constrained group (10/43 or 23.3%) compared to three in the dual-mobility group (3/36 or 8.3%; $p = 0.06$). There were 15 repeat revisions in the constrained group (10 for instability, 4 for infection, and 1 broken locking mechanism) compared to 4 in the dual mobility group (2 mechanical failures and 2 for infection); 34.9% vs. 11.1% ($p = 0.01$). With repeat revision for instability as an endpoint, the failure rate was 23% (10/43) for the constrained group and 5.5% for the dual mobility group (2/36; $p = 0.03$).

CONCLUSION: Although follow-up is shorter in the dual mobility group, these results suggest a lower risk of dislocation and repeat revision for a dual mobility bearing compared to a constrained liner when used for patients who are at high risk for instability following a revision THA.

Long-Term Risk Factors for Revision, Reoperation, and Infection Following Revision THA for Mechanical Failure

Abstract ID: Paper 050

Matthew T. Houdek, M.D.
Eric R. Wagner, M.D.
Chad D. Watts, M.D.
Cody C. Wyles, B.S.
*Casey R. Stuhlman, M.D.
Daniel R. Whiting, M.D.
David G. Lewallen, M.D.
Tad M. Mabry, M.D.
Rochester, MN

INTRODUCTION: As the incidence of primary total hip arthroplasty (THA) increases, there will be an accompanying increase in need for revision THAs, especially for those patients with mechanical failure of the primary THA. The purpose of this study was to evaluate the long-term outcomes of patients who have undergone a revision THA for mechanical failure.

METHODS: Using our institutions total joint registry, we examined 4,713 patients who had undergone a revision THA with at least 5-years of clinical follow-up (mean follow-up 10.4 years) over a 20-year period (1987-2007). From this group, we identified 3,416 patients (53% female) with a mean age of 64 years and body mass index (BMI) of 28 who had undergone revision THA for mechanical failure. The most common indication for revision surgery was aseptic loosening of the acetabular component (n=1049, 31%). Analysis included Kaplan-Meier implant survival outcomes and Cox hazard models.

RESULTS: The overall 10-, 15-, and 20-year survival was 88%, 72%, and 58%. Improved rates of implant failure and reoperation were seen in patients with osteoarthritis ($p<0.01$), while those patients with rheumatoid arthritis (RA), pediatric hip disease had increased rates of implant failure and reoperations ($p<0.04$). Patients undergoing revision THA for hip instability or isolated acetabular loosening were at increased risk for revision surgery and reoperation ($p<0.03$). Those undergoing simultaneous revision of the acetabular and femoral component loosening were at reduced risk of reoperation and implant failure. Rates of revision surgery for infection were increased in male patients and those with a diagnosis of rheumatoid or inflammatory arthritis ($p<0.02$). Neither obesity nor morbid obesity leads to rates of implant failure or reoperation after revision THA for mechanical failure.

DISCUSSION: Revision THA for mechanical failure is a difficult problem with a relatively high rate of implant failure over the long-term follow-up period. Factors that have a negative impact on survival and complications include patients with inflammatory arthritis, congenital hip pathologies, and those undergoing THA for instability. Likewise, patients undergoing revision THA for instability are at increased risk for further complications; however, patients undergoing a revision THA of both components are a reduced risk for failure.

Patient Reported Reasons for Dissatisfaction Following Revision Total Hip Arthroplasty

Abstract ID: Paper 051

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*George F. Bonadurer, III, B.S.
Cody C. Wyles, B.S.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: The majority of patients who undergo revision total hip arthroplasty (THA) have marked improvement in pain and function. A relatively small percentage of patients are dissatisfied after surgery. There is little research examining why these patients are dissatisfied or feel their hip has worsened due to surgery. The purpose of this study was to quantify the percentage of patients that feel their hip is worse than before revision THA and note the patients' perceived primary and secondary reasons for the poor outcome.

METHODS: We retrospectively reviewed revision THA patients from a single institution from 2000 – 2009. Of the 2,677 revision THA patients with a completed two-year postoperative recheck form (via clinic visit, mail, or phone), 85 (3%) indicated their hip was worse than before surgery. These 85 patients were further surveyed regarding their attitudes on their revision THA, including a self-completed Western Ontario and McMaster Universities (WOMAC) Arthritis Index. 61% (52/85) completed the survey via mail or phone. The mean age of respondents was 71 years with 60% being female, and the average time since revision THA was 8 years. Of the 52 that completed the survey, 10% contradicted their two-year recheck form, indicating their hip is now better than before their revision THA, and their results were not included in analysis.

RESULTS: 53% indicated pain is the primary reason that they indicated their hip was worse than before surgery. 35% indicated difficulty walking was the primary reason. Other reported primary reasons included stiffness, postoperative complications, and perceived leg shortening. Despite stating their hip is worse than before surgery, 36% still reported they are very or somewhat satisfied with the surgery, and 62% are very or somewhat satisfied with their surgeon. Those that were very or somewhat dissatisfied had worse WOMAC Pain and Functional Ability scores than those who were very or somewhat satisfied ($p<0.01$).

DISCUSSION: Following revision THA, 3% of patients indicated that their hip is worse than before surgery. Pain (53%) and difficulty walking (35%) are the primary reasons why patients feel their hip is worse. Despite the perceived poor outcome, 36% of these patients are satisfied with the procedure, and 62% are satisfied with their surgeon.

Revision Total Hip Arthroplasty: National Trends and Perioperative Outcomes

Abstract ID: Paper 052

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*Brian E. Schwartz, M.D.
Vincent M. Moretti, M.D.
Nicholas B. Schraut, M.D.
Mark H. Gonzalez, M.D.
Chicago, IL

INTRODUCTION: Over 330,000 total hip arthroplasties (THA) are performed each year in the United States, and the demand for both primary and revision THA is expected to rise. The purpose of this study was to evaluate perioperative outcomes and recent national trends in revision THA.

METHODS: The National Hospital Discharge Survey database was searched ICD-9 codes for patients admitted to U.S. hospitals for primary THA and revision THA for the years 2001-2010. ICD-9 codes were used to identify patient demographics, in-hospital adverse events, and discharge disposition. Statistical analysis included linear regression with Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis for proportions with a significance level of 0.05.

RESULTS: 18,186 patients who underwent primary THA and 3,161 patients who underwent revision THA were identified. After adjusting for fluctuations in annual hospital admissions, the rates of primary THA (r=0.83) and revision THA (r=0.67) both demonstrated a positive correlation with time. Over the ten years studied, primary THA increased 99.8% and revision THA increased 36.9%. The mean patient age of the primary THA group was significantly lower than the revision THA group (65.2 vs. 66.5 years, $p<0.01$). Gender was not significantly different between the groups, with men accounting for 43.2% of primary THA and 41.8% of revision THA ($p=0.27$). Revision THA had a significantly longer average length of stay (5.64 vs. 3.98 days, $p<0.01$), were more likely to be discharged to rehab (34.5% vs. 28.8%, $p<0.01$), and less likely to be discharged home (41.6% vs. 47.4%, $p<0.01$). There was no significant difference for DVT rate (Primary 0.15% vs. Revision 0.22%, $p=0.14$) and PE rate (Primary 0.25% vs. Revision 0.41%, $p=0.25$). Revision THA had a significantly higher rate of transfusion (29.7% vs. 25.9%, $p<0.01$), mortality (0.41% vs. 0.21%, $p=0.01$), and a higher average number of medical co-morbidities (5.81 vs. 4.86, $p<0.01$).

DISCUSSION: This study demonstrates that the rates of both primary and revision THA are rising, with primary THA increasing at a rate of nearly three times greater than revision THA. While the rate of DVT and PE were not significantly different between the two groups, the revision THA group had a higher transfusion rate, more medical co-morbidities, increased mortality, longer length of stay, and decreased rate of discharge home.

Reoperation After Revision Surgery for Recalled Modular Neck Femoral Implants: A One-Year Follow-Up

Abstract ID: Paper 053

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*Christopher P. Walsh, M.D. / Detroit, MI
Joseph M. Nessler / St. Cloud, MN
Joseph P. Nessler, M.D. / St. Cloud, MN
David C. Markel, M.D. / Southfield, MI

INTRODUCTION: Hip stems with modular necks were designed to provide more options for anatomic hip reconstruction. Adverse local tissue reactions related to the implant led to a voluntary recall and multiple revision operations, but there has been no major study of revision surgery outcomes in this population

METHODS: A review of prospectively collected data was performed on 103 patients who underwent revision of a modular neck hip implant between May 2012 and February 2013, giving at least a 1-year follow-up on all patients. 95 patients were revised via direct lateral approach, 7 via posterolateral, and 1 via direct anterior approach. Operative reports and imaging data were reviewed and descriptive statistics were performed.

RESULTS: 25.2% (26/103) patients required at least one re-operation after the initial revision surgery, and 8.7% (9/103) have required two or more reoperations. Of the 95 patients revised via direct lateral approach, 23 required re-operations (24.2%), with 14 of these operations for abductor necrosis. Of the 14 patients with abductor necrosis, 9 required tensor-fascia lata to gluteus maximus muscle transfers on first reoperation, and 4 required muscle transfer on second reoperation. An additional 8 of the 95 patients revised via direct lateral approach have abductor detachment on imaging, but have not yet undergone revision. Of the 7 patients revised via posterolateral approach, 2 (28.6%) required return to the OR for closed reduction of dislocations, with no evidence of abductor detachment. The one patient revised via direct anterior approach required revision for a trochanteric fracture.

CONCLUSION: There is a high rate of reoperation required after revision surgery for modular neck stem implants. We recommend using the posterolateral approach for the initial revision surgery, as we have noted an unacceptably high rate of abductor destruction following revision with the direct lateral approach.

Synovial Fluid Cytokine Changes Between First and Second Stage Revision Arthroplasty

Abstract ID: Paper 054

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*Salvatore J. Frangiamore, M.D.
Nicholas Gajewski, B.S.
Anas Saleh, M.D.
Mario Farias Kovac, M.D.
Thomas Daly, M.D.
Thomas W. Bauer, M.D.
Alison K. Klika, M.S.
Wael K. Barsoum, M.D.
Carlos A. Higuera, M.D.
Cleveland, OH

INTRODUCTION: Current protocols for managing periprosthetic joint infection (PJI) have proven ineffective in preventing further surgical intervention, with as many as 28% requiring further surgical intervention for infection. Evaluating the changes in synovial fluid cytokine markers between revision arthroplasty stages could provide a useful adjunct to the current diagnostic algorithm. The purpose of this study was to (1) measure variation of synovial fluid cytokines between aseptic and septic revision hip or knee arthroplasty (rTHA/rTKA), (2) measure changes between 1st and 2nd stages of septic revision, and (3) correlate these values with diagnosis of aseptic or septic.

METHODS: 132 consecutive synovial fluid aspirates were prospectively obtained on patients undergoing aseptic rTHA/rTKA, 1st stage, or 2nd stage revision of septic rTHA/rTKA. Aseptic and septic cases were categorized using MSIS criteria for PJI. Of these cases, n=70 were aseptic procedures, n=30 were 1st stage revisions, and 32 were 2nd stage. Synovial fluid levels of nine pro-inflammatory cytokines (IL-6, GM-CSF, IL-1β, IL-12, IL-2, IL-8, IFN-γ, IL-10, TNF-α), were measured using a cytokine immunoassay. Receiver operating characteristics analysis was performed.

RESULTS: All 9 cytokines were significantly elevated in 1st stage of a two-stage revision compared to aseptic revision (all $p<.001$). Comparing 1st and 2nd stage of two-stage revisions, 6 cytokines were found to be significantly higher during the 1st stage of the procedure compared to the 2nd stage (all $p<0.001$). IL-6 was found to be 8X higher (95% CI 3.2-20.4) during 1st stage compared to 2nd stage, and IL-1β was found to be 7.1X higher (95% CI 3.0-17.2). For two-stage procedures, IL-2 and IFN-γ had highest sensitivity (75%), and IL-6 had highest specificity (97%) for predicting infection.

CONCLUSIONS: IL-6 and IL-1β had the greatest change between 1st and 2nd stage procedures, and may be appropriate targets to further study as indicators of infection eradication and optimized timing of reimplantation.

Predictors of Staphylococcus Aureus Colonization and Results After Decolonization

Abstract ID: Paper 055

Tennison Malcolm, M.D.
Le Don Robinson, M.D.
Alison K. Klika, M.S.
*Carlos A. Higuera, M.D.
Trevor G. Murray, M.D.
Cleveland, OH

BACKGROUND: The risk of surgical site infection following total joint arthroplasty (TJA) is two to nine times higher among patients colonized with methicillin-sensitive Staphylococcus aureus (MSSA) than not; methicillin resistance (MRSA) confers an additional four-fold increase in failure risk. The goals of this study were to determine whether (1) clinical criteria can reliably predict MSSA and/or MRSA colonization and whether (2) global screening and decolonization reduces the risk of revision compared with chlorhexidine body wipes alone.

METHODS: Electronic medical records were retrospectively reviewed for all primary TJA patients screened for S. aureus peroperatively between October 2011 – March 2014 (n = 4098) and those not screened between October 11 – March 2013 (n = 1582). All patients received chlorhexidine body wipes preoperatively. MSSA and MRSA carrying patients were treated preoperatively with mupirocin and vancomyin, respectively, along with the standard preoperative antibiotics and chlorhexidine body wipes. Demographic (i.e., age, gender) and clinical (i.e., preoperative diagnosis, comorbid disease burden, body mass index, previous admissions, hospital location) trends were used to predict S. aureus colonization. Revision rates of all TJA patients (n = 4045) were compared between screened and unscreened TJA patients

RESULTS: Twenty-one percent and 5% were colonized with MSSA and MRSA, respectively. Age, gender, comorbid disease, previous inpatient stay, and hospital location were significantly associated with S. aureus colonization ($p < 0.01$). Multivariate regression models were poorly accurate in predicting MSSA and MRSA colonization, AUC = 0.59 and AUC = 0.62, respectively. Bivariate analyses indicate a preoperative screening afforded a 37.5% reduction in risk of revision arthroplasty ($p=0.02$).

CONCLUSION: Demographic and clinical criteria could not be used reliably as surrogates for screening and, with significant regional variance, such endeavors may not be feasible for the general population. As such, this study indicates nasal decolonization should be routinely practiced in all TJA patients when possible.

Varus-Valgus Constrained Knee Implants: Survivorship and Outcomes

Abstract ID: Paper 056

Marcelo Siqueira, M.D.
Paul Jacob, D.O.
John McLaughlin, D.O.
Alison K. Klika, M.S.
*Robert M. Molloy, M.D.
Carlos A. Higuera, M.D.
Wael K. Barsoum, M.D.
Cleveland, OH

INTRODUCTION: Varus-valgus constrained (VVC) knee implants provide coronal plane stability and are the implants of choice in severely deformed knees or cases with soft tissue deficiencies. The purpose of this study was to (1) estimate survivorship of VVC implant in primary, aseptic revision, and septic revision total knee arthroplasty (TKA), (2) determine functional outcomes, and (3) main modes of failure.

METHODS: 685 consecutive cases of TKAs with VVC implants in 597 patients performed between 1999 and 2008 were identified and retrospectively reviewed using electronic medical records. Data collected included demographics, clinical and surgical variables, and preoperative modified Knee Society (KSS) and Function Scores (KFS). Patients were followed-up via telephone and assessed for further knee surgery, reason for further surgery, and postoperative KSS and KFS if the VVC implant was not removed. Revision for any reason was the primary end-point.

RESULTS: Of the 597 patients, 465 (77.9%) had a minimum two-year follow-up. Mean follow-up was 6.5 years (range, 0.1-15.1). Of these, n=246 were primary TKAs, n=316 were aseptic revisions, and n=123 were septic revisions. A total of 23 (9.4%), 55 (17.4%), and 39 knees (31.7%), underwent further revision surgery (primary TKA, aseptic revision, and septic revision groups, respectively). Five-year survival was 92.8% (95% CI 91.9% – 97.7%) for primary TKAs, 83.7% (95% CI 79.4% – 88.2%) for aseptic revisions, and 71.2% (95% CI 63.2% – 80.2%) for septic revisions. KSS and KFS improvement were significant in primary TKAs and aseptic revisions ($p<0.0001$ all), and for KSS only for septic revisions ($p<0.0001$). Infection was the main mode of failure in all 3 groups (primary 12/23 [52%]; aseptic revision 12/55 [22%]; septic revisions 28/39 [72%]).

CONCLUSIONS: VVC implant showed similar survivorship at 5 years to cruciate retaining and posterior stabilizing implants, and superior survivorship at 5 years to hinged implants. The main failure mode was infection for all three groups.

Factors Associated with 20-Year Cumulative Risk of Infection After Aseptic Index Revision TKA

Abstract ID: Paper 057

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*O. Brant Nikolaus, M.D.
Paul B. McLendon, M.D.
Cathy D. Schleck, B.S.
Arlen D. Hanssen, M.D
Tad M. Mabry, M.D.
Elie F. Berbari, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

BACKGROUND: The purpose of this study was to calculate the cumulative risk of periprosthetic joint infection (PJI) after aseptic index revision TKA, and to identify both patient- and procedure-specific risk factors associated with deep infection.

METHODS: We retrospectively reviewed all aseptic revision TKAs performed with condylar knee designs at our institution from 1970-2000 (n=2985). Using study criteria, 1,183 knees were excluded due to previous infection, previous revision, or because a custom-type prosthesis was used to revise the failed TKA. This resulted in 1,802 aseptic, index revision TKA (1,615 patients) as the final cohort. The medical records of all patients were reviewed for index revision surgical information, medical comorbidities, medical and surgical complications, and reasons for reoperation after index revision TKA. The occurrence of deep PJI requiring reoperation was analyzed as a time-to-event outcome using survivorship methodology, including Kaplan-Meier estimation and Cox proportional hazards regression. Hazard ratios for infection are reported with 95% confidence intervals.

RESULTS: There were 60 reoperations performed for infection. These infections occurred from 13 days to 18.6 years after index revision. Eighteen of the 60 infections (30%) had occurred within the first year after surgery, with 40 (67%) within 5 years, and 50 (83%) within 10 years. The cumulative risk of infection at 1, 5, 10, and 20 years after index revision was 1% (CI: 0.6-1.5), 2.4% (CI: 1.7-3.2), 3.3% (CI: 2.4-4.2), and 5.6% (CI: 3.7-7.4), respectively. Male gender (HR 2.28, p=<.01), increased constraint of the prosthesis being revised (HR 2.02, p=<.01), operative time greater than 3 hours (HR 1.73, p=0.04), and anesthesia time greater than 4 hours (HR 1.92, p=0.02) were associated with deep infection. At the time of index revision surgery, the presence of liver disease (HR 3.12, p=0.01) and a Charlson comorbidity index score of 3 or higher showed increased risks of PJI (HR 2.9, p=0.03). Furthermore, a new diagnosis of leukemia (HR 9.89, p=0.02) or renal insufficiency (HR 4.26, p=0.001) was associated with the onset of late PJI.

CONCLUSION: Following aseptic revision TKA, the cumulative risk of infection was 5.6% at 20 years. The risk of reoperation for PJI increases steadily at about 1.5% for every 5 years that the implant is in-situ. Male gender, longer operative times, history of liver disease, increased Charlson comorbidity index score, and a new diagnosis of leukemia or renal insufficiency after index revision were significantly associated with PJI.

Tibial Alignment in Revision Total Knee Arthroplasty

Abstract ID: Paper 058

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*Kevin M. Smith, M.D.
Stephen J. Incavo, M.D.
Andrew Moorman, B.S.
Houston, TX

BACKGROUND: Alignment in revision total knee arthroplasty has received much less attention than primary total knee arthroplasty in the literature. For most cases in revision arthroplasty, stemmed components are often used because they help overcome some of the inherent difficulties of revision TKAs. Modifications such as modular stems of varying lengths, diameters, and cemented vs. press-fit stems further enhance the ability of the surgeon to overcome the inherent difficulties of revision TKAs. However, while some total knee arthroplasty designs allow for minor adjustments in offset, the final alignment of the knee joint seems to be largely determined by the stem alignment and its relationship with the intramedullary canal of the tibia.

QUESTIONS/PURPOSES: In valgus bowed tibias, does using stemmed revision tibial components allow satisfactory coronal alignment?

METHODS: A retrospective, radiographic review of 88 revision total knee arthroplasties performed between 2011 and 2014 by a single experienced joint surgeon was performed. The full length leg radiographs of revision TKAs were examined for coronal alignment, utilization of canal filling or non-canal filling tibial stems, and the degree of bow of the tibia. The tibial bow was measured by the angle formed by the center of the tibial tray to the apex of the tibial bow (center of the canal at the point which would yield the largest deviation from 180°) to the center of the talus. The cases were separated into three groups – valgus bowed tibias of 3° or more, neutral bowed tibias that were within 2° of a straight 180°, and varus bowed tibias of 3° or more.

RESULTS: A comparison of canal filling and non-canal filling tibial stems was performed examining tibias with a valgus bow of 3° or more vs. a neutral tibial bow that was within 2° of a straight coronal alignment. A statistically significant difference ($p=0.007$) was found in the coronal alignment of canal filling stems vs. non-canal filling stems in valgus tibias of 3° or more. A statistically-significant difference in neutral tibias was not found ($p=0.19$) when evaluating coronal alignment of canal filling vs. non-canal filling stems.

CONCLUSIONS: In valgus bowed tibias, the ability to achieve a satisfactory alignment of the knee joint is significantly affected by how the stem aligns with the intramedullary canal of the tibia.

Morbid Obesity: A Significant Risk Factor for Failure Following Aseptic Revision TKA

Abstract ID: Paper 059

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*Chad D. Watts, M.D.
Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
David G. Lewallen, M.D.
Tad M. Mabry, M.D.
Rochester, MN

INTRODUCTION: Obese patients have a higher risk of complication following primary total knee arthroplasty (TKA). However, there is a paucity of data on the effects of obesity in revision TKA. The aims of this study were to assess the incidence and risk factors for subsequent revision, reoperation, and periprosthetic joint infection in morbidly obese (BMI ≥ 40 kg/m^2) patients who underwent a first-time revision TKA for aseptic reasons, compared to a matched cohort of non-obese patients (BMI <30 kg/m^2).

METHODS: We performed a retrospective matched cohort analysis using our institution's total joint registry database to identify all patients who underwent a first-time, both-component, aseptic revision TKA over a 15-year period (1992-2007) with minimum follow-up of five years. All patients with a BMI ≥40 were identified (n=93, average follow-up 7.9 years) and compared to a cohort of non-obese patients (n=93, average follow-up 7.3 years), which was matched by sex, age (+/- 3 years), and date of surgery (+/- 1 year). Medical records were examined for details regarding patient factors, operative techniques, implant status, and clinical outcomes.

RESULTS: Reconstruction techniques and reason for revision were similar for both groups at the time of initial revision TKA. Morbidly obese patients had a significantly higher risk for re-revision (HR 3.8, p<0.02), periprosthetic joint infection (HR 6.4, p<0.03), and reoperation (HR 2.9, p<0.02). Kaplan-Meier implant survival rates were 96% and 100% at five years and 81% and 93% at ten years for the morbidly obese and non-obese patients, respectively (p<0.01). Knee Society pain and function scores significantly improved postoperatively for both groups, but were higher in the non-obese patients at all time points (p<0.01).

CONCLUSION: Morbid obesity is associated with an increased risk of re-revision, reoperation, and prosthetic joint infection following aseptic revision TKA. The poorer outcomes in morbidly obese patients argue for increased attention to health and weight optimization strategies for patients at all stages of knee arthritis.

Complications and Readmissions After Revision Knee Arthroplasty: Analysis of ACS-NSQIP 2006-2012

Abstract ID: Paper 060

Arjun S. Sebastian, M.D.
Sanjeev Kakar, M.D.
Kristine Thomsen, B.S.
Elizabeth B. Habermann, Ph.D.
*Mark W. Pagnano, M.D.
Rochester, MN

INTRODUCTION: There is an increasing number of revision total knee arthroplasties being performed in the U.S. While the risk factors for postoperative complications have been defined in primary TKA, further work is needed to determine the incidence and predictors of postoperative complications following revision TKA.

METHODS: The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) Participant Use File was used to identify 4,209 patients who underwent revision TKA from 2006-2012. Patient demographics, comorbidities, and operative factors were evaluated. Thirty-day postoperative complications and unplanned readmission (2011-2012) were described. Univariate testing and multivariable logistic regression analysis was used to determine independent risk factors for complications.

RESULTS: Of the 4,209 patients, 60.3% of patients were obese (BMI ≥ 30), 20.8% were diabetic, and 57.2% were ASA class 3 or greater. The 30-day mortality rate was 0.4% with 9.3% of patients suffering postoperative complications. The 30-day unplanned readmission rate was 6.5% from 2011-2012. Recent weight loss (OR 3.43, p = .014), peripheral vascular disease (OR 3.17, p = .053), ASA class ≥3 (OR 1.77, p = .001), bleeding disorders (OR 1.77, p = .015), African American race vs. Hispanic and non-Hispanic white (OR 1.66, p = .014), male gender (OR 1.54, p = .004), and postoperative length of stay (LOS) (OR 1.56 per three-day increase, p < .001) were all predictors of major systemic complications. Recent weight loss (OR 5.99, p = .006) and postoperative LOS (OR 1.19 per three-day increase, p = .003) were predictors of major local complications. Recent weight loss (OR 5.40, p = .008), BMI ≥40 vs. <25 (OR 1.93, p = .047), serum sodium < 130 (OR 4.50, p = .010), WBC ≥ 12 (OR 2.35, p = .003), male gender (OR 1.70, p = .002), African American race vs. Hispanic and non-Hispanic white (OR 1.96, p = .004), and ASA class 3 or greater (OR 1.66, p = .009) were predictors of unplanned readmission (2011-2012).

DISCUSSION: Complications following revision TKA is higher than that reported for primary TKA. Multiple independent predictors were identified. Of note, recent weight loss was an independent predictor of major systemic and local complications as well as readmission. Further studies are needed to examine potential health disparities responsible for the higher complications and readmission rate in African American patients.

MAOA BREAKOUT SESSION #5
BASIC SCIENCE/OTHER/JOINT ARTHROPLASTY
April 23, 2015

Adipose-Derived Mesenchymal Stem Cells Are a Superior Cell Source for Regenerative Orthopedics

Abstract ID: Paper 061

Cody C. Wyles, B.S.
*German A. Norambuena-Morales, M.D.
Matthew T. Houdek, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Mesenchymal stem cells (MSCs) have created new therapeutic opportunities for regenerative orthopedics. Bone marrow-derived MSCs (bmMSCs) have been the most common source and used to treat avascular necrosis (AVN), bony defects, and nonunion, as well as coating of implants. Adipose-derived MSCs (aMSCs) are hypothesized to be a more efficient regenerative cell source given their greater quantity and protection from physiologic stress. In this study, we aimed to compare proliferative and bone differentiation potential between bmMSCs and aMSCs.

METHODS: bmMSCs and aMSCs were isolated and cultured from 15 patients undergoing primary total hip arthroplasty (THA) for AVN. After third passage in culture, MSCs were plated at 300,000 cells/10 cm dish and passaged every 96 hours for 20 days to establish population doubling time (PDT). Both MSCs were also grown in osteogenic differentiation media for 14 days and then measured with an alkaline phosphatase (ALP) assay to assess bone differentiation potential. Ribonucleic acid (RNA) was isolated from aMSCs and bmMSCs from 5 patients to assess differentially expressed genetic pathways using the Affymetrix GeneChip® Human Transcriptome Array 2.0 platform.

RESULTS: Proliferation capacity was increased in aMSCs which produced an average of 550,000 cells in 20 days compared to an average of 140,000 cells in bmMSCs ($p<0.001$). Bone differentiation efficiency as measured by ALP activity was increased two-fold in aMSCs compared to bmMSCs ($p<0.001$). RNA transcriptome analysis is pending, but will show which genes and pathways are differentially expressed that may govern these observed performance differences.

DISCUSSION AND CONCLUSINS: aMSCs outperform bmMSCs in growth rate and bone differentiation potential suggesting they may provide a superior cell source for regenerative orthopedic therapeutic strategies. Differential expression of genes and pathways need to be further explored for mechanistic understanding and therapeutic optimization.

The Cost-Effectiveness of Utilizing Platelet-Rich Plasma During Rotator Cuff Repair

Abstract ID: Paper 062

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*Eric M. Samuelson, M.D. / Omaha, NE
James E. Fleischli, M.D. / Charlotte, NC

INTRODUCTION: It is well known that a certain percentage of arthroscopically repaired rotator cuffs do not heal postoperatively. There is significant interest in enhancing the healing potential of the repaired rotator cuff using biologic factors such as cytokines, scaffolds, mesenchymal stem cells, etc. Platelet-rich plasma (PRP) has been one of the most studied of these biologic factors. Currently, there is no conclusive evidence to suggest that the addition of PRP to rotator cuff repair results in improved outcomes or reduced retear rates. The purpose of this study was to determine whether the use of PRP during rotator cuff repair is cost-effective.

METHODS: Typical patient costs of undergoing arthroscopic rotator cuff repair were obtained by examining associated charges from a local orthopedic practice and outpatient surgery center. Utility values were based upon those previously reported in the literature regarding rotator cuff tears and their repair. Retear rates were determined by examining the highest quality evidence related to rotator cuff repair with the addition of PRP. A decision analysis model was constructed utilizing these costs, utility values, and retear rates. In our base case scenario, we assumed an additional cost of $750 for the use of PRP during rotator cuff repair and a retear rate of 31% in both groups (with and without PRP).

RESULTS: The cost per quality-adjusted life year ($/QALY) of rotator cuff repair with and without PRP was $6,775.00 and $6,612.54, respectively. In our base case scenario, the use of PRP was “dominated” and was not cost-effective. Sensitivity analysis was performed regarding the retear rate following PRP-augmented rotator cuff repair. In order to achieve a willingness-to-pay threshold of $50,000/QALY, the addition of PRP would need to be associated with a 9.1% reduction in retears. If the cost of PRP were increased to $1,000, the retear rate would need to be reduced 12.1% in order to reach this same threshold. This is compared to a reduction of only 6.1% if the additional cost of PRP was $500.

DISCUSSION AND CONCLUSION: There is conflicting evidence in the literature as to whether there is significant benefit in utilizing PRP to augment rotator cuff repair. This study suggests that, currently, the use of PRP in arthroscopic rotator cuff repair is not cost-effective. Further research is needed to show that the use of PRP in arthroscopic rotator cuff repair is associated with a significant reduction in retear rates before it can be considered cost-effective.

Identifying Potential Genetic and Epigenetic Markers for Susceptibility to Avascular Necrosis

Abstract ID: Paper 063

Cody C. Wyles, B.S.
Matthew T. Houdek, M.D.
German A. Norambuena-Morales, M.D.
*Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Avascular necrosis (AVN) is a disease with multiple etiologies; however, a substantial proportion of cases are designated as idiopathic. Steroid use has been identified as a primary risk factor, yet only a minority of patients on high-dose steroid regimens develop AVN. These factors raise suspicion that genetic predisposition for AVN and epigenetic sensitivity to steroids may exist for some patients. To identify novel genetic loci associated with AVN susceptibility, we conducted a genome-wide association study (GWAS), using deoxyribonucleic acid (DNA) samples from 89 AVN cases and 178 controls. Identification of genetic anomalies in AVN patients could provide valuable insight for disease pathophysiology, risk stratification screening tests, and targeted interventions for at-risk patients.

METHODS: All cases were patients with atraumatic AVN of the femoral head. Fifty of the 89 cases were steroid-induced. Controls were 2:1 frequency matched to cases based on age, gender, body mass index (BMI), and ethnicity. Furthermore, 50 steroid-induced cases were matched to 100 controls with a history of high-dose steroid exposure (>20 mg/day x >3 months) who never developed AVN. DNA was genotyped using the Illumina Omni 5.0 array, which is capable of probing 4.5 million single nucleotide polymorphisms (SNPs). We evaluated genotyping quality by dropping samples or SNP variants with call rates <95%. Tests for sex concordance, Hardy-Weinberg equilibrium, related subjects, and population stratification were also done. Association testing was conducted assuming a log-additive genetic model, adjusting for the top 5 significant principal components. Statistical significance was set at $p<10^{-5}$ for the overall dataset and $p<10^{-4}$ for the steroid dataset.

RESULTS: For the entire cohort, 11 genes contained 2 or greater SNPs that were significant at the $p<10^{-5}$ level. For the steroid cohort, 39 genes contained 2 or greater SNPs that were significant at the $p<10^{-4}$ level. Identified genes were involved in cell differentiation and survival, lipid, glucose, protein, and nucleic acid metabolism, ribosome structure, phospholipid synthesis, inflammatory response generation, tissue development, cell migration, and genome regulation.

DISCUSSION AND CONCLUSIONS: Although further validation is required, this study provides the most comprehensive dataset to our knowledge investigating genetic and epigenetic markers of AVN. If validated, these unique genetic loci can provide new insight for disease pathophysiology and serve as a foundation for novel screening and therapeutic targets.

Does Insurance Status Alter Outcomes if a Standardized Fracture Treatment Pathway is Utilized?

Abstract ID: Paper 064

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*Alicia F. Worden, M.D.
Lisa K. Cannada, M.D.
J. Tracy Watson, M.D.
St. Louis, MO

PURPOSE: It has been documented that the socioeconomic status of a patient affects the overall surgical outcomes of many types of orthopedic procedures (1-6). It has been assumed that underinsured patients have a prolonged length of stay (LOS) as well as other factors contributing to a poor outcome (1-3, 7-18). We believe by following a routine tibial fracture treatment pathway, hospital outcomes should be similar for patients with an acute tibia fracture regardless of insurance status. We hypothesized that a patient's insurance status does not affect LOS when following a standardized tibia fracture treatment protocol.

METHODS: The data was collected from two level one trauma centers: an inner city academic hospital and a large, community hospital. The standardized treatment protocol regarding tibial shaft fractures was instituted at both institutions. Our inclusion criteria were all patients with isolated tibial fractures who were treated with intramedullary (IMN). All closed fractures and open fractures that were closed primarily were eligible. Exclusion criteria included prior surgery on the injured leg and other injuries that would modify the weight-bearing status or require additional operative procedures. Insurance status was grouped by either private (PHI), government provided (example, Medicaid) (GHI), and uninsured (UI). The records were reviewed to evaluate demographic data, fracture details, complications, and hospital LOS.

RESULTS: The treatment pathway was instituted in 2004 with 204 patients who met the inclusion criteria. Fifty percent (102 patients) had PHI, 13% (27 patients) with GHI, and 37% (75 patients) UI. There was no significant difference between age, gender, and insurance status. The LOS ranged from 2-11 days with a mean of 4.2±1.0 (range 2-8) for PHI, 4.8±1.8 (range 2-11) for GHI, and 3.9±1.2 (range 2-8) for UI. Insurance status and LOS was found to be significant (P=0.007); however, the difference was only 9.5 hours. There was no difference in complication rates or time to surgery.

CONCLUSIONS: A disparity is known to exist between insured and uninsured patients, and the advent of mandated insurance law is one attempt to minimize this divide. Since 2004, we have adhered to a tibial fracture treatment pathway and using standardized care we have found that a patient's LOS and other outcome measures after IMN treatment of a tibial fracture were not affected by insurance status. We advocate use of routine fracture protocols to guide treatment and minimize burden to the hospitals.

Analyses of 22,833 Orthopedic Surgeons' Scores from Two Major Physician-Rating Websites

Abstract ID: Paper 065

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*Mohammed S. Hussain / Chicago, IL
Waqas M. Hussain, M.D. / Moline, IL
Haroon M. Hussain, M.D. / Cincinnati, OH
Hristo I. Piponov, M.D. / Sofia, Bulgaria
J. Martin Leland, III, M.D. / Chicago, IL
Douglas R. Dirschl, M.D. / Chicago, IL
Lewis L. Shi, M.D. / Chicago, IL

INTRODUCTION: With patients' increasing use of the Internet, more information is available on surgeons through physician rating websites. Patients are relying on these resources to evaluate and select health care providers. No comprehensive review of this information on orthopedic surgeons exists in the United States. This study aims to collect and analyze patients' ratings of orthopedic surgeons on Healthgrades and Vitals.

METHODS: A web data collection algorithm was developed that systematically searched the names and associated locations of 26,472 active U.S. orthopedic surgeons on these two sites. These were chosen because they have the highest Internet traffic of physician rating sites. The names of active U.S. orthopedic surgeons were obtained from a commercial directory, which also included demographic information. The variables collected from the websites were classified as organizational or interpersonal as they relate to the practice or the physician; there is also an overall patient rating of each physician on the websites. Correlation between organizational and interpersonal subscores and overall score were measured with Pearson coefficients and Spearman's rho. Multiple regression helped determine whether demographic factors influence overall scores. Administrators of these sites were notified that their data was being collected for this research.

RESULTS: Of all the orthopedic surgeons, 22,833 (86.3%) had a rating on either site, and 15,453 (58.4%) had ratings on both. The average overall score for Healthgrades is 3.967±0.932 (15) and 3.21±.81 (14) for Vitals. Interpersonal scores were highly correlated with a patient's overall score for a physician on Healthgrades (trust, r = .9706; explanation, r =.9512; dialogue, r = .9532; time, r = .9324). Organizational factors had weaker correlations with overall score (scheduling, r = .7779; office environment, r = .7618; office friendliness, r = .7779). Wait time had the weakest correlation (rho = .4157). Ratings from Vitals corroborated these findings. All p values were <.00001. In the multiple regression, several physician demographic factors were significant for influencing the overall score, including age ($p<0.0001$) and board certification ($p = .043$), with younger board certified surgeons garnering higher ratings. However, the overall effect of surgeon demographic factors was minimal (Healthgrades, $R2 = .0329$; Vitals, $R2 = .0194$).

DISCUSSION: The overall ratings for orthopedic surgeons are highly associated with interpersonal factors. Although organizational factors are correlated, they are less strongly associated with a patient's overall assessment of an orthopedic surgeon. These findings suggest that orthopedists can positively influence their online ratings by improving their face-to--face interactions with patients.

Physician-Owned MRI More Cost Effective than Hospital-Owned Imaging

Abstract ID: Paper 066

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*Christopher M. Graves, M.D.
Cameron W. Schick, M.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

INTRODUCTION: Diagnostic imaging is a large component of annual health care expenditure. Government organizations and insurers continue to scrutinize the in-office ancillary service (IOAS) exemption to the Stark Law in an effort to contain rising health care costs. The authors have hypothesized that charges for patients obtaining MRI imaging are actually higher in hospital owned imaging centers than independent imaging centers owned by physicians. The purpose of this study is to compare the cost of obtaining a non-contrast MRI of the shoulder at hospital owned vs. independent imaging centers in the state of (redacted).

METHODS: Using data from the (state) Hospital Association and the (state) Orthopaedic Society, we identified 71 hospitals and 26 independent centers who owned and operated an MRI machine. Each site was contacted via telephone and given a scripted request for the cash-price of the cost of a non-contrast MRI of the shoulder for a hypothetical uninsured patient. The price requested was for the technical component only; radiologist reading fees were excluded. Statistical analysis was performed on the data using standard methods and significance was defined as $p < 0.05$.

RESULTS: The average technical component charges for an MRI obtained at hospital owned imaging centers was $2,062 (SD = $664), vs. $1,400 (SD $441) at the independent imaging centers ($p < 0.001$). A wide variance was noted in the quoted price for the imaging study ($500 to $4,000, $p < 0.001$). The seven districts within (state) had relatively uniform distribution of imaging centers (range 13 to 16, $p > 0.05$). Within a geographic region, imaging at Urban and Critical Access imaging centers trended towards a lower cost than Rural and Rural Referral imaging centers.

DISCUSSION AND CONCLUSIONS: Within the state of (redacted), physician-owned imaging centers charge substantially less for an outpatient MRI. Referring physicians and patients should be aware that there may be significant price discrepancies when deciding where to obtain non-emergent imaging. Legislators should consider the cost effectiveness of independent physician owned imaging centers when reviewing the merits of the IOAS.

SUMMARY: Independent (physician-owned) imaging centers represent a lower cost alternative to hospital-owned imaging centers for upper extremity studies. Referring physicians, patients, and legislators will find this data useful in their decision-making processes.

The Impact of Obesity on Operative Time in Orthopedic Surgery

Abstract ID: Paper 067

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*J. Joseph Gholson, M.D.
Yubo Gao, Ph.D.
Nicolas O. Noiseux, M.D.
Apurva S. Shah, M.D., M.B.A.
Iowa City, IA

INTRODUCTION: The obesity epidemic impacts all aspects of medicine including orthopedic surgery, with a cost burden estimate of $190 billion annually[1]. Previous single-center investigations have demonstrated an association between body mass index (BMI) and increased operative time using univariate analysis, primarily in total joint arthroplasty. We present a multicenter, multivariate analysis of the impact of obesity on operative time across a wide variety of common orthopedic procedures.

METHODS: The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database (2006-2012) was utilized to identify a cohort of 92,266 patients having one of 14 common procedures representative of the orthopedic subspecialties. Multivariate linear regression was used to determine whether BMI and other patient characteristics or comorbidities have an independent effect on operative time (time from incision to closure) and anesthesia time (time from induction to wake-up). Univariate analysis of the effect of BMI on each procedure was also completed.

RESULTS: Multivariate regression demonstrated an incremental increase in both operative time and anesthesia time with increasing BMI Class. Male sex, DNR code status, and general anesthesia were also found to be statistically and clinically significant predictors of increased operative time. BMI was associated with increased operative time on univariate analysis for 9 of the 14 procedures. The greatest increase in operative time occurred in trauma patients, with an increased operative time of 33 minutes for intramedullary nailing of femur fractures in obese class III (BMI >40) patients as compared to normal weight patients. The most common procedure in the cohort was total hip arthroplasty, with an increased operative time of 17 minutes in obese class III patients as compared to normal weight patients.

DISCUSSION: Obesity results in clinically significant increases in operative time and anesthesia time in all orthopedic subspecialties, even after controlling for other patient comorbidities. The greatest impact of obesity on operative time occurred in trauma patients. In patients with morbid obesity (BMI > 40), median operative time can be expected to increase up to 49% based on the procedure performed. Prolonged operative times have important implications for patient safety and healthcare cost.

[1]Cawley J, Meyerhoefer C. The medical care costs of obesity: an instrumental variables approach. J Health Econ. 2012; 31:219-30.

Orthopedic Surgery Arthroplasty Clinics See a Larger Proportion of Obese Patients

Abstract ID: Paper 068

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*Kristina L. Welton, M.D.
Joel J. Gagnier, Ph.D.
Andrew A. Urquhart, M.D.
Ann Arbor, MI

INTRODUCTION: Over the past three decades, obesity has doubled to 34.9% of the U.S. population. As such, more total joint replacement surgeries are being performed in younger age groups because of the obesity problem. It is likely that total joint replacement surgeons see a larger portion of obese individuals than exists in the general population. The purpose of this study is to demonstrate that an orthopedic joint replacement practice in a public tertiary hospital sees a significantly higher percentage of obese individuals than is present in the general population.

METHODS: With IRB approval, we performed a retrospective comparative study of patients seen in total joint replacement clinics at a public tertiary hospital with an ICD-9 diagnosis of hip or knee osteoarthritis and a documented BMI. Patients who had previously undergone hip or knee replacement surgery were excluded. Demographic data and patient comorbidities were documented. The proportion of obese patients seen in total joint clinics were compared to the Center for Disease Control's (CDC) most recent data. Comorbid conditions were compared between obese and non-obese cohorts. Based on a standard prospective power analysis, the number of medical records required to determine significance was 406. Data was retrieved from Sept 2012 - February 2013.

RESULTS: 406 patients were included in the study; age range was 36-92 (average age 63.8) and 61.3% were female. Of the study population, 223 (54.9%) were obese. When compared to the CDC's 2011 data, the total joint replacement clinics saw significantly greater percentage of obese patients than exist in the general population (54.9% vs. 34.9%, $P<0.0005$, OR = 2.23). When compared to the CDC's regional and state data, there was also a significant difference, 54.9% vs. 29.5% in the Midwest ($P<0.0005$, OR = 2.85) and 54.9% vs. 31.1% of the state population ($P<0.0005$, OR = 2.64). While non-obese patients only averaged 1.07 comorbid conditions, the obese cohort had 1.75 ($P<0.0005$).

CONCLUSION: This study highlights the magnitude of obese patients presenting to orthopedic total joint clinics. Not only are the majority of patients in this setting more obese than the general population, but they come with significantly more medical conditions. Obese patients who undergo total joint replacement pose a higher risk in both the technical demands of surgery and perioperative complications. This knowledge taken into consideration, the orthopedic total joint surgeon has a unique opportunity to facilitate weight loss in the obese osteoarthritic patient prior to total joint replacement.

Bacterial Suture Adherence and Biofilm Formation in an In Vivo Contaminated Wound Model

Abstract ID: Paper 069

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*Michael R. Morris, M.D. / Detroit, MI
Christopher Bergum, B.S. / Southfield, MI
Nancy M. Jackson, Ph.D. / Southfield, MI
David C. Markel, M.D. / Southfield, MI

INTRODUCTION: Bacterial wound infections continue to be problematic for the orthopedic surgeon. The choice of suture material has drawn scrutiny as a way to possibly reduce wound infection. Monofilament and barbed suture have been shown in in-vitro models to have less bacterial adherence than a braided suture. This study evaluates bacterial adherence to suture materials and tissue reactivity with a bioluminescent in-vivo mouse model.

METHODS: We utilized a mouse air pouch model to simulate a joint environment. Bioluminescent Staphylococcus aureus were utilized to create an in-vivo contaminated wound model at two amounts (106 CFU & 108 CFU). Three types of commonly used absorbable suture were evaluated: braided, monofilament, and barbed monofilament. Groups of 8 mice had two 1 cm strands of one of the suture types surgically placed into the air pouch followed by inoculation of either a high or low amount of the bioluminescent S. aureus. The mice were sacrificed on day 8. Bacterial suture adherence was evaluated with suture culture, a photon-capturing camera system, and scanning electron microscopy (SEM). Tissue reactivity was assessed through histology, RNA expression, and protein expression.

RESULTS: The braided suture group with the high amount of S. aureus exhibited frank purulence and air pouch hypertrophy in all 8 mice. In the low amount groups, the infection was predominantly cleared across all suture types. A significant difference between the optical density (OD) emitted per millimeter of suture was found between the suture groups with inoculation of high amounts of S. aureus ($p<0.05$). More specifically, the braided group demonstrated higher ODs/mm than both the monofilament ($p<0.005$) and barbed monofilament groups ($p<0.005$). No difference was appreciated between the monofilament and barbed monofilament groups. SEM demonstrated biofilm in all high amount groups with the most robust in the braided suture group. Kruskal-Wallis test demonstrated a difference between groups in regards to levels of TNF ($p<0.05$) and IL-1 ($p<0.05$).

CONCLUSIONS: We believe that this is the first in-vivo, contaminated wound model that provides information for the selection of suture material including barbed monofilament. Braided suture should be avoided when dealing with contaminated wounds or wounds at high risk of infection. Interestingly, this model demonstrated no difference between the use of monofilament and barbed monofilament sutures in a contaminated wound.

Diagnosing Infection in the Setting of Periprosthetic Fractures

Abstract ID: Paper 070

Roshan P. Shah, M.D. / Chicago, IL
Darren R. Plummer, M.S. / Chicago, IL
Mario Moric, M.S. / Chicago, IL
*Scott M. Sporer, M.D. / Winfield, IL
Brett R. Levine, M.D. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

INTRODUCTION: Currently, no guidelines exist to diagnose periprosthetic joint infection (PJI) in patients who have periprosthetic fractures, and there is a concern that the commonly used tests may be unreliable. The purpose of this study is to investigate the utility of commonly used diagnostic tests for PJI in patients with periprosthetic fractures.

METHODS: We reviewed 121 patients (97 hips, 24 knees) with periprosthetic fractures treated operatively (mean interval before fracture, 4.8 years; range, 7 days to 30.2 years). The cohort's mean age was 72.9-years-old and included 93 females (77%). ESR, CRP, synovial WBC, and differential were compared between patients who did and did not meet MSIS criteria for PJI. Student's t-test was used to compare means, and ROC curves were generated to determine optimal cut-off values and evaluate testing performance.

RESULTS: 14 (11.2%) patients met MSIS criteria for PJI. Mean ESR, CRP, cell count, and differential were significantly higher among infections (each $p<0.05$). Synovial WBC and differential were the best diagnostic tests, each with an AUC of 84% (good test performance). A synovial WBC cut-off of 2,707 resulted in sensitivity of 100% and specificity of 65%. A differential polymorphonuclear cell cut-off of 77% resulted in sensitivity of 100% and specificity of 63%. The AUC values for CRP and ESR were 63% (poor test performance) and 76% (fair test performance), respectively. ESR of 30 mm/hour resulted in an 85% sensitivity and 40% specificity; CRP of 8 mg/L resulted in an 86% sensitivity and 36% specificity.

CONCLUSIONS: The diagnosis of PJI in the setting of a periprosthetic fracture can be challenging. Specifically, the ESR and CRP have overall lower test performance, but still remain relatively sensitive. The synovial fluid WBC count and differential are the best tests with optimal cut-off values (3,000 WBC/μL and 80%) that are similar to those used for patients without fracture.

Enhanced Detection of Staphylococcus Aureus Colonization in Patients Undergoing Total Joint Arthroplasty

Abstract ID: Paper 071

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*Andrew Taiber, M.D.
Angela Hewlett, M.D.
Tyler White, B.S.
Paul Fey, Ph.D.
Elizabeth Lyden, M.S.
Kevin L. Garvin, M.D.
Beau S. Konigsberg, M.D.
Curtis W. Hartman, M.D.
Omaha, NE

SUMMARY: Patients were assessed for Staphylococcus aureus colonization in the nares, oropharynx (OP), axilla, groin, and surgical site. The nares, OP, and groin combined detected 97% of the colonized patients.

BACKGROUND: Prosthetic joint infections (PJI) often result in multiple surgeries and long-term antibiotic administration, along with substantially increased healthcare costs. Due to the catastrophic nature of these infections and the increasing number of patients undergoing total joint arthroplasty (TJA), attention has turned to the development of prevention strategies for PJI. Studies have shown that colonization with S. aureus is a risk factor for surgical site infection, but few data are available on S. aureus colonization in patients undergoing TJA. This study sought to determine which anatomic site(s) are most frequently colonized with S. aureus in patients undergoing TJA, and to evaluate the utility of a preoperative questionnaire to predict S. aureus colonization.

METHODS: A cross-sectional study was performed on patients undergoing TJA at an academic medical center. A questionnaire assessing medical history and potential risk factors for S. aureus colonization was administered at a routine preoperative visit. Patients were cultured for S. aureus in the nares, oropharynx (OP), axilla, groin, and the proposed surgical site.

RESULTS: Sixty-six of the 232 patients in the study (28%) were found to be colonized with S. aureus, including 19 patients (8%) colonized with MRSA. The nares, OP, and groin were the most common sites of colonization; detecting 80%, 36%, and 15% of the colonized patients, respectively. None of the variables assessed in the questionnaire were found to be significantly associated with S. aureus colonization, although having a household member with a history of S. aureus approached significance (p=0.08).

CONCLUSIONS: S. aureus colonization is common in patients undergoing TJA, and the MRSA colonization rate of 8% is relatively high compared with other study populations. Sampled together, the nares and OP had a sensitivity of 92%, which increased to 97% when the groin site culture was added, indicating these as optimal screening sites. Awareness of S. aureus colonization status may assist with infection prevention strategies, including the use of decolonization protocols and adjustment of perioperative antimicrobial regimens. An infection risk assessment questionnaire was not helpful in predicting S. aureus colonization.

Altering Polymerization Temperature of Antibiotic-Laden Cement Can Increase Porosity and Subsequent Antibiotic Elution♦

Abstract ID: Paper 072

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*Jeffrey J. Sundblad, M.D. / Detroit, MI
Christopher Bergum, B.S. / Southfield, MI
Nancy M. Jackson, Ph.D. / Southfield, MI
Jeffrey C. Flynn, Ph.D. / Southfield, MI
David C. Markel, M.D. / Southfield, MI

BACKGROUND: Antibiotic-laden cement (ABLC) is a valuable device for the delivery of high-doses of local antibiotics in the treatment of osteomyelitis. Most studies on antibiotic elution have shown that only approximately 10% of the incorporated antibiotics effectively elute over a period of 6-8 weeks. Antibiotic elution from cement occurs as a result of the complex interplay of a number of factors. The relationship between the polymerization temperature, ABLC porosity, and elution has not been completely examined. The purpose of this study was to examine the role of polymerization temperature on cement porosity and antibiotic elution in an effort to optimize antibiotic release from ABLC.

METHODS: We examined the elution of vancomycin and tobramycin from 20-mm in diameter ABLC disks of Simplex Speedset prepared at two different antibiotic dosages and in three different curing environments (8, 21, and 37°C). The low-dose ABLC group consisted of 1.2 g of tobramycin and 1 g of vancomycin per 40 g bag of cement, while the high-dose ABLC group contained 3.6 g of tobramycin and 3 g of vancomycin per 40 g bag of cement. Three replicate disks/temperature at both antibiotic doses were created and placed into PBS at 37°C; samples were collected at 1, 4, 8, 24, 72, 168, and 336 hours. Antibiotic elution was calculated by measuring the optical density at 280 nm. MicroCT analysis was used to determine porosity of each ABLC disk. One way analysis of variance with Tukey's post hoc test was used to compare group means.

RESULTS: Porosity of the ABLC disk and total elution of antibiotic were generally increased in both the cold and warm groups as compared to room temperature. In the low-dose ABLC group, average porosities at 21°C (4.61%) and 8°C (5.60%) were comparable, but less than at 37°C (9.55%, $p<0.001$). In the high-dose ABLC group, average porosities at 21°C (3.24%), 8°C (7.78%), and 37°C (5.47%) were all significantly different ($p<0.02$). Compared to room temperature, the cumulative antibiotic elution of the low-dose ABLC disks was increased by 118% and 42% when the disks were created at 8°C and 37°C, respectively ($p<0.003$). The high-dose ABLC showed a similar relationship ($p<0.02$).

CONCLUSIONS: Altering the polymerization temperature of the ABLC led to a more porous antibiotic disk with increased total antibiotic elution. Future studies can be done at more clinically applicable temperature ranges to determine if the effect is still significant.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (use of vancomycin and tobramycin in PMMA bone cement).

Intrawound Vancomycin Powder Reduces Surgical Site Infections in Total Hip and Knee Arthroplasty♦

Abstract ID: Paper 073

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*Jeffrey E. Otte, M.D.
Joel R. Politi, M.D.
Bryan T. Chambers, M.D.
Craig A. Smith, M.D.
Columbus, OH

INTRODUCTION: Surgical site infections (SSIs) are a devastating complication with significant patient morbidity in total joint arthroplasty. Intrawound vancomycin powder has shown efficacy and safety in decreasing postoperative spine infections. Its use in arthroplasty has not been well established. The purpose of this study was to compare the rate of SSIs with and without the use of intrawound vancomycin powder during total hip and knee arthroplasty.

METHODS: A retrospective chart review of all patients who underwent primary or revision hip or knee arthroplasty by two fellowship-trained orthopedic surgeons over a 2-year time period at a single hospital system was performed. One group (control group) received standard systemic prophylaxis only, whereas another group (treatment group) received 0.5-gram vancomycin powder in the surgical wound in addition to systemic prophylaxis. The incidence of SSIs, recognized as positive deep cultures within 90 days of the procedure, was the primary outcome evaluated.

RESULTS: 13 patients in the control group (N=824) and 4 patients in the treatment group (N=816) were found to have a SSI. A statistically significant difference in SSI rate was found between the treatment group (1.6%) and control group (0.49%, p=0.0479).

CONCLUSION: The use of intrawound vancomycin powder was associated with a significant reduction in the incidence of SSIs following total hip and knee arthroplasty. This study supports the current evidence that local vancomycin powder can reduce the risk of SSIs and is the first to address this specific population.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (vancomycin powder in knee and hip wounds).

MAOA SECOND PLENARY SESSION
April 24, 2015

Does Complete Capsular Repair Improve Outcomes After Hip Arthroscopy Compared to Partial Repair?

Abstract ID: Paper 075

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*Rachel M. Frank, M.D.
Simon Lee, M.P.H.
Charles A. Bush-Joseph, M.D.
Bryan Kelly, M.D.
Michael J. Salata, M.D.
Shane J. Nho, M.D.
Chicago, IL

INTRODUCTION: Hip capsular management following hip arthroscopy for femoroacetabular impingement (FAI) is controversial. The purpose of this study was to compare the clinical outcomes of patients undergoing hip arthroscopy for FAI with T-capsulotomy with partial capsular repair (PR; vertical incision closed, interportal incision left open) vs. those with complete capsular repair (CR; full closure of both incisions), at a minimum two-year follow-up.

METHODS: Consecutive patients undergoing hip arthroscopy for FAI by a single fellowship-trained surgeon were prospectively collected and analyzed. Inclusion criteria included all patients between ages 16 and 65 years with physical examination and radiographic findings consistent with symptomatic FAI, with a minimum two-year follow-up. For analysis, patients in each group were matched according to gender and age ± two years. Primary clinical outcomes were measured via the Hip Outcome Score Activity of Daily Living (HOS-ADL) and Sport-Specific Subscales (HOS-SS), the modified Harris Hip Score (mHHS), patient satisfaction, and clinical improvement at baseline, six months, one year, and two years. Statistical analysis was performed utilizing student's paired and unpaired T-tests, with $P<0.05$ considered significant.

RESULTS: Sixty-four patients were included in the study, with 32 patients (12 males, 20 females) in each group. The average follow-up was 29.9±2.6 months. Both groups demonstrated significant improvements in the HOS-ADL ($P<0.0001$ for both groups) and HOS-SS ($P<0.0001$ for both groups) at final follow-up. The CR group demonstrated significantly superior outcomes in HOS-SS at six months ($P=0.039$), one year ($P=0.006$), and two years ($P=0.001$) following surgery compared to the PR group. Patient satisfaction at final follow-up was significantly better in the CR group (PR: 8.0±0.9 vs. CR: 8.6±1.1, $P=0.025$). There were no significant differences in the mHHS between the groups at final follow-up (PR: 81.8±5.6 vs. CR: 83.0±4.4, $P=0.364$). The overall revision rate was 6.25%; all patients (n=4) who required revision arthroscopy were in the PR group (13% of 32 patients).

DISCUSSION AND CONCLUSION: Regardless of closure technique, significant overall improvements were noted in both groups at all time points. However, patients who underwent CR of the hip capsule demonstrated higher satisfaction, less revisions, and superior sports specific outcomes compared to those undergoing PR. While longer-term outcomes studies are needed to determine if these results are maintained over time, this data suggests improved outcomes following complete capsular repair compared to partial repair at 2.5 years following hip arthroscopy for FAI.

Femoral Nerve Block Use in Adolescent Anterior Cruciate Ligament Reconstruction Leads to Slower Return to

Abstract ID: Paper 076

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*T. David Luo, M.D. / Rochester, MN
Ali Ashraf, M.D. / Rochester, MN
Diane L. Dahm, M.D. / Rochester, MN
Amy L. McIntosh, M.D. / Dallas, TX

INTRODUCTION: Femoral nerve block (FNB) is a popular method of postoperative analgesia for anterior cruciate ligament (ACL) reconstruction in pediatric and adolescent patients. The objective of this study was to compare strength, function, and clearance for sports 6 months after ACL reconstruction in pediatric and adolescent patients who received a FNB vs. patients who did not receive a nerve block.

METHODS: We identified patients 18 years of age or younger who underwent primary ACL reconstruction between 2000 and 2010 at our institution. Based on institutional protocol, patients participated in a comprehensive rehabilitation program and underwent isokinetic strength and functional testing at 6 months postoperatively.

RESULTS: There were 124 patients that met the inclusion criteria, including 62 patients in the FNB group (31 males, 31 females) and 62 patients in the control group (25 males, 37 females). There were no significant differences between the FNB and control groups with respect to age (16.2 vs. 15.9, $p = 0.263$), sex ($p = 0.279$), BMI (23.7 kg/m^2 vs. 23.8 kg/m^2, $p = 0.890$), or Tegner score (8.4 vs. 8.2, $p = 0.295$). Univariate analysis showed a significantly higher deficit at 6 months in the FNB group with respect to fast isokinetic extension strength (17.6% vs. 11.2%, p=0.01), as well as fast (9.9% vs. 5.7%, p=0.04) and slow (13.0% vs. 8.5%, p=0.03) isokinetic flexion strength. There was no difference in slow extension isokinetic strength deficit between the two groups (FNB 22.3% vs. control 18.7%, p=0.20), although the deficit was higher for the FNB group. With respect to function, there were no differences in deficit for vertical jump (FNB 9.4% vs. control 11.3%, p=0.30), single hop (7.6% vs. 7.5%, p=0.96), or triple hop (8.0% vs. 6.6%, p=0.34) between the two groups. A significantly higher percentage of patients in the control group met functional and isokinetic criteria for return to sports at 6 months (90.2% vs. 67.7%, odds ratio 4.37, p=0.002). The mean time between ACL reconstruction and clearance for return to sports were 208.9 days for the FNB group and 190.9 days for the control group (p=0.025).

DISCUSSION AND CONCLUSION: Pediatric and adolescent patients treated with a FNB for postoperative pain control after ACL reconstruction had significant isokinetic deficits in knee extension (quadriceps) and flexion (hamstring) strength at 6 months when compared to patients who did not receive a nerve block. Patients in the control group were 4 times more likely to be cleared for progressive return to sports at 6 months.

Total Joint Arthroplasty in Patients with Chronic Renal Disease: Is it Worth the Risk?

Abstract ID: Paper 077

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*Lucian C. Warth, M.D.
Andrew J. Pugely, M.D.
Christopher T. Martin, M.D.
Yubo Gao, Ph.D.
Nicolas O. Noiseux, M.D.
John J. Callaghan, M.D.
Iowa City, IA

INTRODUCTION: Chronic Renal Disease (CRD) has been previously associated with high complications after Total Joint Arthroplasty (TJA). While recognized as a risk factor, the degree of renal dysfunction has not been previously quantified. The purpose of this study is to quantify the impact of increasing renal impairment on short-term systemic morbidity following TJA.

METHODS: A large prospectively collected clinical registry was queried for patients undergoing TJA from 2006 to 2012. After exclusion for incomplete data, 74,300 of 86,172 cases were analyzed. CRD was quantified using preoperative serum creatinine and estimated glomerular filtration rate (eGFR) for each patient. The stage of CRD (1-5) was assigned based on eGFR. Propensity scores were used to match patients based on preoperative comorbidities and the procedure type performed. The incidence of 30-day morbidity and mortality were then compared between patients with none or mild renal impairment, (Stage 1,2: eGFR ≥60 mL/min/1.73 m^2), against those with moderate or severe disease (Stage 3,4,5: eGFR<60). Separately, the morbidity risk associated with eGFR was analyzed as a continuous variable.

RESULTS: In 74,300 patients undergoing TJA, the risk of morbidity increased dramatically with worsening CRD (eGFR: R2=0.77). In the propensity score matched cohorts, there was a significantly greater rate of overall complications in patients with moderate to severe renal impairment, as compared to patients with no or mild disease (6.1% vs. 7.6%, $p < 0.001$). In those with CRD (Stage 3-5), mortality was twice as high (0.26% vs. 0.48%, $p < 0.001$). Major morbidity was also higher in patients with CRD: including pneumonia (p=0.001), unplanned intubation (p<0.001), UTIs (p<0.001), cardiac arrest (p=0.005), myocardial infarction (p=0.02), blood transfusions (p<0.001), sepsis (p=0.01) and septic shock (p=0.3). For many of these outcomes, CRD patients had twice the complication rates compared with those without CRD. Compared with patient without CRD, patients with Stage 4 and 5 CRD had a 213% increased risk of any complication (OR 2.13, 95% CI: 1.73-2.62).

CONCLUSIONS: The quality of care institutions and surgeons provide is being publically scrutinized based on short-term patient outcomes. While Medicare risk-adjustment models account for renal disease as a dichotomous variable, they fail to quantify the severity of disease and its effect on outcome. Our data has shown higher complication rates in those with severe renal disease. Surgeons may use these findings to discuss the risk-benefit ratio of operating on patients with significant CRD, particularly in elective cases.

Efficacy of Scheduled Intravenous Acetaminophen Pain Management Protocol in Hip Fractures

Abstract ID: Paper 078

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*Alexander J. Bollinger, M.D.
Paul D. Butler, M.D.
Matthew S. Nies, B.S.
Debra L. Sietsema, Ph.D., R.N.
Terrence J. Endres, M.D.
Clifford B. Jones, M.D.
Grand Rapids, MI

PURPOSE: Prior studies have demonstrated the safety of intravenous (IV) acetaminophen and its efficacy in decreasing perioperative narcotic consumption. The purpose of this study was to evaluate the efficacy of a scheduled IV acetaminophen perioperative pain-control protocol for improving outcomes and decreasing length of hospital stay for geriatric hip fracture patients.

METHODS: A retrospective CPT code search was performed and the charts were reviewed of all patients 65 years or older admitted to the orthopedic service at a Level I trauma center who underwent operative treatment for a hip fracture from June 1, 2011, through May 31, 2013. The patients were divided into two cohorts; Group 1 consisted of patients treated before the initiation of a standardized IV acetaminophen pain-control protocol, and Group 2 consisted of those treated after the protocol was initiated. 365 consecutive fractures in 360 patients were identified. Pathologic fractures (8), periprosthetic fractures (8), patients with concomitant injuries requiring operative intervention (8 fractures in 7 patients), and perioperative deaths (5) were excluded.

RESULTS: We analyzed 336 fractures (169 in Group 1, 167 in Group 2) in 332 patients with a mean age of 82.5 years old (range 65-101). There was no statistically significant difference in demographic data or time from admission to the operating room between the two cohorts. Group 2 had a shorter mean length of hospital stay (3.8 vs. 4.4 days, $p<.001$), lower mean narcotic usage (28.3 vs. 41.3 mg 'morphine equivalent', $p<.001$), lower mean VAS pain score (2.8 vs. 4.2, $p<.001$), lower number of physical therapy sessions missed (10.4 vs. 21.8%, $p<.001$), and higher likelihood of discharge home instead of to a secondary care facility (19.1 vs. 7.1%, $p=.001$). The two groups did not show a statistically significant difference in use of as-needed bowel motility agents or anti-emetic medications. Utilization of IV acetaminophen was an independent predictor of decreased length of stay, decreased VAS pain scores, lower narcotic usage, fewer missed physical therapy sessions, and higher likelihood of discharge to home ($p<.05$).

CONCLUSION: The utilization of scheduled perioperative IV acetaminophen as part of a standardized pain-management protocol for operative geriatric hip fractures resulted in improved pain measures, fewer physical therapy sessions missed, and ultimately a shorter length of hospital stay and increased home discharge rate.

MAOA BREAKOUT SESSION #6
FOOT AND ANKLE
April 24, 2015

Simple Neurectomy vs. Neurectomy with Intramuscular Implantation for Interdigital Neuroma: A Comparative Study

Abstract ID: Paper 079

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*Chamnanni Rungprai, M.D.
Ong-art Phruetthiphat, M.D.
John E. Femino, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
Iowa City, IA

BACKGROUND: The simple neurectomy is a standard treatment of interdigital nerve neuroma after failure of conservative treatment. Recently, neurectomy with intramuscular implantation of proximal nerve stump was claimed to be an effective method with significantly pain improvement. However, there remains little evidence supporting one technique over the other. The purpose of this study was to compare functional outcomes and complications of the simple neurectomy vs. neurectomy with intramuscular implantation.

MATERIAL AND METHODS: Retrospective chart review of 100 consecutive patients (106 feet) who were diagnosed with interdigital neuroma of the foot and underwent simple neurectomy (64 patients / 72 feet) and neurectomy and implantation proximal nerve stump into the foot muscle (36 patients / 37 feet) between 2000 and 2013. The minimum follow-up to be included in the study was 6 months in both techniques (mean, 44.6 months; range, 6 to 150 months for simple neurectomy and mean, 19.1 months; range, 6 to 66 months for neurectomy and implantation of proximal nerve stump into muscle). The primary outcome was Foot Function Index (FFI); pain, disability, activity limitation, and total score, Short Form-36 (SF-36); physical and mental component scores, and Visual Analogue Scale (VAS). The secondary outcomes included operative time and complications. Pre- and postoperative SF-36, and Foot Functional Index (FFI), pain (Visual Analog Scale) were obtained and compared using pair t-test. Independent t-test was used to assess the functional outcomes and operative time between the two groups and complications between the two techniques were compared using Chi-square test.

RESULTS: Both groups demonstrated significant improvement of postoperative functional outcomes (FFI, SF-36, and VAS [$p < 0.001$ all]) compared to preoperative period. Neurectomy with intramuscular implantation demonstrated significant improvement of pain compared to simple neurectomy as measured with VAS ($p = 0.002$); however, the operative time was significantly longer than the simple neurectomy ($p = 0.001$). The rest of the functional outcomes measured were comparable between the two techniques. Persistent pain and revision surgery were higher in the simple neurectomy, but did not reach statistical significance. The rate of revision surgery was significantly higher in the simple neurectomy group ($p = 0.035$).

CONCLUSION: Both simple neurectomy and neurectomy with intramuscular implantation demonstrated significant improvement in terms of functional outcomes as measured with the FFI, SF-36, and VAS in patients with interdigital neuroma. While having longer operative time,

neurectomy with intramuscular implantation demonstrated lower overall complications and provided significantly better pain relief.

Foot Function Index Outcomes of Gastrocnemius Recession for Treatment of Chronic Plantar Fasciitis

Abstract ID: Paper 080

Ashish Shah, M.D.
Osama Elattar, M.D.
*Brooks W. Ficke, M.D.
Sameer Naranje, M.D.
Birmingham, AL

INTRODUCTION: Isolated gastrocnemius recession for recalcitrant plantar fasciitis led to improvement in foot function based on the Foot Function Index in this case series.

METHODS: 34 consecutive patients with an average of 12 months of conservative treatment underwent isolated gastrocnemius recession for the treatment of recalcitrant plantar fasciitis at one institution by a sole surgeon. The surgical procedure was standardized using the described strayer techinique through a single medial incision. After receiving IRB approval for the study, the queried group of patients were contacted by telephone and asked to participate in the study. Each patient in the study filled out a survey which was either mailed directly to them and returned, or they completed the survey via telephonic interview. A chart review was completed for each patient to determine age, sex, and comorbid conditions. The chart review also served to assess preoperative duration of symptoms, preoperative conservative and failed surgical management, postoperative complications, recovery time, and in clinic reported subjective and objective strength testing outcomes. Outcome measures are the Foot Function Index Score (FFI), Visual Analog Scale (VAS), subjective and objective calf weakness, and other subjective satisfaction outcome markers.

RESULTS: With a mean follow-up time of 8 months (4-36), significant improvement in FFI scores from a mean preoperative score 72 (range 97-40) to a mean postoperative score of 22 (range 0-48). VAS of heel pain improved from a preoperative mean 9.14 to a postoperative mean 1.71. 90% of patients report no subjective weakness. 100% of patients were satisfied with the outcome and would recommend the same surgery to a friend.

CONCLUSION: Isolated Gastrocnemius Recession for treatment of recalcitrant plantar fasciitis is a short surgical procedure with minimal risk, high subjective satisfaction, and significant pain relief seen on VAS and leads to quantifiable improvement in function postoperatively.

First Metatarsophalangeal Joint Arthrodesis with Interposition Allograft Bone Block

Abstract ID: Paper 081

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*Sandra E. Klein, M.D. / Chesterfield, MO
Pamela C. Luk, M.D. / St. Louis, MO
Jeffrey E. Johnson, M.D. / Chesterfield, MO
Jeremy J. McCormick, M.D. / Chesterfield, MO

BACKGROUND: Joint replacement for painful first metatarsophalangeal joint arthritis is of interest due to the desire to maintain motion. However, failure of the implant often requires a complex conversion to arthrodesis. We present a technique of first metatarsophalangeal joint arthrodesis utilizing an interposition allograft bone block with a bi-polar reaming technique that creates congruent fusion surfaces on both ends of the graft-host bone interface. In addition, we examine the union rates, fusion position, patient satisfaction, and functional outcome of this technique.

METHODS: Fifteen patients underwent first metatarsophalangeal joint arthrodesis with an interposition allograft bone block between September 2004 and October 2013. Charts and radiographs were reviewed. Six measures were compared on preoperative and postoperative radiographs. Clinical outcomes were measured using a telephone questionnaire, preoperative and postoperative Visual Analog Scale (VAS) pain scale, and Foot and Ankle Ability Measure (FAAM).

RESULTS: Thirteen of 15 (87%) patients achieved bony union at an average of 21 weeks. Average follow-up was 46 weeks (range 19-97). Improvement was noted in VAS pain scores (6 to 2) and functional scores as measured by the FAAM. There were no postoperative wound complications or infections. Average length of the first ray on AP x-ray increased from 10.7 cm to 11.3 cm and from 10.0 cm to 10.7 cm on the lateral radiograph. Thirteen of 14 patients were very satisfied or satisfied. One patient expressed dissatisfaction with the procedure.

CONCLUSION: First metatarsophalangeal joint allograft bone block arthrodesis using the bi-polar reaming technique achieves high bony union rates and satisfactory radiographic and clinical outcomes. This procedure is an effective salvage option.

Effect of Arthroscopic Evaluation of Acute Ankle Fractures on PROMIS Intermediate-Term Functional Outcomes

Abstract ID: Paper 082

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*Daniel J. Fuchs, M.D.
Bryant S. Ho, M.D.
Mark W. LaBelle, B.S.
Armen S. Kelikian, M.D.
Chicago, IL

INTRODUCTION: Following anatomic reduction and stabilization of unstable ankle fractures, there exists a population of patients who continue to have persistent pain and poor outcomes. It has been proposed that this may be secondary to chondral injuries that occur at the time of fracture and previous studies have shown that these injuries occur in up to 79% of unstable ankle fractures. Ankle arthroscopy at the time of ankle fracture open reduction internal fixation (ORIF) has been proposed as a potential method to address these chondral injuries. However, there has been minimal investigation into whether ankle arthroscopy at the time of ORIF improves clinical outcomes, and, therefore, the role of ankle arthroscopy in this setting remains unclear. This study assesses the utility of ankle arthroscopy by comparing patient reported functional outcomes in patients who underwent ankle ORIF with and without ankle arthroscopy.

METHODS: An institutional database was used to retrospectively identify 94 patients who underwent ORIF for an unstable ankle fracture with an intact medial malleolus between 2002 and 2013. 42 patients had ankle arthroscopy at time of ORIF and 52 did not. Functional outcomes between groups were compared using Patient Reported Outcomes Measurement Information System (PROMIS) Physical Function and Pain Interference computerized adaptive tests (CAT) at a minimum follow-up of one year. Outcomes were also measured with the Visual Analog Scale (VAS) pain score and the Olerud and Molander ankle fracture outcome scale. A retrospective chart review of intraoperative findings and postoperative complications was performed.

RESULTS: Average patient follow-up was 67 months. PROMIS Physical Function and Pain Interference scores were not significantly different between the ankle arthroscopy and control groups (Physical Function 57.2 vs. 55.2, p=0.51; Pain Interference 45.2 vs. 45.6, p=0.88). Surgical time was significantly increased in the arthroscopy group (74 minutes vs. 61 minutes, p=0.05). Of the patients who had ankle arthroscopy, 59.5% (25/42) had chondral lesions of the talus, 7% (3/42) had chondral lesions of the tibial plafond, and 21% (9/42) had loose bodies requiring removal. No nerve injuries occurred secondary to establishment of arthroscopy portals (0/42).

CONCLUSION: At intermediate term follow-up of patients with unstable ankle fractures and intact medial malleoli, functional outcomes were not significantly improved in patients who underwent ankle arthroscopy. However, there were no complications attributable to ankle arthroscopy and total surgical time was increased by an average of only 13 minutes.

Intraoperative O-Arm Evaluation on the Effect of Ankle Position on Accuracy of Syndesmotic Reduction

Abstract ID: Paper 083

Paul M. Lafferty, M.D.
Timothy G. Hiesterman, M.D.
*Amir R. Rizkala, M.D.
St. Paul, MN

PURPOSE: This is a prospective study aimed at evaluating the effects of ankle position on the spatial relationships of the tibiofibular syndesmosis by utilizing intraoperative O-arm imaging. The differences in spatial relationships of the tibiofibular syndesmosis during intraoperative dorsiflexion and plantarflexion were observed by comparing each reduction with its contraleral, uninjured side (control).

METHODS: Twenty patients with obvious complete syndesmotic disruptions noted on static x-rays underwent O-arm scans after placement of a clamp across the syndesmosis, but prior to definitive fixation. The clamp was placed at the level of the distal tibiofibular joint and at 0° with respect to the tibiofibular axis. O-arm images were then taken with patient's ankle dorsiflexed to a neutral position and then in resting plantarflexion. The same procedure was repeated on the opposite, uninjured, ankle for later comparison. All uninjured ankles had no history of previous injury. The same syndesmotic spatial measurements cited in Dikos et al. and Nault et al. were used for the measurement of all O-arm scans. Measurements from the injured side were then subtracted by the measurements taken in the same ankle position on the uninjured side. This difference was then compared to the difference in measurements when the ankle was placed in the other position. The significance of this comparison was then assessed.

RESULTS: Out of the 14 different types of spatial measurements taken for each ankle position, a significant difference in measurement between ankle positions was found with 7 types of spatial measurements and ratios. These included tibiofibular overlap (TFO) ($p< 0.001$), anterior tibiofibular interval (ATF) ($p<0.001$), 0_1 ($p<0.001$), 0_2 ($p<0.001$), a ($p= 0.04$), a:b ($p< 0.001$), d:e ($p< 0.001$). While in dorsiflexion, ATF (mean = 2.4 mm), 0_2 (mean = 7.3°), a (mean = 0.1 mm), a:b (mean = 0.1), and d:e (mean = .2) were measured to be most similar to their contralateral uninjured measurements when compared to plantarflexion. While in plantarflexion, TFO (mean = 0.5 mm) and 0_1 (mean = 5.5°) were measured to be most similar when compared to dorsiflexion.

CONCLUSION: Seven out of the 14 measurements performed showed a significant difference in reduction depending on ankle position. Compared to the contralateral uninjured ankle, syndesmotic reduction was shown to be closest to anatomic alignment during dorsiflexion in 5 out of the 7 parameters measured. These findings could have implications with regards to the position of the ankle during placement of syndesmotic fixation.

Click here to view Figure

Lateral Ankle Instability and Association of Peroneal Tendon Pathology and Posterior Ankle Impingement

Abstract ID: Paper 084

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*Ashish Shah, M.D.
Osama Elattar, M.D.
Sameer Naranje, M.D.
Birmingham, AL

INTRODUCTION: Ankle sprains are the most common musculoskeletal injury, with an incidence of 30,000 per day in the United States; 40% of all athletic injuries involve the ankle. Most ankle sprains involve the lateral ligament complex, specifically the anterior talofibular ligament (ATFL) and the calcaneofibular ligament (CF) and are caused by an inversion stress on a plantarflexed foot. However, many soft tissue structures are at risk of injury with such inversion stresses including the distal tibia-fibula ligament, posterior talofibular ligament, subtalar interosseus ligament, peroneal tendons, peroneal retinaculum, superficial peroneal nerve branches, and the medial ankle structures. The purpose of this retrospective study is to evaluate the frequency of associated injuries with particular attention to peroneal tendon pathology and posterior ankle impingement lesions. A high index of suspicion for possible associated injuries may improve outcomes with nonoperative and operative treatment of chronic lateral ankle instability patients.

METHODS: 44 patients (46 ankles) underwent a primary ankle lateral ligament reconstruction (Brostrom-Gould) for chronic instability with failed conservative treatment between 2010 and 2013 by the same surgeon. A retrospective review of the clinical history, physical examination, MRI examination, and intraoperative findings was conducted on these 44 patients with 46 ligament reconstructions. Chronic lateral ankle instability was confirmed by history, physical examination, and intraoperative stress testing. All patients underwent MRI study. Minimum history of pain with or without instability for 6 months prior to surgery. The purpose was to determine the type and frequency of associated injuries found at surgery and during the preoperative evaluation.

RESULTS: Peroneal tendon pathology was found in 41/46 (89%); ankle synovitis in 28/46 (61%) with ankle arthroscopy done at same setting of ligament reconstruction. OCD lesions in 10/46 (21.7%) with 8 being talar lesions and 2 tibial lesions. Posterior impingement in 17/46 (23%) (Os Trigonum 12/46, FHL tenosynovitis 13/46 and prominent posterolateral process talus 4/46). Anterolateral impingement in 5/46 (11%). Radiologists were able to diagnose 25/41 peroneal tendon pathologies, 7/10 OCD lesions and 4/17 posterior impingement lesions on MRI. Generalized ligamentous laxity was found in 10/44 patients (23%) and heel varus in 11/46 ankles of which 7 underwent concomitant calcaneal shift osteotomy.

CONCLUSION: This retrospective study confirms the frequency of associated conditions in individuals with chronic lateral ankle instability. The frequency of identification of peroneal tendon injuries was as frequent or more than other studies. The frequency of posterior impingement syndrome was more than other studies. The study shows the importance of examination of generalized ligament laxity, heel varus as common predisposing factors. Knowledge of identification of different pathologies on MRI is also very important.

Risk Factors for Complications Following Open Reduction and Internal Fixation of Ankle Fractures

Abstract ID: Paper 085

Jimmy J. Jiang, M.D.
*Robert J. Stewart, M.D.
Erwin Bennett, M.D.
Douglas R. Dirschl, M.D.
Brian C. Toolan, M.D.
Chicago, IL

INTRODUCTION: We examined the risk factors of short-term complications following open reduction internal fixation (ORIF) of ankle fractures using a validated national database.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was queried from 2005-2012. Current Procedural Terminology (CPT) codes 27766, 27792, 27814, 27822, and 27823 were used to identify all patients who underwent ankle ORIF. The ACS-NSQIP is a statistically representative sample of prospectively collected perioperative surgical data from participating hospitals across the United States. The 30-day postoperative complications and hospitalization data were collected. Demographics, comorbidities, and preoperative laboratory values were analyzed to identify potential risk factors of postoperative complications. Preoperative variables that were significantly different in univariate analyses between patients with and without a complication were incorporated into multivariate analyses to adjust for confounders.

RESULTS: There were a total of 5,090 patients from this database who underwent an ORIF of the ankle during 8 consecutive years. The overall percent of patients with at least one complication was 5.4% with wound a complication rate of 1.8% and return to operating room rate of 1.8%. Age (Relative Risk [RR]=1.023 per year, 95% confidence interval [CI]=1.013-1.034), diabetes (RR=1.6, 95% CI=1.2-2.2), bleeding disorder (RR=1.6, 95% CI=1.0-2.6), ASA classification ≥ 3 (RR=1.8, 1.3-2.5), bimalleolar fractures (compared to medial [RR=0.48] or lateral malleolar [RR=0.69] fractures), open wound (RR=2.6, 95% CI=1.7-4.0), surgical time (RR=1.004, 95% CI=1.001-10.007 per minute), delay in surgery (RR=1.11, 95% CI=1.03-1.20 per day), and administration of general anesthesia (RR=1.5, 95% CI=1.1-2.3 compared to regional anesthesia) were independently associated with higher risks of postoperative complications. Similarly, the presence of diabetes, dyspnea, ASA classification ≥ 3, open wound, and increased surgical time were associated with higher risk of return to the operating room. Peripheral vascular disease and and open wounds were independently associated with increased risk of wound complications.

DISCUSSION: The overall 30-day complication rate was 5.4% in this study. Risk factors that were independently associated with increased postoperative complication following ORIF of ankle fractures include increased age, diabetes, bleeding disorder, ASA classification ≥ 3, fracture type, open wound, increased surgical time, delay in surgery, and administration of general anesthesia.

Level of Evidence: Therapeutic Level III

Evaluation of Posterior Malleolar Fractures and the Posterior Pilon Variant in Operatively Treated Ankle Fractures

Abstract ID: Paper 086

Paul J. Switaj, M.D. / Chicago, IL
Brian M. Weatherford, M.D. / Baltimore, MD
Daniel J. Fuchs, M.D. / Chicago, IL
*Brett D. Rosenthal, M.D. / Chicago, IL
Eric Pang, M.D. / Chicago, IL
Anish R. Kadakia, M.D. / Chicago, IL

INTRODUCTION: Substantial attention has recently been placed on fractures of the posterior malleolus. Identification of these fractures are an important consideration for appropriate fracture management. Fracture extension to the posteromedial rim (“posterior pilon variant”) may change surgical approach, and result in articular incongruity and talar subluxation if untreated. Current classification systems fail to account for these fractures. The relative frequency of this fracture, its associated patient characteristics, and the reliability of its diagnosis have never been reported in such a large series.

METHODS: We retrospectively identified 270 patients with operative ankle fractures that met inclusion criteria. Basic demographic data was collected. Two reviewers classified the fractures according to the Lauge-Hansen and AO/OTA based on plain radiographs. Additional radiographic data included whether the fracture involved the posterior malleolus, and whether the fracture represented a posterior pilon variant, which was determined by presence of the medial malleolar double-contour sign, a posterior malleolar fracture in the sagittal plane, or posterior malleolar impaction. Consensus classification, defined as any fracture classification made in agreement between both reviewers, was utilized. Chi-squared analysis and univariate statistical methods were applied. The interobserver reliability was assessed by the kappa-coefficient and observed agreement percentage.

RESULTS: The relative frequency of posterior malleolus fracture was 50%. The relative frequency of the posterior pilon variant was 20%. 40% of posterior malleolar fractures represented posterior pilon variants. Interobserver reliability data revealed substantial agreement for posterior malleolar fractures and posterior pilon variants. No significant difference was noted with respect to the frequency of posterior malleolar or posterior pilon variant between the subgroups of the AO/OTA and Lauge Hansen classification systems when compared to the overall fracture distribution. Patients with posterior malleolar fractures and posterior pilon variants were significantly older. Females were significantly more likely than men to sustain posterior malleolar fractures and posterior pilon variants. Patients with diabetes trended toward a greater risk of both types of fractures.

DISCUSSION AND CONCLUSION: This data represents the highest reported rate of posterior malleolar involvement in operative ankle fractures, and the highest rate of posterior pilon variant in operative ankle fractures. Fractures of the posterior malleolus and posterior pilon variant can occur in all fracture types across all traditional mechanisms, and are not accounted for by conventional systems. Identification of the posterior pilon variant and posterior malleolar fractures demonstrate substantial interobserver reliability, and may occur with increased frequency in older, diabetic female patients.

Early Weight Bearing as Tolerated Following Open Reduction Internal Fixation of Ankle Fractures

Abstract ID: Paper 087

Shannon R. Carpenter, M.D.
Michael P. Planalp, M.D.
*S. Brandon Luczak, B.S.
Denise Kouetier, M.S.
Kevin D. Grant, M.D.
Jason Sadowski, M.D.
Royal Oak, MI

INTRODUCTION: There is some controversy regarding standard of care for weight bearing following open reduction internal fixation (ORIF) of an ankle fracture. It is the standard of care among many surgeons to keep patients non-weight bearing for 6 to 12 weeks to reduce the likelihood of implant failure. However, some literature shows that early weight bearing (EWBAT) after ORIF of an ankle fracture has no detrimental effects on recovery. EWBAT allows patients to return to work and ADLs earlier than NWB patients, while having beneficial effects on fracture healing and lowering morbidity due to prolonged recumbency. To date, no study has directly compared outcomes of EWBAT vs. NWB in patients with ankle fractures fixed with a distal fibular locking plate.

METHODS: A retrospective chart and radiograph review of patients from 2007—2012 was conducted. Patients with a bimalleolar, bimalleolar equivalent, or trimalleolar fracture were included. Minors and patients with multi-trauma were excluded. It is standard of care for one of the surgeons to make all patients NWB for 6-12 weeks and standard of care for the other surgeon to make all patients WBAT within 0-2 weeks postoperatively. Medical charts were reviewed for age, gender, BMI, history of smoking, and incidence of diabetes. Follow-up radiographs were analyzed for complications including malalignment, loss of internal fixation, and nonunion. The time to first signs of fracture healing was recorded. Medical charts were reviewed for complications including wound complications, thrombotic events, instability, and prolonged stiffness.

RESULTS: A total of 46 NWB patients were included and 57 early WBAT patients. The average age did not differ between groups. There was a significant difference in gender between groups (P=0.008). Average follow-up was significantly greater for the NWB patients (7.8 months ± 4.1) than for early WBAT patients (6.2 months ± 4.2) (P=0.016). There were no radiographic signs of implant failure or nonunion in either group. There was an insignificant greater incidence of wound complication in the NWB group. (P=0.088). There was no significant difference between groups in the incidence of DVT/PE (P = 0.289).

DISCUSSION: There was not a difference in the incidence of radiographic or clinical complications between patients that remained NWB for 6-12 weeks and patients that were allowed EWBAT. Given the benefits of EWB such as the return to normal daily activity, EWB may be considered as a feasible postoperative management following ORIF of ankle fractures using distal fibular locking plate.

The Independent Effects of Diabetes, Smoking, and Obesity on Operative Ankle Fracture Complications

Abstract ID: Paper 088

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*Bryant S. Ho, M.D.
Shobhit V. Minhas, B.S.
Paul J. Switaj, M.D.
George Ochenjele, M.D.
Mary J. Kwasny, ScD
David W. Manning, M.D.
Anish R. Kadakia, M.D.
Chicago, IL

INTRODUCTION: Diabetes, smoking, and obesity have been linked to increased postoperative complications following fixation of ankle fractures. However, the significance and magnitude of this link may be distorted by confounding factors. We sought to determine the true independent effect of these risk factors by creating statistical models that controlled for possible confounding factors.

METHODS: We conducted a retrospective analysis of 5,141 closed ankle fractures treated with open reduction internal fixation from 2006-2012 using the American College of Surgeon's National Surgical Quality Improvement Program (ACSNSQIP) database. Each risk factor was independently analyzed by creating matched groups for the factor of interest: diabetes (non-diabetic, noninsulin dependent [NIDDM], insulin dependent [IDDM]), smoking, or obesity. Groups were matched by sex, age, American Society of Anesthesiologist (ASA) class, diabetes, smoking, and obesity (where appropriate) with final matched groups meeting criteria consisting of 609 (diabetes), 2,308 (smoking), and 1,200 (obesity) patients. Conditional logistic and negative binomial regression models were fit to determine the association of diabetes, smoking, or obesity on 30-day postoperative complications and total length of stay.

RESULTS: IDDM was associated with increased wound dehiscence or infection (odds ratio [OR] 4.56, p=0.04). IDDM was also associated with increased reoperations within 30 days (OR 4.56, p=0.04), and increased hospital length of stay (OR 4.4, p=0.03). In contrast, NIDDM was not associated with increased complications or hospital length of stay. Smoking and obesity were not associated with any increased risk of medical complications, wound dehiscence, or wound infection. However, there was an increased risk of reoperations associated with smoking (OR 2.11, p=0.03) and obesity that was most pronounced when body mass index (BMI) was between 30 and 35 (OR 10.30, p=0.03).

DISCUSSION AND CONCLUSION: By controlling for confounding factors, this study clarifies the association of diabetes, smoking, and obesity on ankle fracture complications. Only IDDM, and not NIDDM, was a predictor of increased postoperative complications. While smoking and obesity did not change overall complication rates, they increased the risk of reoperation rates, suggesting that complications in these patients are more likely to be devastating and require repeat surgery.

Gait and Balance in Total Ankle Arthroplasty vs. Ankle Arthrodesis at 12 to 36 Months After Surgery

Abstract ID: Paper 089

Brandon W. King, M.D.
*Todd A. Irwin, M.D.
James S. Wrobel, M.D.
James R. Holmes, M.D.
Markus Byron, B.S.
Ann Arbor, MI

INTRODUCTION: The evolution of total ankle arthroplasty with good intermediate term result now offers patients with ankle arthritis a treatment choice. Subjective patient self-scoring scales have shown ankle arthroplasty and arthrodesis to be similar; however, little objective data exists. Our hypothesis was that patients who previously underwent total ankle arthroplasty would have significantly improved postoperative objective functional findings and similar self-scoring to ankle arthrodesis patients.

METHODS: Patients who had previously undergone ankle arthroplasty or arthrodesis 1 to 3 years ago by one of two fellowship-trained orthopedic surgeons including either an open ankle arthrodesis vs. a total ankle arthroplasty using the InBone II prosthesis.

A novel, validated gait analyzer consisting of five wearable sensors for spatio-temporal and gait initiation was utilized (PAMSys). Data includes gait speed, stride length, double support time, and gait symmetry. Tandem and single leg stance with eyes open and eyes closed are evaluated individually. Subjective outcomes were measured using the Ankle Osteoarthritis Scale (AOS).

RESULTS: 21 of the 26 patients identified agreed to undertake our evaluation, 12 arthroplasties and 9 arthrodeses. The mean age was greater in the arthroplasty cohort, 69 vs. the arthrodesis cohort, 60.6 ($p=0.11$). The time since surgery between arthroplasty and arthodesis was statistically significantly different ($p=0.008$), 17.9 months vs. 26.8 months, respectively. All gait characteristics were not statistically significant between the cohorts.

Balance characteristics were calculated and the only statistically significant finding ($p=0.05$) was open-eye tandem Romberg testing in the anterior-posterior plane with the arthrodesis cohort scoring better than the arthoplasty cohort. Functional outcomes using the AOS scale (Table 2) showed a trend toward better outcomes in the arthroplasty cohort, though the numbers did not reach significance.

DISCUSSION AND CONCLUSION: Our data lends support to previous studies which have shown pain and disability to be similar after surgery in both arthroplasty and arthrodesis cohorts. This is, however, the first study to our knowledge showing gait to be similar in arthrodesis and arthroplasty patients and only study of its kind evaluating the InBoneII prosthesis. We also demonstrate the utility of a portable, wireless gait and balance system that can be used for clinical and research purpose.

Click here to view Table

Long-Term Follow-Up of Patients with Ankle Distraction as a Treatment for End Stage Osteoarthritis

Abstract ID: Paper 090

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*Mai P. Nguyen, M.D.
Annunziato Amendola, M.D.
Douglas Pedersen, Ph.D.
Iowa City, IA

BACKGROUND: Treatments for end stage ankle osteoarthritis (OA) remain challenging especially in young patients. Initial reports have shown early benefits of joint distraction for the treatment of ankle OA. This is the first long-term follow-up study in the U.S. on patient outcomes following ankle distraction surgery.

METHODS: All 36 patients who underwent ankle distraction surgery between December 2002 and October 2006 were contacted. Written, witnessed consent was obtained from all subjects who agreed to enroll using IRB-approved information forms. Patients were evaluated by a clinical investigator and completed the Ankle Osteoarthritis Scale (AOS) and the Short Form 36 (SF-36) surveys. Plain radiographs, CT, and MRI of ankles were obtained at follow-ups.

RESULTS: Minimum of 5-year follow-up was obtained in 29 patients (81%) with average 8.3 ± 2.2 years. Sixteen of 29 patients (55%) still had their native ankle joints while 13 patients (45%) went on to either ankle arthrodesis or total ankle arthroplasty. Positive predictors of ankle survival include better AOS scores at two-year (hazard ratio = 20.71, 95% confidence interval [95% CI] 1.19-360.98, p =0.04), older age at surgery (hazard ratio = 0.91, 95% CI 0.83-0.99, p=0.04), and fixed distraction (hazard ratio = 10.62, 95% CI 1.93-58.45, p<0.01). There was no significant difference in patient reported outcomes between the group with native ankles and the group that underwent conversion to ankle arthrodesis or total ankle arthroplasty (native: PCS 32.8 ± 9.5, AOS of 59.8 ± 20.7; conversion: PCS 37.8 ± 11.8, AOS 42.5 ± 35.3, p>0.05). Radiographs of the native ankles revealed progression of OA.

CONCLUSION: Ankle distraction offers young patients a joint preserving surgery that does not preclude more definite treatment if eventually necessary. Patients should be well informed of the commitment during the treatment period as well as the long-term results after surgery.

A Comparison of Perioperative Outcomes After Tibiotalar Fusion for Patients with Osteoarthritis vs. Rheumatoid Arthritis and Fractures

Abstract ID: Paper 091

Jimmy J. Jiang, M.D. / Chicago, IL
Oliver N. Schipper, M.D. / Chicago, IL
*Joseph B. Cohen, M.D. / Chicago, IL
Lan Chen, M.D. / Evanston, IL
Brian C. Toolan, M.D. / Chicago, IL

INTRODUCTION: This study compares perioperative outcomes after tibiotalar fusion between patients with osteoarthritis, rheumatoid arthritis, and fractures during the index hospitalization.

METHODS: Using International Classification of Diseases, Ninth Revision (ICD-9) coding to analyze the Nationwide Inpatient Sample (NIS) database, we identified 7,183 patients with osteoarthritis, 758 patients with rheumatoid arthritis, and 1,903 patients with fractures (acute, malunion, or nonunion) who underwent tibiotalar fusion. The NIS database, part of the Healthcare Cost and Utilization Project, is a statistically representative sample of hospitals that includes inpatient data on approximately 20% of all admissions (about 8 million inpatients per year) from across the United States. The perioperative complications and hospitalization outcomes were compared between patients with osteoarthritis vs. rheumatoid arthritis and in patients with osteoarthritis vs. fracture during the index hospital stay.

RESULTS: The overall complication rates were 6.7%, 8.1%, and 15.0% for the osteoarthritis, rheumatoid arthritis, and fracture groups, respectively. Compared to the osteoarthritis patients, rheumatoid arthritis patients had similar hospitalization charges ($p=0.94$), but fracture patients incurred higher hospitalization charges ($p<0.001$). Both the rheumatoid arthritis (2.8 days) and fracture patients (3.9 days) had longer length of hospital stay ($p<0.001$) than the osteoarthritis patients (2.5 days). Rheumatoid arthritis patients were older (59.0 vs. 57.6 years, $p=0.02$) and had more comorbidities (2.0 vs. 1.5, $p<0.001$) compared to osteoarthritis patients. After adjusting for differences in demographics and comorbidities through multivariate analyses, rheumatoid arthritis was not independently predictive of increased risk of pneumonia ($p=0.30$), deep vein thrombosis ($p=0.34$), pulmonary embolus ($p=0.64$), myocardial infarction ($p=0.99$), irrigation and debridement during index hospital stay ($p=0.09$), blood transfusions ($p=0.92$), and overall complication rate ($p=0.10$). As compared to the osteoarthritis patients, fracture patients were younger (54.3 vs. 57.6 years, $p<0.001$ and had more comorbidities (1.9 vs. 1.4, $p<0.001$). After adjusting for differences in demographics and comorbidities, having a fracture was independently associated with increased risk of urinary tract infection (Relative Risk [RR]=1.5, $p<0.001$), blood transfusion (RR=1.4, $p<0.001$), irrigation and debridement during index hospital stay (RR=1.2, $p=0.02$), and overall complication (RR=1.3, $p<0.001$). However, fracture was not independently associated with risk of pneumonia ($p=0.75$), deep vein thrombosis ($p=0.10$), pulmonary embolus ($p=0.10$), myocardial infarction ($p=0.80$), and cerebrovascular accident ($P=0.85$).

CONCLUSION: In patients undergoing tibiotalar fusion, complication rates were similar between osteoarthritis and rheumatoid arthritis patients. Fracture patients, as compared to osteoarthritis patients, had higher complication rates, hospital costs, and longer length of hospitalization.

Comparison of Union Rate Using Different Screw Insertion Techniques for Isolated Subtalar Arthrodesis

Abstract ID: Paper 092

Ashish Shah, M.D.
Osama Elattar, M.D.
*Sameer Naranje, M.D.
Birmingham, AL

INTRODUCTION: Considerable controversy exists about the ideal screw insertion technique for isolated subtalar arthrodesis. The purpose of this retrospective study is to compare the union rates of isolated subtalar arthrodesis using the different screw insertion techniques (1 screw vs. 2 screws, double parallel vs. double divergent, and screw insertion from talus vs. from calcaneus).

METHODS: We retrospectively reviewed the clinical charts and radiographs of 133 patients with 135 STJ fusions done by two surgeons at our institution between January 2010 to December 2013. All procedures were performed in a consistent manner using a standard lateral approach (sinus tarsi incision) with joint debridement and preparation. Inclusion criteria included any patient treated with an isolated STJ fusion. Exclusion criteria included any patient with distraction arthrodesis, concomitant or prior foot and ankle fusion, concomitant total ankle replacement, and revision subtalar fusion patients. The screw insertion technique was based on surgeon preference. STJ fusion was determined by clinical signs of no pain or swelling at the surgical site and by radiographic trabeculation of the most recent postoperative radiographs. All symptomatic patients underwent CT scan to confirm nonunion. The mean follow-up was 24 months.

RESULTS: Demographics including age, gender, and primary diagnosis consisting of osteoarthritis, post-traumatic, posterior tibial tendon dysfunction, and tarsal coalition were compared. Confounding factors that may affect fusion rates, such as diabetes and smoking, were also compared. The union rate of 1 screw was 93.7% (15/16) vs. 2 screws 84% (100/119). The union rate of double parallel screws was 81.8% (9/11) vs. double divergent 84.3% (91/108). The union rate for talus to calcaneus screws was 86.5% (83/96) vs. calcaneus talus screws 80.5% (29/36), 3 patients had one screw from talus and one from calcaneus and all achieved union (100%). All the results were not statistically significant ($p > 0.05$).

CONCLUSION: No significant differences in STJ union rates were noted when comparing the different screws insertion techniques in this retrospective study.

MAOA BREAKOUT SESSION #7
SPORTS
April 24, 2015

Effect of Combined Bony Defects on Anterior Glenohumeral Stability: A Cadaveric Study

Abstract ID: Paper 093

*****Piyush Walia, B.S. / Garfield Heights, OH
Ronak M. Patel, M.D. / Garfield Heights, OH
Lionel J. Gottschalk, M.D. / Garfield Heights, OH
Matthew Kuklis, M.S. / Garfield Heights, OH
Morgan H. Jones, M.D. / Garfield Heights, OH
Stephen D. Fening, Ph.D. / Cleveland, OH
Anthony Miniaci, M.D. / Garfield Heights, OH

INTRODUCTION: The purpose of this study was to investigate and quantify the effects of combined bony defects on shoulder instability.

METHODS: Eighteen fresh-frozen cadaveric specimens were tested at combinations of glenohumeral abduction (ABD) angles of 20°, 40°, and 60° and external rotation (ER) angles of 0°, 40°, and 80°. Each experiment applied a 50N medial load on the humerus to replicate the static load of soft tissues, and then simulated anterior dislocation by translating the glenoid in an anterior direction. Translational distance and medial-lateral displacement of the humeral head, along with horizontal reaction forces, were recorded for every trial. Every specimen was tested in an intact condition (no defect) and then different combinations of defects. Since it is not possible to test every defect combination in a single specimen, three different pathways were chosen to maximize the possibilities for a defect creation matrix (4 levels of glenoid defects and 5 levels of humeral defects). Six specimens were used per pathway.

RESULTS: Results are summarized in Fig. 1. The vertical axis represents the normalized distance to dislocation with respect to the values of the intact joint. The horizontal axis represents the varying sizes and combinations of bony defects. With a 6% humeral head defect, percent intact translation decreased from 100% to 41.3% with increasing glenoid defect size, but the percent intact translation was not affected by arm position. (Fig. 1 A).

With a glenoid defect of 20%, stability was 75% intact translation with an arm position of 20° ABD and 0° ER and did not increase with increasing size of humeral defect. However, with the arm in greater degrees of abduction and external rotation, increasing humeral defect size led to a decrease in stability. With 60 ABD and 80 ER and a 44% humeral defect size, stability was 0.

CONCLUSIONS: The results of this cadaveric model demonstrate that combined bony defects magnify instability as compared to isolated defects in positions of greater abduction and external rotation. Furthermore, instability secondary to an isolated glenoid defect is not affected by changing arm position. This study proposes a clinically relevant model that signifies the importance of considering both humeral and glenoid bony defects when treating anterior instability of the glenohumeral joint.

Click here to view Figure

The Effects of Latarjet Reconstruction on Glenohumeral Instability in the Presence of Combined Bony Defects: A Cadaveric Model

Abstract ID: Paper 094

Ronak M. Patel, M.D. / Garfield Heights, OH
Piyush Walia, B.S. / Garfield Heights, OH
*Lionel J. Gottschalk, M.D. / Garfield Heights, OH
Matthew Kuklis, M.S. / Garfield Heights, OH
Morgan H. Jones, M.D. / Garfield Heights, OH
Stephen D. Fening, Ph.D. / Cleveland, OH
Anthony Miniaci, M.D. / Garfield Heights, OH

INTRODUCTION: The purpose of this study was to evaluate the stability achieved through a Latarjet procedure in the presence of combined bony defects. Our hypothesis was that Latarjet augmentation would increase shoulder stability for glenoid defects with small HSD, but have limited success in cases with large concomitant HSD.

METHODS: Eighteen fresh-frozen cadaveric specimens were tested at combinations of glenohumeral abduction (ABD) angles of 20°, 40°, and 60° and external rotation (ER) angles of 0°, 40°, and 80°. Each experiment applied a 50N medial load on the humerus to replicate the static load of soft tissues, and then simulated anterior dislocation by translating the glenoid in an anterior direction. Translational distance and medial-lateral displacement of the humeral head, along with horizontal reaction forces, were recorded for every trial. Specimens were tested in an intact condition (no defect), different combinations of defects, and with Latarjet augmentation. The Latarjet was performed for 20% and 30% glenoid defects by transferring the specimen's coracoid process anterior to the glenoid flush with the articulating surface.

RESULTS: Results are summarized in Fig. 1. The vertical axis represents the normalized distance to dislocation with respect to the values of the intact joint. The horizontal axis represents the varying sizes and combinations of bony defects. Latarjet augmentation improved stability for every combination of bony defects. At 20° ABD, 0° ER, and 20% glenoid defect size, the percentage of intact translation did not change with increasing HSD size, and the Latarjet augmentation increased percent intact translation to greater than 100% for all cases (Fig. 1A). However, at 60° ABD, 80° ER, and 20% glenoid defect size, increasing HSD size caused decreased stability, and Latarjet augmentation did not increase the percent intact translation to normal levels for HSD sizes greater than 30% (Fig. 1B).

CONCLUSIONS: These results demonstrate that some degree of stability can be regained for combined bony Bankart and Hill-Sachs defects with a Latarjet procedure. However, for humeral defects larger than 30%, the HSD led to persistent instability in the abducted externally rotated position, even after the Latarjet procedure. Thus, directly addressing the humeral defect to restore the articular surface should be considered in these cases.

Click here to view Figure

Analysis of Major League Baseball Pitchers' Velocity Before and After Surgical Treatment of Superior Labral Anterior-Posterior Tears

Abstract ID: Paper 095

Jimmy J. Jiang, M.D.
*Kyle Borque, M.D.
J. Martin Leland, III, M.D.
Chicago, IL

INTRODUCTION: Baseball pitchers often undergo surgery for symptomatic superior labrum anterior-posterior (SLAP) tears that have failed to improve with nonoperative management. We examine the velocity of pitches thrown by pitchers in a cohort of Major League Baseball (MLB) pitchers before and after surgical treatment of SLAP tears.

METHODS: Twenty-seven MLB pitchers between the years 2007 to 2011 were identified in this retrospective cohort study as players who underwent surgical intervention of a SLAP tear. Eight pitchers have not returned to play at the Major League level at time of this study. Two additional pitchers were excluded from the study due to lack of preoperative velocity data. Velocity and performance data from the remaining 17 pitchers over a minimum of 4 seasons each were analyzed. A pair-matched control group of pitchers who did not have a known SLAP tear were analyzed for comparison.

RESULTS: The average age of patients at time of surgery was 29.1 years. The mean time from MLB debut to time of surgery was 6.5 years. There were 18 starting pitchers and 9 relief pitchers. Thirteen of the 27 pitchers (48%) had an associated rotator cuff tear. The rate of return to major league play was 70% (19/27) by a minimum follow-up of 2 years after surgery. The mean time to return to play at the MLB level was 16 months (median=14 months). There was a small, but statistically significant, decrease in pitch velocity between the pre-surgical year and index year of surgery (Difference=0.9 miles per hour, $p=0.05$). There were no differences in pitch velocity between index year and each subsequent post-surgical year. When compared with a control group, the mean percent change in velocity was not significantly different in each year studied. In terms of performance data, the mean innings pitched was statistically different ($p=0.04$) only for the first post-index year. There were no differences between the two patient groups in regards to commonly used baseball statistical performance measurements including earned run average, walks plus hits per inning pitched, batting average against, walks per 9 innings, and strikeouts per 9 innings.

DISCUSSION: Pitchers who successfully returned to the major league level following surgery for SLAP tears (70% in this study) had no significant difference in pitch velocity and common baseball performance measurements compared to a control group.

Level of Evidence: Therapeutic Level III

Predictors of Postoperative Pain and Narcotic Use After Primary Arthroscopic Rotator Cuff Repair

Abstract ID: Paper 096

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*Troy A. Roberson, M.D.
Frederick M. Azar, M.D.
Robert H. Miller, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

BACKGROUND: The purpose of the current study is to further define risk factors for increased pain and narcotic usage in the early postoperative period after primary arthroscopic rotator cuff repair.

METHODS: After IRB approval, all primary arthroscopic rotator cuff repairs performed by a single surgeon from 2009-2013 were identified via CPT code. The patient specific preoperative factors investigated included tobacco use, preoperative narcotic use, fibromyalgia, chronic pain syndromes, disability claims, mood disorders (depression/anxiety), worker's compensation claims, lawsuits, and obesity. Patients with follow-up documentation at 2, 6, and 12 weeks were included. Outcome measures included visual analog pain scores pre- and postoperatively and narcotic usage, standardized to oral morphine equivalent doses. Statistical analyses were performed using student's t-tests and ANOVA with p-values of <0.05 considered significant.

RESULTS: Sixty-five patients were included in the study. In the overall study population, the average visual analog pain score decreased from 5.7 to 5.0 ($p = 0.03$) at 2 weeks, 3.2 ($p < 0.0001$) at 6 weeks, and 2.5 ($p<0.0001$) at 12 weeks postoperatively.

Significant predictors of increased pain scores at 12 weeks of follow-up included preoperative narcotic use (3.3 vs. 1.9, $p = 0.03$), fibromyalgia (7.0 vs. 2.3, $p = 0.004$), other chronic pain syndromes (4.5 vs. 2.1, $p = 0.002$), and mood disorders (4.5 vs. 2.3, $p = 0.02$). Tobacco use trended towards increased pain scores (3.7 vs. 2.2, $p = 0.07$), while obesity, disability claims, and worker's compensation claims were not associated with higher pain scores.

Cumulative narcotic usage at 12 weeks was significantly higher in patients with tobacco use (2023 vs. 1332 mg, $p = 0.04$), preoperative narcotic use (1893 vs. 1172 mg, $p = 0.01$), and mood disorders (2881 vs. 1270 mg, $p<0.001$). A strong trend was noted in patients with disability claims (3029 vs. 1472 mg, $p = 0.051$) for narcotic usage while no significant difference was noted in patients with fibromyalgia, other chronic pain syndromes, worker's compensation claims, or obesity.

CONCLUSIONS: Preoperative narcotic use and mood disorders are most predictive of difficulty in pain management after primary arthroscopic rotator cuff repair with both increased postoperative pain scores and narcotic usage. Tobacco use and chronic pain syndromes are associated with either increased pain scores or increased narcotic usage while disability claims show only a trend towards increased narcotic usage. Each of these factors was more associated with increased postoperative pain and narcotic use than obesity or worker's compensation claims.

Cross-Sectional Analysis of the Long Head of the Biceps Tendon and Its Relationship to the Pectoralis Major Tendon: An Anatomic Study

Abstract ID: Paper 097

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*Sarah B. Nossov, M.D. / Ann Arbor, MI
James R. Ross, M.D. / Fort Lauderdale, FL
James E. Carpenter, M.D. / Ann Arbor, MI
Christopher Robbins / Ann Arbor, MI

OBJECTIVES: There is current controversy surrounding the anatomical location to perform a tenodesis of the long head of biceps tendon (LHBT). Many have argued for subpectoral tenodesis for cosmesis and in order to remove the biceps tendon from the bicipital groove. However, at times a significant portion of the long head at that level is muscle and not tendon tissue. The amount of tendon composition of the LHBT at that location is currently unknown. The purpose of this study was to determine the percent tendon composition of the LHBT at varying anatomical locations along the LHBT.

METHODS: Twenty fresh cadaveric shoulders were dissected and samples were photographed. The LHBT length was measured from the leading edge of the supraspinatus tendon to the upper and lower borders of the pectoralis major tendon. The width of the pectoralis major tendon at its humeral insertion was also measured. The tendon circumference was measured at the anterior edge of supraspinatus, supra-pectorally, mid-pectorally, and sub-pectorally. The muscle was then removed from the LHBT and the tendon circumference was again measured at the supra-, mid-, and sub-pectoral levels. This data was used to calculate area of tendon. All measurements were performed by two independent observers. Statistical analysis was performed to assess reliability of data and difference between serial measurements.

RESULTS: The mean age of the cadaveric specimens was 76.9 years (range, 61 to 93 years). Seventy-five percent of the shoulders were male; 55% of the shoulders were left-sided. The mean calculated percentage of the cross-section composed of tendon tissue decreased from 86.7% at the superior edge of PM to 49.8% at the midpoint of PM and to only 17.5% at the inferior edge of PM (these changes were significantly different at each level, $p<0.05$).

CONCLUSIONS: The results of this study demonstrate that in the majority of shoulders distal to the pectoralis major, the long head of the biceps is composed of mostly muscle, not tendon. Tenodesis performed at the sub-pectoral level, between the midpoint of the pectoralis major insertion and more distal points, involve a significant portion of muscle which may affect mechanical strength of fixation.

The Effect of Recombinant Human Parathyroid Hormone (rhPTH) on Tendon-to-Bone Healing in a Rat Rotator Cuff Model♦

Abstract ID: Paper 098

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*Kyle R. Duchman, M.D.
Jessica E. Goetz, Ph.D.
Andrew A. Amendola
Bastian Uribe, M.D.
Allison Malandra, M.S.
Joshua Barber, M.D.
Carolyn M. Hettrich, M.D., M.P.H.
Iowa City, IA

INTRODUCTION: Successful rotator cuff tendon repair is predicated upon secure tendon-to-bone healing. A recent study has shown that recombinant human parathyroid hormone (rhPTH) treatment results in improved tendon-to-bone healing at the latter stages of healing, but not at early time points (Hettrich et al., J Orthop Res, 2012). We hypothesized that delaying administration of rhPTH until after the acute inflammatory phase would improve tendon-to-bone healing at all time points in a rat rotator cuff repair model.

METHODS: 108 male Sprague Dawley rats underwent detachment and subsequent repair of the supraspinatus tendon based on an a *priori* power analysis. 54 rats underwent repair alone, and 54 rats received repair plus daily subcutaneous injections of 10 µg/kg of rhPTH beginning on postoperative day 7 and continuing for 12 weeks. Rats were sacrificed at 2 and 16 weeks postoperatively for biomechanical testing or histologic and immunohistochemical analysis. Histologic slides were digitized, and the enthesis was evaluated quantitatively using NIH Image J and VisioMorph software.

RESULTS: At 2 weeks postoperatively, the rhPTH group had significantly higher load to failure than the control group (10.85 vs. 5.16 N; $p = 0.003$). At 16 weeks, there was no significant difference in load to failure between the two groups. With respect to stiffness of the repair, there was no significant difference between the two groups at either time point, but there was a trend toward increased stiffness in the rhPTH group at 2 weeks postoperatively compared to the control group (5.09 vs. 3.77 N/mm; $p = 0.12$). Histologically, the rhPTH specimens had more fibrocartilage and osteoblasts at all time points, with significantly better collagen fiber orientation at 2 weeks.

DISCUSSION: Administration of rhPTH significantly increased load to failure at 2 weeks postoperatively in a rat rotator cuff repair model, with improved collagen fiber organization and increased fibrocartilage formation. Delaying administration of rhPTH until postoperative day number 7, after the resolution of the acute inflammation from surgery had subsided, improved rotator cuff healing in the early postoperative period while maintaining later-stage mechanical strength.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (Teriparatide or recombinant human parathyroid hormone has previously been approved for use in patients at high risk for osteoporotic fractures and for patients who have failed or are intolerant of other osteoporosis therapy. The 'off label' use for this study is for tendon-to-bone healing following rotator cuff surgery.)

Arthroscopic Debridement and Capsular Release for the Treatment of Shoulder Osteoarthritis

Abstract ID: Paper 099

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*Nathan W. Skelley, M.D.
Surena Namdari, M.D., MSc
Aaron M. Chamberlain, M.D.
Jay D. Keener, M.D.
Leesa M. Galatz, M.D.
Ken Yamaguchi, M.D.
St. Louis, MO

PURPOSE: The purpose of this study was to evaluate patients who underwent only arthroscopic debridement and capsular release for primary glenohumeral osteoarthritis to determine clinical and functional outcomes, and time until conversion to shoulder arthroplasty.

METHODS: We performed a retrospective review of 33 patients that underwent arthroscopic debridement and capsular release for shoulder osteoarthritis at our institution between 2006-2011. All procedures were performed by a single surgeon and evaluated for preoperative and postoperative clinical variables, self-assessments, and conversion to total shoulder arthroplasty. Clinical follow-up was on average 40.3 weeks postoperatively, and telephone interview follow-up was performed at a minimum of 2 years postoperatively on all patients.

RESULTS: There was an initial improvement in range of motion and pain scores; however, patients in our study returned to preoperative levels approximately 3.8 months after debridement and capsular release. Twenty patients (61.0%) reported that they were not satisfied with the outcome of their procedure. Total shoulder arthroplasty was undertaken by 14 (42.4%) patients an average of 8.8 months post arthroscopy. Among the 19 (57.6%) patients that did not go on to have a total shoulder arthroplasty, ASES scores (42.2 to 50.8, p=0.41) and VAS pain scores (7.8 to 7.4, p=0.59) were similar preoperatively and at final telephone follow-up.

CONCLUSIONS: Arthroscopic glenohumeral joint debridement and capsular release were associated with only temporary pain relief and improvement in motion. Though there are limited non-arthroplasty surgical options available for glenohumeral arthritis, arthroscopic debridement and capsular release may not provide substantial benefit to justify utilization in most patients.

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Predictors of Perioperative Complications Following Rotator Cuff Repair

Abstract ID: Paper 100

Troy A. Roberson, M.D.
Frederick M. Azar, M.D.
Robert H. Miller, M.D.
*Thomas W. Throckmorton, M.D.
Memphis, TN

BACKGROUND: The purpose of current study is to better define predictors which may portend a higher rate of complications in the early postoperative period of rotator cuff repair.

METHODS: After IRB approval, all rotator cuff repairs performed by a single surgeon over a four-year period from 2009-2013 were identified via CPT code. Patients with follow-up at 2, 6, and 12 weeks postoperative were included in the study group to investigate the perioperative complication rate. The technique of repair (open vs. closed, single vs. double row, use of patch augmentation) was chosen at the discretion of the surgeon.

Complications were classified as minor or major with minor complications including serous drainage, local erythema, or associated tendinitis. Major complications were classified as wound or deltoid dehiscence, recurrent rotator cuff tear with clinical decompensation, or deep infection requiring surgical treatment. Statistical analysis was performed using Pearson's Chi-square, odds ratios, and Lambda measure of association. Chi-square p-values of <0.05 were considered significant.

RESULTS: Ninety-five total procedures were included in the study with 31 open, 64 arthroscopic, 86 primary, and 9 revision repairs. The overall complication rate at 12 weeks was 10.5% with three minor complications and seven major complications. Of the major complications, five recurrent tears with associated clinical decompensation were noted.

The complication rate for open repair was significantly higher than for arthroscopic repair at 26% vs. 3% ($p = 0.001$) with an odds ratio of 11.1 for open repair (95% CI: 2.2-56). There was no statistically significant difference in complication rate between single and double row repairs (10% vs. 29%, $p = 0.14$). Similarly, revision repair showed a higher rate of complication than primary repair at 22% vs. 9%, but did not reach statistical significance ($p = 0.26$).

Patient specific risk factor analysis showed statistically significant increases in complications for tobacco use (24% vs. 6%, $p = 0.004$), preoperative narcotic use (16% vs. 2.5%, $p = 0.03$), and disability claims (33% vs. 9%, $p = 0.03$). Preoperative factors not predictive of complications included pain syndromes (16% vs. 9%, $p = 0.44$), mood disorders (14% vs. 10%, $p = 0.59$), worker's compensation (13% vs. 10%, $p = 0.76$), and obesity (9% vs. 13%, $p = 0.45$).

CONCLUSIONS: Open repair technique, tobacco use, preoperative narcotic use, and disability claims are statistically significant predictors of complications in the early postoperative period after rotator cuff repair.

Evaluation of the Accuracy of Ultrasound in Patients with Rotator Cuff Tears

Abstract ID: Paper 101

William K. Vasileff, M.D. / Columbus, OH
Carissa J. Trippa, D.O. / Alamosa, CO
*Patricia A. Kolowich, M.D. / Detroit, MI

OBJECTIVES: Rotator cuff tears are a significant source of pain, activity limitation, and disability. History and physical examination findings are important in the diagnosis of tears, but imaging techniques can assist with diagnosis and treatment decisions. Ultrasound is regularly used to evaluate rotator cuff tears. Some rotator cuff tears are treated non-operatively, but arthroscopic repair commonly utilized to reduce pain and improve function. The purpose of this study was to examine the accuracy of ultrasound in diagnosing rotator cuff tears when compared to arthroscopic findings.

METHODS: 315 patients who underwent arthroscopic shoulder surgery and diagnostic ultrasound less than one year prior were retrospectively reviewed. Ultrasound reports were reviewed to record the location, thickness, and size of the tear preoperatively. Surgical reports were utilized to record findings visualized during arthroscopy. Statistical comparison between the ultrasound and surgical results was performed.

RESULTS: The 315 subject study group included 225 patients where anterior-posterior tear size was comparable. On ultrasound, average tear size was 1.42 cm and arthroscopy demonstrated 1.72 cm. The difference noted is 0.30 cm ($p<0.001$). 37.6% of those had a greater than 1 cm difference ($p<0.001$). In 190 patients where medial-lateral dimension was comparable, the difference was 0.02 cm, which was not statistically significant. 25.3% of those were greater than 1 cm ($p>0.001$). For subscapularis tears, sensitivity and specificity were 64.3%, and 98.9%. With supraspinatus tears, sensitivity was 98.5% and specificity was 87.0% compared to 60.9% and 98.7% for infraspinatus tears. Comparing bursal and articular sided partial thickness tears, sensitivity was 39.1%, and 61.5%, and specificity was 92.6% and 97.0%, respectively. When looking at full thickness tears, sensitivity was 88.7%, and specificity 76.8%.

CONCLUSION: Imaging is an important part of the diagnosis of rotator cuff tears along with history and physical examination, and can aid in making treatment decisions when contemplating surgical and non-operative options. This study demonstrated a sensitivity of 88.7% for full thickness tears. Ultrasound was most specific for subscapularis and infraspinatus tears, but most sensitive for supraspinatus tears. The difference in A/P size noted at 3 mm is likely not clinically significant, although there were a number of patients with significant discrepancies. These findings indicate that ultrasound is an accurate and reliable imaging technique for rotator cuff tears, and that the results can be utilized to assist treatment decisions. Ultrasound examinations are inexpensive, can be rapidly performed noninvasively, making them attractive for in-office use and suitable for rotator cuff evaluation.

Infection Rates in Arthroscopic vs. Open Rotator Cuff Repair

Abstract ID: Paper 102

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*Justin H. Bartley, M.D.
Kindyle L. Brennan, Ph.D.
Daniel C. Jupiter, Ph.D.
Derek K. Lichota, M.D.
Robert E. Reeve, M.D.
John Welsh, M.D.
William P. Hamilton, M.D.
Temple, TX

BACKGROUND: The prevalence of rotator cuff repair operations continues to rise with a noted transition from open to arthroscopic technique in recent years. One advantage of arthroscopic repair has been a reported lower infection rate in the literature. However, to date, the infection rates of these two techniques have not been compared directly at a single institution with fully integrated medical records.

METHODS: We retrospectively compared the postoperative infection rates between arthroscopic and open rotator cuff repair in 2,909 patients at a single institution using a Fisher's exact test.

RESULTS: A total of 940 patients were managed with an open repair and 1,969 were managed with an arthroscopic repair. Patients who underwent open repair were significantly more likely to develop a postoperative infection, with 13 (1.38%) confirmed infections in the open group vs. 4 (0.20%) in the arthroscopic group ($p < 0.001$).

DISCUSSION AND CONCLUSION: Patients undergoing open rotator cuff repair had a significantly higher rate of postoperative infection in comparison with those undergoing arthroscopic rotator cuff repair. This is the first study to our knowledge that compares the infection rates of arthroscopic vs. open rotator cuff repairs at a single institution with integrated medical records.

Sports Hernia: Role of Dynamic Ultrasound Evaluation

Abstract ID: Paper 103

William K. Vasileff, M.D. / Columbus, OH
Mikhail Nekhline, M.D. / Portland, OR
Patricia A. Kolowich, M.D. / Detroit, MI
Gary B. Talpos, M.D. / Detroit, MI
*Marnix van Holsbeeck, M.D. / Detroit, MI

OBJECTIVES: Sports hernia and athletic pubalgia are significant causes of groin pain and activity limitation in athletes, but there is no consensus regarding the underlying pathology. The purpose of this study was to examine the role of inguinal hernia in athletic pubalgia and determine the diagnostic utility of dynamic ultrasound.

METHODS: 47 athletes with sports-related groin pain underwent dynamic ultrasound to evaluate for inguinal hernia, hip pathology, osteitis pubis, and adductor longus tears. Clinical course and surgical findings were retrospectively reviewed and correlated to diagnostic findings. Results were compared to 41 prospectively evaluated age-matched athletic control subjects.

RESULTS: The 47-subject symptomatic group included 39 males and 8 females. These included 41 patients with direct inguinal hernias (87%), 1 with an indirect hernia, and 5 with normal ultrasound. Of the 41 with direct hernias, 27 were unilateral, and 14 were bilateral. Of those 14 with bilateral hernias, 11 had symptoms bilaterally (23%), and 3 were only symptomatic on the side with the larger hernia (6%). No femoral or obturator hernias were found.

Of 42 patients with proven hernia, 39 significantly improved with herniorrhaphy. Two patients with unilateral positive findings failed to improve after surgery were later diagnosed with adductor longus injury. One patient with positive ultrasound improved with physiotherapy. Five patients with negative sonography were diagnosed with MRI confirmed labral tear (4/5) and osteitis pubis (1/5).

The 41-subject control group revealed 3 direct, 2 indirect, and 3 femoral asymptomatic hernias with 12% (5/41) prevalence of inguinal hernias and 20% (8/41) prevalence of all the groin hernias.

Surgical findings in the direct hernia group corroborated ultrasound describing patulousness of the muscular wall and transversalis fascia, or frank defect of the inguinal canal floor during intraoperative Valsalva maneuver. The sensitivity of dynamic ultrasound in the symptomatic group from surgical and clinical results was 100%, positive predictive value 93%, and negative predictive value 100%. 95% (39/41) of patients with sonographically proven inguinal hernia became asymptomatic or significantly improved after repair.

CONCLUSION: Direct inguinal hernia is an important component of athletic pubalgia. The prevalence of direct inguinal hernia in symptomatic athletes was increased compared to controls ($p<0.001$). Surgical herniorrhaphy is successful, as 95% returned to sport. This pathology reflects a dynamic condition different than classically described hernia, more evident with valsalva maneuver mimicking musculofascial wall stress with athletic activity. Dynamic ultrasound is sensitive and specific for inguinal hernia in the setting of athletic groin pain.

Pitching Performance of Major League Baseball Players After Revision Ulnar Collateral Ligament Reconstruction

Abstract ID: Paper 104

Robert A. Keller, M.D.
*Nathan E. Marshall, M.D.
Jonathan Lynch, M.D.
Vasilios Moutzouros, M.D.
Detroit, MI

INTRODUCTION: Medial ulnar collateral ligament (UCL) reconstruction is a common procedure performed on major league baseball pitchers. As the incidence of UCL injuries increase, so does the number of revision reconstructions. Our purpose was to evaluate pitching statistical performance, return to play, and career longevity in Major League Baseball (MLB) pitchers after undergoing revision surgery.

METHODS: A total of 33 MLB pitchers who had undergone revision UCL reconstruction (UCL-R) were identified and compared with 33 age, position, and performance-matched controls (CTL). Return to play and total years played after revision reconstruction were evaluated. Performance was evaluated 3 years before and after revision reconstruction. Performance statistics collected include: innings pitched, earned run average (ERA), walks hits innings pitched (WHIP), wins above replacement (WAR), runs above replacement (RAR), walks per 9 innings (BB/9), home runs per 9 innings (HR/9), strikeouts per 9 innings (SO/9), strikeouts per walk (SO/BB), hits per 9 innings (H/9), wins, losses, win %, runs against per 9 innings (RA/9), and runs against per 9 innings average (RA/9avg).

RESULTS: 84.8% of pitchers who underwent revision UCL reconstruction returned to sport, but only 65.5% returned to the MLB level. On average, the revision UCL reconstruction pitchers played 0.8 years less in the majors ($p<0.01$) and 0.9 years less total, including minors ($p<0.05$), than the control pitchers. The pitchers who returned to the MLB level post-revision had a similar ERA (UCL-R: 4.88, CTL: 4.76, $p=0.82$) and WHIP (UCL-R: 1.58, CTL: 1.44, $p=0.22$) as compared to the control pitchers. There were significant declines; however, when comparing revision UCL reconstruction pitchers to control pitchers post-revision in terms of innings pitched (UCL-R: 36.95, CTL: 75.00, $p<0.01$), BB/9 (UCL-R: 4.75, CTL: 3.49, $p=<0.01$), wins (UCL-R: 1.88, CTL: 4.10, $p<0.01$) and non-significant declines in WAR (UCL-R: 0.25, CTL: 0.62, $p=0.06$) and RAR (UCL-R: 3.26, CTL: 6.91, $p=0.07$).

DISCUSSION/CONCLUSIONS: MLB pitchers who undergo revision UCL reconstruction return to MLB play at lower rates than primary reconstruction. Many of these pitchers also have shortened careers after return. Pitchers who returned to the MLB level maintained performance in several statistics such as ERA and WHIP; however, pitchers returned with an overall decreased amount of workload with a decreased amount of innings pitched, wins, and an increased amount of walks.

Use of On-Field Physical Examination and Survey to Characterize Youth Pitchers Likely to Under-Report Injuries

Abstract ID: Paper 105

Alan D. Edwards
*Evan P. Larson
Nikhil K. Sahai
John P. Albright, M.D.
Iowa City, IA

CONTEXT: The intensity with which those who still participate in Little League baseball has increased dramatically in recent years. Recent studies have shown that youth pitchers have a propensity to under-report pitching-related arm pain and injuries.

OBJECTIVE: To describe a sample population of youth injury and arm pain under-reporters relative to their counterparts that correctly report the presence or absence of arm pain and injury sustained while pitching.

STUDY DESIGN: Cross-sectiona.l

SETTING: Little League baseball tournaments held during the summers of 2010 and 2012 in and around the Iowa City area.

PARTICIPANTS: 202 Little League baseball players between the ages of 9 and 18.

DATA COLLECTION AND ANALYSIS: A team of athletic training students, medical students, physical therapy students, and registered athletic trainers collected data. The team administered surveys and performed upper extremity physical examinations on all athletes who had pitched in the past 12 months. We then identified differences between the group of under-reporters and correct-reporters using IBM SPSS statistical software.

RESULTS: There was a statistically significant difference between under-reporters and correct-reporters in presence of a pitching injury that caused the athlete to miss practice or game playing time ($p = 0.00093$) and number of pitches thrown in 1 week when in season ($p = 0.047$). There was a difference between the groups that approached statistical significance in pitching when the athlete's arm was tired ($p = 0.079$).

CONCLUSIONS: Predictors of youth pitching injury under-reporting include possibility of loss of practice or game time, pitch count, and pitching when the athlete's arm is tired. A new, shorter survey is needed to further identify characteristics of this population so that they can be monitored and injuries prevented.

Pre- and Post-Season Dynamic Ultrasound Evaluation of the Pitching Elbow

Abstract ID: Paper 106

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*Robert A. Keller, M.D.
Nathan E. Marshall, M.D.
Nima Mehran, M.D.
Hafeez Ahmed, M.D.
Courtney Scher, M.D.
Marnix van Holsbeeck, M.D.
Michael J. Bey, M.D.
Vasilios Moutzouros, M.D.
Detroit, MI

OBJECTIVES: A baseball pitcher places tremendous stresses on the throwing elbow during a season of pitching, particularly to the medial ulnar collateral ligament (UCL). Our purpose was to evaluate the changes of the UCL, and structures about the elbow, using dynamic ultrasound in a cohort of high school varsity pitchers over the course of a single baseball season.

METHODS: Twenty-two high school pitchers (mean age: 16.9 years) were prospectively followed. Each pitcher was evaluated before the start of their season via physical examinations, Modified Disabilities of the Arm, Shoulder, and Hand outcome measures (QuickDASH), and both throwing and non-throwing elbow ultrasound evaluation. Players were then re-evaluated within 1 week of the last game of the season (mean 6 days). Dynamic ultrasound images of preseason non-throwing, throwing, and post-season throwing elbows were then randomized and blinded and evaluated by two fellowship-trained musculoskeletal radiologists. Comparisons between pre- and post-season examinations were evaluated via paired t-test and Fishers Exact tests.

RESULTS: Pitchers pitched a mean of 27.04 innings and 435.4 pitches. Nine (40.1%) players complained of arm pain throughout the season. In comparison of pre-season throwing and non-throwing arms, there was no difference found in regards to UCL thickness ($p=0.48$), UCL heterogeneity ($p>0.99$), unloaded ulnohumeral joint space ($p=0.83$), loaded ulnohumeral joint space ($p=0.30$), or ulnar nerve cross-sectional area ($p=0.29$). When comparing pre-season to post-season there were significant increases in the UCL thickness (1.8 vs. 2.2 mm) ($p=0.02$), ulnar nerve cross-sectional area (5.0 vs. 6.0 sq mm) ($p=0.001$), and UCL substance heterogeneity (32% vs. 41%) ($p=0.001$). In addition, there was a trend towards an increase in the loaded ulnohumeral joint space (3.9 vs. 4.3 mm) ($p=0.10$). Also, no pitchers were found to have loose bodies in the throwing elbow on pre-season examination while 3 demonstrated having loose bodies on post-season examination. DASH scores also increased significantly from pre-season (3.5 ± 6.6) to post-season (10.6 ± 14.7, $p=0.03$).

CONCLUSION: This study is the first to evaluate the elbow, particularly the UCL, of baseball pitchers before and after a season of competition. The stresses placed on the elbow throughout one season of pitching create adaptive changes to multiple structures about the elbow. These findings lend insight to possible pathologic changes in the throwing elbow, such as UCL heterogeneity and thickening, increased ulnohumeral joint space laxity, and enlarged ulnar nerve cross-sectional area.

MAOA BREAKOUT SESSION #8
PEDIATRIC SPINE/ADULT SPINE
April 24, 2015

Percutaneous Pedicle Screw Stabilization without Fusion of Adolescent Thoracolumbar Spine Fractures

Abstract ID: Paper 107

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*Shari Cui, M.D.
Aki S. Puryear, M.D.
Gennadiy Busel, M.D
St. Louis, MO

INTRODUCTION: Pediatric spine trauma results from high-energy mechanisms and is often managed using adult injury criteria. Ligamentous injuries are fused and bony injuries are treated accordingly. A young healthy population, however, possesses greater healing potential and longer time and opportunity for adjacent segment changes. We present the short-term results of a select group of adolescent patients treated using percutaneous pedicle screw instrumentation without fusion.

METHODS: An IRB-approved retrospective review was performed at a Level I pediatric trauma center for all thoracolumbar spine fractures treated by percutaneous pedicle screw instrumentation. Patients were excluded if arthrodesis or anterior stabilization was performed or if instrumentation was not removed. Data was collected on demographics, injury mechanism, associated injuries, fracture classification, surgical data, radiographic data, and complications. Statistical analysis was performed to compare pre- and postoperative radiographic deformity.

RESULTS: Between 2005 and 2013, 46 patients were treated surgically. Of the 17 patients treated by percutaneous fixation (age 10-18 years), 14 met criteria for inclusion (5 males, 9 females). Mechanisms of injury included 8 motor vehicle collisions, 4 falls from height, and 2 all-terrain vehicle/motorcycle collisions. There were 8 Magerl type A injuries, 4 type B injuries, and 2 type C injuries. Average Gaines score was 5.9 (range 0-9) and Thoracolumbar Injury Classification and Severity score was 4.1 (range 2-7). There was 1 incomplete spinal cord injury on presentation. Twelve patients were surgically stabilized during their index admission and 2 were delayed. Implants were removed between 5-12 months in 12 patients and after 12 months in 2 patients. Statistical analysis revealed significant differences in average pre- and postoperative sagittal wedge angle (17.6° to 10.3°, p=0.000), coronal wedge angle (4.7° to 1.5°, p=0.011), and vertebral body height ratio (0.67 to 0.79, p=0.002). There were no neurologic complications, 1 soft-tissue wound infection, and 2 instrumentation failures (treated by standard implant removal). 11 patients ultimately returned to unrestricted activities including sports. Average follow-up was 9 months after implant removal and 19.3 months after index procedure.

CONCLUSION: Adolescent thoracolumbar fractures present unique challenges and treatment opportunities that differ from adult patients. Compliance can be a struggle and long fusions must face an even longer test of time. We present a non-consecutive series of 14 patients temporarily stabilized with percutaneous pedicle screw fixation for injuries including fracture-dislocations and purely ligamentous injuries. Fusionless instrumentation is an available alternative, and can provide successful management in select pediatric thoracolumbar spine trauma.

Association Between Obesity and 30-Day Outcomes for Spinal Arthrodesis in Children

Abstract ID: Paper 108

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*Jason R. Ferrel, M.D.
Justin B. Mahida, M.D.
Lindsey Asti, M.P.H., M.T. (ASCP)
Katherine J. Deans, M.D.
Peter C. Minneci, M.D.
Allan C. Beebe, M.D.
Brian D. Kenney, M.D.
Columbus, OH

INTRODUCTION: Obesity has been associated with adverse surgical outcomes, but the effect of obesity on complication rates in children undergoing spinal arthrodesis is unknown. The purpose of this study was to determine if obesity is associated with higher 30-day complication rates in patients undergoing spinal arthrodesis using a validated national database.

METHODS: We identified all instances of elective spinal arthrodesis performed on patients with neuromuscular, syndromic, or idiopathic spinal disease in the 2012 NSQIP Pediatric public use file and compared demographic, clinical, and 30-day complication rates between obese and non-obese patients. Obesity was defined as BMI ≥ 95th percentile for age and gender. Major complications included deep or organ space surgical site infections, reintubation, pulmonary embolism, ventilator dependence >48 hours, acute renal failure, coma >24 hours, cardiac arrest, peripheral nerve injury, venous thromboembolism, pneumonia, sepsis, unplanned reoperation, and death. Patients were stratified into two groups based on preoperative diagnosis: neuromuscular scoliosis and adolescent idiopathic scoliosis (AIS). Multivariable logistic regression models were fit to determine a risk-adjusted odds ratio (OR) with 95% confidence intervals (CI) of major complications for obese patients after adjusting for other factors associated with obesity on univariable analysis.

CONCLUSION: After adjusting for other factors, obesity is an independent predictor of an increased likelihood of major complications following spinal arthrodesis in children with neuromuscular scoliosis and AIS.

Early Radiographic Results of Sagittal Deformity Correction and Maintenance with Percutaneous Pedicle Screw Stabilization in Thoracic and Lumbar Spine Fractures

Abstract ID: Paper 109

Shari Cui, M.D.
*Irshad A. Shakir, M.D.
Dirk H. Alander, M.D.
St. Louis, MO

INTRODUCTION: Thoracolumbar spine trauma is common and frequently associated with high-energy polytraumatized patients. Percutaneous pedicle screw fixation (PPSF) has evolved as a means of internal bracing to improve mobilization while limiting blood loss, postoperative pain, and soft tissue insult compared to open techniques. We present early radiographic data on its utility in deformity correction and maintenance of correction after implant removal.

METHODS: An IRB-approved retrospective review was performed at a Level I trauma center for all thoracolumbar spine fractures treated by PPSF. Patients were excluded if arthrodesis or anterior stabilization was required, instrumentation was not removed, or they lacked follow-up at the designated intervals. Data was collected on demographics, injury mechanism, fracture classification, and radiographic measurements. Statistical analysis was performed to compare radiographic deformities pre- and postoperatively, and at subsequent intervals after implant removal. A post-removal loss of sagittal plane reduction was defined as any increase in sagittal wedge angle greater than 5° from instrumented values.

RESULTS: Between 2008 and 2013, 27 patients (age 14-79 years) were treated by PPSF and met inclusion criteria; there were 16 males and 11 females. Mechanisms of injury included 10 motor vehicle collisions, 11 falls, 5 motorcycle/all-terrain vehicle injuries, and 1 bicycle injury. Average Gaines score was 6.9 (range 3-9) and Thoracolumbar Injury Classification and Severity score was 4.6 (range 1-9). There were 15 Magerl type A injuries, 6 type B injuries, and 6 type C injuries. Average duration of instrumentation was 4.5 months. Statistically significant differences were seen in vertebral body height ratio preoperatively, after instrumentation, and at each interval after implant removal (0-1 month, 1-6 months, and over 6 months) (P-values<0.05). This significance was also encountered for coronal and sagittal wedge angles. Sagittal plane reduction was lost in 4 patients in the 0-4 week period, in 3 patients between 1-3 months, and in 4 patients between 3-6 months. No patient, who maintained reduction to 6 months, lost sagittal reduction thereafter. Average sagittal plane deformity was improved from preoperative values despite this change (P=0.01).

CONCLUSION: Percutaneous pedicle screw instrumentation for thoracolumbar spine fractures is an effective means to obtain and maintain deformity correction. Though some loss of reduction is experienced after instrumentation removal, measurements are improved from preoperative values. After 6 months, there was limited additional change in deformity. These results support the use of this technique in select patients with thoracolumbar spine trauma, for whom open fusion is a less desirable option.

Primary Osteosarcoma of the Spine: Outcomes and Risk Factors for Survival Using the SEER Program Database

Abstract ID: Paper 110

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*Andrew J. Pugely, M.D. / Iowa City, IA
Kyle R. Duchman, M.D. / Iowa City, IA
Yubo Gao, Ph.D. / Iowa City, IA
Christopher T. Martin, M.D. / Iowa City, IA
Michael P. Kelly, M.D. / St. Louis, MO
Benjamin J. Miller, M.D. / Iowa City, IA

INTRODUCTION: Primary osteosarcoma of the spine is a rare, but devastating primary bone sarcoma. To date, the disease epidemiology and treatment outcomes have been poorly defined. Thus, the purpose of this study was to evaluate the outcomes and risk factors for survival after diagnosis of a primary osteosarcoma of the mobile spine.

METHODS: The SEER Program database was used to identify all patients diagnosed with high-grade primary osseous osteosarcoma of the mobile spine from 1973 to 2011. Patient, tumor, and treatment characteristics including age, sex, race, tumor size, presence of metastatic disease, surgical intervention other than biopsy, and the use of radiation therapy were analyzed to determine differences in cause-specific survival at 2, 5, and 10 years. Univariate and multivariate survival analyses using Kaplan-Meier methods were employed to determine prognostic factors for survival. Additionally, 5-year cause-specific conditional survival, which measures the change in risk of cause-specific mortality given that a patient has survived a defined period of time.

RESULTS: In total, 119 patients were identified with a minimum of 5-year follow-up. The overall cause-specific survival was 56.4% at 2 years, 36.5% at 5-years, and 28.7% at 10-years. Cause-specific survival for patients with local/regional disease at diagnosis was 63.4%, 41.9%, and 30.9% at 2, 5, and 10 years, respectively, while survival for patients with metastatic disease at diagnosis was 17.6% at 2 years with no patients living at 3 years. Univariate analysis revealed metastatic disease at diagnosis ($p < 0.001$), patient age greater than 60 years ($p=0.009$), and absence of surgical intervention other than biopsy ($p < 0.001$) were associated with significantly decreased cause-specific survival at 2 and 5 years. Multivariate analysis revealed metastatic disease at the time of diagnosis (HR at 5 years = 3.73; 95% CI, 1.87-7.42) as a statistically significant independent risk factor for decreased cause-specific survival at 2 and 5 years. Conditional survival analysis revealed that survival conditional on having survived 5 years after diagnosis was significantly improved from baseline (78.7% vs. 36.1%, $p < 0.05$).

CONCLUSIONS: Primary osteosarcoma of the mobile spine is a rare entity with poor long-term survival. Surgical intervention was associated with improved survival at 1 and 5 years. Metastatic disease at the time of diagnosis has a universally dismal prognosis. The 5-year cause-specific conditional survival estimates for patients with primary osteosarcoma continue to improve with each additional year of survival after diagnosis.

Intrawound Vancomycin Powder for Spine Tumor Surgery

Abstract ID: Paper 111

Addisu Mesfin, M.D.
*Richard Okafor, M.D.
Robert W. Molinari, M.D.
William J. Molinari, M.D.
Rochester, NY

INtRODUCTION: Intrawound vancomycin powder has been shown to decrease infection rates following surgery for spine deformity, spine trauma, and degenerative conditions of the spine. Animal studies have also shown the efficacy of intrawound vancomycin powder in eradiating infections. Infections are common complications following spine tumor surgery. No studies to date have specifically evaluated infection rates following intrawound application of vancomycin powder for spine tumor surgery. Our objective was to evaluate infection rates following intrawound vancomycin powder application during spine tumor surgery.

METHODS: Patients ≥18 at a single center undergoing spine tumor surgery and receiving intrawound vancomycin powder from 1/2008 to 6/2014 were identified. This is a single institution, retrospective evaluation of prospectively collected data. Patient demographics, tumor type and location, surgical data, radiation therapy use, infection rates, and death rates were evaluated.

RESULTS: 34 patients (38 procedures) undergoing spine tumor surgery and intrawound vancomycin powder application were identified. Four were excluded (death less than 30 days postoperative) and 30 patients (34 procedures) were enrolled: 11 females and 29 males with an average age of 61.3 years (19 - 86) and average BMI of 26.6 (17.4 – 35.4). Fourteen of 30 (46.7%) were deceased at latest follow-up. Three were primary spine tumors. Five were hematologic malignancies and 22 were metastatic cancers. 17 tumors were in the thoracic spine, 10 in the lumbar, and 3 in the cervical spine.

Average estimated blood loss was 1021 ml (25 to 3500), 15 underwent transpedicular decompressions, and an average of 4.8 levels (2 -14) were fused. Average length of surgery was 232 minutes (90 - 474) and average hospital stay was 15.9 days (3 - 49). Two culture-proven infections (Staphylococcus aureus, Enterobacter cloacae) were noted in 34 procedures (5.9%). Infections were treated with irrigation and debridement and antibiotic administration. Eight (26.7%) had preoperative radiation only; 12 (49%) had postoperative radiation only, 4 (13.3%) had both preoperative and postoperative radiation and 6 (20%) had no radiation. There were no associations between radiation treatment and post-surgical infections (p=0.19).

CONCLUSION: In this first study evaluating intrawound vancomycin powder for spine tumor surgery, we report an infection rate of 5.9%. Compared to previous studies of infection rates ranging from 9.6% to 20% (non-sacral spine tumors), our findings are significant. We also found no correlations between radiation treatment and post-surgical infections (p=0.19). Intrawound vancomycin powder can contribute to decreased infection rates following spine tumor surgery.

Incidental Extra-Spinal Findings in Lumbar Spine MRI: Incidence and Clinical Significance

Abstract ID: Paper 112

Hossein K. Elgafy, M.D.
*Nicholas J. Peters, M.D.
Hassan Semaan, M.D.
Tawfik Obri, M.D.
Paul Aldinger, M.D.
Mohamed Al Natour, M.D.
Jacob Bieszczad, M.D.
Mohamed Bazerbashi, M.D.
Toledo, OH

INTRODUCTION: Lumbar spine MRI is commonly used to evaluate patients with low back pain (LBP). Occasionally, the lumbar spine MRI reveal many incidental extra-spinal findings that may contribute to the LBP or more importantly identify an extra-spinal pathology, such as malignant lesion, that may require urgent further investigations and management. The primary objective of the current study was to determine the prevalence and types of the incidental extra-spinal findings in adult patients undergoing MRI of the lumbar spine. The secondary objective was to evaluate the non-detection rates of findings that were not mentioned in the original radiological report.

METHODS: After obtaining IRB approval, a retrospective database review was performed to identify all patients older than 18 years that had lumbar spine MRI for LBP in our institution from January 2011 to December 2013. Repeated cases of lumbar spine MRI and all cases with known history of trauma were excluded. A total of 3,024 lumbar spine MRI cases were identified and included in current study. All incidental extra-spinal findings mentioned in radiology reports were recorded. The MRI scans were systematically reviewed by a musculoskeletal radiologist, a urologist, and an orthopedic spine surgeon to identify all extra-spinal findings. The three researchers findings were then compared to the original radiology reports, to determine non-detection rate. Incidental extra-spinal findings were classified according to the organ involved, as well as the model adopted by the modified CT colonography reporting and Data system (C-RADS).

RESULTS: Incidental extra-spinal findings were found in 671 (22%) of 3,024 lumbar spine MRI. 380 were women (57%) and 292 of cases were men (43%). 616 (75%) were categorized E2 (clinically unimportant finding), 163 (20%) were categorized E3 (likely unimportant finding), and 38 (5%) were categorized E4 (potentially important finding). By means of the structured approach used, non-detected findings accounted for 305 of 817 (non-detection rate = 37%), while non-detected findings of E4 category alone were only 11 out of 38 (29%).

CONCLUSIONS: The current study confirmed that incidental extra-spinal findings on lumbar spine MRI are significantly common (22%). There was statistically significant association between incidental extra-spinal findings, age, and female sex. This study showed that non-detection rate was high. Based on these findings, it is recommended that on routine lumbar spine MRI, extra-spinal structures should be carefully evaluated especially in certain categories such as elderly patients and those whom their lumbar spine findings cannot explain their LBP.

The Clinical Utility of MRI for Cervical Spine Evaluation and Clearance Following Blunt Trauma

Abstract ID: Paper 113

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*Byron F. Stephens, M.D.
Richard A. Smith, Ph.D.
Keith D. Williams, M.D.
Memphis, TN

INTRODUCTION: The optimal algorithm for the evaluation of patients following cervical spine trauma continues to be the subject of significant debate. Some experts believe that CT alone is adequate for cervical spine evaluation in the absence of neurologic deficit. However, the incidence of acute abnormalities detected by MRI but not by CT is as high as 20.9%. MRI has a reported 97.2% sensitivity and 98.5% specificity in detecting cervical spine injury. Despite its reported efficacy, controversy still remains and there is a dearth of information regarding how often patient care is actually changed by MRI results.

MATERIALS/METHODS: A retrospective review of our Level I trauma center's registry was performed, identifying 105 blunt trauma patients over a 5-month period that underwent both CT and MRI of the cervical spine based on our current algorithm. Basic patient information was collected and presented in a blinded fashion to an attending spine surgeon with over 20 years of experience treating traumatic spine injury. The CT was then reviewed and treatment recommendations were recorded. Subsequently, the MRI was reviewed and additional injuries and changes in treatment recommendations were recorded. Discordance between the CT and MRI treatment recommendations was noted, as was agreement or disagreement with the attending radiologist's MRI report.

RESULTS: 105 patients were identified in our study. 69.5% of patients were male and the average age was 46.4 years. There was a 25.2% disagreement rate between the spine surgeon's and radiologist's interpretation of the MRI. Overall, the treatment of 9 patients (8.6%) was altered by additional injuries elucidated by MRI. 3 patients were treated with external immobilization based on injury identified on MRI. 6 patients (5.7%) were treated surgically due to additional injury provided by MRI. Of the 39 patients with negative CT results, MRI analysis altered treatment in 9 (or 23.1%).

CONCLUSIONS: In this retrospective review of patients with cervical fracture or obtunded mental status, we found that information gained from MRI changed the patient's treatment in 8.6% of cases, including 5.7% of patients whose treatment was changed from conservative to operative management. Despite inherent study design weaknesses (retrospective review, single institution, single surgeon), we feel that our study exemplifies the utility of MRI in evaluating patients with subaxial cervical spine fractures and those with significant head trauma. Further study is needed to prospectively confirm our results with multiple surgeons and to define the cost-effectiveness of MRI in this setting.

Thromboembolic Disease After Cervical Spine Surgery: A Review of 5,405 Procedures and Matched Cohort

Abstract ID: Paper 114

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*Arjun S. Sebastian, M.D.
Bradford L. Currier, M.D.
Peter S. Rose, M.D.
Dirk Larson, B.S.
Paul M. Huddleston, M.D.
Michael J. Yaszemski, M.D., Ph.D.
Ahmad Nassr, M.D.
Rochester, MN

INTRODUCTION: The majority of the literature on venous thromboembolism (VTE) in spine surgery is limited to studies of thoracolumbar surgery. Furthermore, many of these studies involve analysis of high risk patients with spinal deformity or trauma. The incidence and risk factors for VTE following cervical spine surgery need to be better defined.

METHODS: 5,405 patients were identified at our institution as having undergone cervical diskectomy, laminectomy, corpectomy, laminoplasty, or fusion between 1995 and 2012. 85/5405 (1.57%) suffered either a DVT (55) or PE (51). The frequency of several medical comorbidities was determined. The cases were matched 2:1 to controls based on age, gender, and date of surgery. Data was collected regarding length of stay, indications, comorbid traumatic injuries, surgical approach, number of operated levels, blood loss, paralysis, use of iliac crest autograft, and staged surgery. Univariate and multivariate analysis were performed to determine significant predictors of thromboembolic disease.

RESULTS: Several significant risk factors were identified for postoperative VTE in the 5,405 patient cohort. Significant medical comorbidities included chronic venous insufficiency (OR=3.40), atrial fibrillation (OR=2.69), obesity (OR=2.67), and ischemic heart disease (OR=2.18). 82 VTE cases were matched to a cohort of 164 controls. Staged surgery (OR=28.0), paralysis (OR=19.0), combined anterior-posterior approach (OR=7.46), surgery for infection (OR=18.5), surgery for trauma (OR=11.1), comorbid traumatic injuries (OR > 10), oncologic procedures (OR = 5.2), use of iliac crest autograft (OR=4.16), two or more surgical levels (OR=3.48), blood loss greater than 300 cc (OR = 1.66), and length of stay five days or greater (OR=3.47) were all found to be significant risk factors for VTE ($p<0.05$) in a univariate analysis of the matched cohort. Multivariate analysis found staged surgery (OR=35.7), paralysis (OR=7.86), and nonelective surgery (OR=6.29) to be independent risk factors for VTE.

DISCUSSION AND CONCLUSION: Although the incidence of VTE following cervical spine surgery is fairly low, we have identified several risk factors which are predictive. Of note, patients who underwent staged surgery, nonelective surgery, or suffered paralysis were several times more likely to have had a thromboembolic event in our study. More aggressive approaches to prophylaxis and surveillance in certain patient populations may be warranted.

Anterior Fixation of Floating Facet Fractures in the Cervical Spine. A Prospective Case Series and Biomechanical Analysis

Abstract ID: Paper 115

Christopher D. Chaput, M.D. / Temple, TX
*Nathan B. Haile, M.D. / Temple, TX
Aditya Muzumdar, M.S. / Audubon, PA
David Gloystein, M.D. / Fort Hood, TX
Vasilios Zerris, M.D. / Temple, TX
P. Justin Tortolani, M.D. / Baltimore, MD
Mark Moldavsky, B.S. / Audubon, PA
Suresh Chinthakunta, M.S. / Audubon, PA

BACKGROUND CONTEXT: Unilateral fractures involving complete separation of the lateral mass from the vertebra and lamina (floating facet) are a unique subset of cervical spine fractures. Despite a seemingly benign fracture pattern, these injuries are at significant risk of displacement without operative fixation. Posterior fixation has proven to facilitate adequate fusion. However, there is little data regarding the clinical success of anterior fixation.

STUDY DESIGN: 1. Laboratory-based biomechanical evaluation of floating facet fractures 2. Prospective case series of patients with rotationally unstable floating fractures treated with anterior fixation using an integrated cage-screw device with anterior plating (ISPP).

BIOMECHANICAL AND PATIENT SAMPLE: Seven fresh human cadaver cervical spines (C2-C7), 13 patients with floating facet fractures.

MATERIALS AND METHODS: Biomechanical: Segmental flexibility testing was performed in human cadaveric cervical spines using a floating facet injury model using two types of single-level anterior fixation and one type of two-level posterior fixation were compared. Clinical: 13 patients with a floating facet fracture of the cervical spine underwent anterior fixation with a cage and 2 integrated screws device in additional to standard anterior plating. Cervical radiographs were obtained to assess bone healing and alignment, and clinical outcomes were retrospectively reviewed.

RESULTS: All instrumented constructs significantly ($p<0.05$) reduced ROM compared with injured condition in all 3 planes of motion. All instrumented constructs also significantly ($p<0.05$) reduced ROM compared with the intact condition in lateral bending. Posterior instrumentation (PI) (11 ± 5%) and anterior fixation with cervical plate and interbody spacer (SP) (18 ± 9%) constructs significantly reduced ROM compared with the intact condition (100%) in flexion/extension. The PI (13 ± 8%) construct significantly ($p<0.05$) reduced ROM compared to the intact (100%) condition for axial rotation. The SP (71 ± 40%) and ISPP (48 ± 26%) constructs reduced ROM compared to the intact condition for axial rotation, without statistical significance. Thirteen patients with floating facet fractures of the cervical spine were treated with an ISPP and followed clinically and radiographically. There were no long-term complications, subsidence >2 mm, failure of fixation, re-operation, pseudoarthrosis, or significant adjacent segment listhesis at final follow-up.

CONCLUSIONS: The addition of two screws placed through a cervical cage can improve anterior fixation in a human cadaveric model of floating facet fractures. Early clinical results in

patients with this injury pattern demonstrate a low complication rate and a high rate of healing with single level anterior fixation using this technique.

What Are the Risk Factors Associated with Mortality After Type II and Type III Odontoid Fractures in the Elderly?

Abstract ID: Paper 116

Tan Chen, B.S.
Debra L. Sietsema, Ph.D., R.N.
Michael T. Merrick, M.D.
Casey L. Smith, M.D.
*Clifford B. Jones, M.D.
Scott S. Russo, M.D.
James R. Stubbart, M.D.
Grand Rapids, MI

PURPOSE: Odontoid fractures occur in approximately 10-15% of cervical fractures with an increasing incidence in the older population. Operative and nonoperative treatments of these fractures have created controversy due to the relatively high complication rates especially in the elderly. Older patients frequently have significant medical comorbidities, poor ability to tolerate external immobilization, and poor healing potential. Treatment varies based on fracture pattern, age, comorbidity, and body habitus. These factors affect complications and ultimately mortality. Previous studies focusing on risk factors associated with injury mortality have not been comprehensive and often inconclusive. The purpose of this study was to analyze risk factors for mortality in Type II and III Odontoid fractures.

METHODS: Between 2002 and 2011, 97 consecutive patients, age 65 years and older, with Type 2 and Type 3 odontoid fractures were treated at a single Level I teaching trauma center, followed in a single large orthopedic private practice, and retrospectively evaluated. Demographics and comorbidities, individually and using the Charlson Comorbidity Index, were recorded. Mortality was determined up to one year follow-up. There were 43 (44.3%) males and 54 (55.7%) females with an average age of 81 (range 65 - 100) and Body Mass Index (BMI, kg/m^2) of 26.3 (range 16.9-37.5). There were 74 (76.3%) Type II and 23 (23.7%) Type III fractures.

RESULTS: The mortality was 23.7% (23) with a mean of 27.3 days (range same day - 172) following injury. Fourteen (60.9%) died within three weeks of injury. One (4.3%) operative case died 20 days after surgery. Compared to the survivors, those that died were older (80 vs. 85 years, $p=0.008$) with a lower BMI (26.9 vs. 24.3, $p=0.014$) and Charlson Index (1.9 vs. 4.6, $p<0.001$). Individual comorbidities associated with death were history of dementia, congestive heart failure, non-metastatic tumor, moderate to severe renal disease, myocardial infarction, and peripheral vascular disease ($p<0.05$).

CONCLUSION: A one-year mortality rate of 23.7% occurred with the highest rate within 3 weeks post injury. Mortality occurred more frequently among those of normal weight and older with increased comorbidities. Management of odontoid injuries in the elderly should be individualized based on risk factors.

Selective Thoracic Fusion of Lenke I and II Curves Affects Sagittal Profiles, but not Sagittal or Spino-Pelvic Alignment: A Case-Control Study

Abstract ID: Paper 117

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*Zachary G. Ries, M.D.
Christopher M. Graves, M.D.
Bethany G. Harpole, B.S.
Sergio A. Mendoza-Lattes, M.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

INTRODUCTION: Sagittal profiles and alignment of the spine has gained significant attention in spinal deformity outcomes. The sagittal profile of AIS patients has been previously reported, as well as the effects of surgical correction, with inconsistent results and no clear references to non-scoliotic controls. The purpose of this study is to compare the pre- and postoperative sagittal profiles of adolescent patients with scoliosis (Lenke I and II curves) with an age-matched cohort of non-scoliotic individuals to examine the effects of surgery on the fused thoracic spine and unfused lumbar spine. Additionally, these data will be compared to previously-published reports.

METHODS: Sagittal profiles of 50 patients presenting with Lenke I or II AIS curves treated with selective thoracic fusion were compared to 32 age-matched controls without spinal pathology. Baseline, 6-month and 2-year postoperative standardized standing radiographs were measured. Sagittal parameters examined include Pelvic Incidence (PI), Pelvic Tilt (PT), C7-Plumbline (SVA), Thoracic Kyphosis (TK) and Lumbar Lordosis (LL). A literature review was performed comparing previously published data. Data is presented as mean (95% Confidence Interval). $P<0.05$ was considered significant.

RESULTS: Interobserver reliability (Cohen's $\kappa = 0.49 - 0.95$). All demographic and preoperative sagittal alignment parameters were comparable between controls and AIS patients prior to surgery. Following selective thoracic fusion, TK decreased significantly from baseline 37.0° (8.9-65.2) vs. (32.3° [8.9-55.7]; $p=0.03$) at 6 months and at 2 years (30.8° [7.2-54.5] $p=0.05$). The LL significantly decreased at 6 months from baseline (54.5° [28.6-80.5] vs. 61.8° [33.4-90.1]; $p<0.001$) and at 2 years (55.4° [29.0-81.9]; $p<0.001$). SVA, PT, and PI were comparable between controls and AIS patients at baseline, and did not vary with surgery.

CONCLUSIONS: Adolescents with Lenke I or II curves have comparable sagittal profiles to those of healthy controls of the same age. Following selective thoracic fusion, AIS patients have a significantly decreased TK, which is accompanied by reciprocal changes in the non-instrumented lumbar curve. SVA and PT are not significantly affected. These results agree with previous reports, which suggest that constructs with pedicle-screws have a higher impact on sagittal curves, but do not affect sagittal or spino-pelvic alignment. The long-term effects of abnormal sagittal profiles need further clarification.

Effectiveness and Safety of Transforaminal Lumbar Interbody Fusion in Revision Lumbar Surgery Patients with Previous Laminectomy

Abstract ID: Paper 118

Hossein K. Elgafy, M.D.
*Doug E. Olson, M.D.
Jiayong Liu, M.D.
Caitlin Lewis, B.S.
Hassan Semaan, M.D.
Toledo, OH

BACKGROUND: Revision lumbar spine surgeries are technically demanding. Interbody fusion is used in such cases to improve the fusion rate, and in some patients to correct the sagittal and coronal imbalance. The postoperative fibrosis and adhesions that occurs following lumbar spinal laminectomy creates some challenges arising from dural or nerve root retraction with the posterior approach.

PURPOSE: To determine the efficacy and safety of transforaminal lumbar interbody fusion (TLIF) for revision lumbar spine surgery in patients with previous laminectomy. The secondary objective was to evaluate the clinical and radiological outcome after such a procedure.

STUDY DESIGN: Retrospective case series study.

PATIENT SAMPLE: Eighty-two patients were included. There were 48 women (58.5%) and 34 men (41.5%) with a mean age of 51 years (range 26-84) at the time of index procedure.

OUTCOME MEASURES: Oswestry Disability Index and visual analog scale for back and leg pain.

METHODS: The outpatient and inpatient charts were reviewed to identify patients' demographic data, preoperative, perioperative, and postoperative data. An independent spine surgeon and musculoskeletal radiologist reviewed the imaging studies.

RESULTS: The average operative time was 160 minutes (range 131-250). The average estimated blood loss (EBL) was 652 cc (100-1400 cc). Nineteen patients (23.1%) required blood transfusion. Five patients (6%) had dural tear. One patient (1.2%) had a surgical site infection. Two patients (2.4%) had thromboembolic events. The average hospital stay was 3.8 days (2-5 days). At a mean follow-up of 28 months, there were statistically significant improvement in the ODI and VAS for back and leg pain. None of the patients' radiographs showed hardware failure or pedicle screw loosening and no patient returned to the operating room for pseudarthrosis.

CONCLUSION: The current study confirmed that TLIF approach in patients with previous laminectomy is effective, safe, and with good outcomes. The debate continues, on the optimal approach for revision lumbar spine surgery, front, back, lateral or combined. What to do still strongly depends on the surgeons' preference as informed by training, expertise, and the past experience of what works best in their hands.

Prospective Evaluation of Radiculitis Following BMP-2 Use for Interbody Arthrodesis in Spine Surgery♦

Abstract ID: Paper 119

Arjun S. Sebastian, M.D.
Paul M. Huddleston, M.D.
Mark A. Pichelmann, M.D.
Bradford L. Currier, M.D.
Grigoriy Arutyunyan, M.D
*Jeremy L. Fogelson, M.D.
Vickie M. Treder, B.S.
Ahmad Nassr, M.D.
Rochester, MN

INTRODUCTION: Recently, the use of BMP in transforaminal lumbar interbody fusion (TLIF) has been examined. Concerns have been raised regarding the use of BMP close to nerve roots as it may cause inflammation or heterotopic ossification leading to postoperative radiculitis. Prospective studies regarding use of BMP in TLIF are lacking. The purpose of this study is to evaluate the safety and efficacy of BMP-2 use in TLIF with regards to postoperative radiculitis.

METHODS: Between May 2009 and September 2013, 77 patients were enrolled in this prospective study. Use of BMP-2 was determined on an individual basis. Demographic and operative characteristics were recorded. Fusion rates were determined by a blinded reviewer and several functional outcomes were collected including visual analog pain scores (VAS), Oswestry Disability Index (ODI), Sciatica Bothersome Index (SBI), and Short Form-36 (SF-36) scores. Outcomes data was collected at each follow-up visit.

RESULTS: Of the 77 patients enrolled, 29 received BMP and 48 did not. There were no significant differences between the two groups with regards to age, sex, diabetes, tobacco use, revision surgery, and number of levels. Increased use of allograft spacers (60.4% vs. 3.5%, $p < .001$), iliac crest autograft (41.7% vs. 6.9%, $p = .001$), and blood loss (1035.2 vs. 608.6 cc, $p = .042$) were noted in the control group. There were significant improvements in postoperative leg pain as measured by VAS leg and SBI scores for the entire cohort without significant differences between the BMP and control groups. Significant improvements were also found in VAS back, ODI, and SF-36 scores for the entire cohort without significant differences between groups. A significantly increased 6-month fusion rate was noted in the BMP group (82.8% vs. 55.3%, $p = .024$) with no significant difference at 12 months (100% vs. 86.8%, $p = .147$) and 24 months (100% vs. 90.9%, $p=.466$) follow-up. Heterotopic ossification was appreciated in 7 patients, 6 in the BMP group and 1 in the control group, without any clinical impact.

CONCLUSION: In this prospective trial, the use of BMP in TLIF did not lead to significant postoperative radiculitis as measured by VAS leg and SBI scores. BMP did increase short-term fusion rates and led to less blood loss. Back pain and other functional outcome scores also improved following TLIF with no difference between BMP and control groups. Careful use of BMP in TLIF appears to be both safe and efficacious.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (Bone Morphogenetic Protein is used off label in transforaminal interbody fusion).

Modifiable Risk Factors in Patients with Low Back Pain

Abstract ID: Paper 120

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*Scott T. Shemory, M.D.
Kiel J. Pfefferle, M.D.
Ian M. Gradisar, M.D.
Akron, OH

PURPOSE/OBJECTIVE: Low back pain (LBP) is a common diagnosis and results in increases in disability, sick days, and medical costs to society. Many studies have evaluated risk factors related to LBP, with conflicting results. Determining modifiable risk factors for LBP is important to help avoid the morbidity and cost associated with chronic symptoms. The goal of this study is to determine the relative risk of LBP in patients with risk factors of nicotine dependence, obesity, alcohol abuse, and depressive disorders.

METHODS: A commercially available software platform was used to mine a pooled electronic healthcare database consisting of the medical records of over 26 million patients. 1.2 million individuals had the diagnosis of LBP. The incidence of LBP in patients regarding nicotine dependence, obesity (BMI >30), depressive disorders, and alcohol abuse were determined, and relative risks were calculated for the defined risk factors. The Pearson's Chi Squared statistical instrument was used to determine significance with a $p=0.05$.

RESULTS: The incidence of LBP in the general population was found to be 4.54%. The incidence of LBP was 16.53% in nicotine dependent patients, 14.66% in alcohol abuse patients, 16.75% in patients with a BMI >30, and 19.30% in patients with a depressive disorder. Patients with nicotine dependence, obesity, depressive disorders, and alcohol abuse were determined to have relative risks of 4.49, 6.01, 5.51, and 3.33 for LBP, respectively, when compared to the group without the defined risk factor. A statistically significant difference was found in the incidence of LBP between all four groups with the risk factors evaluated and the general population ($p<0.05$).

CONCLUSION: To minimize the morbidity, cost, and potential disability in patients diagnosed with low back pain, it is important to determine modifiable and treatable patient risk factors. Defining patient risk factors for developing low back pain will enable physicians to more closely monitor and counsel at-risk patients to help prevent development and progression of their pain. Nicotine dependence, obesity, depressive disorders, and alcohol abuse were determined to be significant patient risk factors for low back pain in our cohort of 26 million patients.

MAOA BREAKOUT SESSION #9
TOTAL KNEE ARTHROPLASTY
April 24, 2015

Increased Risk of Postoperative Complications After TKA in Patients with Previous Patellectomy: A Matched Cohort Analysis of 134 Knees

Abstract ID: Paper 121

Omar Haque
*Hilal Maradit Kremers, M.D.
Walter K. Kremers, Ph.D.
Daniel J. Berry, M.D.
David G. Lewallen, M.D.
Robert T. Trousdale, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Few studies have reported the long-term results of total knee arthroplasty (TKA) in patients after previous patellectomy and compared them to patients undergoing TKA with intact patella. Thus, the objective of this study was to assess the long-term clinical outcomes and survivorship of primary TKA among patients who previously had a patellectomy.

METHODS: This study included 13,257 patients with degenerative arthritis who underwent 17,946 primary TKA procedures. In this cohort, a total of 134 (0.75%) knees in 127 patients had previous patellectomy at the time of primary TKA surgery. The constraint type of the 134 post-patellectomy knees was 81 posterior-stabilized (PS), 50 cruciate-retaining (CR), and 3 constraint-condylar knees (CCK). TKA procedures were performed using 20 different femoral components (63% various PFC designs). Statistical analyses were performed in two ways: (a) multivariable Cox regression analysis adjusting on age, sex, surgery year, femoral component type, and PCL status, and (b) matched cohort analysis with matching of post-patellectomy TKA surgeries to intact patella surgeries on age, sex, surgery year, PCL status, and femoral component type.

RESULTS: We identified 58 complications (the most common being soft tissue contracture and limited motion, hematoma, and infection) and 21 all-cause revision surgeries during long-term follow-up of 134 post-patellectomy knees. Survivorship free from revision in post-patellectomy knees was 91%, 82%, and 80%, respectively at 5, 10, and 15 years. In age, sex, surgery year, femoral component type, and constraint type adjusted Cox regression analyses, the risk of complications (Hazards Ratio: 1.38, 95% Confidence Interval: 1.05, 1.81) was significantly higher among post-patellectomy knees, but revisions did not reach significance (HR: 1.32, 95% CI: 0.80, 2.18). There was no significant difference in complications (CR vs. PS: HR: 0.56, 95% CI: 0.31, 1.05) or revisions (CR vs. PS: HR: 0.72, 95% CI: 0.25, 2.12) when comparing constraint type. The results of the matched cohort analyses (based on 134 post-patellectomy knees and 526 resurfaced knees) were almost identical. Previous patellectomy was associated with a higher risk of complications (HR: 1.47, 95% CI: 1.13, 1.92), but not revisions (HR: 1.18, 95% CI: 0.76, 1.85).

CONCLUSION: This large post-patellectomy series of TKA show an increased risk of

complications in these patients (most commonly arthrofibrosis, postoperative hematoma, and wound problems). However, the risk of revisions was not significantly elevated when compared to a tightly-matched cohort of patients with resurfaced patellae at the time of TKA.

Prior Patella Fracture Has No Effect on Long-Term Survivorship of TKAs

Abstract ID: Paper 122

Matthew T. Houdek, M.D.
Chad D. Watts, M.D.
Eric R. Wagner, M.D.
Steven F. Shannon, M.D.
*Matthew M. Crowe, M.D.
Matthew P. Abdel, M.D.
S. Andrew Sems, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Previous studies have shown that patients who undergo a total knee arthroplasty (TKA) following a distal femur and/or tibial plateau fracture have diminished implant survival. To our knowledge, there are no previous studies examining the outcomes of patients who sustained a patellar fracture prior to TKA. The purpose of this study was to evaluate the long-term survivorship of patients undergoing TKA following a previous patellar fracture.

METHODS: We retrospectively identified 122 patients who underwent a TKA with a previous patella fracture from 1990-2013. Kaplan-Meier survivorship and complications were assessed. Component survival rates were compared to 20,474 patients undergoing TKA for osteoarthritis (OA) during the same time period. Mean age was 66 years, with 57% female and 18% obese. Fifty-seven percent of fractures were treated operatively, including 37% with open reduction internal fixation, 12% with partial patellectomy, and 8% with total patellectomy. Forty percent of patients underwent removal of hardware prior to TKA, and 86% of patients had a resurfaced patella. Mean follow-up was 6 years.

RESULTS: The mean 5-, 10-, and 15-year survival for TKA following a previous patella fracture was 93%, 91%, and 86%, respectively. There was no difference (HR 0.71, $p = 0.31$) in survival between patients with a previous patellar fracture and those undergoing TKA for OA, where 5-, 10-, and 15-year survivorship were 97%, 93%, and 86%, respectively. The mean time to revision TKA and reoperation for any cause was 2.9 and 2.2 years; occurring in 7% and 19% of patients, respectively. However, patients with a previous patella fracture did have increased rates of arthrofibrosis ($p = 0.005$), need for manipulation under anesthesia ($p = 0.0001$), and patellar component loosening ($p = 0.0001$). Hazard ratios showed that age <60 increased the risk of reoperation (HR 2.48 [95% CI 1.01-5.81] $p=0.04$.)

DISCUSSION: Patients who undergo primary TKA following a patella fracture have similar overall revision free survival compared to those undergoing TKA for OA at 15 years. However, patients with a previous patella fracture had significantly increased rates of complications related to motion and patellar component loosening.

Patient Characteristics Affect the Anatomic Dimensions of the Patella

Abstract ID: Paper 123

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*Timothy D. Gossett, B.S.
Sapan H. Shah, B.S.
Joseph D. Morrison, B.S.
Vincent M. Moretti, M.D.
Samuel J. Chmell, M.D.
Chicago, IL

SUMMARY: Patella dimensions vary with patient factors. Short patients, females, and low-weight patients are more likely to have a small/thin patella, with potentially increased fracture risk after resurfacing.

INTRODUCTION: Patellar fractures, while uncommon, can present as a severe complication following total knee arthroplasty. Literature suggests that a minimum of 12-15 mm of patellar thickness post-resection lowers the risk of patellar fracture. However, little is known about which patients are at risk of having a small/thin patella. This study's goal was to define standard patella sizes and evaluate its variability across different patient demographics.

PATIENTS AND METHODS: MRI studies of the knee were retrospectively reviewed for 144 adult patients. On axial images, patella thickness was the distance between the anterior and posterior patellar borders. On coronal images, the patella length was the distance between the superior and inferior patellar poles, and patella width was the distance between the medial and lateral patellar borders. Recorded data included patient age, gender, ethnicity, height, weight, and BMI. Statistical analysis was performed using Pearson's correlation coefficient (r), Student's t-test, and ANOVA with a significance level of 0.05.

RESULTS: Mean patient age was 45.3 years (18.0-76.0). 81 patients were female and 63 were male. Mean reported patient height, weight, and BMI were 1.69 m (1.27-2.03), 90.0 kg (46.5-189.0), and 31.78 (13.56-48.75), respectively. 53% of patients were African-American, 26% Caucasian, 12% Hispanic, 9% other, and <1% Asian.

The mean thickness, height, and width of the patella were 23.3 mm (15.8-29.6), 39.3 mm (28.4-52.0), and 42.1 mm (32.2-54.8), respectively. Patella thickness demonstrated moderate correlation with patient height (r=0.44), weak correlation with weight (r=0.22), and weak negative correlation with age (r=-0.13). Patella height demonstrated moderate correlation with patient height (r=0.53), weak correlation with weight (r=0.14), and no correlation with age (r=-0.00). Patella width demonstrated moderate correlation with patient height (r=0.52), weak correlation with weight (r=0.25), and weak correlation with age (r=0.16).

Statistically significant ($p<0.05$) decreases in patellar thickness, width, and length were found for patients shorter than 1.7 m, females, and patients weighing <88 kg. Age, ethnicity, and BMI were not significant for changes in patellar dimensions.

DISCUSSION: This study suggests that patella dimensions can vary with patient demographics. Short patients (<1.7 m), females, and low-weight patients (<88 kg) are most likely to have a small/thin patella, potentially placing them at risk of fracture after patella resurfacing. When

patient risk factors are present, surgeons should preoperatively consider using custom implants or not resurfacing the patella.

Perioperative Outcomes Following Unilateral vs. Bilateral Total Knee Arthroplasty

Abstract ID: Paper 124

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*Linda I. Suleiman, M.D.
Adam Edelstein, M.D.
Rachel E. Mednick, M.D.
Hasham M. Alvi, M.D.
Mary J. Kwasny, ScD
Matthew D. Beal, M.D.
David W. Manning, M.D.
Chicago, IL

INTRODUCTION: Bilateral simultaneous total knee arthroplasty (B-TKA), when compared to staged bilateral surgery over time, has been proposed to shorten patient rehabilitation, limit anesthetic exposure, and reduce cost. These benefits must be considered within the context of potential increased perioperative complication risk. In this study, we aim to utilize a large national database to compare medical and surgical complication risk in patients undergoing unilateral TKA and B-TKA.

METHODS: Using the American College of Surgeons - National Surgical Quality Improvement Program (ACS-NSQIP) 2010-2012 data, a study population was generated using the CPT code for total knee arthroplasty (27447). Bilateral cases were identified via concurrent procedure coding. Demographic characteristics, comorbidity burden, and 30-day outcomes - including complications, reoperation, length of hospital stay, readmission, and mortality - were studied using a propensity score-matched analysis. Propensity scores were calculated for each patient using a logistic regression model and were matched using a variable ratio approach. Outcomes were then compared using conditional logistic or negative binomial regression models. Significance was defined at $p < 0.05$.

RESULTS: After propensity matching, a total of 4,489 patients (3,516 TKA, 973 B-TKA) were available for analysis. No significant difference in demographic or comorbidity variables existed between the groups. Bilateral TKA was associated with increased overall complications (OR 1.48, p=0.023), medical complications (OR 1.88, p=0.002), and reoperation risk (OR 2.12, p=0.020). Total length of hospital stay (4.0 vs. 3.4 days, $P<0.001$) was significantly longer following B-TKA. There was no significant difference in surgical complications (p=0.267), specifically periprosthetic infection (p=0.982), readmission rate (p=0.675), or 30-day mortality (p=0.925). There was a strong positive association between increasing ASA class and postoperative medical and surgical complication risk in both the unilateral and bilateral groups.

CONCLUSION: Bilateral TKA is associated with an increased risk of postoperative complication, reoperation, and overall longer hospital stays compared to unilateral TKA. Perioperative complication risk is increased in patients with increasing ASA class. Our findings should assist physicians and patients in performing accurate relative risk assessment when considering B-TKA.

Complex Primary Total Knee Arthroplasty: 25-Year Results

Abstract ID: Paper 125

John R. Martin, M.D.
*Taylor R. Beahrs, M.D.
Matthew T. Houdek, M.D.
Eric R. Wagner, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Primary total knee arthroplasty is a safe and reproducible surgery on most patients. However, with increasing preoperative deformity, ligamentous instability, and bone loss, a more constrained implant may be necessary to improve initial outcomes. These complex primary total knee arthroplasties are often performed with implants ranging in constraint from a varus-valgus constrained implant to a hinge. We present the long-term outcomes in this patient population including revision and implant survival rates as well as compare various implant type.

METHODS: Utilizing the joint registry at our institution, all primary total knees performed between 1979 and 2013 were identified. This included 30,784 primary total knee arthroplasties, which were limited to only those performed utilizing a varus-valgus constrained VVC (n=325), fixed-hinge FH (n=248), or rotating-hinge RH design (n=46). Complication rates and implant survival rates at 5, 10, 20, and 25 years were determined for each implant. Hazard ratios were calculated for each implant type compared to a standard posterior stabilized total knee arthroplasty.

RESULTS: The overall reoperation and implant revision free survival rates for the VVC implant at 5, 10, and 20 years was 82.53%, 76.68%, and 59.32%, and 97.10%, 93.30% and 78.18%, respectively. The overall reoperation and implant revision free survival rates for the FH implant at 5, 10, 20, and 25 years was 63.72%, 49.81%, 19.45%, and 19.45%, and 91.85%, 79.32%, 57.25%, and 57.25%, respectively. The overall reoperation and implant revision free survival rates for the RP implant at 5 and 10 years was 79.31% and 79.31%, and 97.22% and 97.22%, respectively. The hazard ratios for any reoperation and implant revision were 2.20 ($p<0.001$) and 2.41 ($p<0.001$) for the VVC implant, 5.51 ($p<0.001$) and 6.23 ($p<0.001$) for the FH implant, and 1.79 ($p=0.244$) and 3.96 ($p=0.170$) for the RP implant.

CONCLUSIONS: Complex primary total knee arthroplasty is associated with a statistically significantly increased reoperation and revision rate compared with standard primary total knee arthroplasty. There is approximately a two to six times increased risk of revision in patients that require a more constrained implant. This study should not be utilized to discourage the use of constrained implants; however, should serve as a reference when discussing implant survival and revision rates in patients requiring a complex primary total knee arthroplasty.

Two Year Postoperative Outcomes of Arthroscopically Assisted Knee Resurfacing Device

Abstract ID: Paper 126

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*Robert A. Cagle, M.D.
Morgan H. Jones, M.D.
Anthony A. Miniaci, M.D.
Cleveland, OH

Arthroscopic resurfacing is a good option, and early outcomes can provide important information for defining indications which may predict which patients will most benefit from this surgery.

BACKGROUND: Definitive treatment of osteoarthritis of the knee has focused on unicompartment knee arthroplasty (UKA) or total knee arthroplasty (TKA), but recently, a novel arthroscopically-assisted knee resurfacing device has been developed for implantation with minimal disruption to the underlying bone, adjacent cartilage, or menisci. Minimizing bony resection and implanted hardware may lead to less surgical morbidity, simplify potential revision surgeries, and delay the need for UKA/TKA. Despite increasing wide-spread use of this prosthesis, evaluation of outcomes has been hindered by small study sample sizes and limited published outcomes data.

OBJECTIVES: Our aim is to retrospectively evaluate the early two-year clinical results of the largest cohort to date following placement of this device including patient-reported outcomes and potential complications to better define surgical indications for this procedure.

METHODS: Seventy-seven patients two years status post device implantation were mailed questionnaires including the SF-12, a standardized musculoskeletal review of systems, and a modified Knee Injury and Osteoarthritis Outcome Score (KOOS). Additionally, each patient participated in a telephone interview to assess the occurrence of infection, additional surgeries, intra-articular injections, or deep vein thromboses (DVT) following surgery. Of the 77 available patients, telephone contact was made with 66 (involving 77 knees) with 47 patients mailing back the questionnaire.

RESULTS: To date, 18 patients (20 knees) underwent revision surgery to TKA/UKA. Three patients (4 knees) required revision of the knee resurfacing to include additional knee compartments. None of the implants were loose or failed. There were no deep infections requiring surgical intervention, but there were 2 superficial infections that resolved with oral antibiotic therapy. Sixteen patients received intra-articular injections after the knee resurfacing. There was 1 postoperative DVT. Statistically significant increases in the KOOS scores were observed in all 5 categories.

CONCLUSIONS: Knee resurfacing is new technology designed to help patients with bifocal arthrosis of the medial or patellofemoral compartments that have failed conservative and biologic treatments. This resurfacing system does improve knee pain, symptoms, and function as long the patient is carefully selected.

Young Patients Have Less Severe Arthritis and Lower Total Knee Replacement Outcome Scores Than Older Patients

Abstract ID: Paper 127

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*Jacob Haynes, M.D. / St. Louis, MO
Ryan M. Nunley, M.D. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Robert L. Barrack, M.D. / St. Louis, MO
John C. Clohisy, M.D. / St. Louis, MO
James A. Keeney, M.D. / Columbia, MO

INTRODUCTION: Total Knee Arthroplasty (TKA) is being performed more frequently for young patients. Malalignment and obesity may increase osteoarthritis progression. Previous reports have associated mild preoperative radiographic arthritis and patient dissatisfaction with well-aligned TKAs. We performed this study to assess the relationship between gender, body mass index (BMI), radiographic disease severity, and preoperative knee alignment on clinical outcome scores among young TKA patients < 55 years old.

METHODS: 100 consecutive young patient TKAs (82 patients) were compared to 100 gender-matched TKAs performed for patients 65-75 years old (85 patients). Radiographs were assessed for coronal alignment, joint space narrowing, osteophyte prominence, and Kellgren-Lawrence grading. Patient reported clinical outcomes were assessed using SF-12, Knee Society, and WOMAC instruments.

RESULTS: Young TKA patients had less severe articular cartilage loss ($p<0.0001$), osteophytes ($p<0.01$), knee malalignment ($p=0.003$), osteoarthritis severity ($p<0.001$), and Kellgren-Lawrence score ($p=0.05$). BMI > 32 kg/m^2 was associated with lower UCLA activity ($p=0.01$), SF-12 physical function, and SF-12 mental health subscores ($p<0.01$). Female patients had uniformly lower preoperative and postoperative scores ($p<0.01$), and 53 of 61 young female TKA patients (85%) had neutral or mild preoperative malalignment. Patients with mildly malaligned knees reported lower postoperative UCLA activity ($p<0.01$), SF-12 mental health ($p<0.001$), Knee Society function ($p=0.03$), and WOMAC subscores ($p<0.01$) while patients with at least 50% articular cartilage loss had trends toward higher SF-12 physical function ($p=0.07$), SF-12 mental health ($p=0.07$), and WOMAC pain subscores ($p=0.09$).

CONCLUSION: Young TKA patients with aligned knees, mild osteoarthritis, and higher BMI may not experience the same improvement as gender-matched older TKA patients. Setting appropriate expectations and assessing for alternative sources of pain are appropriate for young patients without severe radiographic knee arthritis.

Outcomes After Total Knee Arthroplasty as a Function of Body Mass Index

Abstract ID: Paper 128

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*Eric R. Wagner, M.D.
Cathy D. Schleck, B.S.
W. Scott Harmsen, M.S.
Daniel J. Berry, M.D.
Rochester, MN

PURPOSE: Although morbid obesity has been associated with increased rates of complications after total knee arthroplasty (TKA), studies examined BMI using specific ranges. The purpose of this investigation was to quantify implant survival and the risk of complications after TKA using BMI as a continuous variable.

METHODS: Using a single institution's total joint registry, 22,289 consecutive knees, in 16,136 patients, treated with primary TKA from 1985-2012 were examined. Patients were routinely followed until revision or death. The patient's average BMI was 31.3 (range, 11-69). 12,111 knees (55%) had a BMI >30, and 2,128 (10%) had a BMI >40. The 6,238 patients alive and unrevised were followed for an average of 9.5 years. The associations of factors and outcomes were assessed using Cox regression, with a smoothing spline parameterization.

RESULTS: Increasing BMI was associated with an increased risk of infection, reoperation, periprosthetic fracture, patellar instability, and revision surgery. The most striking correlation between increasing BMI and any complication in TKA was with the risk of any wound infection in patients with BMI ≥35 (HR 1.07, $p<0.001$) as well as deep infections in patients with BMI ≥35 (HR 1.08, $p<0.001$) (Figure 1). Furthermore, increasing BMI was also associated with an increased rate of reoperation (HR 1.03, $p<0.001$), and periprosthetic fractures (HR 1.07, $p<0.02$). Increasing BMI was also associated with an increased risk of revision surgery (HR 1.05, $p<0.001$) (Figure 1). Relative to non-obese (BMI <30) patients, morbidly obese patients (BMI >40) had a significantly increased risk of revision surgery (HR=1.6, $p<0.001$), while obese patients (BMI 30-40) had a non-significant increased risk (HR=1.1, $p=0.25$). Subgroup analysis of the etiologies underlying the revision surgeries revealed that risk of revision surgery for mechanical failure was not significantly associated with BMI when examined as the three categories of BMI ($p=0.25$).

SUMMARY POINTS: BMI is strongly associated with increased rates of common postoperative complications and revision surgery after TKA. The increased complications are demonstrated in a greater than linear fashion across most BMIs. These findings are important to consider when counseling patients, estimating risk, and utilizing a comprehensive team approach to reduce risks, as well as to consider when valuing complication risk in policy decision-making.

Click here to view Figure

Quantitative Perfusion Differences Afforded by Three Closure Techniques in Total Knee Arthroplasty: A Randomized Clinical Trial with a Novel Technology

Abstract ID: Paper 129

Cody C. Wyles, B.S.
Steven R. Jacobson, M.D.
Matthew T. Houdek, M.D.
Franklin H. Sim, M.D.
Rafael J. Sierra, M.D.
*Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Maintaining robust perfusion is an important physiologic parameter in wound healing. The effect of different closure techniques on wound perfusion after total knee arthroplasty (TKA) has not been reported previously. The purpose of this randomized clinical trial was to quantitatively compare blood flow between three commonly used closure techniques in patients receiving primary TKA as measured by a laser-assisted indocyanine green angiography (LA-ICGA) device.

METHODS: Forty-five patients undergoing primary TKA were prospectively randomized to receive superficial skin closure with one of the following: (1) running subcuticular (3-0 Monocryl), (2) vertical mattress (2-0 nylon) or, (3) skin staples. Exclusion criteria were previous surgery about the knee, smoking history within one year of surgery, diabetes mellitus, peripheral arterial disease, chronic or recent infection, or long-term use of corticosteroids or anticoagulants. Perfusion was assessed with an LA-ICGA device and software system immediately following closure to quantify fluorescence once the arterial and venous phases reached equilibrium. Twenty-seven points were assessed in each patient (9 along incision and 9 pairs medial and lateral to incision). Mean incision perfusion was determined from the 9 points along the incision with higher values indicating greater blood flow. Mean perfusion impairment was determined by calculating the difference between the 9 pairs of surrounding skin and the 9 points along the incision, with smaller values indicating less perfusion impairment. These parameters were compared with analysis of variance (ANOVA) and subsequent pairwise comparisons.

RESULTS: Mean incision perfusion in fluorescent units was as follows: running subcuticular, 63.7; vertical mattress, 31.7; and staples, 18.7. Mean perfusion impairment was as follows: running subcuticular, 20.6; vertical mattress, 37.0; and staples, 68.6. ANOVA and all pairwise comparisons showed a statically significant difference in these parameters ($p<0.001$) even after adjusting for age, gender, and body mass index, with running subcuticular closure having the best overall perfusion.

DISCUSSION AND CONCLUSIONS: These data suggest that a significant difference exists in the skin and soft tissue perfusion afforded by wound closure techniques in medically and surgically uncomplicated patients undergoing TKA. Running subcuticular closure enables the most robust blood flow. Perception that a tighter wound closure is obtained by staples or interrupted vertical mattress sutures may need to be challenged with the fact that running subcuticular suture provides better perfusion and may be preferred in high-risk patients.

Mobile Compression Devices and Aspirin Are Effective VTE Prophylaxis for Simultaneous Bilateral TKA

Abstract ID: Paper 130

Ryan M. Nunley, M.D. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Staci R. Johnson, M.S. / St. Louis, MO
*James A. Keeney, M.D. / Columbia, MO
Robert L. Barrack, M.D. / St. Louis, MO

BACKGROUD: Thromboembolic events are the most common complication following total joint replacement procedures. Several studies have indicated that patients undergoing bilateral total knee arthroplasty (TKA) at the same setting are more likely to develop venous thromboembolic events (VTE). In the literature, there is currently little information to indicate what is the best VTE prophylaxis for patients undergoing simultaneous bilateral TKAs. One of the AAOS recommendations includes the use of mechanical compressive devices for the prevention of VTE following elective total joint replacement and the American College of Chest Physicians (ACCP) has a grade 1C recommendation for the use of intermittent pneumatic compression devices, but these devices must be portable, battery-powered, and capable of recording and reporting proper wear time on a daily basis. The purpose of this study was to prospectively compare the use of a mobile compression device with Aspirin to the use of warfarin therapy in regards to safety and efficacy for the prevention of (VTE) postoperatively and to determine if there was a difference in patient satisfaction between these two treatment cohorts.

METHODS: We retrospectively reviewed the records of adult patients undergoing elective bilateral TKAs. Patients were stratified to either a standard risk or high risk anticoagulation therapy according to the local clinical protocol. Standard risk patients wore a mobile compression device for 10 days and were treated with aspirin therapy for six weeks postoperatively. High risk patients received warfarin adjusted for target INR for 4 weeks with the use of compression stockings for 6 weeks postoperatively. Anticoagulation therapy, occurrence of symptomatic VTE, and hospital readmissions within 6 months were evaluated.

RESULTS: 72 participants were enrolled and eligible for 6-month follow-up. Of those, 42 were stratified to the standard risk therapy and 30 were stratified to the high-risk therapy. There were no symptomatic VTEs (distal/proximal DVT or PE) in either group during the 6-month follow-up period. Only 3 participants (4%) were readmitted within 6 months of surgery. There was no difference between groups, with 2 (5%) readmissions in the standard risk group and 1 (3%) readmission in the high risk group ($p=0.67$). Only 1 of these readmissions (in the standard risk group) was related to the index surgery.

CONCLUSION: Patients undergoing elective bilateral TKAs at the same setting are safely treated with mobile compression devices and aspirin to prevent VTEs.

Early Experience with Bi-Cruciate Retaining Total Knee Arthroplasty

Abstract ID: Paper 131

Craig J. Della Valle, M.D. / Chicago, IL
Tom Andriacchi, Ph.D. / Stanford, CA
Keith R. Berend, M.D. / New Albany, OH
*Jeffrey H. DeClaire, M.D. / Rochester Hills, MI
Adolph V. Lombardi, Jr., M.D. / New Albany, OH
Christopher L. Peters, M.D. / Salt Lake City, UT

INTRODUCTION: Bi-cruciate retaining total knee arthroplasty (BiCrTKA) has recently been re-introduced into the armamentarium of the orthopedic surgeon for treatment of end stage knee arthritis for patients with an intact ACL and PCL. As with the introduction of any new technology into orthopedic surgery, there is concern that the technique may be associated with a learning curve and adverse outcomes. The purpose of this report is to describe our initial experience with BiCrTKA.

METHODS: Following FDA clearance, six surgeons implanted a cemented BiCrTKA with patella resurfacing in 383 patients (67% female, mean age 65 years +/- 8.6) between May 2013 and April 2014, and followed them for a minimum of 90 days. After the first 119 cases, the surgeons discussed the adverse outcomes and the surgical technique was re-assessed. The rate of complications prior to and following the change in technique was compared using a chi square test with p-values < 0.05 considered significant.

RESULTS: The most commonly identified complication was intraoperative fracture of the bone island. There were 11 island fractures among the first 119 cases compared to 5 in the subsequent 258 cases (9.2% vs. 1.9%; $p = 0.001$). There were 4 manipulations performed for range of motion <90° in the first group compared to none in the second group (3.4% vs. 0%; $p = 0.003$). There were two reoperations overall (0.5%; one for instability and one for tibial loosening), both in the first group. Mean operative time decreased from 82.7 minutes in the first group to 77.5 minutes in the second ($p = .031$).

CONCLUSIONS: Our initial experience with BiCrTKA was associated with a low risk of overall complications that was decreased significantly with a greater understanding of and changes to the surgical technique. The most common complication observed was intraoperative bone island fracture that was easily converted to a standard TKA.

Tranexamic Acid Decreases Transfusion and Hospital Cost in Simultaneous Bilateral Total Knee Arthroplasty♦

Abstract ID: Paper 132

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*Daniel R. Whiting, M.D.
Thomas M. Stewart, M.D.
Hilal Maradit Kremers, M.D.
Christopher M. Duncan, M.D.
Hugh M. Smith, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

SUMMARY STATEMENT: Tranexamic acid decreases transfusion rates, is associated with a decreased length of stay, and decreases hospital costs in bilateral total knee arthroplasty.

LEVEL OF EVIDENCE: Level III, retrospective controlled study

INTRODUCTION: Tranexamic acid (TXA) reduces blood loss and transfusion rates in unilateral total knee arthroplasty (TKA), but few studies have reported on its effectiveness in bilateral TKA. The objective of this paper is to report the clinical and financial effects of TXA in simultaneous, primary bilateral TKA.

METHODS: 449 patients undergoing primary simultaneous bilateral TKA during 2005-2013 were retrospectively reviewed through the institutional joint registry and medical record. Outcome measures included postoperative allogeneic transfusion, hospital length of stay (LOS), hospital costs, 30-day thromboembolic events (TEE), and 30-day mortality. Total direct medical costs during each hospitalization were obtained from an institutional research database. These included all medical costs during hospitalization and were adjusted to nationally representative unit costs in 2013 inflation-adjusted dollars.

RESULTS: 221 patients (49%) received TXA. Transfusion rates were 17% with TXA and 60% without TXA ($p<0.0001$). There were 2 (0.9%) TEE in patients who received TXA and 7 (3.1%) in those who did not ($p=0.102$). Patients receiving TXA had a significantly shorter LOS; mean difference 0.9 days ($p<0.0001$, 95% confidence interval (CI) 0.68-1.13). After excluding implant costs, patients receiving TXA had significantly lower total hospital costs; mean difference $1,317 (95% CI $394-$2,238). Those receiving TXA had significantly higher pharmacy costs (mean difference $334; 95% CI $254-$415), lower room and board costs (mean difference $713; 95% CI $239-$1,187); and lower blood costs (mean difference $178; 95% CI $146-$209).

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (tranexamic acid [cyklokapron]).

All Polyethylene Tibial Components: A Survival and Infection Analysis Compared to Their Metal-Backed Counterparts

Abstract ID: Paper 133

Matthew T. Houdek, M.D.
Eric R. Wagner, M.D.
Clint J. Wooten, M.D.
Cody C. Wyles, B.S.
John R. Martin, M.D.
Robert T. Trousdale, M.D.
*Joseph R. Cass, M.D.
Rochester, MN

INTRODUCTION: Although total knee arthroplasty (TKA) overall is a very successful procedure, there has been debate regarding tibial component modularity and composition. Biomechanical studies have suggested superior results in metal-backed tibial trays; however, these results have not been observed in the clinical arena. Currently, there is a paucity of information examining the survival and outcomes of all-polyethylene tibial components. The purpose of this investigation was to analyze all-polyethylene components, and to compare their outcomes to their metal-backed counterparts.

METHODS: Using an institutional total joint registry, we reviewed 34,177 patients undergoing a primary TKA over a 43-year period (1970-2013). There were 30,434 (89%) metal-backed and 3,744 (11%) all-polyethylene tibial components. The metal-backed group was 57% female, the mean age was 67 years with a mean BMI of 31.5. The all-polyethylene group was 57% female, at a mean age of 71 years, with a mean BMI of 31. The mean follow-up over this period was 9 years (up to 40 years).

RESULTS: The mean survival for all primary TKAs at the 5-, 10-, 20- and 30-year time points were 95%, 88%, 72%, and 56%, respectively. All-polyethylene tibial components were found to have a significantly improved survivorship when compared to their metal-backed counterparts (HR 0.30, $p<0.0001$), with 5-, 10-, 20- and 30-year survival of 98% vs. 95%, 96% vs. 88%, 90% vs. 71%, and 82% vs. 54%, respectively. All-polyethylene tibial components were also found to have a significantly lower rate of infection, instability, tibial component loosening, tibial component wear, and periprosthetic fracture ($p<0.0001$, 0.0001, 0.001, 0.0001, 0.004). Of note, all poly tibial components had higher rate ($p<0.0001$) of postoperative flexion contracture. Patients in the metal-backed group were significantly younger (67 vs. 71 years, $p=0.0001$); however, in all age groups (Age <50, 50-60, 60-70, 70-80, >80), survival was significantly increased in the all-polyethylene group ($p<0.0001$). When separating the patients based on BMI, all-polyethylene tibial components had improved survival for BMI ranging from 25-40 ($p<0.0001$); however, there was no difference in component survival for patients with a BMI <25 or >40 ($p=0.16$).

CONCLUSION: All-polyethylene tibial components have significantly improved outcomes when compared to metal-backed tibial components. The all-polyethylene components had significantly improved survival, as well as reduced rates of postoperative infection, fracture, and tibial component failure. The use of all-polyethylene should be considered for all patients, as they appear to offer improved survival lower complication rates when compared to the metal-backed tibial components.

Which Tibial Tray Design Achieves Maximum Coverage and Ideal Rotation: Anatomic, Symmetric, or Asymmetric? An MRI-Based Study

Abstract ID: Paper 134

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*S. David Stulberg, M.D.
Nitin Goyal, B.S.
Chicago, IL

INTRODUCTION: The goal of tibial tray placement in total knee arthroplasty (TKA) is to maximize tibial surface coverage while maintaining proper rotation. The purpose of the present study was to utilize MRI information, obtained as part of the PSI planning process, to determine, for anatomic, symmetric, and asymmetric tibial tray designs, (1) which tibial tray design achieves maximum coverage, (2) the impact of maximizing coverage on rotation, and (3) the impact of establishing neutral rotation on coverage.

METHODS: In this prospective comparative study, MR images for 100 consecutive patients were uploaded into PSI software that was used to evaluate characteristics of tibial component placement. Anatomic, symmetric, and asymmetric designs from a single manufacturer were evaluated to assess the relationship of tibial coverage and tibial rotation. Tibial surface coverage, defined as the proportion of tibial surface area covered by a given implant, was measured using digital imaging software. Rotation was calculated with respect to the tibial AP axis, which was defined as the line connecting the medial third of the tibial tuberosity and the PCL insertion.

RESULTS: When tibial surface coverage was maximized, the anatomic tray compared to the symmetric/asymmetric trays showed significantly higher surface coverage (82.1% vs. 80.4/80.1%; $p<0.01$), significantly less deviation from the AP axis (0.3° vs. 3.0/2.4°; $p<0.01$), and a significantly higher proportion of cases within 5° of the AP axis (97% vs. 73/77%;$p<0.01$). When constraining rotation to the AP axis, the anatomic tray showed significantly higher surface coverage compared to the symmetric/asymmetric trays (80.8% vs. 76.3/75.8%; $p<0.01$). No significant differences were found between symmetric and asymmetric trays.

DISCUSSION: The anatomic tibial tray resulted in significantly higher tibial coverage with significantly less deviation from the AP axis compared to the symmetric and asymmetric trays. When rotation was constrained to the AP axis, the anatomic tray resulted in significantly higher tibial coverage than the symmetric and asymmetric trays. Tibial rotation is recognized as an important factor in the success of a total knee replacement. Maximizing coverage with the least compromise in rotation is the goal for tibial tray design. In this study, the anatomic tibia seemed to optimize the relationship between tibial surface coverage and rotation. This study additionally illustrates the way by which advanced preoperative planning tools (i.e., MRI/computer reconstructions) allow us to obtain valuable information with regard to implant design.

MAOA BREAKOUT SESSION #10
HIP PRESERVATION AND ARTHROSCOPY
April 24, 2015

Ultrasound Evaluation of Asymptomatic Femoroacetabular Impingement and Inguinal Hernia in Female Olympic Soccer Athletes

Abstract ID: Paper 135

William K. Vasileff, M.D. / Columbus, OH
*Ashraf Elbanna, M.D. / Detroit, MI
Hafeez Ahmed, M.D. / Detroit, MI
Marnix van Holsbeeck, M.D. / Detroit, MI

OBJECTIVES: Femoroacetabular impingement (FAI) as well as inguinal hernias are common causes of groin pain and decreased performance in athletic populations and present with overlapping clinical features. Ultrasound is useful for the diagnosis of both conditions. Our study evaluated the incidence of asymptomatic FAI and inguinal hernia in elite female soccer players and a control group with ultrasound evaluation.

METHODS: 27 asymptomatic United States Olympic Team female soccer players (54 hips, age 21-34) were evaluated with ultrasound to quantify cam-type FAI and static inguinal hernia. A control group of 15 subjects (30 hips, age 25-30) were evaluated for the same specific markers.

RESULTS: The study population showed an asphericity of the femoral head in 15/54 hips (28%). Cam-lesion was identified in 16/54 (30%). No labral tears were noted. A total of 18/54 (33%) hips showed evidence of FAI, and 5 subjects had changes noted bilaterally. 4/54 subjects showed evidence of inguinal hernia. The control group showed asphericity of the femoral head in 3/30 hips (10%). Cam-lesion was identified in 4/30 (13%). No labral tears were noted. In total, 4/30 hips showed evidence of FAI, and 1 subject had changes bilaterally. 2/30 exams showed evidence of an inguinal hernia.

We observed a 33% incidence of cam-type FAI markers in the study group compared to 13% in the controls (p=0.07). The study group had a 7.4% incidence of inguinal hernia, compared to 6.7% in the controls (NS).

CONCLUSION: Ultrasound evaluation is effective to visualize cam morphology FAI, as well as inguinal hernia. Here we showed a rate of cam-type morphology in a high level athletic population of 33% compared to 13% for a control population. The rates of FAI demonstrated agree with prior studies, and trend towards a higher rate in the high level female athlete compared to our controls. There were a number of subjects identified within both groups with asymptomatic hernia using static ultrasound, with a significant amount of overlap with patients who also demonstrated CAM morphology. All subjects in both groups were asymptomatic at the time of examination which reinforces the importance of clinical correlation when making treatment decisions. We must also continue to exercise caution when diagnosing patients as these two clinical entities can exhibit similar clinical findings and may coexist in the same patient, but ultrasound examination can be a simple and useful clinical tool to aid in accurate diagnosis.

Prevalence of Radiographic Femoracetabular Impingement in Asymptomatic vs. Symptomatic Adolescents

Abstract ID: Paper 136

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*Jared W. Daniel, M.D.
Stuart L. Weinstein, M.D.
Ryan M. Ilgenfritz, M.D.
Lori Dolan, Ph.D.
Yubo Gao, Ph.D.
Iowa City, IA

BACKGROUND: Femoroacetabular impingement (FAI) is a known pre-arthritic condition in young adults. Multiple theories are proposed describing the etiology of FAI. The prevalence of radiographic FAI is high in young adults. There is little data describing the prevalence of radiographic morphology in adolescent populations. The purpose of this study is to determine the prevalence of radiographic morphology in asymptomatic and symptomatic adolescents.

METHOD: 384 patients were identified with standing EOS imaging over a two-year period. Patients were divided into asymptomatic (39 patients, 74 hips) and symptomatic (38 patient, 73 hips) cohorts based on self-reported data and chart review. Exclusion criteria were poor image quality or incomplete data. Eight radiographic parameters were evaluated for each hip.

RESULTS: The average age of the asymptomatic cohort was 13.9 years compared to 15.1 years in the symptomatic cohort. There were more females than males in each cohort. Coxa profunda was a common radiographic marker in both cohorts (right: 97.2% vs. 94.7%, p = 1.0 and left: 97.3% vs. 77.8%, p = 0.013). Protrusion acetabula, center-edge angle, and crossover/ischial spine sign were relatively uncommon abnormal markers in each cohort. There was a trend for the symptomatic cohort to have a larger percentage of abnormal radiographic markers. The number of abnormal radiographic indices (>3) suggested inclusion within the symptomatic cohort. The prevalence of abnormal alpha angles was higher in the symptomatic cohort compared to the asymptomatic cohort (right hip: 63.9% vs. 21.05, p = 0.0002; left hip: 64.9% vs. 33.3%, p = 0.007). Abnormal triangular index had a higher prevalence in the symptomatic cohort (right hip: 55.6% vs. 13.16%, p = 0.0001; left hip: 37.8% vs. 25%, p = 0.237). Symptomatic patients were more likely to have abnormal measures for anterior alpha angle and triangular index combined. (right hip: PPV 88%, p = 5.06e-05; left hip: 71%, p = 0.063).

CONCLUSION: There were a high prevalence of radiographic FAI in our study, and there was a higher prevalence of abnormal morphology in the symptomatic cohort. The number of abnormal radiographic morphologic measures correlated with symptoms; however, this is only a trend and is not evidence of causation. The combination of the anterior alpha angle and triangular index improved the diagnostic accuracy of FAI in the symptomatic group. FAI remains a dynamic, three-dimensional orthopedic hip condition. Management should focus on the individual patient vs. radiographic morphology.

Femoroacetabular Impingement in Asymptomatic Adolescents: At What Age Do CAM and Pincer Deformities First Appear?

Abstract ID: Paper 137

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*G. Ying Li, M.D. / Ann Arbor, MI
Peter Helvie, B.S. / Ann Arbor, MI
Matthew Mead, B.S. / Ann Arbor, MI
Joel Gagnier, Ph.D. / Ann Arbor, MI
Matthew R. Hammer, M.D. / Dallas, TX
Nahbee Jong, B.S. / Ann Arbor, MI

INTRODUCTION: Femoroacetabular impingement (FAI) can lead to acetabular chondrolabral damage and has been theorized as a causative factor in the development of osteoarthritis. The pathogenesis of FAI is unclear. The reported prevalence of CAM-type FAI in asymptomatic adults ranges from 14-24%. CAM morphology is more common in males. The purpose of this study was to determine the prevalence of FAI deformities in asymptomatic adolescents.

METHODS: We identified children 10 to 18 years of age who had undergone a pelvic CT at our institution between 2007 and 2012. Exclusion criteria included hip pain, any hip pathology, bone tumor, long-term steroid use, history of chemotherapy or radiation therapy, nonambulatory status, neuromuscular disorder, chromosomal abnormality, and metabolic bone disease. Multiplanar reformatted images were created from axial images to calculate alpha angles and lateral center-edge angles (LCEA). CAM impingement was defined as an alpha angle ≥55° and pincer impingement was defined as a LCEA ≥40°. We performed chi-squared analyses for all categorical comparisons of FAI types between genders.

RESULTS: We analyzed 558 patients (1,116 hips). There were 276 males and 282 females. The average age was 14.4 years. The mean alpha angle was 47.9° and the mean LCEA was 34.4°. Males had a significantly higher mean alpha angle (49.7° vs. 46.0°) ($P < 0.0005$) and females had a significantly higher mean LCEA (35.7° vs. 33.0°) ($P < 0.0005$). Ninety-four adolescents (16.8%) had an alpha angle ≥55° (11.6% unilateral, 5.2% bilateral). CAM morphology was significantly more common in males (23.9%; 66 of 276) than in females (9.9%; 28 of 282) ($P < 0.001$, OR = 2.85, RR = 1.55).

CONCLUSION: Our study demonstrates that the prevalence of CAM-type FAI in asymptomatic adolescents is similar to the reported prevalence in asymptomatic adults. Pincer morphology may be more common than CAM morphology in adolescents. CAM deformities are more prevalent in males, whereas pincer and mixed deformities are equally prevalent in both sexes. These findings support a congenital or developmental etiology for FAI. Further studies are necessary to determine the prevalence of FAI morphology in younger children.

Measuring the Alpha-Angle on a False Profile View to Verify Adequate Femoral Osteochondroplasty

Abstract ID: Paper 138

Michael D. Hellman, M.D.
*Molly C. Meadows, M.D.
Bryan D. Haughom, M.D.
Nicholas M. Brown, M.D.
Yale Fillingham, M.D.
Shane J. Nho, M.D.
Chicago, IL

PURPOSE: CAM-type femoroacetabular impingement (FAI) is characterized by an asphericity of the femoral head-neck junction causing hip pain. Plain radiographs are used as the initial diagnostic tool in the evaluation of FAI. Multiplanar imaging of the hip is required to circumferentially visualize the head-neck junction. AP pelvis, Dunn lateral, frog leg lateral, and cross-table lateral views have traditionally been used. The false profile view has traditionally only been used to assess for acetabular overcoverage (pincer-type FAI), but recently has been proven to adequately visualize the head-neck junction at the 2 o'clock to 3 o'clock position. The purpose of this study is to compare preoperative and postoperative alpha-angle measurements on the false profile view.

METHODS: 40 consecutive patients undergoing femoral osteochondroplasty between January 2011 and September 2012 were retrospectively reviewed. An alpha-angle was measured on each patient's preoperative and postoperative hip radiographs (AP pelvis, 90° Dunn, False Profile) using the technique described by Notolzi et al. Preoperative and postoperative measurements were compared using a student's t-test. Two surgeons independently performed all measurements.

RESULTS: 20 female and 20 male patients were included. The average preoperative false profile alpha-angle was 49.93° (range 37.8-63.6°). The average postoperative false profile alpha-angle was 39.58° (range 31.1-47.3°). The difference between preoperative measurements and postoperative measurements was 10.61° (range 0-24.1°, $p<0.0001$). The average preoperative AP pelvis and 90° Dunn lateral alpha-angles were 52.11° (range 31-132.6°) and 51.97° (range 39.8-71.9°) respectively. The average postoperative AP pelvis and 90° Dunn lateral alpha-angles were 42.88° (range 33.5-71.6°, $p=0.64$) and 37.53° (range 33-45.7°, $p<0.0001$), respectively. The difference between preoperative measurements and postoperative measurements were 11.65° (range 0.1-87.7°) and 14.52° (range 0.8-31.7°), respectively. An ICC was found to be 0.81 for the measurements obtained on the false profile view radiographs.

CONCLUSIONS: This study shows that alpha-angles measured on the false profile view differ significantly before and after femoral osteochondroplasty. It further validates the clinical importance of the false profile view for evaluation and treatment of CAM-type femoroacetabular impingement. Both the 90° Dunn lateral view and the false profile view showed significant changes between preoperative and postoperative alpha angles. These radiographs visualize the femoral head-neck junction where most CAM-lesions occur – the anterior superior quadrant.

The false profile view gives excellent visualization of the anterior femoral head-neck junction between the 2 o'clock and 3 o'clock positions and should be used with the 90° Dunn lateral to verify adequate femoral osteochondroplasty.

Heterotopic Ossification Excision Following Hip Arthroscopy

Abstract ID: Paper 139

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*Molly A. Keegan, M.D. / Rochester, MN
John M. Redmond, M.D. / Jacksonville, FL
Asheesh Gupta, M.D. / Fairfax, VA
Jon E. Hammarstedt, B.S. / Westmont, IL
Christine E. Stake, M.A. / Westmont, IL
Benjamin G. Domb, M.D. / Westmont, IL

BACKGROUND: Heterotopic ossification (HO) is a recognized complication following hip arthroscopy. Whether this ossification is clinically relevant in the postoperative period is currently debated. There is currently a paucity of data analyzing patient outcomes following heterotopic ossification excision following hip arthroscopy.

PURPOSE: The purpose of this study was to evaluate pain and outcome scores in patients undergoing revision surgery with heterotopic ossification excision.

METHODS: From 2008 to 2014, prospective data was collected on 2,379 arthroscopic hip surgeries, and we identified 68 patients who underwent revision hip arthroscopy with removal of heterotopic ossification or a loose body. We used ossification of at least 1 cm on radiographs for inclusion in this review; which eliminated 45 patients, and left 23 patients for review. All patients were assessed pre- and postoperatively for the primary and revision surgery using four patient-reported outcome (PRO) measures: the modified Harris Hip Score (mHHS), Non-Arthritic Hip Score (NAHS), Hip Outcome Score - Activity of Daily Living (HOS-ADL), and Sport-Specific Subscales (HOS-SSS). Pain was estimated on the visual analog scale (VAS) measured on a scale from 0-10.

RESULTS: Of the 23 patients undergoing revision surgery with heterotopic ossification removal, 19 were available for average follow-up of 1.5 years. Three patients converted to total hip arthroplasty (16%) and one patient underwent a second revision at an outside facility. This left 15 patients available for follow-up. Prior to the revision procedure with heterotopic ossification excision, patients had an average mHHS of 53.36, HOS ADLS of 51.38, HOS SSS of 24.48, NAHS of 50.28, and VAS of 6.71. Following HO excision, all patients showed improvement in functional outcome scores and VAS ($p<0.05$), with an average mHHS of 73.62, HOS ADLS of 68.88, HOS SS of 58.51, NAHS of 70.83, and VAS of 4.33. Three of 15 (20%) patients had a follow-up mHHS greater than 80 points.

CONCLUSION: Patients undergoing revision hip surgery with HO excision demonstrated improvement in outcome scores and pain; however, few patients achieved a good or excellent result. Revision hip surgery with HO excision should be approached cautiously given the modest results in this patient group.

Reverse Periacetabular Osteotomy Provides Excellent Results in Select Patients with Hip Impingement and Dysplasia

Abstract ID: Paper 140

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*Joshua A. Parry, M.D. / Rochester, MN
R. Presley Swann, M.D. / Rochester, MN
Jill Erickson, P.A. / Salt Lake City, UT
Christopher L. Peters, M.D. / Salt Lake City, UT
Robert T. Trousdale, M.D. / Rochester, MN
Rafael J. Sierra, M.D. / Rochester, MN

INTRODUCTION: We report the mid- to long-term outcomes of using reverse periacetabular osteotomy (RPAO) to reorient hips with femoroacetabular impingement (FAI) associated with isolated retroversion (IR) or retroversion with hip dysplasia (HD).

METHODS: A retrospective review was performed to identify RPAOs at two institutions. Acetabular retroversion with FAI was diagnosed clinically and radiographically, with a positive cross-over and posterior wall signs on AP radiographs. Dysplastic hips with retroversion were defined by a lateral center-edge angle (LCE) of 19° or less and a positive cross-over sign. Twenty-four patients (31 hips), including 17 women, met the inclusion criteria; 16 patients (21 hips) in the IR group and 8 patients (10 hips) in the HD group. Average age at the time of the procedure was 26 years (range, 13-45). Average follow-up was 5 years (range, 2-19). Harris hip score (HHS) and radiographs were evaluated preoperatively and at last follow-up.

RESULTS: Average preoperative LCE was 30° in the IR group and 8° in the HD group ($p<0.0001$). Postoperative LCE increased to 35° in the IR group and 34° in the HD groups ($p<0.7$). Cross-over sign corrected in 52% of IR group and 88% of the HD group, and it improved to a more cephalad position in the remaining hips. At follow-up, the Tönnis grade in one hip in the IR group progressed to a grade 1, and another hip progressed to grade 2. In the HD group, one hip progressed to grade 1 and another progressed to grade 2. The average preoperative HHS in the HD and IR groups was 44 and 62, respectively ($p<0.02$). At the latest follow-up, the HHS was significantly improved to 93 in the HD group and 92 in the IR group ($p<0.0004$). Improvement in HHS did not differ significantly between groups ($p<0.1$). Complication rates were similar between groups and included LFCN neuralgias (22%), pubic nonunions (13%), infections (10%), and heterotopic ossification (3%). Excluding hardware removal, additional surgeries were performed in 16% (5/31). Subsequent procedures in the IR group included one THA (10 years postoperative), one hip offset procedure, and two chondroplasties for continued FAI. In the HD group, there was one THA (two years postoperative) and one surgery for a wound infection.

CONCLUSIONS: RPAO for hip impingement in the young patient with acetabular retroversion, with or without hip dysplasia, had excellent clinical and radiographic results at mid- to long-term follow-up.

Previous Surgery for Femoroacetabular Impingement Does Not Compromise Total Hip Arthroplasty Outcomes

Abstract ID: Paper 141

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*Luke Spencer-Gardner, M.D.
Christopher L. Camp, M.D.
John R. Martin, M.D.
Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
Aaron J. Krych, M.D.
Rochester, MN

INTRODUCTION: Open and arthroscopic approaches have been described to address femoroacetabular impingement (FAI). Despite good outcomes, there is a subset of patients that may have progression of hip disease that requires total hip arthroplasty (THA). There is a paucity of data on the results of THA in patients that have undergone prior surgery for FAI. The purpose of this study is to determine if a difference exists in clinical outcomes of THA after open vs. arthroscopic treatment of FAI when compared to matched controls without previous surgery.

METHODS: This case-matched retrospective review included 23 patients (24 hips) that underwent THA after previous surgery for FAI and compared them to 24 controls with no history of prior surgery on the operative hip. Controls were matched for age, gender, surgeon, surgical approach, and implants used. Group 1 included 14 cases that had prior arthroscopic treatment, group 2 included 10 cases with previous surgical hip dislocation (SHD), and group 3 included the 24 matched controls. The primary outcome measure was the Harris Hip Score (HSS). Operative time, blood loss, transfusion rates, and the presence of heterotopic ossification after THA were also compared between groups.

RESULTS: The mean follow-up after THA across all groups was 30 months. There was no significant difference in HHS between groups. Mean and standard deviation (SD) of the HHS were: group 1 93.3 (9.1); group 2 91.4 (13.6); and group 3 95.2 (6.5) ($p = 0.4$). Increased operative times were noted for group 2 (mean 109.3, SD 29.8) compared to group 3 (mean 88.0, SD 24.2) ($p < 0.05$). There was no significant difference in blood loss between groups. The occurrence of heterotopic ossification was significantly higher in group 2 compared to group 3, relative risk (RR) 3.2, and group 1, RR 2.3 ($p < 0.05$).

CONCLUSION: In this retrospective matched cohort, patient reported outcomes after THA are not affected by prior open or arthroscopic procedures for FAI. However, increased operative times and an increased risk of heterotopic ossification were noted after SHD. This study provides data for surgeons when counseling their patients on the treatment options for FAI, and the effect that these options may have on subsequent THA.

A Comparison of Athletes to Non-Athletes in Recovery After Hip Arthroscopy

Abstract ID: Paper 142

Misty Suri, M.D.
*Neil L. Duplantier, M.D.
Rami Elkhecher, M.D.
Walter S. Choate, M.D.
Shawn Johnson, M.D.
Stephanie Pawlak, M.D.
Deryk G. Jones, M.D.
New Orleans, LA

OBJECTIVE: The purpose of this study was to compare recovery patterns after hip arthroscopy between patients who self-identify as athletes and patients who self-identify as non-athletes. We hypothesized that patients who self identify as athletes will have different recovery patterns compared to patients who self-identify as non-athletes.

METHODS: We investigated 265 hip arthroscopies excluding patients with SCFE or Perthes disease (n=18), revisions from other surgeons (n=45), arthroscopic procedures where no bony work was performed (n=20) or micro-fracturing was performed (n=7), and patients with incomplete data (n=9). Patients were prospectively assessed both preoperatively then at 6 weeks, 3 months, 6 months, and yearly up to 4 years with regards to the VAS pain scale, modified Harris Hip Score (mHHS), and short form-12 physical / mental subscales (SF-12 PS) / (SF-12 MS). Patient outcomes were compared using Student t-test. The patients were split into an athletic group and a non-athletic group. The non-athletic group consisted of patients with no athletic involvement (n=98) and recreational athletes (n=22). The athletic group consisted of high school or collegiate athletes (n=32) and semi-professional or professional athletes (n=14). A good outcome was defined as mHHS>80 at one year post surgery. The Pearson Chi Squared test was used to assess outcomes. We then performed a one-to-one matched case control study adjusting for age discrepancy between the two groups. P<.05 was used to measure significance.

RESULTS: The athletic group reported significantly lower VAS at 6 weeks (p=.004), 3 months (p=.0006), 6 months (p=.03), and 1 year (p=.04). The athletic group reported significantly higher mHHS preoperatively (p= .03), at 6 weeks (p<.001), 3 months (p<.001), 6 months (p=.0007), and 1 year (p=.03). The SF-12 PS showed significantly higher scores for athletes from 6 weeks to 2 years: (p=.0007), (p=.0013), (p=.013), (p=.004), and (p=.02), respectively. The SF-12 MS showed significantly higher scores for athletes at 3 months (p=.03), 6 months (p=.005), and 2 years (p=.046). At one year post hip arthroscopy, there was no significant difference with regards to outcome when comparing athletes to non-athletes. The one-to-one matched case control sub-analysis showed no significant difference between the athletes and non-athletes when adjusted for age at all time points.

CONCLUSIONS: Athletes recover differently than non-athletes after hip arthroscopy. However, at 1 year post surgery, athletes and non-athletes are equally likely to experience a good outcome. Younger age appears to be associated with athletic involvement and early recovery post hip arthroscopy.

Return to Sports After Hip Arthroscopy with a Minimum Two-Year Follow-Up

Abstract ID: Paper 143

Benjamin G. Domb, M.D. / Westmont, IL
Kevin F. Dunne, B.S. / Westmont, IL
Nathan A. Finch, M.S. / Westmont, IL
Asheesh Gupta, M.D. / Fairfax, VA
John M. Redmond, M.D. / Jacksonville, FL
Christine E. Stake, M.A. / Westmont, IL
*William Cregar, B.S. / Richmond, VA

BACKGROUND: Hip pain and injuries are common in athletes at all levels, from the recreational to the elite. Several studies have assessed athletes' level of return to sport, but there are minimal descriptive studies examining a general cohort of patients and return to sports levels. The study purpose is to compare patient-reported outcomes (PRO) scores and sports-related movements between a group of patients who returned to playing their sport and a group who did not.

METHODS: From the period of September 2008 to April 2012, 1346 patients underwent hip arthroscopy and 316 listed playing a sport before surgery. Out of the 316, 297 (94%) had two-year follow-up and 161 (54%) provided sports-related abilities pre- and postoperatively. The primary hip outcome score used was the Hip Outcome Score – Sports Specific Subscale (HOS-SSS). Total scores and answers related to specific sport-related abilities were analyzed. Revision surgery and conversion to arthroplasty were noted.

RESULTS: Out of 161 patients included in the study, 93 (58%) reported returned to their sport after surgery, while 68 (42%) patients opted not to return to playing their preoperative sport. Average age for RTS group was 30.7 years (range, 13.2-61.4) and 30.4 years (range, 14.8-59) for NRTS group. Both groups demonstrated statistically significant improvements from preoperative to postoperative scores based on four PRO measures, including the HOS-SSS ($p<0.001$). There was no significant difference between groups for HOS-SSS scores preoperatively. However, the group who returned to sports (RTS) had significantly higher HOS-SSS scores at three month, one year, and minimum two-year follow-up scores. For the NRTS group, 84% had additional follow-up regarding return to activity status, other then level. Out of 57 patients, 25 (44%) reported not returning to sport for specific hip-related issues. A higher percentage of patients from the RTS group were able to perform sports-specific movements than the non-RTS group, and this difference was statistically significant ($p<0.05$). Significant sport-specific movements included running one mile, jumping, landing from a jump, stopping quickly, and cutting/lateral movements. VAS pain scores were 5.4 for both groups preoperatively and 1.7 for RTS and 3.3 for non-RTS postoperatively ($p<0.001$). Both groups reported one conversion to THR.

CONCLUSION: Hip arthroscopy patients who were able to return to their sport demonstrated significantly higher HOS-SSS scores and abilities to perform several sport-related movements. Additional research is needed to further examine which factors influence a hip arthroscopy patient's ability to return to sports.

Results of Microfracture of Chondral Defects in the Hip Joint and an Analysis of the Current Indications for Its Use

Abstract ID: Paper 144

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*Darrin J. Trask, M.D.
Matthew W. Squire, M.D.
James S. Keene, M.D.
Madison, WI

BACKGROUND: The criteria and outcomes of microfracture in the knee are well established. In contrast, data on the efficacy of microfracture for treatment of chondral defects in the hip is limited, and the criteria for its use (a focal, contained lesion <4 cm^2 in size) have been those that were established for the knee. The purpose of this study was to analyze the outcomes of microfracture in 70 hip arthroscopy patients and determine if the current microfracture (i.e., knee) criteria are appropriate for chondral lesions in the hip.

METHODS: From the senior author's data base of 1100 hip arthroscopies, 70 patients that had microfracture performed for full-thickness chondral defects and at least two years of follow-up were identified. The size and location of the chondral defects were recorded on each patients "hip sheet" and operative note at the time of their hip arthroscopy and these findings were confirmed from a review of each patient's intraoperative photographs. The indications for microfracture in the 70 patients in this study were a full-thickness chondral lesion of the acetabulum and/or femur. All such chondral defects were debrided and microfractured regardless of their size. All hips were assessed with Byrd's 100-point modified Harris hip scoring system (MHHS) prior to the release and at 3, 6, 12, and 24 months after surgery.

RESULTS: The average age of the 70 patients was 41 years; there were 34 men and 36 women and their preoperative scores averaged 41 points. The chondral lesions were located in the acetabulum in 63, the femur in 6, and in both surfaces in one patient. The average size of the lesions microfractured was 141 mm^2 (range 24 to 750 mm^2). Nine of the 70 patients (10%) had chondral lesions greater than the recommended maximum size (4 cm^2) for microfracture in the hip. The two-year MHHS of these 9 patients averaged 85 points (range 59 to 100 points). The two-year MHHS scores of the 61 patients with smaller lesions (<4 cm^2) averaged 80 points (range 39 to 100 points), and there was no significant difference in the average two-year scores of these two groups (p=0.5). Seven (12%) of the 70 patients went on to have total hip arthroplasties and all of these patients had smaller (<4 cm^2) lesions. The two-year MHHS scores of the 19 patients that were ≥ 50 years old averaged 86 points and were the same as the two-year scores of the 51 patients that were under that age.

CONCLUSIONS: Microfracture of chondral defects in the hip should not be limited to the criteria used for knee lesions (<400 mm^2) or to younger (< 50 years old) patients. Results of microfracture in larger lesions (≥400 mm^2) and older (≥50 years old) patients were very good (average two-year MHHS of 85 and 86 points) and the same as those observed with smaller lesions (80 points) and in younger patients (86 points).

Long-Term Outcomes of Arthroscopic Lesser Trochanteric Iliopsoas Tenotomies

Abstract ID: Paper 145

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*James S. Keene, M.D.
Brian J. Ludwig, M.D.
Madison, WI

BACKGROUND: Short-term results (≤ 2 years) of arthroscopic iliopsoas tendon releases have documented that the procedure will prevent recurrent, painful snapping of the tendon. To date, however, the long-term results (> 3 years) have not been reported. This study presents the results of 60 consecutive patients who had an arthroscopic release of their iliopsoas tendon and were evaluated three or more years after their iliopsoas tenotomy.

METHODS: Between January 2008 and June 2009, 200 patients with painful snapping hips were evaluated with MR arthrograms that included injection of the hip with bupivacaine, Omnipaque, and gadolinium. The 60 patients reported here had minimal relief of their hip pain, and thus had real-time imaging of their psoas tendons and anesthetic injections into the psoas bursa. In all 60 patients, the bursal injections relieved their pain, and in 36, ultrasound demonstrated snapping of the tendon. All 60 patients had an arthroscopic, lesser trochanter release of their iliopsoas tendon. All hips were assessed with Byrd's 100-point modified Harris hip scoring system prior to the release, and at 3, 6, 12, 24, and 36 months after surgery.

RESULTS: Average age of the 60 patients was 35 years, and their preoperative scores averaged 42 points (range 14-72 points). After surgery, the patients had used crutches for 2 to 4 weeks, and had 6-week scores that averaged 68 points. Their scores continued to improve, and at 6 months averaged 88 and 90 points, respectively. The two patients that scored 45 points had total hip replacements 14 months after their releases due to increasing pain from progression of their DJD. Three patients had a second arthroscopic iliopsoas tenotomy performed 15, 18, and 25 months after the first release to treat recurrent snapping of the tendon. The scores of these three patients one year after the second release were 81, 84, and 96 points, respectively, and they had not experienced any further snapping of the tendon. At a minimum follow-up of 36 months (range 36-72 months), the scores of the 55 patients that had not had a second surgery averaged 91 points (range 65-100 points). All but the two patients that had THRs returned to their preoperative jobs, including heavy construction, and none had hip flexor weakness or post-tenotomy heterotrophic bone formation.

CONCLUSIONS: An arthroscopic, lesser trochanteric iliopsoas tenotomy is a safe, outpatient procedure that will provide long-term (> 3 years) relief from painful snapping of the tendon. In 3 cases (5%), painful, snapping of the tendon recurred, and a second arthroscopic, lesser trochanteric tenotomy was required to permanently relieve the snapping and pain. There were no cases of post-tenotomy heterotopic ossification or chronic hip flexor weakness in this series of patients.

Outcomes of Endoscopic Treatment for Greater Trochanteric Pain Syndrome: Minimum of Two-Year Follow-Up

Abstract ID: Paper 146

Benjamin G. Domb, M.D. / Westmont, IL
Dror Lindner, M.D. / Westmont, IL
Leslie E. Schwindel, M.D. / Chicago, IL
*Austin W. Chen, M.D. / Chicago, IL
Youssef El Bitar, M.D. / Westmont, IL
John M. Redmond, M.D. / Jacksonville, FL

OBJECTIVE: Greater trochanteric pain syndrome (GTPS) is a common complaint with an estimated incidence of 1.8/1,000 persons. GTPS usually responds well to conservative treatment. In refractory cases, endoscopy offers a less invasive approach than open surgery, and offers the advantage of evaluating and treating coexistent intra-articular disorders. The purpose of this study is to report the clinical outcomes of endoscopic treatment for GTPS at a minimum of two years follow-up and to report the incidence and outcomes of hip abductor tears.

METHODS: During the study period, patients who presented with lateral hip pain, pain on palpation over the greater trochanter or hip abductor weakness and were treated with an endoscopic trochanteric bursectomy were included. Exclusion criteria were previous hip conditions and Tonnis grade ≥ 2. Patient reported outcome (PRO) scores used include the modified Harris Hip Score (mHHS), the Non-Arthritic Hip Score (NAHS), the Hip Outcome Score–Activities of Daily Living (HOS-ADL), and the Hip Outcome Score–Sport Specific Subscale (HOS-SSS). PRO scores were collected preoperatively and two years postoperatively. Visual analog scale (VAS) scores and patient satisfaction ratings were also collected. Any revision surgeries, complications, or conversions to total hip arthroplasty (THA) were noted.

RESULTS: A total of 59 cases met the inclusion/exclusion criteria, of which 50 patients (85%) were available for follow-up at minimum two years. Forty-six patients reported two-year follow-up PRO scores and four patients needed total hip replacement surgery. All patients had endoscopic trochanteric bursectomy. Thirteen patients (26%) had a gluteus medius tear treated during surgery. Average follow-up was 31 months (range 24-50). Average age was 50 years (range 23-75). Patients demonstrated significant improvement ($p<0.01$) from preoperative to last follow-up in all PROs (Table 1). Patients who underwent gluteus medius (GM) repair demonstrated higher improvement in all PROs compared to patients without GM pathology (Table 1). Four patients (8%) went on to have THA; three patients (6%) required revision arthroscopy. Nine patients (18%) had a complication; however, all were transient and none required further surgical intervention.

CONCLUSION: Patients experienced a statistically significant clinical improvement in PROs, and pain scores, and reported high satisfaction after endoscopic trochanteric bursectomy with or without gluteus medius repair. We conclude that peritrochanteric endoscopy is a safe and efficient treatment option for recalcitrant GTPS.

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Outcomes for Hip Arthroscopy Based on Gender and Age: A Comparative Matched-Group Analysis

Abstract ID: Paper 147

Rachel M. Frank, M.D.
*Simon Lee, M.P.H.
Charles A. Bush-Joseph, M.D.
Michael J. Salata, M.D.
Richard C. Mather, III, M.D.
Shane J. Nho, M.D.
Chicago, IL

INTRODUCTION: For appropriately indicated patients, hip arthroscopy for femoroacetabular impingement (FAI) is a beneficial procedure with the majority of patients experiencing decreased pain and improved function. The purpose of this study was to compare the clinical outcomes of patients undergoing hip arthroscopy for FAI based on between gender and age. The authors hypothesized improved outcomes in younger, male patients compared to older, female patients.

METHODS: Patients undergoing hip arthroscopy for FAI by a single fellowship-trained surgeon were prospectively collected and analyzed. A total of 150 patients were included, with 25 patients categorized in each of the following groups: (1) females <30 years, (2) females 31-45 years, (3) females >45 years, (4) males <30 years, (5) males 31-45 years, and (6) males >45 years. Primary clinical outcomes were measured via the Hip Outcome Score Activity of Daily Living (HOS-ADL) and Sport-Specific Subscales (HOS-SS), the modified Harris Hip Score (mHHS), and clinical improvement at baseline and final follow-up. Statistical analysis was performed utilizing ANOVA and student's paired and unpaired t-tests, with $P<0.05$ considered significant.

RESULTS: All groups demonstrated significant improvements in HOS-ADL, HOS-SS, and mHHS outcomes at final follow-up compared to preoperative levels ($P<0.0001$). Females >45 scored significantly worse on the HOS-ADL, HOS-SS, and mHHS compared to females <30 ($P<0.0001$, $P<0.0001$, $P<0.0001$, respectively) and females 30-45 ($P<0.0001$, $P<0.0001$, $P=0.016$, respectively). Similarly, males >45 scored significantly worse on the HOS-ADL, HOS-SS, and mHHS compared to males <30 ($P=0.016$, $P<0.0001$, $P=0.003$, respectively) and males 30-45 ($P=0.015$, $P=0.003$, $P=0.013$, respectively). Comparison across genders in similar age groups showed that males >45 scored significantly better than females >45 on the HOS-SS ($P=0.019$) and the mHHS ($P=0.029$). Incorporating both genders, patients >45 scored significantly worse on the HOS-ADL, HOS-SS, and mHHS compared to patients <30 ($P<0.0001$, $P=0.007$, $P<0.0001$, respectively) and patients 30-45 ($P<0.0001$, $P=0.012$, $P=0.007$, respectively).

DISCUSSION AND CONCLUSIONS: While all patients, regardless of age or gender, had significant improvements in all outcomes following hip arthroscopy for FAI, patients >45 performed worse compared to patients in younger age groups, with females >45 demonstrating the poorest outcome scores. Despite lower scores, patients >45 reached the patient acceptable symptomatic state for HOS-ADL and mHHS. Overall, care must be individualized to optimize outcomes following hip arthroscopy for FAI, especially in the older population.

MAOA THIRD PLENARY SESSION
April 25, 2015

Predictors and Causes of 30-Day Readmission After Shoulder and Knee Arthroscopy: An Analysis of 15,228 Cases

Abstract ID: Paper 149

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*Robert W. Westermann, M.D.
Andrew J. Pugely, M.D.
Yubo Gao, Ph.D.
Christopher T. Martin, M.D.
Zachary Ries, M.D.
Annunziato Amendola, M.D.
Brian R. Wolf, M.D., M.S.
Iowa City, IA

BACKGROUND: Shoulder and knee arthroscopic procedures are among the most common procedures performed in the United States. With the passage and affirmation of the Affordable Care Act, 30-day readmission rates after surgical procedures have become an important quality metric. Hospitals and physicians will soon be publicly ranked according to these measures. Within arthroscopic surgery, readmission rates are typically very low, but the exact incidence has not been previously explored. Thus, the purpose of this study was to evaluate the incidence, causes, and risk factors for unplanned 30-day readmission after shoulder and knee arthroscopy.

METHODS: A multi-center, prospective clinic registry, the ACS NSQIP, was queried for CPT codes representing the most common shoulder and knee arthroscopic procedures. The cohort was then subdivided and analyzed based on procedure type. Unplanned readmissions within 30 days were evaluated dichotomously, and causes of readmission were identified based on ICD-9 coded readmission diagnoses. Both univariate and multivariate logistic regression analysis were utilized to identify patient demographic variables, comorbidities, and operative variables predictive of readmission.

RESULTS: In total, we identified 15,228 patients that underwent shoulder and knee arthroscopic procedures in 2012. Overall, 140 (0.92%) were readmitted within 30 days and rates were similar after shoulder (0.87%) and knee (0.94%) procedures. Readmissions were most common following procedures primarily addressing articular cartilage lesions in the knee (1.56%) and lowest after rotator cuff and labral repairs (0.68%) and cruciate reconstructions (0.78%). When patient-factors were controlled for using multivariate analysis, there was no difference in readmission for procedure type, operative time, or inpatient vs. outpatient surgery. The most common causes for readmission were surgical site infections (32.4%), DVT and PE (16.9%), and postoperative pain (7.0%). Multivariate analysis identified age >80 (OR 3.2 95% CI 1.4-7.3), chronic steroid use (OR 3.4 95% CI 1.6-7.2), and elevated ASA class (OR 4.5 95% CI 1.7-12.3) as independent risk factors for readmission.

CONCLUSIONS: Unplanned readmissions within 30 days of shoulder and knee arthroscopic procedures are low, at <1%, with wound-related complications being the most common cause. In patients with advanced age, taking chronic steroids, and with chronic systemic disease the

risk of readmission may be higher. These findings may aid in the informed consent process, patient optimization, and the quality reporting risk-adjustment process. In an era of quality reporting in healthcare, surgeons and hospitals must understand these risk factors and explore measures to minimize unplanned readmissions.

Secondary Pathology with Time to ACL Reconstruction Surgery

Abstract ID: Paper 150

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*Steven Ralles, B.S. / Philadelphia, PA
Julie Agel / Minneapolis, MN
Michael Obermeier / Minneapolis, MN
Marc Tompkins, M.D. / Minneapolis, MN

OBJECTIVES: The purpose of the study was to determine the relationship between a delay in primary ACL reconstruction and the incidence/location of concomitant intra-articular pathology. A secondary purpose was to determine the effects of patient age and pre-injury activity level on injury pattern.

METHODS: A retrospective review was carried out on 1,434 ACL deficient patients who underwent primary ACL reconstruction at a single institution between 2009 and 2013. Patients were grouped based on time to surgery after initial injury: 0-3 months, 4-12 months, and >12 months. Through the use of operative notes and arthroscopic images, 10 parameters were then analyzed across time to surgery groups: cartilage damage in the patella, trochlea, medial femoral condyle, lateral femoral condyle, medial tibial plateau, and lateral tibial plateau; medial and lateral meniscus injury; and the incidence of procedures involving either the meniscus or cartilage. The same parameters were then analyzed across time to surgery groups in patients with negative MRI findings following injury, but positive findings at surgery. Four age groups (<17, 18-21, 22-30, and 31+ years) were also evaluated for the injury parameters based on time to surgery groups. Finally, to evaluate for the effect of patient activity level, patients were divided into 2 pre-injury activity-level groups (Marx Activity Scale running <1 time per week and minimum of 1 time per week), which were evaluated for the injury parameters based on time to surgery groups. The relationships were analyzed using the Chi-square test.

RESULTS: An association was noted between time to surgery and increased incidence of pathology in the trochlea, lateral femoral condyle, medial tibial plateau, and medial meniscus ($P<0.001$). A similar pattern held true in patients with negative MRI and positive findings at the time of surgery. The age group categories were noted to have less of a pattern depending on age, but overall, the same anatomic locations were found to be involved. Finally, similar sites of pathology were also seen for the two activity level groups. This final analysis also suggested that pre-injury activity level does not affect the risk of concomitant injury with a delay in surgery.

CONCLUSION: A delay in timing to ACL reconstruction may be associated with an increased incidence of concomitant pathology seen, particularly in the trochlea, lateral femoral condyle, medial tibial plateau, and medial meniscus. Separate analyses of post injury MRIs, patient age, and pre-injury activity level support the findings in the initial analysis.

Subacute Effects of Local Anesthetics on Human Chondrocytes In Vitro in an Alginate Bead Model

Abstract ID: Paper 151

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*Jon B. Carlson, M.D. / Detroit, MI
Nancy M. Jackson, Ph.D. / Southfield, MI
Jeffrey C. Flynn, Ph.D. / Southfield, MI
David C. Markel, M.D. / Southfield, MI

BACKGROUND: The toxic effects of local anesthetics on articular cartilage have been documented by clinicians and in animal models. Our recent study demonstrated the dose-response nature of the acute toxicity in a human chondrocyte alginate bead in vitro model. However, anesthetic use in joints remains common in clinical practice.

PURPOSE: This study examined the subacute effects of lidocaine, bupivacaine, and ropivacaine on chondrocytes by evaluating changes in gene expression as well as indicators of toxicity. Alginate bead culture was chosen to simulate the in vivo environment and avoid complications such as dedifferentiation when these cells are grown in monolayer.

METHODS: Discarded tissue from eight total knee arthroplasty patients was collected with IRB approval. Cells from different donors were not mixed. The beads were exposed for one hour to lidocaine, bupivacaine, or ropivacaine mixed 1:1 with culture media, washed, and reincubated for 24 hours prior to harvest and testing. Cells were divided for RNA isolation, toxicity, and apoptosis assessment. Outcome measures included: cell death and apoptosis measured by flow cytometry, as well as RTPCR for aggrecan, nitric oxide synthase, caspase-3, and collagen-1A1 and collagen-2A1 changes in gene expression. The paired Student's t-test was used to determine significant differences between means.

RESULTS: 1.5% lidocaine was significantly more cytotoxic than 0.5% lidocaine ($p=0.006$) and controls ($p=0.004$). 0.25% bupivacaine was significantly more cytotoxic than 0.125% bupivacaine ($p=0.008$) and controls ($p=0.006$), and 0.125% bupivacaine was significantly more toxic than controls as well ($p=0.009$). 0.5% ropivacaine was significantly more toxic than 0.25% ropivacaine ($p=0.029$) and controls ($p=0.018$), but there was no difference between 0.25% ropivacaine and controls ($p=0.099$). A trend toward increased apoptosis was found for high dose lidocaine ($p=0.09$) or bupivacaine ($p=0.05$) when compared to controls. The significant changes in gene expression 24 hours after an acute 1 hour anesthetic exposure were limited to a decrease in collagen-2A1 with 0.5% lidocaine ($p=0.003$), 0.125% bupivacaine ($p=0.0002$), or 0.25% ropivacaine ($p=0.02$) and an increase in caspase-3 expression following 0.25% bupivacaine ($p<0.05$).

CONCLUSION: Increased cytotoxicity was found for high vs. low dose lidocaine and bupivacaine which is consistent with the literature and our previous studies. Both flow cytometry and gene expression data indicate that apoptosis is not a major factor in anesthetic induced chondrocyte death. The anesthetic induced decreases in collagen-2A1 expression indicate a disruption of normal chondrocyte function which could lead to joint damage.

Evaluation of Full-Thickness Rotator Cuff Tears in a Surgical Population: Ultrasound vs. Magnetic Resonance

Abstract ID: Paper 152

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*Nima Mehran, M.D.
Kelechi R. Okoroha, M.D.
Jonathan S. Duncan, M.D.
Vasilios Moutzouros, M.D.
Detroit, MI

INTRODUCTION: Rotator cuff repairs are one of the most common procedures performed by orthopedic surgeons. Ultrasound (US) and Magnetic Resonance Imaging (MRI) are both capable of diagnosing full-thickness rotator cuff tears. However, it is unknown if ultrasound can evaluate rotator cuff tear characteristics as accurately and precisely as MRI. This study compared US to MRI in the evaluation and classification of preoperative full-thickness RCTs in a surgical population.

METHODS: We performed a retrospective review of 114 patients who had an arthroscopic repair of full-thickness RCT over a one-year period at a large academic center. All 114 patients had preoperative MRIs, 61 of which also had a preoperative US of the surgical shoulder. Three musculoskeletal radiologists evaluated each US and MRI in a randomized and blinded fashion. Tear size, retraction status, atrophy, and fatty degeneration were all analyzed and compared between the two modalities. Atrophy was classified by the occupation ratio (OR) and converted to the 3-stage Thomazeau classification for comparison to MRI. Fatty Degeneration was evaluated on the modified Strobel (US) and Goutallier (MRI) Classifications. We treated the MRI data as the “gold standard” and expressed error in the US measurements in terms of bias and precision.

RESULTS: US measurements statistically underestimated both tear size ($p=0.016$) and retraction status ($p=0.016$) when compared to MRI. Atrophy OR demonstrated a significant difference between US (0.76) and MRI (0.57) ($p<0.0001$). Atrophy US classification was converted for comparison to MRI and demonstrated that 89% vs. 41% were graded as normal-mild, 8% vs. 46% as moderate, and 3% vs. 13% as severe atrophy for US and MRI, respectively. Regarding fatty degeneration, 37% vs. 23% were graded as normal, 51% vs. 70% as mild to moderate, and 12% vs. 7% as severe on US vs. MRI respectively, with a statistically significant difference ($p<0.0001$). Based on the bias error, US consistently underestimates tear size compared to MRI.

CONCLUSIONS: Historically, ultrasound has been shown to detect the presence of a rotator cuff tear. However, it has consistently low sensitivity in detecting subtle but clinically important degeneration of the cuff musculature when compared to MRI. Additionally, ultrasound demonstrates poor accuracy in calculating the retraction status and size of the tear when compared to MRI.

Shoulder Arthroplasty for Arthritis After Instability Surgery: A 10-Year Follow-Up Study

Abstract ID: Paper 153

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*Peter L. Kok, M.D.
Joshua A. Parry, M.D.
Bradley S. Schoch, M.D.
Cathy D. Schleck, B.S.
Robert H. Cofield, M.D.
John W. Sperling, M.D.
Rochester, MN

INTRODUCTION: We previously reported the outcomes of patients treated with shoulder arthroplasty for glenohumeral arthritis after instability surgery. This study found that, although arthroplasty improved pain and motion, it was associated with high rates of revision and unsatisfactory outcomes. Now, 10 years later, we aim to evaluate the long-term outcomes of this cohort along with additional cases.

METHODS: Between January 1,1976, and December 31, 2003, 65 consecutive shoulders with glenohumeral arthritis after instability surgery were treated with shoulder arthroplasty. 63 shoulders were followed for a minimum of five years or until reoperation, mean 12 years (range, 5-33). Twenty-one shoulders underwent hemiarthroplasties (HA) and 44 total shoulder arthroplasties (TSA). Prior instability procedures included soft tissue procedures alone in 46 shoulders and bony transfers in 17 shoulders. Outcome measures included pain, range of motion, postoperative modified Neer ratings, and survivorship.

RESULTS: Both HA and TSA treatment groups showed similar and significant improvements in abduction ($p < 0.0001$), external rotation ($p < 0.0001$), and pain scores ($p < 0.0001$). There were a total of 11 excellent, 16 satisfactory, and 34 unsatisfactory results based on modified Neer result ratings. There was no difference between treatment groups ($p < 0.7$). Overall, there were 24 reoperations, with 43% (9 of 21) of the HAs and 34% (15 of 44) of the TSAs requiring reoperation. The estimated survival of the components was 73% at 10 years and 49% at 20 years. There was no difference in survivorship between HA and TSA ($p = 0.86$). There was a trend towards decreased implant survival in patients who had undergone bony transfer stabilization procedure ($p=0.053$). In the HA group, all revisions were for progressive glenoid arthritis. In the TSA group, the major indication for revision was painful glenoid wear with instability (10 of 15 shoulders).

CONCLUSION: Hemiarthroplasty and total shoulder arthroplasty were both effective at improving range of motion and pain due to glenohumeral arthritis after prior instability surgery. However, these younger patients have high rates of revisions and unsatisfactory outcomes secondary to component failure, instability, and pain. Furthermore, the type of instability procedure may ultimately affect implant survival.

Reverse Shoulder Arthroplasty Superior to Hemiarthroplasty for Cuff Tear Arthropathy with Preserved Motion

Abstract ID: Paper 154

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*Jonathan D. Barlow, M.D. / Columbus, OH
Dexter Bateman, B.S. / Philadelphia, PA
Gerald R. Williams, Jr., M.D. / Philadelphia, PA

INTRODUCTION: Patients with rotator cuff tear arthropathy (CTA) and preserved motion were historically treated with hemiarthroplasty (HA) with satisfactory outcomes. The reverse total shoulder arthroplasty (RSA) provides an alternative treatment option for these patients. It is unclear whether HA or RSA will provide better outcomes and fewer complications and revisions in patients with CTA and preserved motion (>90˚).

METHODS: Records of patients who underwent RSA or HA for CTA at a single institution from 2007-2013 were reviewed. Patients were included if they had a minimum of 2 years of follow-up, or until complication or revision. Shoulder ROM, ASES, SST, SANE score, and VAS for pain were recorded.

RESULTS: 68 shoulder arthroplasties in 65 patients met inclusion criteria, with 33 HAs (36 shoulders) and 32 RSAs (32 shoulders). 26 HAs and 21 RSAs had over two-year follow-up or had a revision or complication, and were included in the final analysis. The mean follow-up was 38.6 months in the HA group and 36 months in the RSA group. Patients in the RSA group were significantly older (73.9 vs. 65.1; p = .003). There was a trend toward improved preoperative motion in HA patients compared to RSA patients (forward elevation: 138° vs. 127° [p=0.09], external rotation: 39° vs. 30° [p=0.05], respectively). Postoperatively, the mean change in active elevation was -15° for HA vs. 26° for RSA, with RSA having significantly greater active flexion (152° vs. 123°; p = .013). There were no differences in final internal or external rotation between groups. Superior functional outcome scores were reported for RSA compared with HA for ASES score (86 vs. 66, p=0.001), SST (72 vs. 61, p=0.2 [not statistically significant]), SANE score (87 vs. 70, p=0.004), and VAS (0.9 vs. 3.2, p=0.002). There were 11 complications (31%) and five revisions (14%) in the HA group and four complications (13%) and one revision (3%) in the RSA group, but these differences were not significant (p=0.09 and 0.2, respectively). The most common complication in the hemiarthroplasty group was subscapularis failure, seen in 7 patients (19%).

DISCUSSION: In patients with CTA and preserved preoperative forward flexion, RSA provided greater pain relief, superior functional outcomes, and increased active elevation compared with HA. While not statistically significant, there was a lower rate of complications and revisions in the RSA group. Subscapularis failure was a frequent complication in patients with HA in this series.

MAOA BREAKOUT SESSION #11
HIP ARTHROPLASTY
April 25, 2015

Tranexamic Acid: Optimal Blood Loss Management in Surface Replacement Arthroplasty

Abstract ID: Paper 155

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*Adam A. Sassoon, M.D. / Seattle, WA
Staci R. Johnson, M.S. / St. Louis, MO
Ronald Jackups, M.D. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Ryan M. Nunley, M.D. / St. Louis, MO
Robert L. Barrack, M.D. / St. Louis, MO

BACKGROUND: The exposure required to perform surface replacement arthroplasty (SRA) is more extensive than that used in total hip arthroplasty and may lead to increased blood loss. This study investigated whether the routine use of tranexamic acid (TXA) during SRA decreased blood loss when compared to patients who did not receive TXA.

METHODS: A retrospective review of patients treated with TXA during a SRA, who did not receive autologous blood, (TXA group) was performed. Two additional groups were established for comparison; the first group was comprised of patients who donated their own blood preoperatively (auto group) and the second group consisted of patients who did not donate blood preoperatively (control). Outcomes included transfusions, postoperative hemoglobin, and complications. Additionally, a cost-analysis related to transfusions was performed.

RESULTS: Between 2009-2013, 150 patients undergoing SRA were identified for inclusion: 51 in the auto, 49 in the control, and 50 in the TXA group. The percentage of patients receiving allogeneic transfusions in each group was 4%, 8%, and 2%, respectively. While there were no differences in the preoperative hemoglobin concentrations between groups, the mean postoperative hemoglobin was 11.3 mg/dL in the auto and TXA groups, and 10.6 mg/dL in the control group ($p=0.001$). The length of stay was 1.7 days for the auto, 1.4 days for the control, and 1.2 days for the TXA group ($p<0.001$). The total transfusion related costs were $62,973, $2,265, and $453 for the auto, control, and TXA groups.

DISCUSSION: TXA is the optimal solution for perioperative blood management in hip resurfacing, demonstrating higher postoperative hemoglobin concentrations when compared to controls. Additionally, TXA avoids potential patient risks and financial burden related to autologous and allogeneic transfusions.

Total Hip Arthroplasty with Highly Cross-Linked Polyethylene in Patients 50 Years and Younger

Abstract ID: Paper 156

Kevin L. Garvin, M.D.
*Tyler C. White, B.S.
Patrick Anderl, M.D.
Anand Dusad, M.D.
Curtis W. Hartman, M.D.
Beau S. Konigsberg, M.D.
John Martell, M.D.
Omaha, NE

PURPOSE: Patients 50 years or younger are at highest risk for wear-related complications of their total hip arthroplasty because of their level of activity. Highly crosslinked polyethylene is believed to be more durable for this population than conventional polyethylene because of its improved wear. The purpose of this study was to evaluate the mid-term results (9-14 years) of patients 50 years or younger who had a THA using HXLPE of their acetabular component and to determine the effect of the bearing head diameter and the bearing head material (CoCr, oxidized zirconium, ceramic) on the wear of the HXLPE material.

METHODS: From November 1999 to April 2005, 105 total hip arthroplasties were performed in 95 patients 50 years or younger (average 41, 20-50). The average BMI was 30.2 (17-51). Harris Hip Scores were recorded preoperatively and postoperatively at the patient's most recent follow-up. UCLA and Tegner activity scores were recorded and compared to the linear wear measurements obtained using the Martell method.

RESULTS: The mean follow-up was 11.5 years (range 9-14). Two patients died and five were lost to follow-up. We used the most recent clinical and radiographic data on the deceased and lost patients. The Harris Hip Scores improved from 52 preoperatively to 95 postoperatively. UCLA and Tegner activity scores also improved from 3.7 and 2 preoperatively to 6.1 and 3.3 postoperatively, respectively. True linear wear rate was 21 μm/year (95% CI± 77 per year). None of the hip radiographs had evidence of loosening or osteolysis. Wear was not associated with the femoral head diameter or femoral head material.

CONCLUSION: Patients with total hip arthroplasty using highly crosslinked polyethylene have had excellent clinical results with minimal radiographic evidence of wear (21 μm/year) at a minimum follow-up of 9 years.

Hospital-Based Orthopedically Trained PA-C Improves Length of Stay, Cost, and Discharge Following TJA

Abstract ID: Paper 157

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*Daniel P. Hoeffel, M.D. / Woodbury, MN
Brandon J. Kelly, B.S. / Minneapolis, MN
Marc R. Giveans, Ph.D. / Woodbury, MN
Susan Mehle, B.S. / St. Paul, MN

INTRODUCTION: Hospital-based orthopedically trained certified physician assistants (PA-C) have shown to decrease patient length of stay (LOS) in orthopedic trauma settings. We examine their impact on discharge, LOS, and direct cost per admission for total joint arthroplasty in a community setting.

PA-Cs were trained and assigned full-time at three hospitals in a single community health system. The health system and a large metropolitan private practice orthopedic group shared salary and benefits of the PA-Cs equally. The orthopedic group assumed oversight of core competencies and day-to-day management.

METHODS: Analysis of an internal quality metric database and economic data was performed from six months prior to PA-C start to six months following PA-C start. Discharge disposition (home vs. transitional care facility), LOS, and direct costs of hospitalization were analyzed for 2,004 patients who underwent TJA. Six patients were excluded from analysis (2 deaths, 4 discharged to correctional facility). Chi-squared analyses, independent samples t-test, and Mann-Whitney U-tests were used. Hospitals 1 and 2 have similar acuity and hospital 3 has less acute cases.

RESULTS: There was a statistically significant difference in the percentage of patients discharged to home after PA-C start (72% before vs. 78% after, p=.006) for the system. Hospital 1 (60.1% vs. 68.7%, p=.076), 2 (63.5% vs. 72.3%, p=.082), and 3 (79.6% vs. 81.4%, p=.406) saw increases in discharge home individually. Greater gains were observed at higher acuity facilities.

LOS was statistically significantly reduced after PA-C implementation (3.02 days vs. 2.79 days, p<.001) for the system. Hospital 1 (3.3 days vs. 2.9 days, p=.001), 2 (3.2 days vs. 2.7 days, p<.001), and 3 (2.9 days vs. 2.8 days, p=.154) saw decreases in LOS individually. Greater reductions were seen at higher acuity facilities.

Direct cost per admission was statistically significantly reduced after PA-C implementation ($11,811 vs. $11,487, p=.029) across the health system. Hospital 1 ($12,742 vs. $11,803, p=.010) and 2 ($13,661 vs. $12,865, p=.027) saw decreases in direct cost per admission individually. Hospital 3 ($10,843 vs. $11,082, p=.151) saw increase in direct cost per admission.

CONCLUSION: Significant gains were made at all three hospitals for LOS, discharge home, and direct cost per admission following TJA. PA-C presence has increased access of patients and hospital staff to an orthopedic provider. Timely communication is enhanced and participation on hospital quality improvement committees has led to more rapid development and implementation of patient care and quality initiatives. Total annualized savings is approximately $1.3 million.

Trunnionosis: Are Large Metal Heads on Polyethylene a Significant Source of Increased Metal Ions?

Abstract ID: Paper 158

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*John R. Martin, M.D.
Christopher L. Camp, M.D.
Luke Spencer-Gardner, M.D.
David G. Lewallen, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Recently, there have been increasing reports of adverse local tissue reactions in the setting of metal on polyethylene bearing surface total hip arthroplasty (THA). Patients present with increased metal ion levels similar to what has been observed with metal on metal hip replacements. The elevated metal ion levels in these patients have been attributed to corrosion at the head neck junction secondary to the differing metals articulating at the junction of the cobalt chromium femoral head and titanium trunnion. Some have speculated that increasing femoral head size may lead to increased rates of corrosion at the trunnion. The primary goal of this study was to establish a baseline value for serum metal ion levels in asymptomatic THA patients and to correlate these levels with femoral head size.

METHODS: Inclusion criteria for the study were: patients 2-5 years status post metal (cobalt chrome) on polyethylene bearing surface primary THA, no hip pain or other symptoms, no other joint replacements, and age > 18. Patients were enrolled in the study at the time of their clinical follow-up appointment, and serum cobalt (Co) and chromium (Cr) levels were checked. Patient implant information, serum metal ion levels, and functional outcomes were assessed.

RESULTS: To date, 30 patients have been enrolled in the study. There are 15 men and 15 women with a mean age of 63. Femoral head size ranged from 32-44 mm, with a mean of 36 mm. Thirteen (43%) patients had Co levels <0.2ng/mL and seven (23%) patients had Cr levels <0.1ng/mL. The average values for the remaining patients were Cr 0.85ng/mL and Co 0.57ng/mL. Two patients were noted to have elevated metal ion levels. The first patient had a 36 mm head and a Co level of 0.4 and Cr of 6.4 while the second patient received a size 44 mm head and demonstrated a Co level of 8.4 and a Cr level of 0.4. Currently, there is no significant difference between femoral head size and metal ion levels.

CONCLUSION: Trunnion corrosion is becoming more frequently recognized as a mechanism of failure in metal on polyethylene THA. In our series of 30 asymptomatic patients, we identified a 7% prevalence of elevated metal ion levels. Moving forward, consideration may be given to using alternative bearing surfaces or initiating a screening protocol even in asymptomatic patients with metal on polyethylene THA.

Modular Shell Metal-on-Metal Bearings in THR: As Bad as Monolithic? As Good as Polyethylene?

Abstract ID: Paper 159

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*Justin Greiner, B.S. / Iowa City, IA
John J. Callaghan, M.D. / Iowa City, IA
Nicholas A. Bedard, M.D. / Iowa City, IA
Michael Stefl, M.D. / Los Angeles, CA
Steve S. Liu, M.D. / Iowa City, IA
Devon D. Goetz, M.D. / West Des Moines, IA
Craig R. Mahoney, M.D. / West Des Moines, IA
Nicolas O. Noiseux, M.D. / Iowa City, IA
Yubo Gao, Ph.D. / Iowa City, IA

INTRODUCTION: One-piece cementless acetabular shells have not performed well when used in a metal-on-metal bearing THR construct. The purpose of this study was to evaluate the use of a modular shell MoM bearing THR construct and to compare the results to cementless THR constructs with polyethylene-metal and one-piece MoM bearing surfaces.

METHODS: We prospectively evaluated 169 hips in 148 patients who underwent THR using a cementless modular acetabular MoM bearing shell at 5-9 year follow-up. Need for revision, clinical surveys (WOMAC, HHS, UCLA, and Tegner activity) and radiographic evaluation for loosening and osteolysis were recorded. Similar evaluation was performed on a prospective cohort of 150 hips in 139 patients who underwent THR using the identical acetabular shell with a polyethylene-metal bearing surface that were followed for a minimum of 10 years.

RESULTS: At minimum 5-9 year follow-up, only 1 hip was revised for ALTR in the MoM cohort. No hip demonstrated evidence of loosening and only 7 cases of osteolysis were noted. This compares to the polyethylene-metal cohort where at minimum 10 years, no cases were revised for loosening, there is no evidence of radiographic loosening, and only 1 case of osteolysis was detected ($p=0.03$ compared to MoM series).

CONCLUSION: Cementless modular shell MoM bearing THR constructs performed well at 5-9 year follow-up with only 1 case (0.6%) revised for adverse local tissue response, none revised for loosening, and none demonstrating radiographic loosening. There were only 7 cases of relatively small (< 1 cm^2) acetabular or femoral osteolytic lesions. These results are markedly better than the results of monolithic shell MoM THR constructs where revision rates of up to 10% at 5 years have been reported. However, these results are not comparable to a series of polyethylene-metal bearing THR constructs using the identical cementless acetabular shell where there were no revisions for loosening, no radiographic loosening, and only 1 hip (0.7%) with a small osteolytic lesion.

Patient Outcomes Following Implantation of Modular Neck Hip Prostheses in Primary THA

Abstract ID: Paper 160

Takayuki Murayama, M.D.
*J. David Blaha, M.D.
Aidin Eslam Pour, M.D.
Andrew G. Urquhart, M.D.
Brian R. Hallstrom, M.D.
Robert Bordern, B.S.
Mary Groll-Brown, M.D.
Ann Arbor, MI

PURPOSE: Although total hip arthroplasty remains one of the most successful orthopedic interventions for coxarthrosis, optimizing implant size, length, and offset is critical to ensuring optimal function. To this end, bi-modular femoral neck components were introduced to allow for better intraoperative sizing. While this design feature offers several advantages to the surgeon, failures have been reported and thus the long-term outcome of modular necks must be assessed to ensure that their use does not compromise implant longevity. The purpose of this study was to investigate the results of a series of modular neck implants and catalog the causes of failure of these devices.

METHODS: Our series included 275 patients (124 male and 151 female) with 'PROFEMUR-E' and 'PROFEMUR-Z' femoral stems. This population included primary, unilateral, and bilateral cases with metal-on-metal (MoM), metal-on-polyethylene, and ceramic-on-ceramic bearing surfaces. Data for this cohort of patients included patient demographics, implant dimensions, and the type of articular surface. Correlation of these variables with failure was analyzed to estimate the effect of each on survivorship. Implant failure was defined as cases requiring revision surgery.

RESULTS: The average follow-up time was 49 months (range 0.13-126 months). In 65% of the patients, a MoM bearing surface was used. PROFEMUR-E was the more commonly used stem (62%). The rate of revision surgery was 19.3%. The most common reason for aseptic revision was femoral stem loosening (5.5%), followed by modular neck fracture (2.5%), acetabular implant loosening (2.5%), metal reaction (1.5%), and periprosthetic fracture (1.5%). The rate of revision for any reason was higher among those patients with MoM bearing surface (21.8% in MoM, 14.6% in non-MoM), but the difference was not significant ($p = 0.149$). The rate of stem loosening was significantly higher among PROFEMUR-E stems (8.8% E vs. 0% Z, $p = 0.002$), but the rate of modular neck fracture was significantly higher among PROFEMUR-Z patients (5.7% Z vs. 0.6% E, $p = 0.009$). The revision rate for modular neck fracture was significantly higher among the long-neck implant patients (15% vs. 0% for the short neck, $p < 0.001$). The revision rate for modular neck fracture was slightly correlated with greater offset and larger head diameter ($\eta = 0.31$, 0.22, respectively).

CONCLUSIONS: These data suggest that failure of modular neck junctions may be potentiated by long neck lengths, greater offset, and larger head diameters. It is suspected that these factors contribute to modular neck failure by creating a stronger moment arm about the neck's insertion into the stem. These data may help identify a set of patient dimensions that contraindicate the use of modular neck junctions.

Adverse Local Tissue Reactions Secondary to Corrosion at the Head- Neck Junction in Metal on Polyethylene Bearings

Abstract ID: Paper 161

Darren R. Plummer, M.S. / Chicago, IL
*Craig J. Della Valle, M.D. / Chicago, IL
Richard A. Berger, M.D. / Chicago, IL
Wayne G. Paprosky, M.D. / Winfield, IL
Scott M. Sporer, M.D. / Winfield, IL
Joshua J. Jacobs, M.D. / Chicago, IL

INTRODUCTION: Adverse local tissue reactions (ALTR) related to corrosion at the head-neck junction in metal-on-polyethylene (MOP) bearings have been described with increasing frequency. Diagnosis and appropriate management, however, is not well understood. The purpose of this report is to describe our experience with the diagnosis and management of this complication.

METHODS: We identified 27 patients who were revised for an ALTR secondary to corrosion at the modular femoral head-neck taper with a MOP bearing. Patients presented at a mean of 4.3 years (range, 0.4 to 25 years) after their index procedure. Patients were treated with debridement and a modular bearing exchange, with use of a ceramic femoral head with a titanium sleeve in 23 of the 27 cases. Student's t-test was used to compare pre- and postoperative metal ion levels with significance set at a p-value of < 0.05.

RESULTS: Preoperative serum cobalt levels were elevated to a greater degree than were chromium levels in all cases, with a mean cobalt of 11.2 ppb (range, 1.1 to 49.8) and chromium of 2.2 ppb (range, 0.2 to 9.8). Repeat metal ions (measured in 16 of 18 patients with > 2 year follow-up) showed a significant decrease in serum cobalt to a mean of 0.33 ppb (range 0.18 to 0.6) ($p = 0.004$), and chromium to a mean of 0.51 ppb (range 0.1 to 1.4) ($p = 0.001$). Recurrent ALTR was noted in one case where a metal as opposed to a ceramic head was used.

CONCLUSIONS: The diagnosis of ALTR secondary to corrosion at the head-neck taper in patients with a MOP bearing is associated with serum cobalt levels of > 1 ppb with cobalt levels consistently elevated above chromium. Retention of a well-fixed stem and modular exchange to a ceramic head leads to resolution of symptoms and decreases in metal ion levels.

Primary Total Hip Arthroplasty Dislocation Rates for Femoral Neck Fractures Tend to Decrease with Increasing Femoral Head Size

Abstract ID: Paper 162

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*Jeremiah D. Johnson, B.S. / Minneapolis, MN
Ryan D. Horazdovsky, M.D. / Minneapolis, MN
Scott B. Marston, M.D. / St. Paul, MN

Total hip arthroplasties (THA) provide many functional advantages over hemiarthroplasties (HA) in femoral neck fracture (FNF) patients; however, THA's precedence of having a higher dislocation rate has likely limited its use. Elective THA studies have seen modest reductions in dislocation rates with larger head sizes, but the literature is lacking in the sub-population of FNF patients. This study compared current dislocation rates of small vs. large femoral head sizes in FNF patients and hypothesized that larger head sizes have reduced the THA dislocation rate.

We retrospectively reviewed all primary THAs for FNFs treated by 2 surgeons between August 1, 2004, and October 31, 2013. CPT and ICD9 codes initially identified 147 patients, but after excluding code errors, fractures due to metastatic lesions, and dual-mobility implants, our sample size was comprised of 107 patients and 111 THAs. The sample was analyzed with small heads categorized as <36-mm and large heads >36-mm.

There were significant differences in our sample's demographics with the small head size cohort comprising younger patients (71.07 vs. 75.77; p=0.0118) and more females (92.68% vs. 54.29%; P<0.0001). There were 4 dislocations in the small head size cohort and 1 in the large cohort producing a total of 5 dislocations and an overall rate of 4.50% (CI=14.8-102). Comparing the small and large head size dislocation rates, 9.76% and 1.43% respectively, revealed a 6.83 greater likelihood of dislocation with smaller sizes (p=0.0612). A logistic regression model controlling for age and sex resulted in a 9.576 greater odds of dislocating with smaller head sizes (p=0.1124).

Larger femoral head sizes had a lower dislocation rate that was borderline significant. The data is complicated by differences in the cohorts' demographics including sex and surgical approach. A larger sample size is preferred to analyze the low occurrence of dislocations. Overall, the dislocation rate is lower than previously reported and suggests larger head sizes have reduced THA's dislocation rate in the FNF population.

Simultaneous Bilateral vs. Staged Bilateral Total Hip Arthroplasty: A Survival Study

Abstract ID: Paper 163

Matthew T. Houdek, M.D.
Eric R. Wagner, M.D.
Cody C. Wyles, B.S.
Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
*Michael J. Taunton, M.D.
Rochester, MN

INTRODUCTION: Total hip arthroplasty (THA) is considered one of the most successful orthopedic procedures. For patients with end-stage bilateral hip osteoarthritis, there is debate on whether to perform bilateral THA in a simultaneous or staged fashion. Previous studies have shown that simultaneous bilateral THA is associated with short-term postoperative complications; however, there is limited data comparing the long-term outcomes of these procedures.

MATERIALS AND METHODS: Using our institution's total joint registry, we identified 3,325 patients (6,650 hips), 52% female, with a mean age of 60 years and mean BMI 29.9 underwent staged bilateral THA. Only staged bilateral THA performed within a 12-month time period were included, with the mean time between THA being 3.4 months. 124 patients (248 hips), 43% female, with a mean age of 52 years and mean BMI of 27.5 underwent simultaneous bilateral THA. Mean follow-up was 11.3 years. Kaplan-Meier implant survival outcomes and Cox hazard ratios were calculated to determine risk of revision, reoperation, and infection.

RESULTS: Patients in the staged THA group were significantly older (60 vs. 52 years, p=0.0001), more commonly female (p=0.0001), and had a greater mean BMI (29.9 vs. 27.5, p=0.0001) than patients in the simultaneous THA group. The overall 2-, 5-, 10-, and 15-year survival of all bilateral THA was 99% (±1%), 97% (±1%), 90% (±1%), and 81% (±1%). There was no difference in the overall 15-year survival between the staged and simultaneous THA (HR 0.98, p=0.27). There was no difference in survival (HR 0.95, p=0.47) between staged bilateral THAs performed within 3 months to those greater than 3 months apart. There was no difference in the rate of postoperative 30- (p=0.47) and 90-day (p=0.97) mortality, infection (p=0.74), dislocation (p=0.27), and wound complications (p=0.82) between the staged and simultaneous group; however, DVT was more common in the single stage group (p=0.01).

CONCLUSION: Previous studies have shown increased rates of complications following single stage bilateral THA. In this report, single stage THA was not associated with an increased risk of revision THA, reoperation or infection. Our data shows that single stage bilateral THA is a safe procedure, with similar survival and complication profile compared to staged bilateral THA.

Total Hip Arthroplasty in the Medicaid Population

Abstract ID: Paper 164

Brian E. Schwartz, M.D.
*Matthew G. Robinson, B.S.
Vincent M. Moretti, M.D.
Mark H. Gonzalez, M.D.
Chicago, IL

INTRODUCTION: The Affordable Care Act (ACA), signed into law in 2010, is expected to widen health insurance coverage to include the 32 million uninsured Americans, more than half of which will be covered under Medicaid. The ACA is expected to expand ways for patients to compare physicians online. These statistics may be unfairly skewed for orthopedic surgeons whose practice consists of a large portion of Medicaid patients, as certain outcomes may be worse in this population. The purpose of this study was to evaluate patient demographics and perioperative outcomes for Medicaid patients who underwent a total hip arthroplasty (THA).

METHODS: The National Hospital Discharge Survey searched ICD-9 codes for patients admitted to hospitals for primary THA for the years 2001-2010. Patients were then separated into two groups based on the principal expected source of payment: Medicaid and all other types of insurance (Medicare, worker's compensation, Blue Cross/Blue Shield, HMO/PPO, self-pay, no charge, other). ICD-9 codes were used to identify patient demographics, in-hospital adverse events, and discharge disposition. Statistical analysis included Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis with a significance level of 0.05.

RESULTS: 18,181 THA patients were identified (454 Medicaid, 17,727 other insurance). From 2001-2005, Medicaid accounted for 2.38% of all THA performed, increasing insignificantly to 2.61% between 2006-2010 ($p=0.322$). The Medicaid group was significantly younger (50.3 vs. 65.6 years, $p<0.01$) and more male (44.9% vs. 43.2% male, $p=0.499$) than the other insurance group, respectively. Average length of stay was longer for the Medicaid group (4.6 vs. 4.0 days, $p=0.0008$). Medicaid patients were more likely to be discharged home (53.7% vs. 47.2%, $p=0.007$) and less likely to be discharged to rehabilitation (24.4% vs. 29.0%, $p=0.041$) than the other insurance group. There was no significant difference in the rates of obesity (7.7% vs. 6.8%, $p=0.4593$), diabetes (9.5% vs. 10.3%, $p=0.617$), DVT (0.44% vs. 0.15%, $p=0.356$), PE (0.22% vs. 0.26%, $p=0.871$), blood transfusion (24.4% vs. 26.0%, $p=0.502$), wound infection (0% vs. 0.12%, $p=0.946$), mortality (0.22% vs. 0.22%, $p=0.999$), or number of medical co-morbidities (5.0 vs. 4.85, $p=0.1515$) between the Medicaid and other group, respectively.

DISCUSSION: While the rate of Medicaid in primary THA was relatively unchanged through 2010, the rate is expected to rise significantly with the rollout of the ACA. Orthopedists who treat a significant amount of Medicaid patients may be unfairly judged in the upcoming online comparisons, specifically in terms of length of stay after THA.

Urinary Tract Infection After Total Hip Arthroplasty: A Retrospective Cohort Study

Abstract ID: Paper 165

Brian E. Schwartz, M.D.
*Jonathan D. Lester, M.D.
David E. Mossad, B.S.
Vincent M. Moretti, M.D.
Mark H. Gonzalez, M.D.
Chicago, IL

INTRODUCTION: Recently, there has been significant focus to reduce perioperative urinary tract infections (UTI) after total hip arthroplasty (THA). The Center for Medicare and Medicaid's Services went as far as to name catheter associated UTIs to its list of "never events" in 2008. The purpose of this study was to assess patient demographics, associated perioperative outcomes, and trends in the development of UTIs after THA.

METHODS: ICD-9 procedure codes were used to search the National Hospital Discharge Survey for all patients admitted to surveyed U.S. hospitals after primary THA for each year between 2001-2010. Patients from this population who developed a UTI during the same admission were identified. Data regarding patient demographics, discharge disposition, and in-hospital adverse events were gathered. Statistical analysis included linear regression with Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis with a significance level of 0.05.

RESULTS: 17,614 patients admitted for a primary THA were identified. 3.1% (571 patients) of these patients developed a UTI during the same admission. No significant trend in the rate of UTI after THA (range, 1.9% to 2.5%) was found ($r=0.196$). Patients who developed a UTI had a significantly longer hospitalization (5.4 vs. 3.9 days, $p<0.01$), a diminished rate of discharge directly home (31.7% vs. 47.9%, $p<0.01$), and an increased rate of discharge to a rehabilitation facility (43.4% vs. 28.4%, $p<0.01$) than those patients without a UTI. Patients with a UTI were found to be significantly older (mean age of 71.2 vs. 65.0 years, $p<0.01$), more likely to be female (71.1% female vs. 65.0% female, $p<0.01$), and more likely to receive a blood transfusion (37.8% vs. 25.5%, $p<0.01$) than those without a UTI. While the average number of medical co-morbidities was significantly higher in patients with UTIs (6.5 vs. 4.8 diagnoses, $p<0.01$), the rates of obesity (UTI 4.9% vs. non-UTI 6.9%, $p=0.0628$), and diabetes (UTI 8.7% vs. non-UTI 10.3%, $p=0.22$) were not found to be significantly different. No significant difference was found in rate of DVT ($p=0.53$), PE ($p=0.37$), or mortality ($p=0.24$).

DISCUSSION: This study demonstrates that UTIs happen relatively frequently after THA, occurring in approximately 1 in 33 patients. UTIs after THA were associated with longer hospitalizations and a less favorable discharge disposition. While UTIs after THA are by no means completely preventable, orthopedists should identify those patients at increased risk who per this study are older, female patients with multiple medical co-morbidities who received a blood transfusion.

Ceramic Femoral Heads for All Patients: An Argument for Cost Containment in Hip Surgery

Abstract ID: Paper 166

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*Cody C. Wyles, B.S. / Rochester, MN
Benjamin A. McArthur, M.D. / Chevy Chase, MD
Jose H. Jimenez-Almonte, B.S. / Rochester, MN
Matthew T. Houdek, M.D. / Rochester, MN
Eric R. Wagner, M.D. / Rochester, MN
Robert T. Trousdale, M.D. / Rochester, MN

BACKGROUND: Trunnionosis and taper corrosion has emerged as a concerning issue in total hip arthroplasty (THA). Although more expensive at the time of surgery, ceramic femoral heads eliminate the concern for cobalt toxicity. We provide a theoretical framework for debating whether use of ceramic femoral heads in all THA patients could represent a more cost-effective strategy for healthcare systems.

METHODS: The cost of patient care activities for a metal toxicity workup was obtained from our institution. In order to analyze the cost between ceramic and cobalt-chrome femoral heads, we created two metrics. “Ceramic surplus” (CS) is defined as the extra cost of a ceramic femoral head above that of a cobalt-chrome femoral head. “Maximum ceramic surplus” (MCS) represents the CS value below which using ceramic femoral heads in all patients becomes more cost effective than using cobalt-chrome heads. CS was determined for three different practice settings (high volume academic, high volume private, low volume private) using data from two implant companies (X and Y). MCS models were created with an assumption that approximately 7% of metal-on-polyethylene THA patients will present with groin pain at 1 – 2 years after surgery based on a recent publication. A series of theoretical prevalence ratios (12.5%, 25%, 50%) were applied to each of the following: (1) percentage of patients with painful THA receiving a single metal toxicity workup and (2) percentage of patients receiving a metal toxicity workup eventually needing revision surgery.

RESULTS: The cost of a single metal toxicity workup was $5,085 when magnetic resonance imaging (MRI) was applied to the model and $2,402 for ultrasound (US). The cost of revision THA with a three day inpatient stay allowance was $53,320. This figure does not include the charge for surgical implants or perioperative medications and devices. CS ranged from $500 in high volume academic practice to $1,500 in low volume private practice. MCS ranged from $511 - $2,044 in the models integrating MRI and $488 - $1,950 in the models incorporating US.

DISCUSSION AND CONCLUSIONS: Use of ceramic femoral heads in all patients may provide a more cost-effective strategy for healthcare systems. The required MCS may be as low as $500, which is already the status quo in many high volume centers. Further studies will be needed to define the epidemiology of metal toxicity in THA to substantiate these results.

Do Corticosteroid Injections Increase the Risk of Early Postoperative Complications After Total Hip Arthroplasty?

Abstract ID: Paper 167

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*Michael D. Hellman, M.D.
Bryan D. Haughom, M.D.
Bryan M. Saltzman, M.D.
Aaron L. Wiegmann, B.S.
Ishaq Ibrahim, B.S.
Christopher E. Gross, M.D.
Brett R. Levine, M.D.
Chicago, IL

INTRODUCTION: The impact of corticosteroid injections prior to total hip arthroplasty (THA) remains unknown. Previous studies have reported mixed results with regards to revision, infection, and wound complications. Using a large single institution cohort, our study aimed to determine if hip injections performed within 1-year of THA were associated with early postoperative wound complications and infection.

METHODS: A consecutive series of 203 patients (February 2010-January 2014) who underwent a hip corticosteroid injection and subsequent THA were reviewed. Patients were excluded if they had prior ipsilateral hip surgery, an injection >1 year from THA or were lost to follow-up. An age and sex matched control group of 173 patients who underwent THA without prior hip injection was used for comparison. Comorbidities and demographic information of interest included obesity (BMI>35 kg/m^2), depression, smoking status, diabetes, coagulopathy, preoperative anemia (Hemoglobin<12.0), cardiac arrhythmia, age, and gender. All early postoperative (≤ 6 weeks) wound complications, superficial and deep-space infections were collected. A Fisher's exact test and a multivariate logistic regression analysis were used to assess for statistical significance ($\alpha \leq 0.05$).

RESULTS: 164 patients were included, 66 males and 95 females, average age 65 ± 10 (89-32). Average time between injection and THA was 145 days ± 81.3. There were 19 early postoperative infection complications in the injection group compared to 10 in the control group (11.6% vs. 5.8%, p=0.04). There was no difference in complication rates between giving an injection within 3 months (10.5%), 6 months (13.4%), 9 months (7.5%), and 12 months (20%) of THA. Following multivariate regression, smoking (p=0.01) and obesity (p=0.04) were the only significant independent risk factors. Injections were not found to be an independent risk factor for complications (p=0.15).

DISCUSSION AND CONCLUSION: Although univariate comparisons appear to show that hip injection within 1 year of THA is a risk factor for acute wound complication and infection, multivariate regression did not confirm this as an independent risk factor. Consistent with prior literature, smoking and obesity were found to be independent risk factors for acute wound and infection complications.

Effect of Impact Force and Direction on Stability of Modular Components In Total Hip Arthroplasty

Abstract ID: Paper 168

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*Nicholas B. Frisch, M.D.
Jonathan R. Lynch, M.D.
Patrick Moen, M.D.
Richard Banglemier, Ph.D.
Craig D. Silverton, D.O.
Detroit, MI

INTRODUCTION: Femoral stem modularity in total hip arthroplasty (THA) offers many advantages including versatile biomechanical adjustments independent of stem placement as well as decreased cost and morbidity associated revision surgery. One potential disadvantage of modular THA implants is the development of mechanically-assisted crevice corrosion (MACC), which has many deleterious consequences including release of metallic ions causing adverse local tissue reaction, in vivo neck failures/fractures, and increased distraction forces required to disassemble components at revision surgery. Limiting micromotion between head-neck and neck-stem junction can prevent MASS. The purpose of this study was to evaluate the influence of impact direction on resultant union of head-neck and neck-stem junctions for a variety of hip implant configurations.

MATERIALS AND METHODS: Drop impact tests were conducted using modular THA implant components. The impact force was delivered using a modified surgical mallet dropped from a predetermined height equalling a 30 lb. impact. Impact forces were directed in one of four predefined directions: (1) ideal impact direction along the axis of the neck, (2) impact direction angulated proximally relative to ideal, (3) impact direction angulated anteriorly to ideal, and (4) impact direction angulated antero-proximally to ideal. Three neck component angles were considered (0°, 8°, and 15°). Six impacts were conducted per configuration for a total of 72 impact tests. Load and displacement data recorded during the pull-off tests were used to determine the ball-taper junction stability. Maximum applied tensile force indicated a more stable junction.

RESULTS: The direction of impaction resulted in differences in ball-taper junction stability. The highest distraction force required to displace the components after impaction was in the ideal direction along the axis of the neck indicating a more stable junction.

DICUSSION AND CONCLUSION: Orientation of impaction direction on modular THA components affects initial stability at the head-neck and neck-shaft junction. Increased stability at the junction decreases micromotion which decreases the propensity for MACC. Applying the impact force in the ideal direction along the axis of the neck indirectly leads to decreased MACC and the deleterious consequences associated with it.

The Association of Radiographic Findings with Pain Following Total Hip and Surface Replacement Arthroplasty

Abstract ID: Paper 169

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*Ryan M. Nunley, M.D. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Timothy J. Sauber, M.D. / Pittsburgh, PA
Toby Barrack / St. Louis, MO
Staci R. Johnson, M.S. / St. Louis, MO
Peter J. Brooks, M.D. / Cleveland, OH
Robert L. Barrack, M.D. / St. Louis, MO

INTRODUCTION: Residual pain following both total hip arthroplasty (THA) and surface replacement arthroplasty (SRA) remain significant sources of patient dissatisfaction. Elucidating potential radiographic predictors of pain could affect both surgical technique and implant design. This study's purpose was to determine the association of radiographic findings with pain following THA and SRA reported through pain drawing asssessments.

METHODS: This was a prospective, IRB-approved investigation from two centers. Patients age 18 to 60 years with a pre-symptomatic UCLA score > 6 and at least 1 year of clinical follow-up were included. All THAs were performed using a titanium, proximally coated, tapered stem and hemispherical, cementless acetabulum and all SRAs were performed using the same implant. A pain drawing questionnaire was administered in which patients identify the location (8 areas of interest) and severity of pain (0 to 5) on an anatomic diagram. Radiographs performed at 1 year postoperatively were analyzed by a blinded observer to assess acetabular alignment, uncoverage, femoral position, alignment, offset, and several morphologic indices. Analyses were performed using Student's two-tailed t-tests and chi-square analyses.

RESULTS: 224 SRA and 196 THA patients were included. 30% of patients reported some degree of groin pain following their procedure. In SRA patients, 11 of 21 (52%) with acetabular uncoverage of > 5 mm reported groin pain vs. 43 of 147 (29%) with uncoverage of < 4.9 mm (p=0.03). In THA patients, 4 of 16 (25%) with acetabular uncoverage of > 5 mm reported severe groin pain, vs. 11 of 151 (7%) with uncoverage of < 4.9 mm (p=0.04). 10% of patients reported thigh pain following their procedure, with an increased incidence in the THA cohort (15% THA vs. 5% SRA, p=0.001). In THA patients, a decreased mid-third canal fill ratio (0 to 0.39) was associated with increased severe thigh pain (4 of 9 patients, 44%) vs. patients with a mid-third canal fill ratio of > .40 (19 of 155 patients, 12%; p=0.04).

CONCLUSION: While pain following hip arthroplasty can be multifactorial, this study provides insight into potential radiographic findings that may allow surgeons to predict the occurrence and severity of groin or thigh pain postoperatively.

Mid-Term Survivorship of Modern Bearing Surface Options for Total Hip Arthroplasty in Young Patients: A Systematic Review and Meta-Analysis

Abstract ID: Paper 170

Cody C. Wyles, B.S.
Jose H. Jimenez-Almonte, B.S.
German A. Norambuena-Morales, M.D.
*Miguel E. Cabanela, M.D.
Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Total hip arthroplasty (THA) is increasingly being performed in young and active patients. Newer generation implant bearing surfaces with superior wear characteristics are widely used in this cohort with the goal of improving longevity of the prosthesis. The aim of this study is to synthesize the available data from randomized clinical trials (RCTs) to determine the mid-term survivorship of commonly used bearing surfaces in young and active patients.

METHODS: We conducted a systematic review to identify RCTs published after the year 2000 that reported survivorship of ceramic-on-ceramic (CoC), ceramic-on-highly cross linked polyethylene (CoPxl), or metal-on-highly cross linked polyethylene (MoPxl) bearings. RCTs had to have a minimum two-year follow-up and average patient age of less than 65. Both a traditional meta-analysis and network meta-analysis were performed to combine direct and indirect evidence, respectively. A network meta-analysis is a novel statistical method for analyzing more comprehensive datasets through indirect comparisons and provides a ranking system for interventions based on efficacy. The reported outcome for network meta-analysis is a probability of being ranked the most effective intervention with 95% credible intervals (CrI).

RESULTS: We included 5 RCTs in the direct comparison meta-analysis reporting on 799 THAs. This demonstrated a risk ratio for revision of 0.65 (95% CI 0.19 – 2.23) between CoC vs. CoPxl and a risk ratio for revision of 0.40 (95% CI 0.06 – 2.63) between CoC vs. MoPxl. Network meta-analysis allowed for inclusion of 18 RCTs reporting on 2,599 THAs with average follow-up of 7 years (range 3 – 12). This technique demonstrated the following probabilities of being the most effective implant: CoC = 64.6% (0.0%, 100.0%), CoPxl = 24.9% (0.0%, 100.0%), and MoPxl = 9.9% (0.0%, 100.0%). The credible intervals ranging from 0.0% - 100.0% for all three bearing surfaces indicates that there was no statistically significant difference in survivorship between the three implant types.

DISCUSSION AND CONCLUSIONS: This study is the first to our knowledge in the hip and knee literature using the network meta-analysis methodology. The current published evidence supports comparable performance between the most commonly used modern implants in young patients at mid-term follow-up. In light of this information, decision makers may choose to focus on other factors such as cost and implant-specific complications when debating which implant to use in young and active patients receiving total hip arthroplasty.

What Can and Can't Be Learned from Long-Term Follow-Up Studies of Hip Replacement

Abstract ID: Paper 171

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*Christopher T. Martin, M.D. / Iowa City, IA
John J. Callaghan, M.D. / Iowa City, IA
Lucian C. Warth, M.D. / Iowa City, IA
Steve S. Liu, M.D. / Iowa City, IA
Devon D. Goetz, M.D. / West Des Moines, IA
Andrew J. Pugely, M.D. / Iowa City, IA
Nicolas O. Noiseux, M.D. / Iowa City, IA
Yubo Gao, Ph.D. / Iowa City, IA
Richard C. Johnston, M.D. / Iowa City, IA

PURPOSE: The purpose of this study was to examine the authors' minimum 20-year follow-up studies of their prospectively-followed, consecutively-performed cohorts of hip replacement patients to determine differences in implant durability and performance as well as to provide insight into the long-term study of new designs, materials, and techniques of hip replacement.

METHODS: The authors evaluated four of their long term follow-up cohorts. These included 250 Charnley THRs performed in patients over age 50 and 93 Charnley THRs performed in patients under age 50 that were followed for a minimum of 35 years, and 304 Iowa THRs and 357 Charnley THRs followed for a minimum of 20 years. Survivorship curves of the patients themselves (age at surgery stratified survivorship) were generated for the various age groups in all cohorts in addition to need for revisions and radiographic loosening.

RESULTS: The results at 35-year follow-up of patients over 50 vs. patients under 50: the acetabular survivorship rate for freedom from revision was 87% vs. 70% ($p = 0.005$) and the femoral survivorship rate for freedom from revision was 95% vs. 92% ($p=0.4$) demonstrating excellent cemented femoral fixation durability in both younger and older patients with less durable fixation of the acetabular component in both the young and old. The most dramatic finding was that patient survivorship at 35 years was markedly different between the two groups (2% for the elderly group and 44% for the younger group). Analysis of the other two cohorts demonstrated the same differences.

CONCLUSION: Few patients lived to 20-year follow-up in these studies. In our 35-year follow-up studies of both patients over age 50 and under age 50, there is a dramatic difference in patient survivorship to 35 years (2% for patients over 50, 44% for patients under 50, $p=0.0001$). This study demonstrates the need to perform prospective follow-up studies on populations of younger patients in the future when attempting to evaluate differences in design and technique in order to have robust numbers of living patients at long term follow-up. Otherwise, the statistical power of the conclusions related to durability and long-term performance may be limited.

No Correlation Between Muscle Biomarkers and Early Functional Outcome After Contemporary THA

Abstract ID: Paper 172

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*Kirsten L. Poehling-Monaghan, M.D. / Rochester, MN
Atul F. Kamath, M.D. / Philadelphia, PA
Michael J. Taunton, M.D. / Rochester, MN
Mark W. Pagnano, M.D. / Rochester, MN
Robert T. Trousdale, M.D. / Rochester, MN
Rafael J. Sierra, M.D. / Rochester, MN

INTRODUCTION: Biomarkers of inflammation/muscle damage have proven clinical utility in some areas of medicine, but their value in predicting THA outcomes has not been demonstrated. Despite that lack of clinical correlation, some authors have highlighted lower serum biomarkers as evidence in support of direct anterior (DA) THA. This prompted us to ask: do serum biomarkers of inflammation/muscle damage predict pain or early functional outcomes after contemporary DA or mini-posterior THA?

METHODS: Consecutive groups of 50 direct anterior (DA) and 50 mini-posterior (MP) THA from 2013-2014 were compared. Groups did not differ ($p>0.1$ for all) in age (59 +/-13 years), sex (52% female), BMI (33 +/-5.7), or preoperative Harris Hip Score (57+/-12). Biomarkers including Hbg, Hct, myoglobin, CK, CKMB, CRP, IL-6, and TNF-a were collected preoperatively and on days 1 and 2 and compared with operative details, in-hospital complications, therapy and pain scores, and functional results from a milestone diary.

RESULTS: Serum biomarkers were not correlated with pain or early functional outcome after either surgical approach. The MP group had greater changes in CK and myoglobin ($p<=0.006$), but there were no differences in pain or time to achieve postoperative milestones; specifically, discontinuing gait aids and narcotics, return to driving and work, climbing stairs, and achieving ADLs (all $p\geq0.08$).

CONCLUSION: Serum biomarkers including CK, CKMB, myoglobin, CRP, IL-6, and TNF-a did not predict early pain/function after contemporary THA. While greater elevations in myoglobin/CK were found after mini-posterior THA, this likely represents a threshold effect, not a linear correlation, and that difference in myoglobin/CK likely lies outside the clinically meaningful range. Further reporting of serum biomarkers as a measure of physiological burden after orthopedic surgical procedures should be viewed as suspect until clear linear or threshold values are established.

SUMMARY: Biomarkers of inflammation/muscle damage were not correlated with pain/functional outcome after THA and should not be used as surrogates for physiologic burden until clear correlations are delineated.

Femoral Vein Patency During Total Hip Arthroplasty Using a Direct Anterior Approach

Abstract ID: Paper 173

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*Rachel E. Mednick, M.D.
Hasham M. Alvi, M.D.
Courtney E. Morgan, M.D.
Michael D. Stover, M.D.
David W. Manning, M.D.
Chicago, IL

BACKGROUND: As the demand for smaller incisions and improved soft tissue management increases, the number of surgeons using a direct anterior approach for a total hip arthroplasty (THA) is increasing. However, there is a paucity of literature on this approach as compared to the breadth of information available on previously popularized approaches such as the standard posterolateral approach.

MATERIALS AND METHODS: Ten patients undergoing THA using a direct anterior approach were positioned supine on a Hana table. Ultrasound evaluation of the femoral vein was conducted at four time points during the operation: (1) prior to incision, (2) at the start of acetabular preparation with and without the anterior retractor, (3) at the start of femoral preparation with and without the medial retractor, and (4) after skin closure. A single vascular surgery fellow performed all measurements and calculations using an ultrasound. The position of the operative leg at each time point was recorded including degree of extension, external rotation, and adduction as well as presence or absence of retractors. A simple statistical model to calculate the mean cross-sectional area, mean peak flow velocity, and peak flow at all four time points with and without retractors in place.

RESULTS: The position of the operative hip at the initiation of acetabular preparation was between 0-10° of flexion and 45-60° degrees of external rotation. All veins remained patent in this position; however, with placement of an anterior acetabular retractor, only 3/10 veins remained patent. There was a statistically significant decrease in cross sectional area (1.338 cm^2 to 0.616 cm^2, p .021) and peak velocity, although no change in peak flow velocity in the patent veins. The position of the operative hip during femoral preparation was full extension with 115-130° of external rotation. 8/10 veins remained patent in this position; however, with the placement of the medial femoral retractor, only 6/10 veins remained patent. There was a statistically significant decrease in cross sectional area (1.338 cm^2 to 0.504 cm^2, p 0.008), but there was no change in peak flow and peak velocity.

CONCLUSION: We found that positioning the leg for acetabular and femoral preparation during an anterior THA did not lead to occlusion of the femoral vein in the majority of our subjects. We did find consistent occlusion of the femoral vein with placement of an anterior single-pronged retractor during acetabular preparation and along the calcar cortex of the femoral neck during femoral preparation.

Mid-Term Results of a Large U.S. Series of Hip Resurfacing with Technique and Imaging Recommendations

Abstract ID: Paper 174

Carlos A. Higuera, M.D.
Kurt P. Spindler, M.D.
Phil Golnick, P.A.
Greg Strnad, M.S.
*Peter J. Brooks, M.D.
Cleveland, OH

Hip resurfacing has been proposed as a suitable procedure for young, active patients. Given the concerns with metal-on-metal bearings, it is appropriate to review our results using a resurfacing device with a relatively good clinical record. We describe changes to our preferred component position, and propose additional imaging to narrow the indications for this procedure, which we continue to perform in significant numbers.

We performed 1,333 hip resurfacing procedures, with minimum 2-year follow-up, at a single U.S. institution. All patients were followed using a validated prospective observational registry. All surgery was performed by a single surgeon, using an anterolateral approach.

The average patient age was 53.1 (12-84), and 70% (938) were male. Our weight-bearing protocol was 75% partial weight-bearing for 6 weeks, then avoidance of strenuous exertion for 1 year, then unrestricted activity.

Over time, and in response to reports of poor outcomes from other centers, we modified our target socket inclination from the traditional 45° to 35-40°, and introduced previously undescribed imaging strategies for patient selection.

The average femoral component size in males was 51 mm, in females 45 mm. Less than 1% of cases were < 42 mm, and we now avoid these sizes.

There were no dislocations, no femoral component loosening, and one socket loosening (0.08%). We had two femoral neck fractures (0.15%), 3 deep infections requiring component removal (0.23%), and one late traumatic acetabular fracture requiring revision. One patient was revised for unexplained pain, and continues to be symptomatic. There were 3 cases of excessive metal debris (0.23%), but no destructive pseudotumors. Two of these were attributed to socket malposition. The third was a small female (40 mm head) with dysplasia, accurately resurfaced, but with excessive femoral neck anteversion, and a pelvis which tipped backwards 14° in the standing position. Retrieval analysis showed anterior edge loading. This case led us to modify our patient selection criteria and recommend new imaging protocols, including standing lateral pelvis x-rays, and CT scans for femoral anteversion in smaller patients or those with overt dysplasia. In total, 5 males and 6 females required revision. Overall survivorship was 99.2%, at 2 to 5.7 years follow-up. Aseptic survivorship in males under the age of 50 was 100%.

To our knowledge, this is the largest U.S. series of hip resurfacing involving a single device, by a single surgeon. Mid-term outcomes have been encouraging. Complications, including metal issues, were rare.

Is There a Benefit to Head Size > 36 mm in Total Hip Arthroplasty?

Abstract ID: Paper 175

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*Bryan D. Haughom, M.D.
Darren R. Plummer, M.S.
Mario Moric, M.S.
Craig J. Della Valle, M.D.
Chicago, IL

INTRODUCTION: Dislocation is a devastating complication of total hip arthroplasty. While larger heads are known to decrease the risk of dislocation, some have suggested that there is no benefit to a head size > 36 mm. The purpose of this study is to compare the rates of dislocation between 36-mm heads and more anatomic head sizes including large diameter metal-on-metal THA (MOM), dual-mobility articulations (DM), and hip resurfacing arthroplasty (HRA).

METHODS: We reviewed all primary hip arthroplasties performed over ten years and identified 501 patients who were at higher risk for dislocation. Higher risk was defined as high preoperative range of motion (combined flexion/adduction/internal rotation ≥ 115°, age ≥ 75, neurologic disease, dementia, acute femoral neck fracture, substance abuse, or a desire to engage in activities that require higher ROM. This included 282 THA with a 36 mm head, 24 DM, 83 MOM, and 112 HRA who were followed for a minimum of 90 days postoperatively (mean 3 years, range 90 days-10 years). Fisher's exact tests was employed to compare dislocation rates with a p-value of < 0.05 considered as significant.

RESULTS: There were 13 dislocations in the 36 mm head group compared to one in the anatomic head size group (4.6% vs. 0.5%, p 0.005). Five dislocations in the 36 mm group were noted on recovery room x-rays only and the one dislocation in the anatomic group was a MOM that was successfully closed reduced. There were four patients who dislocated more than once in the 36 mm head group (1.4% vs. 0%; p= 0.04) and two who required a revision for recurrent instability (0.7% vs. 0%; p = 0.11).

CONCLUSIONS: These results suggest that anatomic head sizes are associated with a significantly lower risk of dislocation in patients who are deemed higher risk, and that there may be a benefit to head sizes > 36 mm in diameter.

MAOA BREAKOUT SESSION #12
PEDIATRIC AND ADULT TRAUMA
April 25, 2015

The Biomechanical Advantage of Locked vs. Non-Locked Symphyseal Plating of Unstable Pelvic Ring Injuries

Abstract ID: Paper 176

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*Ryan J. Godinsky, M.D.
Gregory A. Vrabec, M.D.
Loredana M. Guseila, B.S.
Danielle E. Filipkowski, M.S.
John J. Elias, Ph.D.
Akron, OH

INTRODUCTION: Symphyseal plate systems for treating pubic symphysis diastasis in unstable pelvic ring injuries are available with locked and non-locked capabilities. Locked plating systems were developed to improve postoperative stability and reduce the risk of failure, although a biomechanical advantage for locked symphyseal plating has yet to be experimentally demonstrated.

DESIGN: Comparison of locked vs. non-locked symphyseal plating during simulated single leg stance loading of OTA 61-C 1.2 (unilateral sacroiliac joint disruption and pubic symphysis diastasis).

METHODS: 14 pelvic models were constructed and tested (Sawbones full pelvic models, foam with cortical shell). S1 sacroiliac screws (cannulated, partially threaded) were inserted via standard technique under direct visualization and real-time fluoroscopy. Anterior fixation consisted of symphyseal plating (3.5 mm, 6-hole, locked symphyseal plate) used in either a locked (7 models) or non-locked fashion (7 models).

The affected hemi-pelvis was supported by an articulating femoral head and wire cables tensioned to recreate the effects of the abductor musculature. A contralateral load of 80 N was used to simulate the weight of the contralateral limb. Each model was cyclically loaded through the sacrum to a maximum of 350 N at 1 Hz for a total of 1000 cycles, representing the biomechanics of single leg stance.

A series of markers were placed along each side of the pubic symphysis. Motion of each marker was tracked using a video-based three-dimensional tracking system. Relative motion was measured between opposing markers across the symphysis in regards to gap formation, shear along the symphysis, and along an axis perpendicular to the other two (anterior translation of the unsupported hemi-pelvis at the symphysis).

RESULTS: Anterior translation at the end of cyclic loading was larger for the non-locked models than the locked models. At the onset of loading, average (± standard deviation) anterior translations for the non-locked and locked models were 1.6 ± 0.5 mm and 1.2 ± 0.5 mm, respectively (p=0.182). At 1000 cycles, the anterior translations for the non-locked and locked models were 2.3 ± 0.6 mm and 1.4 ± 0.6 mm, respectively (p=0.0.015). No significant

differences were identified for gap formation or shear motion ($p > 0.3$).

CONCLUSIONS: The results indicate that locked plating of symphyseal injuries provides a more stable construct for repetitive loading.

The Acetabular Fracture Prognostic Nomogram: Does it Work for Fractures of the Posterior Wall?

Abstract ID: Paper 177

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*Berton R. Moed, M.D.
Megan J. McMahon, B.S.
Eric S. Armbrecht, Ph.D.
St. Louis, MO

PURPOSE: Recently, a nomogram has been proposed, prognosticating the need for reconstructive hip surgery (RHS) after open reduction and internal fixation (ORIF) of acetabular fractures. The purpose of this study was to determine if, using this nomogram, posterior wall fracture patients at risk for failure with ORIF (thereby being better candidates for primary RHS) could be reliably identified preoperatively.

METHODS: A study group was derived from a database of 103 posterior wall fracture (AO/OTA type 62-A1) patients treated by ORIF having a minimum of two years follow-up or the presence of an unsatisfactory clinical result before two years. Indications for operation were hip joint incongruency and/or instability. Of these 103 patients, 6 had a clearly poor clinical result within 2 years and 97 were followed 2-14 years (mean 4.8 years) of which an additional 3 had an unsatisfactory result at the 2-year follow-up examination. For each of these patients, a preoperative percent risk of requiring RHS within 2 years of ORIF was calculated using the nomogram. The percent risk was then compared to the patients' known clinical outcome, defined as either satisfactory or unsatisfactory within two years of ORIF. An unsatisfactory outcome within two years of ORIF was analyzed using two separate measures: (1) RHS performed and (2) clinically unsatisfactory hip function, which is more inclusive since RHS was recommended, but not yet performed. Clinical hip function was assessed using the modified Merle d'Aubigne score, which was collapsed into satisfactory and unsatisfactory categories: excellent-to-good and fair-to-poor, respectively. Five patients underwent RHS, all occurring within the first 2 years after ORIF. Overall, ten patients had an unsatisfactory modified Merle d'Aubigne score; nine identified at 2 years or less after ORIF. Statistical analysis of the data was accomplished by a Ph.D. level biostatistician.

RESULTS: The nomogram produced a preoperative percent risk for RHS that ranged widely, with much overlap among patients having both satisfactory and unsatisfactory results of ORIF, no matter what the outcome measure. Statistics suggested a cut-point of >16% preoperative risk as an indication for an unsatisfactory result. However, this produced a clinically not useful positive predictive value (PPV) of 0.44 (95% CI: 0.21, 0.69). No other cut-point could be generated to improve the PPV.

CONCLUSION: The acetabular fracture prognostic nomogram in its current form does not provide sufficient information to determine appropriate surgical management for posterior wall fractures.

Adherence to Preoperative Cardiac Clearance Guidelines in Hip Fracture Patients

Abstract ID: Paper 178

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*Andrea C. Stitgen, M.D.
Kim N. Poludnianyk, D.O.
Elizabeth Dulaney-Cripe, M.D.
Ronald J. Markert, Ph.D.
Michael J. Prayson, M.D.
Dayton, OH

PURPOSE: Multiple prior studies have shown the importance of early surgical intervention for hip fracture patients in decreasing perioperative morbidity and mortality. As geriatric patients often have multiple comorbidities, surgical delays can occur due to preoperative medical clearance (optimization and risk stratification). In 2007, the American College of Cardiology (ACC) Foundation and the American Heart Association (AHA) developed guidelines to assist in determining those patients who require further preoperative cardiac evaluation and treatment. Our study aims to identify if cardiac consults are made in accordance with the ACC/AHA guidelines and the delays in care after unnecessary consults.

METHODS: A retrospective review of 315 patients with hip fractures admitted to a Level I trauma center over a two-year period was conducted. After excluding patients under 65 years old and those admitted by the general surgery trauma service, 266 patients were included. Charts were reviewed for criteria which would meet the ACC/AHA guidelines recommending a cardiac consult. The time between admission and surgical intervention was calculated. Postoperative complications and disposition were also reviewed.

RESULTS: Of the 266 patients reviewed, 55 patients (21%) received preoperative cardiac consultations, while 211 patients did not. Only 16 of the 55 patients (29%) with cardiac consults met ACC/AHA guidelines for preoperative cardiac evaluations, while 39 patients received unnecessary cardiac consults. Three patients met the ACC/AHA guidelines; however, did not receive cardiac consults. Of the 247 patients (39 with consults, 208 without consults) that did not meet guidelines for cardiac consults, those who received a preoperative cardiac consult had a significantly longer average time to surgery (43.0 hours vs. 23.1 hours) (p=.006) and significantly longer hospital length of stay (LOS) (7.8 days vs. 5.3 days) (p=.012). There were no significant differences in postoperative complications or disposition between the two groups.

Only 3 of the 16 patients who met cardiac clearance guidelines required a cardiac catheterization preoperatively. Of the 39 patients with cardiac consultations who did not meet guidelines, 21 patients had further cardiac testing beyond an EKG, while none required a cardiac catheterization.

CONCLUSION: Preoperative cardiac consults are frequently overused and lead to delays to surgical intervention and longer hospital LOS while not revealing any further need for cardiac intervention or changing the rate of adverse events. Stricter adherence to the ACC/AHA guidelines will help decrease surgical delay and hospital LOS.

An Implant Focused Analysis of the Anterior Femoral Bow in 3,258 Femurs

Abstract ID: Paper 179

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*Samuel L. Rosenbaum, M.D.
John J. Lee, M.D.
Sven A. Holcombe, B.S.
Stewart C. Wang, M.D.
James A. Goulet, M.D.
Ann Arbor, MI

PURPOSE: Prior analyses of the femoral radius of curvature (ROC) used few points to represent curvature, did not include distal metaphysis where anterior cortical perforation may occur, and did not compare ROC in different regions of the femur. The purpose of this study was to determine the femoral ROC of the region spanned by a modern nail in a large population using a novel automated technique and compare the ROC between the proximal and distal halves.

METHODS: The sagittal ROC of the outer and inner anterior cortical boundaries of 1,629 patients (3,258 femurs) obtained from pulmonary embolism protocol computed tomography (PE CT) scans were analyzed with a custom MATLAB script that determined the location of femoral landmarks, adjusted for body position, and measured the radius of curvature. The region of interest corresponds to the curved portion of contemporary nails, or 15% of the length of the femur distal to the tip of the greater trochanter to 10% proximal to the distal end of the condyles. Length was defined from the tip of the greater trochanter to the distal end of the condyles while the axis was defined as a line between the tip of the greater trochanter and the distal femoral sulcus. Associations between age, gender, ethnicity, femoral length, and height to ROC were determined using bivariate analysis.

RESULTS: Mean age was 53.2 (SD 16.6) years, mean height 66.3 (SD 3.9) inches. Mean outer and inner anterior ROC was 131.3 cm (SD 47.8) and 129.1 cm (SD 49.2) for full length, 359.7 cm and 884.1 cm for proximal half, and 1278.2 cm and 2874.6 cm for distal half. ROC depended on location, height, and length of the femur ($p<0.001$). 10% and 54% of femurs had a lower ROC of the distal and proximal halves, respectively, than of the full length. ROC of the proximal or distal halves was neither dependent on age nor length.

DISCUSSION: Most inner anterior cortical curvature of the femur occurs in the proximal half. 1 in 10 femurs will be more curved distally than its full length and may be at increased risk for cortical perforation. The length of the femur had a significant association with radius of curvature. When broken down by tertiles, the shorter third of femurs had a mean ROC of 119 cm and the longer third 139 cm ($p<0.001$). However, the ROC of the proximal or distal halves did not depend on length. These findings have implications for nail design.

Association of Femur Fractures with Internal Organ Injury

Abstract ID: Paper 180

Catherine Olinger, B.S.
Sean O'Mara, B.S.
*Ryan E. Miller, M.D.
Karl A. Bergmann, M.D.
Dennis Chakkalakal, Ph.D.
Justin C. Siebler, M.D.
Omaha, NE

BACKGROUND/PURPOSE: Injuries capable of fracturing the femur often involve concurrent internal organ damage. However, up to 25% of injuries are initially missed. Prior studies evaluating the association of femur fractures with internal injury included only trauma involving an automobile and were skewed toward more severe injuries. To our knowledge, there are no studies of this kind that include bicycle, motorcycle, and motor vehicle-pedestrian trauma and exclude those deceased at the scene. We hypothesized that in the trauma setting, the presence of a femur fracture would correlate with an increase in concomitant internal organ injuries.

METHODS: Data was retrospectively queried from two Level I Trauma Centers. Patients presenting between January 1, 2005, and December 31, 2012, with trauma activation met inclusion criteria. Patients were stratified based on presence of a femur fracture, fracture pattern, and open/closed fracture status. Internal organ injuries were documented. Logistic regression analysis was used to determine if the presence of a femur fracture, fracture status (open/closed), or fracture pattern (shaft vs. non-shaft) was predictive of internal injuries. Results were reported as odds ratios with 95% confidence intervals (CI). A p-value < 0.05 was statistically significant.

RESULTS: 4,788 patients met inclusion criteria: 530 (11%) with a femur fracture and 4,258 (89%) without a femur fracture. The femur cohort was associated with more internal injuries to the aorta (95% CI: 1.1, 4.4; p=0.029), spleen (95% CI: 1.3, 2.4; p=0.0003), liver (95% CI: 1.1, 2.2; p=0.015), bowel (95% CI: 2.3, 7.1; p<0.0001), and trachea/bronchi (95% CI: 1.5, 19; p=0.0092). For example, patients presenting with a femur fracture were 2.3-7.1 times as likely to have a bowel injury when compared to patients without a femur fracture. Open fractures were more significantly associated with aorta (p=0.011), spleen (p=0.0001), liver (p=0.0045), bowel (p<0.0001), and trachea/bronchi (p=0.023) injuries compared to closed fractures. Femoral shaft fractures were more significantly associated with lung (p=0.042), aortic (p=0.019), spleen (p=0.022), bowel (p=0.0003), bladder (p=0.037), kidney (p=0.008), and trachea/bronchi (p=0.0025) injuries compared to non-shaft femur fractures. Fractures in ages <65 years were more closely associated with internal injury than in ages ≥65 years.

CONCLUSION: Compared to a 1999 study, the current study reveals that fractures of the femur in this setting may be associated with additional internal injuries. Diaphyseal and open fractures may portend more severe organ injury compared to non-shaft and closed fractures. Femoral fracture in age ≥65 may not be as predictive for associated internal injuries. This study demonstrates a strong association between both thoracic and abdominal injuries with fractures of the femur, alerting the provider to the potential for these life-threatening injuries.

Distal Femur Replacement for Acute Distal Femur Fractures in Elderly Patients

Abstract ID: Paper 181

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*Clayton C. Bettin, M.D.
Patrick C. Toy, M.D.
John C. Weinlein, M.D.
Robert K. Heck, Jr., M.D.
Memphis, TN

INTRODUCTION: The annual incidence of distal femur fractures is 4.5 per 100,000 adults with 50% in patients over 70 years of age. The elderly population is more often in poor health; one-year mortality rate following this injury has been reported to be 22% with a 9% late above-knee amputation rate. Cemented modular distal femoral replacement enables immediate full weight bearing and avoids complications of prolonged recumbency. This study reports our outcomes with cemented modular distal femoral replacement as a treatment for distal femur fractures in the elderly population.

METHODS: Retrospective study conducted between years 2005-2013. Inclusion criteria were patients older than 60 years of age who underwent cemented distal femoral replacement for distal femur fracture. Indications included comminuted, intra-articular fractures of the distal femur with osteoporotic bone and pre-existing degenerative joint disease. Patients with prior knee surgery were excluded. Hospital and objective data from the most recent office visit, were recorded for all patients. In the latter part of the study, functional data were available including Knee Society Score, Musculoskeletal Tumor Society (MSTS) score, and Western Ontario and McMaster Osteoarthritis Index (WOMAC).

RESULTS: 18 patients met inclusion criteria with an average age of 77.3 years and follow-up of 2.3 years. All patients were able to bear full weight postoperatively. Of the 18 patients, complete follow-up data consisting of MSTS, Knee Society, and WOMAC scores were available on 12 patients at an average of 1.7 years postoperatively. Knee score averaged 85.7 with a functional score of 35. MSTS score averaged 19.2 and WOMAC score averaged 23.1. 12/12 patients reported themselves as extremely or very satisfied with their outcome at latest follow-up. 11/12 patients returned to baseline functional status. 8/18 patients were followed until death an average of 4.6 years after surgery. Of the surviving ten patients, follow-up averages 2.3 years and all have well-functioning prostheses. Implant related complications occurred in 2/18 (11%) patients. 1/18 patients had periprosthetic fracture requiring revision to a total femur prosthesis, and 1/18 patients had deep infection requiring exchange of components. Aseptic loosening occurred in 0/18 patients and 0/18 patients had patella maltracking.

DISCUSSION AND CONCLUSION: This is the largest study of acute distal femur fractures in the elderly population treated with a modular rotating hinge endoprosthetic reconstruction. Cemented modular distal femoral replacement is a treatment option in elderly patients that enables immediate full weight bearing with the majority of patients returning to preoperative functional status.

Thirty-Day Complications Associated with Plating vs. Nailing of Isolated Closed Femoral Shaft Fractures

Abstract ID: Paper 182

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*George Ochenjele, M.D.
Shobhit V. Minhas, B.S.
Bryant S. Ho, M.D.
Anish R. Kadakia, M.D.
Chicago, IL

INTRODUCTION: Intramedullary nailing (IMN) has become widely regarded as the treatment of choice for femoral shaft fractures in adults. However, plate fixation (PF) is a viable alternative treatment option that may be preferable in select fracture patterns and clinical scenarios. The purpose of this study was to determine any significant differences in the rates of 30-day complications and mortality of patients undergoing IMN or PF of isolated closed femoral shaft fractures when controlling for differences in patient demographics.

METHODS: All patients who underwent IMN or PF for isolated closed femoral shaft fractures between 2006 and 2012 were selected from the American College of Surgeon's National Surgical Quality Improvement Program (ACS-NSQIP) database. Baseline demographics, comorbidities, and complications were compared between the two surgical procedures using univariate analyses. A 1:2 propensity-score matched analysis was employed to reduce confounding variables. Multivariate logistic regression models were created to isolate independent effects of surgical procedure on complications.

RESULTS: A total of 615 patients were included in our propensity-matched analysis, in which no preoperative demographics and comorbidities statistically differed between the PF and IMN groups. PF patients had increased rates of myocardial infarction (MI) (p=0.026) and bleeding (p=0.039) with no other statistically significant differences in complications. Multivariate analysis showed that PF was independently associated with higher rates of postoperative bleeding (Odds Ratio [OR] 1.548, 95% Confidence Interval [CI] 1.056—2.269, p=0.025). PF was not associated with increased medical complications (OR 1.197, CI 0.694—2.065, p=0.519), return to the operating room (OR 2.426, CI 0.701—8.393, p=0.162), or death (OR 0.622, CI 0.192—2.019, p=0.429).

CONCLUSION: Plating of isolated closed femoral shaft fractures is independently associated with an increased rate of 30-day postoperative transfusion requirement when compared to intramedullary nailing of isolated closed femoral shaft fractures. However, there was no significant difference in surgical site infection rates, total medical complications, death, and return to the operating room.

Risk Factors for Infection After Operative Fixation of Tibial Plateau Fractures

Abstract ID: Paper 183

James D. Hlavacek, M.D.
Emily Keener, D.O.
*David Johannesmeyer, M.D.
Brian E. Etier, Jr., M.D.
Amit M. Momaya, M.D.
Jason A. Lowe, M.D.
Birmingham, AL

INTRODUCTION: Tibia plateau fractures are challenging to treat, especially due to the incidence of postoperative infections. Treating physicians should be aware of risk factors for postoperative infection in patients who undergo operative fixation.

PATIENTS AND METHODS: A retrospective review was undertaken to identify all patients with tibia plateau fractures over a 10-year period (2003 – 2012) who underwent open reduction internal fixation. A total of 533 patients were identified who met the inclusion criteria. Several patient and clinical characteristics were recorded, and those variables with a significant association ($p < 0.05$) with postoperative infection were further analyzed using a multivariate analysis.

RESULTS: Ninety-five (18%) of the 533 patients developed an infection. Of these 95 patients, 59 (62%) sustained a deep infection, while 36 (38%) had a superficial infection. The average length of follow-up for those infected was approximately 19.5 months. Methicillin resistant Staphylococcus aureus was the most common species, and it was isolated in 26 (33%) of deep infections and 6 (46%) of the superficial infections. After a multivariate analysis, open fractures, the presence of compartment syndrome, and a Schatzker score of IV-VI were found to be statistically significant risk factors for deep infection.

CONCLUSIONS: The rate of deep infection remains high after operative fixation of tibia plateau fractures. Patients with risk factors for infection should be counselled on the possibility of reoperation, and surgeons should consider MRSA prophylaxis in those patients who are at higher risk.

Risk Factors for Infection in Tibial Plateau Fractures with Compartment Syndrome

Abstract ID: Paper 184

Jason A. Lowe, M.D.
*Brian E. Etier, Jr., M.D.
Birmingham, AL

INTRODUCTION: Infection following surgical fixation of tibia plateau fractures with associated compartment syndrome is a known complication. Factors leading to subsequent infection are not well defined. The purpose of this study was to evaluate injury, patient, and treatment factors that contribute to infection. The hypotheses are: patient factors (diabetes, tobacco use, BMI), increasing fracture severity (Schaztker IV, V, and VI), and operative fixation through fasciotomy incisions positively correlate with postoperative infection.

METHODS: Retrospective review of 925 tibia plateau fractures over a 12-year period revealed 42 tibia plateau fractures with concomitant compartment syndrome. Patient factors, fracture patterns, and surgical treatment were reviewed. Superficial infection was defined as the use of antibiotics and local wound care. Deep infection was defined as infection requiring surgical irrigation and debridement. Discrete predictors for infection were examined using Fisher's Exact Test; continuous predictors (age and BMI) for infection were examined using t-tests. All other continuous variables were analyzed with the Mann Whitney U. A p value <0.05 was statistically significant.

RESULTS: Overall incidence of superficial and deep infections was 38% and 21% respectively. When the surgical incision for operative fixation incorporated the fasciotomy incision 10 of 12 patients (83%) developed superficial or deep infection vs. 6 of 21 patients (21%) when fixation was performed through a separate incision ($p=0.003$). Diabetes was the only patient-related factor which tended toward predicting deep infection (57% with diabetes vs. 15% without diabetes, $p=0.080$). Low Schatzker scores (I, II, or III) tended toward predicting superficial infection when compared to high Schatzker scores (IV, V, or VI) (80% vs. 32%, $p=0.06$). Low Schatzker scores also tended toward predicting deep infections when compared to high Schatzker scores (60% vs. 16%, $p=0.057$).

CONCLUSION: Incorporation of a fasciotomy incision into an exposure for operative fixation is the only treatment factor that statistically increases the risk of postoperative superficial and deep infections. Separate surgical incisions should be utilized when possible. Diabetes is a patient-related factor linked with an increased incidence of postoperative deep infections, while tobacco use, drug use, and obesity are not. Schatzker fracture patterns I, II, or III are associated with higher superficial and deep infection rates compared to Schatzker IV, V, or VI patterns.

The Lateral Tibial Plateau Fracture: Three Types, but One Treatment

Abstract ID: Paper 185

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*Luke P. Robinson, M.D.
Cameron T. Henzman, M.D.
John T. Riehl, M.D.
David Seligson, M.D.
Louisville, KY

Studies have documented the benefit of CT scan when evaluating tibial plateau fractures. This kind of advanced imaging often changes the operative plan and is used routinely for tibial plateau fractures at our institution. This study aims to further elucidate the fracture morphology present in Schatzker Types 1, 2, and 3 tibial plateau fractures as determined by plain film radiography by comparing them to objective CT measurements. Our hypothesis is that few fractures that are thought to be Types 1 and 3 on plain x-rays will truly have isolated lateral articular split and lateral articular depression, respectively.

A surgical database from a Level I Trauma Center was reviewed from 2008 to 2013, and all tibial plateau fractures treated operatively were reviewed. Of 436 cases, 119 were selected. Inclusion criteria included a dedicated AP knee radiograph showing an intra-articular fracture of the tibial plateau. Fractures that obviously included the medial plateau or had metaphyseal-diaphyseal disruption were excluded. AP radiographs were compiled and classified using the Schatzker classification independently by 3 orthopedic trauma surgeons. These results were compared to objective findings based on CT scans that measured maximum joint depression and split of the lateral tibial plateau.

Only 6 of 119 were graded by all three reviewers to be a Type 1 (isolated lateral split). The average maximum articular split of these six tibial plateau fractures was 4.2 millimeters (mm) and joint depression was 4.94 mm as measured on a CT scan. Fifty-eight of 119 were thought to be a Type 2 by all 3 reviewers. The average split was 4.85 mm and the average articular depression was 10.81 mm in this group. Only 1 of 119 fractures was classified by all reviewers to be a Type 3 fracture. For the 1 fracture that was unanimously classified as Type 3 (isolated articular depression), no split was identified on CT scan and the depression was 5.02 mm.

In this Level I Trauma Center, only 1.4% of tibial plateau fractures treated operatively in the past 5 years were thought unanimously to be a Schatzker Type 1, and only 1 of 436 was identified as a Type 3. About 13% were unanimously thought to be Type 2 fractures. CT findings based on classification was also useful; for fractures with lateral plateau involvement on x-ray, it should be assumed that there is both articular split and depression and operative treatment should employ techniques to correct both problems.

Treatment of Unstable Pelvic Ring Injuries with an Internal Anterior Fixator and Posterior Fixation in a Non-Obese Population♦

Abstract ID: Paper 186

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*Sameh Elguizaoui, M.D.
Paul Wilkie, M.D.
William Kurtz, M.D.
Nicholas DiNicola, M.D.
Akron, OH

INTRODUCTION: The objective of the study is to evaluate the functional results of the pelvic internal anterior fixator (INFIX) used for unstable pelvic ring injuries specifically in non-obese patients. While this technique has previously been described and advocated in the morbidly obese, no data exists regarding use in the smaller trauma patient.

METHODS: Institutional IRB approval for this study was obtained. Between August 2010 and June 2012, 10 patients with a BMI < 29.9 kg/m^2 were treated at a single Level I Trauma Center for unstable pelvic ring injuries. Patient demographics, fracture type, length of treatment including duration of fixation, Injury Severity Scores, and complications were recorded. In addition, 8 of the 10 patients were able to participate in a telephone survey regarding functional results after pelvic trauma.

RESULTS: Six men and four women, with an average age of 35.8 years (range, 19-82 years) were included in the study based on pelvic fracture type and body mass index (BMI). According to the fracture classifications, there were five lateral compression, four anterior posterior compression, and one vertical shear pelvic fracture. Average BMI for the patient population was 23.4 kg/m^2(range, 19.8-27.8 kg/m^2). The length of treatment with the INFIX from application to removal was 83-101 days (average, 90.3 days). Average follow-up time was 28.3 months. Patients scored a mean of 76.1 on the Majeed Pelvic Fracture Outcome survey (range, 24-100). Statistical analysis demonstrated a significant relationship between ISS and pelvic score for the treated population (p=0.034).

CONCLUSION: Our retrospective review of non-obese patients treated with the anterior internal fixator demonstrates that this technique for stabilizing pelvic ring injuries can transcend the body habitus for which it was initially described. While the INFIX may be best suited for the obese and super-obese patient, we have had successful outcomes with all body types. The functional assessment results are comparable to previously published data using alternate pelvic fixation techniques. Our overall complication rate is consistent with other recent studies which utilize the INFIX, and lower than that of traditional pelvic external fixation.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation. Spinal pedicle screws and instrumentation are currently not approved for pelvic fixator devices.

Acetabular Reduction Assessed by Computed Tomography and Contact Stress Analysis Correlated with Functional Outcome

Abstract ID: Paper 187

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*Ong-art Phruetthiphat, M.D.
J. Lawrence Marsh, M.D.
Chamnanni Rungprai, M.D.
Matthew D. Karam, M.D.
Donald D. Anderson, Ph.D.
Yubo Gao, Ph.D.
Andrew M. Kern, M.S.
Iowa City, IA

BACKGROUND: The quality of acetabular reduction was classified by Matta's criteria into 3 groups: anatomical (0-1 mm), imperfect (2-3 mm), and poor (>3 mm). Stable anatomical reduction of a displaced acetabular fracture has been shown to correlate strongly with good or excellent outcomes. The reduction is deemed imperfect if 2 to 3 mm displacement by plain radiographs and gap or offset >2 mm by CT. However, the indeterminate range between 1-2 mm gaps has not been classified by both measurements. In addition, the measured reduction has not been correlated with actual variations in contact stress in clinical cases. The purpose of this study was to evaluate the functional outcome after acetabular fixation in relationship to the quality of fracture reduction and compare the results to computationally estimated contact stress.

METHODS: A retrospective chart review of 117 patients who underwent acetabular fixation between 2007 and 2013 was performed. 40 postoperative CT scans were obtained within one month of fixation. Mean age (p=0.562) and BMI (p=0.880) were 42.6 years and 30.0 kg/m^2 in the 1-2 mm group and 45.2 years and 29.8 kg/m^2 in the >2 mm group. Contact stress was measured from the same CT datasets using computational stress analysis. No significant difference in fracture pattern was noted between groups.

RESULTS: The mean time to surgery (p=0.405), operative time (p=0.671), and blood loss (p=0.879) were 4.2 days, 219.9 minutes, and 865 milliliters in gap 1-2 mm while 3.4 days, 233.2 minutes, and 930 minutes in gap >2 mm. There was no difference in duration of follow-up (30.5 vs. 29.4 months), readmission rate within 90 days (8 vs. 9 patients), and conversion to THA (10 vs. 10 cases) between groups. However, the mean time before conversion to THA (21.0 vs. 10.4 months) in gap 1-2 mm was significantly longer than gap >2 mm. Mental component (41.5 vs. 37.1, p=0.386) of SF-36, affected hip score (55.6 vs. 40.0, p=0.306), stiffness (45.4 vs. 37.5, p=0.337), and post-functional score (55.1 vs. 35.7, p=0.299) of WOMAC in gap 1-2 mm were higher than gap >2 mm. Contact stress was higher in the >2 mm group.

CONCLUSION: The indeterminate gap reduction (1-2 mm) resulted in lower contact stress and had better functional outcome than the imperfect gap reduction (>2 mm) in short to mid-term follow-up.

CT or MRI? ED Utilization of Radiographic Studies to Evaluate Low Energy Hip and Pelvic Injuries in the Elderly Patient

Abstract ID: Paper 188

Christina M. Ward, M.D. / St. Paul, MN
*Gregory R. Hildebrand, M.D. / Minneapolis, MN
Amanda V. Ly, M.S. / Minneapolis, MN
Sandy Vang, B.S. / St. Paul, MN
Eileen Eggenberger / St. Paul, MN

INTRODUCTION: Elderly patient falls account for more than two million emergency department (ED) visits annually. Advanced imaging identifies fractures not detected on initial radiographs in 4-10% of these patients. No consensus exists on whether CT or MRI should be obtained in elderly patients with hip or pelvic pain after a low energy trauma. Prior studies found MRI had greater sensitivity than CT for detection of hip and pelvic fractures, but ED physicians often choose CT because of its ready availability. We hypothesized that patients who underwent CT instead of MRI were more likely to lack a definitive fracture diagnosis, and more likely to need further advanced imaging.

METHODS: A retrospective chart review of all patients over 50 who presented to the ED over a 4.5-year period with hip and/or pelvis pain following a low-energy trauma and underwent both plain radiographs and at least one pelvis MRI or CT was performed. We examined age, dementia, osteoporosis, ability to ambulate, MRI contraindications, time spent in the ED, and final diagnosis.

RESULTS: 218 patients were included who had negative initial plain radiographs. CT or MRI later diagnosed a fracture in 69 patients (32%). Seventy-eight patients underwent MRI (24 fractures), 132 underwent CT (41 fractures), and eight had CT and MRI (4 fractures). Patients who underwent CT spent less time in the ED on average (440 minutes) than those who underwent MRI, or MRI and CT (506 minutes and 610 minutes, respectively). Patients with fractures had a higher mean age (77.9 years vs. 69.4 years) and were more likely to have osteoporosis (χ= 9.0). We found no significant difference between fracture and non-fracture patients regarding their ability to walk (χ= 0.32) or history of dementia (χ= 3.0). Patients who underwent CT were just as likely to be diagnosed with a fracture as those who underwent MRI (χ= 0.002). We encountered no cases where CT failed to identify a fracture that was later identified on MRI. Fifty-six patients (26%) had at least one contraindication to MRI.

DISCUSSION AND CONCLUSION: Occult hip and pelvic fractures occurred much more frequently in this patient group (32% of cases) than previously reported. Previous studies suggest MRI has a superior sensitivity for fractures, our study suggests CT is adequate to rule out fracture in this patient population. CT may also be preferable to MRI given decreased ER time and the many elderly patients with contraindications to MRI.

L5 Transverse Process Fracture: A Predictor of Instability for Pelvic Ring Injuries

Abstract ID: Paper 189

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*Thomas D. Falls, M.D.
John T. Riehl, M.D.
Louisville, KY

PURPOSE: The management of pelvic ring injuries is complex, and no classification system addresses stability and the need for surgical fixation. The most important factor affecting pelvic ring stability is posterior ligament competence. The iliolumbar ligament plays a key role in pelvic ring stability. Injury often results in fracture of the L5 transverse process (TP), and may infer further ligamentous damage and pelvic ring instability. The purpose of this study is to determine the prevalence of pelvic ring instability in cases of pelvic fracture with associated L5 TP fracture.

METHODS: A retrospective review of 689 patients with a pelvic ring injury collected from a university hospital database between 2010 and 2013 was performed. Instability of the pelvic ring was defined for this study as any pelvic ring injury that required orthopedic fixation (any combination of internal, external, or percutaneous fixation). There were 543 patients in the group with pelvic ring injury only and 146 patients with associated L5 TP fracture. The difference in the prevalence of surgical compared to nonsurgical treatment was assessed between the two groups using a chi-square test. Injury Severity Score (ISS) and age were compared with a Mann-Whitney U test.

RESULTS: There were no differences in age between the L5 TP and pelvic ring fracture groups; however, there was a difference in ISS ($p<0.005$), with patients in the L5 TP group on average having a higher ISS. There was also a difference in the prevalence of surgical fixation between the groups ($p<0.005$). In the pelvic ring injury only group, 32.6% of the patients were treated surgically, compared with 61% in the patients with a pelvic ring injury and associated L5 TP fracture (OR=3.23, RR=1.87; $p<0.001$).

CONCLUSIONS: Patients with an L5 TP fracture were nearly twice as likely to undergo surgical fixation compared to other patients with a pelvic ring injury. They were also more likely to have an increased ISS and potentially a higher energy injury. Therefore, this is an important predictor of pelvic ring instability and should be carefully considered when evaluating patients with complex pelvic ring injuries. An L5 TP fracture can easily be identified from plain film or CT scan, and should be considered a radiographic marker to alert the treating physician of possible pelvic ring instability even when static radiographs show what appears to be a stable pelvic fracture.

Antibiotics Given for Infection Prophylaxis in Open Tibia Fractures Do Not Cover Common Infecting Organisms

Abstract ID: Paper 190

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*Michael C. Willey, M.D.
Ambar Haleem, M.D.
Matthew D. Karam, M.D.
Robert W. Westermann, M.D.
J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: Surgical site infections (SSIs) are a devastating complication that results in significant healthcare costs and morbidity in patients who suffer orthopedic injuries. The rates of SSIs are increased in patients that suffer open fractures. This study aims to identify causative organisms for infection following treatment of open tibial shaft, tibial plafond, and rotational ankle fractures (Orthopaedic Trauma Association (OTA) Classification 42, 43, and 44) and determine if standard antibiotic prophylaxis targets these organisms.

METHODS: After IRB approval, we performed retrospective review to identify all patients with open tibia fractures OTA classification 42, 43, 44 between 2007-2010. Chart review was performed to identify patient demographics, Gustilo-Anderson Classification (GA) of the injury, preoperative antibiotics, timing of injury to first dose of antibiotics, patients requiring re-operation for infection, and isolated organisms.

RESULTS: We identified 112 patients who suffered open tibial shaft, plafond, and rotational ankle fractures. Six patients were excluded from analysis: 3 patients on the basis of less than 6-week follow-up and 3 patients on account of an inability to classify GA fracture type by chart review. There were 21 (19.8%) GA Type I fractures, 46 (43.4%) Type II fractures, 30 (28.3%) Type IIIA fractures, 9 (8.5%) Type IIIB fractures. Infection was identified in 12/106 (11.3%) patients. There were no infections in GA Type 1 fractures, 4 (8.7%) infections in Type 2 fractures, and 8 (20.5%) infections in Type 3 fractures. The most common infecting organism was Staphylococcus aureus (SA) (6 infections). Methicillin-resistant S. aureus (MRSA) comprised 3/6 of the SA infections. Other isolated organisms included pseudomonas (1), coagulase-negative staphylococcus (2), and bacteroides fragilis (1). Two cultures were negative. Cefazolin or Ampicillin/Sulbactam was given as infection prophylaxis in 89/106 (84.0%). Additional antibiotic prophylaxis was given in 35/39 (89.7%) of GA Type III fractures to cover gram negative organisms and/or anaerobes. Only 1 patient with an open fracture was given prophylaxis for MRSA (Vancomycin). Average time from injury to receiving prophylactic antibiotics for patients directly admitted to the definitive treatment center (38 patients) was 129 minutes (range 39-395 minutes).

DISCUSSION AND CONCLUSION: Standard prophylactic antibiotics given for patients with open tibia fractures do not cover MRSA which accounts for 30% of culture positive SSIs. A revision of traditional antibiotic prophylaxis is warranted. MRSA/MSSA screening and decolonization programs with administration of vancomycin prophylaxis for carriers may help to reduce SSIs in orthopedic trauma patients.

Tibial Pilon Fractures with an Intact Fibula

Abstract ID: Paper 191

Nabil A. Ebraheim, M.D.
*Jiayong Liu, M.D.
Nicholas Peters, M.D.
Krystin A. Hidden, B.S.
Toledo, OH

PURPOSE: The objective of this study was to analyze the clinical results and outcomes of tibial pilon fractures with an intact fibula treated with a two-stage protocol consisting of external fixation with minimal internal fixation of the anterolateral fragment, followed by delayed ORIF of the tibia.

METHODS: This was a retrospective analysis of 18 consecutive patients treated for pilon fractures with an intact fibula performed at a level I trauma center between 2003 and 2014. The mean age was 43.1. Twelve patients presented with AO/OTA type B closed fractures, and six patients presented with type C fractures. Two of the 18 patients had grade II open fractures with small soft tissue contusions and moderate wound contamination. All of the patients received immediate closed reduction and external fixation on the day of presentation, and fasciotomies were performed for patients who had evidence of compartment syndrome. The second stage of operative management, open reduction and internal fixation, was performed on an average of 20 days after the initial external fixation (range, 0-42 days).

RESULTS: Patients were evaluated for clinical and radiological signs of union at 2, 6, 12, 24, and 48 weeks postoperatively. Sixteen fractures achieved an anatomical reduction, and two fractures achieved a fair reduction due to severe comminution of the metaphysis. The patients were followed for a minimum period of one year with an average duration of follow-up of 16 months (12-24 months). Seventeen fractures were united well, both clinically and radiologically, with an average union time of 16 weeks. Delayed union occurred in one patient that required bone grafting and fibular osteotomy; however, the joint healed without complications. Among the population, only one patient sustained a fracture blister infection with successful outpatient antibiotic treatment. None of the patients had soft tissue complications, malunions, or nonunions. There were no differences in the outcomes of the two open fractures compared to the closed fractures when using this two-staged protocol.

CONCLUSIONS: The two-stage protocol consisting of immediate external fixation with minimal internal fixation followed by delayed ORIF of the tibia limits soft tissue complications and allows the intact fibula to aid in the maintenance of tibial length and reduction quality in both open and closed tibial pilon fractures.

Fixation of Tibial Pilon Fractures: Which is the Correct Side to Plate?

Abstract ID: Paper 192

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*Gennadiy A. Busel, M.D.
J. Tracy Watson, M.D.
St. Louis, MO

INTRODUCTION: Fibular fracture evaluation is crucial for treatment of pilon fractures. Comminuted fibular fractures (compression failure) occur with tibial fracture as a result of valgus stress. Transverse fibular fractures (tension failure) occur with varus deformation. No definitive guide for determining location of tibial fixation exists. We hypothesize plate fixation on the anterolateral tibia for valgus fibular failures and medial tibial plating for varus fibular fractures would demonstrate fewer complications.

METHODS: 119 patients with 120 pilon fractures were identified who were definitively treated at our tertiary care center from 2004-2012. Pilon fractures were classified with AO/OTA and included 43-A through 43-C fractures. Inclusion criteria were age of at least 18 years, associated fibular fracture, and definitive tibial plating. Primary factors assessed included age, sex, weight, mechanism of injury, fibular fracture type (comminuted or transverse), tibial plate location (medial or lateral), location of open wound (if any), time to definitive fixation, time to full weight bearing, and complications. Patients were grouped based on the fibular component fracture type (comminuted vs. transverse), and the location of plate fixation (medial vs. lateral) was noted. Clinical outcomes were compared using a chi-square test for nominal data and t-test for continuous variables.

RESULTS: 407 patients were identified. 120 fractures in 119 patients (61 men and 58 women) met inclusion criteria with appropriate follow-up. 48 fractures were a result of varus force as evident by transverse fracture of the fibula and 72 were due to valgus force with comminuted fibula. For transverse fibula group, 14.3% mechanical complications were noted for medially placed plate vs. 83.3% for lateral plate ($p=<0.001$). For comminuted fibular fracture type, 35.1% of medial placed plates demonstrated mechanical complications vs. 17.1% for fractures fixed with lateral plate ($p=0.083$). Time to weight bearing as tolerated (WBAT) was also noted to be significant between groups plated medially and laterally for transverse fibula fractures ($p=<0.001$) and comminuted fibular fractures ($p=0.01$). Overall rate of nonunion/malunion was 25%, with the majority related to these mechanical failures.

CONCLUSIONS: Correctly assessing the fibular component for pilon fractures provides valuable information regarding deforming forces. Using this as a guide for correct tibial side plating can minimize mechanical failures and malunion/nonunion. Soft tissue injury remains an important factor in determining surgical approach; however, plates should be applied such that the tension band is re-established and can resist the original deforming forces as described by the fibular fracture.

Data-Driven Implant Designs Avoid Unnecessary Hardware: A Comparative Study for Complex Tibial Pilon Fractures

Abstract ID: Paper 193

Peter A. Cole, M.D. / St. Paul, MN
Brian W. Hill, M.D. / New Orleans, LA
*Amir R. Rizkala, M.D. / St. Paul, MN

PURPOSE: The purpose of this study was to compare current plates that are being used for tibial pilon fracture fixation with an implant designed to target the common fracture patterns seen with this type of fracture. The need for supplemental implants, the quality of reduction, and peri-operative complications when using each implant were evaluated and compared.

METHODS: From September 2011 to January 2013, 28 patients with 31 complex pilon fractures were treated by the authors using an anterolateral fracture specific pilon plate (FSPP) derived from a previous fracture map through an anterior approach. Thirty-one consecutive patients with similar fracture patterns treated with other forms of hardware fixation between May 2008 and August 2011 were selected for comparison. Outcomes being compared included the need for additional periarticular screws and plates required for fixation, hardware failure, hardware removal, and infection rates.

RESULTS: A total of 62 AO-OTA 43C3 pilon fractures were included in the study. The study cohort consisted of 22 M/9 F with a mean age of 44.4 years (range, 23-68) with the control group having the same gender distribution and mean age of 44.2 years. Average follow-up for the study group was 39.7 weeks (range = 1-110 weeks) while average follow-up for the control arm was 54 weeks (range = 2-193 weeks). Twenty-seven of the fractures were closed and four were open in both groups.

Of the 31 cases in the control group, 14 (45.2%) required additional periarticular screws compared to 19 of the 31 (61.3%) of the control ($p = 0.3$). Three of the 31 study-arm patients required an additional medial buttress plate (9.7%) compared to 14/31 in the standard arm ($p=0.004$). Failure of hardware occurred in 2/31 (6.5%) study patients and 4/31 (12.9%) of the control patients ($p=0.6$). One out of the 30 study patients (3.2%) had a postoperative infection compared to 14/31 (25.8%) in the control arm ($p=0.026$). The surgical approach was evenly distributed among both study arms.

CONCLUSIONS: The infection rate in the novel implant was significantly lower than in the standard anterolateral plate. The need for medial buttress plating was also significantly less for patients fixated with the novel implant than in those with the anterolateral plate. In light of these results, use of the FSPP is superior in reducing the number of implants used for a complex tibial fracture and has been observed to have lower infection rates than other forms of fixation.

Use of Reverse Soleus Flaps for Coverage of Lower Third Leg Wounds

Abstract ID: Paper 194

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*Matthew T. Houdek, M.D.
Eric R. Wagner, M.D.
Cody C. Wyles, B.S.
S. Andrew Sems, M.D.
Steven L. Moran, M.D.
Rochester, MN

PURPOSE: Historically, soft-tissue defects of the lower third of the leg have been covered with free tissue transfers. In situations where free tissue transfers are not possible, the reverse soleus flap is an option to provide soft-tissue coverage. The purpose of this study was to examine the use of reversed soleus muscle flaps for soft-tissue defects of the lower extremity to determine the overall outcome and complication rate for this flap.

METHODS: 11 patients undergoing a distally-based soleus muscle flap for coverage of a distal third leg defect from 2006-2012 were reviewed. This group had a mean age of 66 years, 55% female, and a mean ASA score of 2.9. Complications including flap loss, partial flap loss, and secondary procedures were all recorded. Wounds were due to trauma in 73% (n=8) of patients. Wounds had been present for a mean of 14 days, though three patients had wounds for 6 months or more. 82% (n=9) of the wounds were infected and 45% (n=5) of wounds also had underlying osteomyelitis. The mean follow-up was 4.8 years (range 14 months to 7 years).

RESULTS: Over the course of the study period, there was 1 flap failure requiring a free flap, with an overall graft survival of 91%. Four additional patients required operative revision including debridement and skin grafting (n=4), and flap readvancement (n=1). At most recent follow-up, all patients had achieved a completely healed wound at an average of 7.8 months postoperative. All but one patient was fully weight bearing on the affected extremity at last follow-up. Smoking (HR 13.96, p=0.03) increased the risk of reoperation, while a history of underlying osteomyelitis (HR 1.23, p=0.82) or diabetes (HR 1.03, p=0.97) did not.

CONCLUSIONS: The distally based soleus flap can provide coverage of soft-tissue defects of the lower third of the leg in situations where a free flap cannot be used. Besides the one flap failure, all wounds eventually healed. Distally-based soleus muscle flaps are a safe and reliable option for healing soft-tissue defects in the distal third of the leg.

Tension Band Plate Reconstruction of Comminuted Patellar Fractures: A Superior Novel Technique

Abstract ID: Paper 195

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*Paul D. Butler, M.D.
Travis A. Burgers, Ph.D.
Debra L. Sietsema, Ph.D., R.N.
Clifford B. Jones, M.D.
Grand Rapids, MI

PURPOSE: Patellar fracture research has focused on simple fracture patterns and has demonstrated a standard for these types of fractures. Biomechanical analysis comparing different fixation techniques has not been evaluated for comminuted fractures. The purpose of this study was to compare the stiffness of three internal fixation methods using simulated physiologic demands on a comminuted patellar fracture, status-post reconstruction.

METHODS: 36 fresh frozen cadaver patellae were divided into 3 fixation groups: cerclage wiring (CW, 18 gauge wire), modified tension band with cannulated screws (TBS, 4.0 mm cannulated screws and 18 gauge wire), and tension band plate (TBP, single dorsal 7 hole 2.7 mm ¼ tubular plate with 2.7 mm screws, and dual medial/lateral 5 hole 2.0 mm plates and 2.0 mm screws). Prior to fixation, each patella was cut into a reproducible pattern, simulating a comminuted fracture. Corresponding fracture fixation was performed. Each patella was tested under 3 loading conditions: graduated static load (0-200N), polycyclic load (20-300N for 30 cycles), and failure testing (load until construct failure). Forces were applied and measured via an automated force transducer and fracture gap displacement was recorded with an extensometer. Within each fixation group, 6 patellae were tested in full extension and 6 patellae were tested in 45° of flexion.

RESULTS: Patellae under static loading conditions fixed with CW tested in full extension demonstrated a mean linear stiffness of 89.85 N/mm (+/- 48.78 N/mm) and 150.53 N/mm (+/- 73.66 N/mm) in 45° of flexion. Patellae fixed with TBS had a mean linear stiffness of 317.36 N/mm (+/- 129.53 N/mm) in full extension and 297.85 N/mm (+/- 312.42 N/mm) in 45° of flexion. TBP construct demonstrated a statistically higher mean linear stiffness than CW and TBS in extension and flexion (all $p < 0.05$) with a mean construct stiffness of 975.81 N/mm (+/- 291.67 N/mm) in full extension and 1643.66 N/mm (+/- 482.05 N/mm) in 45°, of flexion.

CONCLUSIONS: Tension band plate construct demonstrated higher linear stiffness than modified tension band with cannulated screws and cerclage wiring in this laboratory biomechanical model for comminuted patella fractures. Tension band plate reconstruction of a comminuted patellar fracture may provide superior fixation and less fixation failure than traditional methods of patellar fixation.

Neuropsychological Outcomes in Long Bone Fractures: What Factors Affect Results? A Pilot Study

Abstract ID: Paper 196

Kimberly A. Jacobsen, M.D.
Lisa K. Cannada, M.D.
Heidi Israel, Ph.D.
Ryan VanPatten, B.S.
John Wright, Ph.D.
St. Louis, MO

INTRODUCTION: Cognitive outcomes in traumatic brain injured patients have long been a topic in the neuropsychological literature. Well-defined cognitive outcomes have been established with specific mechanisms of head trauma. However, there are subsets of trauma patients that have a normal GCS on presentation that progress to have negative cognitive sequelae despite having no obvious signs of head. Such patients usually have long bone fractures that require operative fixation. Our trauma center has a unique situation of having a neuroscience department that assesses trauma patients during their hospital stay. Our aim with this study was to determine if injury time to operative fixation had a role on cognitive outcome and further to define specific patient factors that may also have an effect.

METHODS: A retrospective review was performed on all trauma patients from 2003-2014 that had an isolated long bone fracture with the diagnosis of concussion on admission. Concussion was defined as a witnessed loss of consciousness or post-traumatic amnesia of < 24 hours. Neuropsychological data was reviewed for each of these patients. Timing to OR and patient factors were noted.

RESULTS: Statistical testing showed that timing to fixation and gender had no difference on neuropsychological outcomes. Raw data was made relative to available published aged norms and split in a binary fashion. When independent t-tests were run on normalized data, significance was seen when age was split at 40 years ($p = 0.014$). Further, when comparing this data between the groups, we found that the population over 40 years old were performing more similar to their peers than the younger age groups were performing compared to theirs.

DISCUSSION AND CONCLUSION: To date, there is no study investigating the isolated orthopedic trauma patient and cognitive outcome. Our goal was to identify which factors may lead to differences in neuropsychological testing after injury. Younger trauma patients did not score as well to their aged matched norms, but the older population scored similar to theirs. This brings into question why these young patients are not doing as well. Coping mechanisms and post-traumatic stress may play a role. Often times the orthopedic surgeon is the only healthcare provider that these otherwise young, healthy patients encounter during their hospital stay. There is a sense of social responsibility of the treating orthopedic surgeon to be aware of possible interventions that may be offered to minimize cognitive sequelae.

MAOA BREAKOUT SESSION #13
HIP AND KNEE ARTHROPLASTY
April 25, 2015

Surgeon-Directed Management of Quality Indicators in Total Joint Arthroplasty: Optimizing Quality

Abstract ID: Paper 197

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*Nicolas O. Noiseux, M.D.
John J. Callaghan, M.D.
Charles R. Clark, M.D.
Melissa D. Willenborg, M.D.
Nancy Krutzfield, R.N.
Aldijana Avdic, R.N.
Iowa City, IA

Responding to increasing demands for integrating quality in total hip and knee arthroplasty care, an interprofessional team headed by the joint arthroplasty surgeons designed a dashboard to display key performance indicators as a driver to improve value, quality, and patient safety at our institution.

Using a structured, monthly meeting agenda (started January 2013), our team uses dashboard data to assess, plan, implement, and evaluate performance improvement opportunities. Data is obtained from sources including: United HealthSystem Consortium, American College of Surgeons National Surgical Quality Program, CMS, Value Based Purchasing, Press Ganey, HCAHPS, Joint Commission, and U.S. News and World Report. The dashboard performance indicators provide direction for quality improvement initiatives, functional needs, patient satisfaction, financial impact, and standardizing patient care protocols. Quality metrics were determined for 2013 with the dashboard, and compared to 2012 prior to implementation of the dashboard.

The dashboard concept contributed to numerous significant improvements in quality, safety, and efficiency of care as well as patient satisfaction: 30-day all-cause readmission rate of 4.8% in 2012 reduced to 2.8% in 2013. Mean ICU days decreased from 2 days to 1.5 days. Complication rate decreased from 0.023 to 0.019. AHRQ Safety Indicator Triggers decreased from 1 per month to 0 for 9 consecutive months. Mortality index decreased from 0.54 to 0 for 10 months. Surgeon aggregate HCAHPS were percentiles higher than comparison groups and Press Ganey scores improved nearly every month. Joint Commission SCIP arthroplasty measures improved from 98.8% to 100%. A standardized pain protocol order set was added into the EMR to address patient satisfaction on pain management and was highly successful. Documentation practices improved with case mix indices increasing 2.3 to 2.5. An estimated savings of $5.8 million was attributed to the dashboard meeting initiative for a cohort of 994 total joint cases.

An open, transparent, quality-oriented monthly dashboard meeting has contributed to significant improvements in the quality of care in total joint arthroplasty at our institution. Our success has led to the adoption of our protocol by other surgical services. Particularly with the future of

bundled payments, surgeons may benefit from the time and effort involved in these quality improvement initiatives.

Hospital Based Acute Care Following Total Hip and Knee Arthroplasty: Implications for Quality Measurement

Abstract ID: Paper 198

Roman Trimba, M.D. / Dayton, OH
*Richard T. Laughlin, M.D. / Dayton, OH
Anil Krishnamurthy, M.D. / Dayton, OH
Joseph S. Ross, M.D. / New Haven, CT
Justin P. Fox, M.D. / Dayton, OH

BACKGROUND: While post-discharge quality measurement efforts have focused specifically on hospital readmissions, patients may also experience adverse events prompting an emergency department visit (ED) without the need for subsequent hospital readmission. We conducted this study to describe the frequency of ED visits and hospital readmissions within 30 days of discharge after total hip or knee arthroplasty and to compare performance across hospitals.

METHODS: Using California, Florida, Nebraska, and New York state inpatient and emergency department databases, we identified all discharges for adult patients who underwent total joint arthroplasty between July 2009 and September 2010. Hospital level, 30-day risk standardized readmission, ED visit, and overall hospital based acute care rates were calculated using hierarchical generalized linear models. The correlation between hospital's readmission and ED visit rates was estimated. Hospitals were then stratified into quintiles of performance for the hospital readmission and hospital based acute care measure to determine how inclusions of ED visits would change a hospital's relative assessment of quality.

RESULTS: The final sample included 272,853 discharges (66.6% total knee arthroplasty, 33.4% total hip arthroplasty) from 517 hospitals. The hospital level, 30-day risk standardized ED visit rate (median=5.6% [minimum=2.4-maximum=13.7%]) and hospital readmission (median=5.0% [2.6-9.2%]) rates were similar with wide variation noted in both outcomes. Similar to hospital readmissions, postoperative pain and edema or limb swelling were common diagnoses associated with ED visits. A hospital's risk standardized ED visit rate did not correlate with its readmission rate (correlation coefficient = -0.03, p 0.50). If ED visits were included in a broader "readmission" measure, 246 (47.6%) hospitals would change performance groups.

CONCLUSIONS: Patients may experience symptoms or adverse events following discharge that prompt an ED visit without subsequent hospitalization. Including emergency department visits in a broader hospital-based acute care measure may be warranted to better describe post-discharge healthcare utilization.

The Effects of a Hospitalist Co-Management Model for Joint Replacement Patients in a Teaching Facility

Abstract ID: Paper 199

Neil L. Duplantier, M.D.
David Briski, M.D.
John L. Ochsner, Jr., M.D.
*Mark S. Meyer, M.D.
George F. Chimento, M.D.
New Orleans, LA

BACKGROUND: Hospitalists have assumed an evolving role in the care of postsurgical orthopedic patients. Literature has provided evidence to suggest improved outcomes in postsurgical hip fracture patients managed by hospitalists in nonteaching hospitals. However, the full impact of a hospitalist co-management model has not been fully investigated for elective joint arthroplasty patients in a multispecialty teaching facility. We hypothesized that a hospitalist co-management model in the setting of a teaching hospital would lead to increased unnecessary medical work-ups for joint arthroplasty patients.

METHODS: We retrospectively evaluated 2,231 patients undergoing total hip arthroplasty (THA) or total knee arthroplasty (TKA) between May 2010 and January 2014 at one teaching facility. They were separated into a non-hospitalist (NH) cohort of 1,062 patients not receiving postsurgical hospitalist co-management (PHM), and a hospitalist (H) cohort of 1,169 patients receiving PHM. We used student t-test and significance of ($P<0.05$) to compare the cohorts for length of stay (LOS), readmissions rates at 30 and 90 days postsurgery, diagnoses present on admission (POA), and new diagnoses during admission (DA). We then compared the average number of diagnostic studies performed (DSP) per patient and average cost per hospital stay (CPS).

RESULTS: We found no significant difference in LOS or diagnoses POA. However, the H group experienced a significant increase in new diagnoses DA for both THAs and TKAs ($P=0.03$ and $P=0.002$ respectively). Readmissions for THAs in the H group increased significantly 90 days postsurgery ($P=0.012$). We found no significant difference in DSP or CPS.

CONCLUSION: This study shows a significant increase in new diagnoses in postsurgical THA and TKA patients when using a hospitalist co-management model in a teaching hospital. LOS, DSP, and CPS did not show this increase. Therefore, the H group gained a significant number of diagnoses that remained subclinical. Physician and hospital grading systems view new diagnoses as complications resulting in penalties. Therefore, any benefit of a hospitalist co-management model for THAs and TKAs in a teaching hospital may be outweighed by the potential penalties associated with increased subclinical diagnoses.

Factors That Influence Discharge Disposition and Readmission Following Total Joint Arthroplasty

Abstract ID: Paper 200

Daniel P. Hoeffel, M.D. / Woodbury, MN
*Brandon J. Kelly, B.S. / Minneapolis, MN
Marc R. Giveans, Ph.D. / Woodbury, MN
Susan Mehle, B.S. / St. Paul, MN

INTRODUCTION: Recent studies show that a primary predictor for readmission following total joint arthroplasty (TJA) is discharge to a skilled nursing facility (SNF) or transitional care unit (TCU) instead of home. Increasing TJA caseload, financial pressures, and possible readmission penalties incentivize physicians and hospitals to reduce readmission rates after TJA. Factors that predict discharge disposition and readmission after TJA remain unclear. We examined potential factors from a large community health system in order to better identify at risk patients.

METHODS: 1,972 elective TJA procedures (knees and hips) from 9/1/2011 to 8/31/2012 were retrospectively analyzed from a three-hospital community health system. Age, body mass index (BMI), Charlson co-morbidity index (CCI), length of hospital stay (LOS), living status (alone vs. cohabitating), nationality, race, and sex were examined within this population to determine significant correlations with discharge disposition (home vs. SNF/TCU) and 30-day readmission.

RESULTS: 845 males and 1,127 females were included in the analysis with a mean age of 65.1 years (range, 23-96). 76% of patients were discharged to home, while 24% were discharged to SNF/TCU.

Independent predictors of discharge to SNF/TCU following TJA include: age >65 years, normal weight, CCI >2, length of stay >3 days, living alone, non-white, female, and surgery at a higher acuity hospital ($p<.01$ for each). Patients >65 years old were 4 times more likely to be discharged to SNF/TCU vs. home (39% vs. 10%, $p<.01$).

Independent predictors of 30-day readmission following TJA include: discharge to SNF/TCU, LOS >3 days, living alone, and a CCI >2 ($p<.01$ for all).

CONCLUSION: Patients who live alone, have a hospital stay >3 days and have a CCI >2 are all significantly more likely to be discharged to a SNF/TCU and are at increased risk for readmission. Identifying these patients prior to hospitalization may improve preadmission discharge planning and patient education, which may decrease readmissions. The risk factors identified here allow for the focusing of educational and social support resources in an attempt to reduce the rate of discharge to TCU/SNF and reduce readmission rate for TJA.

Early Success in the Medicare Bundled Payment for Care Improvement Program: Results of the Initial Experience

Abstract ID: Paper 201

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*Mark I. Froimson, M.D. / Livonia, MI
Michelle Schill, R.N. / Cleveland, OH
Monica Deadwiler, M.S. / Cleveland, OH

INTRODUCTION: Delivering value has become among the most often cited goals of health care reform efforts, with a variety of payment innovations emerging designed to improve quality and reduce cost. Among the most prominent and interesting for orthopedic surgeons is the CMS BPCI program that aims to allow providers to benefit financially by improving care and reducing cost. We report on our early experience with this program and the implications moving forward.

METHODS: After securing a contract with Medicare to receive a retrospectively adjusted bundled payment for an episode of care around hip and knee arthroplasty, we evaluated our clinical outcomes and financial performance for the first 180 patients enrolled and for whom data were available. We included all Medicare payments for 7 days prior and 30 days post procedure. Medicare payment for the episode was set at a 3% discount from our hospital's specific Medicare spend per beneficiary for the episode. We assessed the impact of care redesign, including better management of patient medical optimization and post-acute resource utilizations. We evaluated both the revenue impact of bundled payments as well as the internal cost of care for these patients. Impact of risk and demographic factors were assessed and outcomes were tracked.

RESULTS: Data were available for all patients with none lost and no missing data elements. 85% of care was captured within our system. Care redesign resulted in a significant shift of patients to a home discharge rather than a post-acute facility. Hospital length of stay was reduced by 20% and readmissions were reduced by 40%. Changes in discharge disposition and readmission rates favorably impacted Medicare spend whereas hospital LOS favorably impacted internal cost for the acute episode. Total cost of the episode was 6% lower than historic, allowing for a positive adjustment from Medicare of 3% after the discount. More importantly, the internal cost of care was reduced 15% allowing better than breakeven on Medicare total joint replacements. Importantly, quality indicators including infection, reoperation, and readmission were improved compared to historic. In addition, patient satisfaction remained high despite reduction in resource allocation.

DISCUSSION: Early experience with the CMS BPCI program indicates that there is a substantial positive financial benefit to both CMS and to the provider that can accrue from improvement to care redesign. This payment innovation aligns incentives among the provider, the patient and the payer, rewarding higher quality care and reduction in unnecessary or non value-added care. Further experience will determine if this is scalable to a larger cohort of patients.

Medicare Data Transparency May Confuse Consumers Comparing Hospitals for Total Joint Arthroplasty

Abstract ID: Paper 202

Daniel A. Belatti, B.S.
Andrew J. Pugely, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
*John J. Callaghan, M.D.
Iowa City, IA

PURPOSE: The release of new hospital-specific Medicare data was heralded as a major development in transparency that would empower consumers. Our purpose was to critically examine the conclusions patients might make about orthopedic care based on this data.

METHODS: We recorded volume, charge, and payment data for all non-VA hospitals performing >11 primary total joint arthroplasties (TJAs) in 2011 using the new Medicare Provider Charge Database. Surgical outcome data for TJAs at each hospital was collected using Medicare's Hospital Compare website, and included TJA-specific risk-adjusted rates of acute myocardial infarctions or sepsis within 7 days; surgical site bleeding, pulmonary embolism, or death within 30 days; and mechanical failure or periprosthetic infection within 90 days. Hospitals were divided into three groups for analysis: (1) top-ranked for orthopedics by U.S. News & World Report in 2013; (2) non-top-ranked, but located in same referral regions as ranked hospitals; and (3) located outside of referral regions of any ranked program.

RESULTS: Out of the 2,491 included hospitals, 50 were top-ranked by U.S. News; 639 shared a HRR with a ranked program, and 1,802 were located outside of ranked regions. Top-ranked hospitals performed a significantly higher volume of TJAs compared to other hospitals ($p<.001$), and were more likely to report complicated cases. Top-ranked hospitals submitted higher average charges to Medicare, and received higher payments in return ($p<.001$). For example, Medicare paid an average of $17,367 for an uncomplicated TJA at a top-ranked hospital, $2,234 more than the amount paid to other hospitals in ranked regions, and $3,274 more than the amount paid to hospitals outside these regions. No significant differences were observed in available surgical outcome metrics across hospital groups.

CONCLUSION: While this information provides a glimpse into Medicare finances, it provides little help to consumers. Top-ranked hospitals receive higher payments not by setting higher prices, but as the direct result of Medicare's own calculations, including adjustments for teaching status and case complexity. While no statistical difference in TJA outcomes between hospital groups was found, we were able to determine that top-ranked hospitals handle a much higher volume of TJA cases each year.

SIGNIFICANCE: Though comprehensive, Medicare's new databases provide little help to consumers comparing hospitals for TJA. Available quality data reveals few differences across institutions, while Medicare averages portray top-ranked hospitals as unnecessarily expensive. True price transparency would require the availability of data reflecting variations in actual costs to patients.

Total Joint Arthroplasty: Trends in Medicare Reimbursement and Implant Prices

Abstract ID: Paper 203

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*Daniel A. Belatti, B.S.
Andrew J. Pugely, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
John J. Callaghan, M.D.
Iowa City, IA

PURPOSE: Total joint arthroplasty (TJA) has long been a popular target of cost control efforts by Medicare. Our purpose was to examine recent financial trends to determine whether we could find support for the popular perception of declining margins on Medicare patients.

METHODS: We tracked Medicare utilization and expenditures using the most recent publically available records; data on Part A (hospital) payments were available 2008-2011 while Part B (physician) data covered 2000-2011. Average implant list prices were drawn from an annual industry survey encompassing eight manufacturers, representing 90% of the market. Compound annual growth rates for implant prices and Medicare reimbursements were calculated, and then corrected for inflation using the Consumer Price Index.

RESULTS: Although there was a substantial increase in TJA utilization over the period 2000-2011 (+26.9%), utilization has declined since 2005 (-7.5%). After adjusting for inflation, new coding schemes have made complicated cases more lucrative for hospitals (+2.5 to 6.5% per year), while reimbursements for uncomplicated cases have fallen (-0.7 to -0.6%). Physician reimbursements have declined on all case types (-2.5 to -2.1%), while list prices of orthopedic implants have risen (+4.8 to 5.5%). The figures below present average total Medicare reimbursement and list price for primary total knee and hip arthroplasties since 2008.

CONCLUSION: Our study finds support for the perception of a worsening financial environment for TJA. Despite an aging population, TJA utilization has actually declined since 2005. Even nominal reimbursements to physicians have declined since 2000, while implant list prices have continued to rise steeply. While few providers pay full price for their implants, these amounts are generally the starting point in hospital purchasing negotiations. Only selected hospital payments for TJA grew at rates exceeding inflation over the study period. This growth was made possible by the implementation of new coding schemes that arose as the direct result of petitions by orthopedic groups. In 2014, Medicare enacted further cuts to its reimbursement of total hip and knee arthroplasties based on the recommendations of the American Medical Association's own Relative Value Update Committee. As Medicare moves towards bundled payments, this study demonstrates the importance of advocacy and cost control in maintaining the financial sustainability of TJA.

Can the American College of Surgeons Risk Calculator Predict Outcomes After Hip and Knee Arthroplasty?

Abstract ID: Paper 204

Adam I. Edelstein, M.D. / Chicago, IL
*Linda I. Suleiman, M.D. / Chicago, IL
Rishi Khakhkhar, M.D. / Chicago, IL
Michael Moore, M.D. / Urbana, IL
Mary M. Kwasny, ScD / Chicago, IL
Matthew D. Beal, M.D. / Chicago, IL
David W. Manning, M.D. / Chicago, IL

INTRODUCTION: Accurate risk stratification of patients undergoing total hip (THA) and knee (TKA) arthroplasty is essential, and likely soon to be mandated, in the highly scrutinized world of pay-for-performance, value-driven healthcare. The Centers for Medicare and Medicaid Services have already linked quality to reimbursement and currently mandates public reporting of 30-day outcomes, including costly postoperative complications and readmissions. We aim to assess the efficacy of The American College of Surgeon's risk calculator in patients undergoing THA and TKA.

METHODS: We assess the ability of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) online surgical risk calculator to predict 30-day complications using a series of publicly reported Medicare patients who underwent elective THA or TKA at a single institution from July to December 2009. Patient demographic and comorbidity data was retrospectively input and patient-specific risk probabilities were recorded for the following complication/outcome categories: serious, any, urinary tract infection (UTI), venous thromboembolism (VTE), reoperation, death, and discharge to nursing or rehab facility. For each patient, occurrence or non-occurrence in a 30-day postoperative period was recorded for each complication/outcome category. Binomial logistic regression modeling was used to compute odds ratios (OR) for complication occurrence as well as c-statistic values for risk probability predictive value. The level of significance was set at $p<0.05$.

RESULTS: A total of 206 patients were identified for inclusion in the analysis (128 TKA and 78 THA). No patient was lost to follow-up. Mean age was 74 years. Total 30-day complications were as follows: 20 serious, 32 any, 9 UTI, 9 VTE, 6 reoperation, and 115 discharge to nursing or rehab facility. Risk estimates were significantly associated with event occurrence in the categories of serious complication (OR 2.0, $p=0.007$) and any complication (OR 1.2, $p=0.039$). Event predictability for these categories, however, was poor with c-statistics of 0.630 and 0.572, respectively. Risk estimates for discharge to nursing or rehab facility demonstrated both association and predictability (OR 1, $p<0.0001$, c-statistic 0.743). There was neither association nor predictability in the categories of UTI ($p=0.355$), VTE ($p=0.976$), reoperation ($p=0.624$), or death ($p=0.288$).

CONCLUSION: We find that the ACS-NSQIP risk calculator has poor predictive value for 30-day complication rates for THA and TKA and is not an appropriate TKA and THA risk assessment tool. In order to facilitate the equitable provision and reimbursement of patient care, further research is needed to develop an accurate risk stratification tool in TKA and THA surgery.

Total Joint Arthroplasty in Smokers: Should We Wait for Patients to Quit Before Operating?

Abstract ID: Paper 205

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*Nathan A. Nicholson, M.D.
Andrew J. Pugely, M.D.
Christopher T. Martin, M.D.
Yubo Gao, Ph.D.
Kyle R. Duchman, M.D.
John J. Callaghan, M.D.
Iowa City, IA

INTRODUCTION: Smoking has been known to increase complications rates after Total Joint Arthroplasty (TJA). While recognized as a risk factor, the benefit of smoking cessation has not been previously quantified. Thus, the purpose of this study was to compare the short-term complication rates among patients undergoing TJA that have never smoked, quit smoking, and continue to smoke.

METHODS: A multi-center prospective clinical registry, known as the ACS NSQIP, was queried for all adult patients undergoing Total Knee (TKA) and Hip Arthroplasty (THA) from 2006 to 2012. Risk-adjusted 30-day outcomes analyzed and compared between patient cohorts defined as never smokers, ex-smokers, and current smokers. Ex-smokers were defined as cessation for a minimum of 1 year. Primary outcomes were defined as any 30-day complication, wound complications, and mortality. Univariate and multivariate analysis were used to risk-adjust and identify the independent effects of smoking cessation on outcome. The effect of total patient pack-years, or lifetime amount smoked, was also evaluated.

RESULTS: In total, 78,191 patients undergoing TJA were included; 81.8% (63,971) of patients were never smokers, 7.9% (6,158) ex-smokers, and 10.3% (8,062) current smokers. The mean age of current smokers was dramatically lower than the other two cohorts (58.9 years vs. 68 years, $p < 0.001$). Unadjusted overall and wound-related complication rates were higher among smokers ($p <0.001$). Mortality rates did not differ between groups. After logistic regression risk adjustment, smokers had the highest risk of wound complications (OR 1.5, 95% CI: 1.21-1.78). Compared with never smokers, the risk of any complication was higher for both current smokers (OR 1.8, 95% CI: 1.06-1.31) and ex-smokers (OR 1.2, 95% CI: 1.08-1.34). The risk of any complication increases with each successive pack-year smoked; 1-20 pack-years (OR 1.16); 21-40 pack-years (OR 1.17); and 41+ pack-years (OR 1.21), $p < 0.05$.

CONCLUSIONS: Smokers have a higher overall and wound-related short-term morbidity after elective TJA. The risk appears additive with the number of patient pack-years smoked. Quitting smoking for a minimum of 1 year prior to TJA is associated with a lower short-term wound complication risk, and not different than those who have never smoked. These results support the importance of smoking cessation protocols prior to elective arthroplasty.

Seronegative Periprosthetic Joint Infections: Aspiration is Still the Gold-Standard

Abstract ID: Paper 206

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*Benjamin A. McArthur, M.D. / Chevy Chase, MD
Matthew P. Abdel, M.D. / Rochester, MN
Michael J. Taunton, M.D. / Rochester, MN
Douglas R. Osmon, M.D. / Rochester, MN
Arlen D. Hanssen, M.D. / Rochester, MN

INTRODUCTION: A subset of patients with periprosthetic joint infections (PJIs) will present with a normal erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). There is little data describing this cohort, or their outcomes with treatment. The aim of this study was to describe the diagnostic findings, patient and pathogen characteristics, method of treatment, and clinical and radiographic outcomes for patients with PJI and negative serologic studies after total knee arthroplasty (TKA) and total hip arthroplasty (THA).

METHODS: Between 2000 and 2011, 603 TKAs and 920 THAs underwent surgical treatment for PJI. Of these, 538 TKAs and 414 THAs met the diagnostic criteria set forth by the Musculoskeletal Infectious Disease Society. Preoperative ESR and CRP were recorded to identify the seronegative cohort. Mean follow-up was 5 years.

RESULTS: There was a 4% rate of seronegative PJI (21 TKA, 17 THA). Diagnosis was based on ≥2 positive cultures (18 TKA, 16 THA) or ≥4 minor criteria (3 TKA, 1 THA). When performed, preoperative aspirate cultures were positive in 76% of TKAs and 50% of THAs. Cell count and differential were suggestive of infection in 93% of TKA and all THA aspirates. The most common organism isolated was coagulase-negative Staphylococcus (CNS). Except for two acute infections, all patients were treated with a two-stage revision. At final follow-up, reoperation for infection had occurred in 2 TKAs, both with a new organism, and one THA with the same organism treated previously. Mean clinical outcome scores were 73 and 56 for Knee Society pain and function, respectively, and 78 for the Harris hip score. Mean Knee Society radiographic scores were 3, 1, and 1 for the femur, tibia and patella, respectively. For uncemented THAs, the mean Engh radiographic scores were 7 and 16 for fixation and stability, respectively.

DISCUSSION: While some have advocated ESR and CRP as screening tests to rule out infection, we have identified a cohort of PJI patients in whom these tests failed to suggest infection. When performed, preoperative aspirate proved useful in diagnosing PJI in nearly all cases. Moreover, two-stage revision successfully eradicated infection in most patients.

SUMMARY: Preoperative aspiration remains the gold standard, particularly when attempting to diagnose seronegative cases, which occur with a frequency of 4%.

Tranexamic Acid Makes Preoperative Blood Management Obsolete for Blood Transfusion Use During Primary Arthroplasty

Abstract ID: Paper 207

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*Joseph F. Styron, M.D., Ph.D.
Caleb R. Szubski, B.S.
Albair Guirguis, M.D.
Deborah Tolich, R.N.
Alison K. Klika, M.S.
Wael K. Barsoum, M.D.
Carlos A. Higuera, M.D.
Cleveland, OH

INTRODUCTION: In 2013, our institution implemented a preoperative blood management (PBM) protocol to treat preoperative anemia. Additionally, surgeons started intraoperative use of tranexamic acid (TXA) later that year. The study objectives were to evaluate the efficacy of the PBM protocol and TXA administration at reducing blood transfusion after total hip and knee arthroplasty (THA, TKA).

METHODS: Consecutive primary THA and TKA cases between 10/1/11 and 10/31/13 were retrospectively queried (n=1392). After exclusions (n=509; surgeries during pilot program, bilaterals, hip fractures), cases were classified as before (n=330; 37.4%) or after (n=553; 62.6%) PBM protocol implementation (1/1/13). The protocol, coordinated by two nurses, requires various blood and iron labs. Hemoglobin (Hb) ≤13g/dL triggers an evaluation of labs and medical history. Preoperative treatment includes intravenous iron, epoetin alfa, or both. TXA, if used, was typically administered intravenously (1g before incision, 1g at closing). Multiple regression examined the effect of protocol, treatment, and TXA on outcomes (transfusion, units transfused).

RESULTS: Of 553 protocol-eligible patients, 452 (81.7%) were screened (protocol compliance) and 88 (15.9%) received treatment (364 not treated – 323 ineligible/refused, 41 insufficient time/missed). Treatment resulted in a significant, yet minimal, increase in preoperative Hb (11.92g/dL to 12.35g/dL; $p<0.001$). Neither treatment nor protocol eligibility affected transfusion odds (treatment, $p=0.658$; eligibility, $p=0.743$) or the number of transfused units (treatment, $p=0.140$; eligibility, $p=0.138$). 204 patients (36.9%) received TXA after protocol implementation. Receiving TXA had the greatest effect in reducing transfusion odds (OR=0.306; $p<0.001$). Also associated with decreased transfusion odds were high preoperative Hb (OR=0.493; $p<0.001$), undergoing TKA (OR=0.482; $p=0.001$), being younger (OR=0.974; $p<0.001$), and shorter surgery (OR=0.988; $p<0.001$).

CONCLUSION: Preoperative anemia screening with concomitant medical intervention did not significantly decrease transfusion odds or the number of units transfused. In contrast, intraoperative TXA use significantly lowered transfusion risk even when controlling for comorbidities, preoperative Hb, and operative time.

The Effect of Topical Tranexamic Acid During Arthroplasty of the Knee on Blood Loss

Abstract ID: Paper 208

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*Jedediah H. May, M.D.
Geoffery R. Rieser, M.D.
Chad G. Williams, M.D.
Ronald J. Markert, Ph.D.
Anil B. Krishnamurthy, M.D.
Ryan D. Bauman, M.D.
Matthew W. Lawless, M.D.
Dayton, OH

INTRODUCTION: Blood loss during primary total knee arthroplasty represents an important safety concern. Blood loss of 1,000 to 1,500 ml during primary total knee arthroplasty and up to double this amount for revision surgeries have been reported, resulting in transfusion rates of up to 15-40%. Recent studies have demonstrated the effectiveness of tranexamic acid administered both topically and intravenously in decreasing blood loss and transfusion rates. The comparative effectiveness of topically vs. intravenously administered tranexamic acid has not yet been fully elucidated.

METHODS: In this double-blinded study, we randomized 131 patients undergoing primary total knee arthroplasty to receive either topical or intravenous tranexamic acid intraoperatively. Sixty-nine patients were randomized to the intravenous group and 62 to the topical group. Using the formula derived by Nadler et al., preoperative and postoperative blood volumes were calculated. Blood loss for postoperative days one through three were then calculated. The total number of units transfused was recorded, as well as length of hospital stay.

RESULTS: We found no statistically significant difference between topically and intravenously administered tranexamic acid on calculated blood loss on postoperative day #1 (POD#1) (624±326 vs. 644±292; p=0.71), POD#2 (806±368 vs. 835±319; p=0.64), or POD#3 (1076±419 vs. 978±343; p=.55). There was no difference between the two groups in number of blood transfusions; only one patient (topical group) required a blood transfusion. Length of stay and complications were similar in both groups.

CONCLUSIONS: Topically administered tranexamic acid is not inferior to intravenously administered tranexamic acid in decreasing blood loss and blood transfusion rate in primary total knee arthroplasty.

No Increased Risk of VTE and Potential Decreased Mortality Associated with Tranexamic Acid in Total Hip and Knee Arthroplasty♦

Abstract ID: Paper 209

Christopher M. Duncan, M.D.
*Blake P. Gillette, M.D / Porter Ranch, CA.
Adam K. Jacob, M.D. / Rochester, MN
Rafael J. Sierra, M.D. / Rochester, MN
Joaquin Sanchez-Sotelo, M.D. / Rochester, MN
Dirk Larson / Rochester, MN
Hugh M. Smith, M.D. / Rochester, MN

INTRODUCTION: Knee arthroplasty (TKA) and hip arthroplasty (THA) are associated with blood transfusion and risk for postoperative venous thromboembolism (VTE). Tranexamic acid (TA) reduces blood loss and transfusion by interrupting the fibrinolytic pathway Reports show that TA may be safe to use in high-risk orthopedic patients, but further data is needed to substantiate its use.

METHODS: Patients undergoing primary or revision TKA or THA between January 1, 2005, and January 1, 2010, were retrospectively identified. The primary outcome was presence of VTE within 30 days of surgery. A secondary outcome was all-cause mortality within 30 days of surgery. A propensity score model was used to adjust for potential patient factor selection bias in the intravenous administration of TA.

RESULTS: In 13,262 elective TKA or THA procedures, the overall frequency of VTE was 1.5%. Thromboembolic events were less common in patients receiving TA (1.3%) than patients who did not receive TA (1.5%). The odds of VTE was not significant with TA administration (OR = 0.98; 95% CI 0.67-1.45; p=0.939). One death occurred in a patient who received TA (0.04%), and 29 deaths were among patients who did not receive TA (0.28%). Univariate analysis demonstrated patients who did not receive TA had a seven-fold higher odds than patients with TA (OR = 7.73; 95% CI 1.05-56.76; p=0.04). However, the propensity-adjusted odds of death was not significant with TA administration, but trended toward a protective effect (OR = 0.26; 95% CI 0.04-1.80; p=0.171).

CONCLUSION: The major findings of this large, single center, retrospective cohort study show the odds of postoperative VTE were unchanged with TA administration. Equally important, no statistically significant change was seen in 30-day mortality. It appears that TA use does not increase the risk for VTE or 30-day mortality in patients undergoing THA and TKA.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation. Cyklokapron (tranexamic acid) is FDA approved for tooth extraction in hemophiliacs and is used off-label in this study.

Tranexamic Acid Benefits Total Joint Arthroplasty Patients Regardless of Preoperative Hemoglobin Value♦

Abstract ID: Paper 210

Daniel R. Whiting, M.D.
*Christopher M. Duncan, M.D.
Hugh M. Smith, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Tranexamic acid (TA) has been shown to reduce blood loss and postoperative transfusion in total hip and knee arthroplasty (THA and TKA). However, it remains unclear whether there is a preoperative hemoglobin (Hgb) value above which the use of TA is no longer beneficial. The objective of this investigation is to report the effects of TA in relation to preoperative Hgb values in healthy patients undergoing THA and TKA.

METHODS: 2,100 patients with an American Society of Anesthesiologists physical classification score of I-II undergoing primary THA and TKA by six surgeons during 2007-2009 were retrospectively reviewed through the institutional joint registry and medical record. During this time period, three surgeons routinely administered TA and three did not. Patients were categorized on the basis of preoperative Hgb (all values reported as grams/deciliter); these groups were Hgb >15, >14, >13, >12, and >11. Outcome measures included postoperative transfusion, 30-day thromboembolic events (TEE), and length of stay (LOS). Continuous variables were analyzed using student t-tests for differences in means; proportions were analyzed using $\chi 2$ tests; ANOVA tests were used for the comparison of multiple means. All analyses were performed using JMP version 10.0.0.

RESULTS: 1,161 patients (55%) received TA. Throughout all Hgb groups transfusion rates were significantly decreased amongst patients who received TA. In patients with Hgb >15, transfusion rates ranged from 0.5% with TA to 4.5% without TA ($p=0.0086$). In patients with Hgb >11, transfusion rates varied from 4.7% with TA to 18.7% without TA ($p<0.0001$). There were 10 TEE in patients who received TA (0.9%) and 7 in those who did not (0.7%); difference in probability 0.12% ($p=0.81$, 95% confidence interval [CI] -0.9-0.7%). Patients receiving TA had a significantly shorter LOS; mean difference 0.51 days ($p<0.0001$, 95% CI 0.44-0.59). Patients receiving a postoperative transfusion had a significantly longer LOS; mean difference 0.69 days ($p<0.0001$, 95% CI 0.57-0.81).

CONCLUSION: In this study, TA was associated with a four to nine fold decrease in transfusion rates amongst THA and TKA patients. Additionally, TA was associated with a significantly shorter LOS by 0.51 days, while postoperative transfusion was associated with a significantly longer LOS by 0.69 days. These expanded benefits of TA may be related to improved vigor and postoperative activity level leading to early discharge. Given these findings, TA should be considered in all THA and TKA patients independent of preoperative Hgb level.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (tranexamic acid, Cyklokapron).

The Use of Erythropoietin and Its Derivatives in the Treatment of Postoperative Peripheral Nerve Palsies in Total Hip and Knee Arthroplasty

Abstract ID: Paper 211

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*Derek T. Bernstein, M.D.
Kenneth B. Mathis, M.D.
Bradley K. Weiner, M.D.
Houston, TX

BACKGROUND: Peripheral nerve injury in total hip or knee arthroplasty is an uncommon but devastating complication which may compromise postoperative rehabilitation and ultimate functional outcome. Erythropoietin, an endogenous hormone FDA-approved for the treatment of anemia, has shown promise in over 180 preclinical studies as a neuroprotective agent. The purpose of this study was to retrospectively assess a series of 11 patients who underwent total hip or total knee arthroplasty between September 2008 and October 2013 who were found to have postoperative nerve palsies and were subsequently treated with systemic Erythropoietin or one of its derivatives.

METHODS: From January 2005 to October 2013, 11 patients undergoing total hip or knee arthroplasty at a single institution were treated with Erythropoietin or one of its derivatives as well as corticosteroids for an acute postoperative nerve palsy in the sciatic or peroneal nerve distribution. Patients were followed clinically for a minimum of 1 year or until complete motor and sensory recovery. One patient was lost to follow-up and was assumed to have no neurologic recovery in order to perform a worst-case analysis. Primary end points included degree of recovery and time to recovery. Secondary endpoints included the use of walking or orthotic aids.

RESULTS: Of seven patients with complete neurologic injuries, 4 (57%) recovered fully at a mean of 15 days (range: 3-25). Two patients (29%) recovered 4/5 strength and full sensation at 357 and 442 days, and one patient was lost to follow-up and assumed to have no recovery. Of four patients with incomplete neurologic injuries, all patients recovered fully at a mean of 57 days (range: 12-133). No patient with complete follow-up required walking or orthotic aids.

CONCLUSIONS: Overall, 73% of our cohort experienced full recovery at an average of 39 days with 91% of our cohort ambulatory without walking or orthotic aids. One patient was lost to follow-up and assumed to have no recovery for a worst-case analysis. The findings of this study are in concert with an increasingly growing body of evidence supporting the neuroprotective and neuroregenerative capacity of Erythropoietin and its derivatives and highlight the potential for their application in the setting of postoperative peripheral nerve palsies.

The Effective Use of an Arthroplasty Database Registry to Drive Quality Transfusion Practices

Abstract ID: Paper 212

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*Mark W. Allen, D.O. / Madison Heights, MI
Nicole M. Zappa, D.O. / Southfield, MI
David C. Markel, M.D. / Southfield, MI

INTRODUCTION: Standardized care practices are effective at controlling cost and quality for joint replacement programs. Similarly, registries provide insights into the quality of and outcomes for use of implants. In late 2012, several hospitals together with a major insurance company formed a voluntary statewide total joint database/registry. The initial phases included the collection of implant data, surgical procedural data, in-hospital patient data, readmission, and discharge administrative data. Our study used this prospectively collected data to examine whether awareness and education of published transfusion guidelines by the American Association of Blood Banks would result in decreased transfusion rates.

METHODS: Indications for transfusion were already built into the hospital EMR: transfuse one unit a time and limit transfusion to hemoglobin (Hgb) <8 mg/dL unless symptomatic. In October 2013, a quality initiative began for awareness of our transfusion practice variances and education of nationally accepted transfusion guidelines to the orthopedic department. There were no penalties or particular enforcements. We reviewed all transfusions in THA/TKA patients, for the period prior to (May 2012-October 2013) and after (November 2013-April 2014) education about the guidelines. Data collected included sex, age, LOS, preoperative Hgb, lowest postoperative Hgb level, transfusion status, etc. Pre- and post-quality initiative transfusion rates were identified. Chi square analysis was done to compare differences in transfusion rates for patients with an Hgb>8 mg/dL.

RESULTS: Prior to education, the transfusion rate was 15% (203/1351), and 35% were outside the recommended transfusion practice (Hgb>8 mg/dL). In the first and second months following the educational statement at the orthopedic service line and reinforcement of safe practices, the transfusion rate by the orthopedic team decreased to 10% (0% Hgb>8 mg/dL) and 6% (19% Hgb>8 mg/dL), respectively. In the four months thereafter, the transfusion rate was 5.6% (22/391, 14% Hgb>8 mg/dL). Overall, the relative transfusion rate for patients with an Hgb>8 mg/dL decreased 54% (p=0.023).

CONCLUSION: Simple education and awareness of quality practices drives safety and compliance. The impact can be immediate and lasting. Registries are important and may be used for important data-driven quality initiatives.

SIGNIFICANCE: Registries can promote quality and improve patient care. This study highlights the effectiveness of a quality initiative project founded on data from a collaborative joint registry. The project was rapidly effective at decreasing transfusion rates.

Rivaroxaban vs. Warfarin vs. Aspirin for Venous Thromboembolism Prophylaxis After Total Hip and Knee Arthroplasty

Abstract ID: Paper 213

Blaine T. Manning, B.S. / Chicago, IL
Robert A. Medairos, B.S. / Chicago, IL
Shiv I. Sutaria, B.S. / Chicago, IL
Vicky Kang, B.S. / Chicago, IL
Brandon J. Erickson, M.D. / Chicago, IL
Mario Moric, M.S. / Chicago, IL
Richard A. Berger, M.D. / Chicago, IL
Scott M. Sporer, M.D. / Winfield, IL
*Brett R. Levine, M.D. / Chicago, IL

INTRODUCTION: The purpose of our study is to determine whether differences exist in rates of deep venous thrombosis (DVT), pulmonary embolus (PE), and major bleeding complications between total hip (THA) and knee arthroplasty (TKA) patients receiving rivaroxaban, warfarin, or aspirin for venous thromboembolism (VTE) prophylaxis.

METHODS: We retrospectively reviewed patients who underwent primary THA or TKA by three surgeons at our institution between January 1, 2010, and December 31, 2013. Patients were excluded if they underwent bilateral procedures, had incomplete data, or received other anticoagulants. After exclusion, 1,512 patients were included and followed until most recent clinic visit. Primary endpoints were VTE (DVT, PE), blood loss requiring 2+ units of blood, and stroke.

RESULTS: Rivaroxaban was received by 509 patients (33.7%), warfarin by 494 patients (32.6%), and aspirin by 509 patients (33.7%). Interim analysis of 303 patients (102 rivaroxaban; 102 warfarin, 99 aspirin) revealed one rivaroxaban patient (1%) with DVT, one aspirin patient (1%) with PE, and no warfarin patients with DVT or PE. These differences were not significant (DVT, p=1.0; PE, p=0.3267). Significant differences were found in major bleeding complications, as ten rivaroxaban patients (9.8%), three warfarin patients (3%), and no aspirin patients experienced major bleeding requiring transfusion of two or more blood units (p=0.0020). Significantly, 48 (47%) of warfarin patients were male compared to 30 (32%) and 37 (37%) of rivaroxaban and aspirin patients, respectively (p=0.0340). There were no significant differences between groups with regards to age, postoperative stroke, BMI, ASA classification, and history of stroke, DVT, PE, or smoking.

DISCUSSION AND CONCLUSION: To our knowledge, this is the only study comparing these three medications for VTE prophylaxis in primary THA and TKA patients. Interim analysis of 303 of our 1,512 patients suggested that although rivaroxaban patients may be prone to increased risk of major bleeding, no significant difference exists between rivaroxaban, warfarin, and aspirin with regards to DVT or PE rates

Trends of Synovial Fluid Cytokines in Non-Arthritic, Arthritic, and Painful Hip and Knee Arthroplasty

Abstract ID: Paper 214

Salvatore J. Frangiamore, M.D.
*Nicholas Gajewski, B.S.
Anas Saleh, M.D.
Mario Farias Kovac, M.D.
Colin O'Rourke, B.S.
Thomas Daly, M.D.
Alison K. Klika, M.S.
Wael K. Barsoum, M.D.
Carlos A. Higuera, M.D.
Cleveland, OH

INTRODUCTION: Synovial fluid pro-inflammatory cytokines have shown potential for increased sensitivity in diagnosis of periprosthetic joint infection (PJI). However, it is unclear if some specific cytokines are markers for inflammation related with infection or other conditions such as osteoarthritis (OA). The purpose of this study was to evaluate the efficacy of broader synovial fluid cytokine panel in differentiating inflammation in the setting of OA and infection.

METHODS: 151 consecutive patients that underwent either arthroscopic surgery for a non-arthritic condition (n=17), primary knee or hip arthroplasty for OA (n=34), and non-infected (n=70) or infected (n=30) revision of a primary knee or hip arthroplasty were prospectively included. Aseptic and septic samples were categorized using MSIS criteria for PJI. Synovial fluid levels of nine pro-inflammatory cytokines (IL-6, GM-CSF, IL-1β, IL-12, IL-2, IL-8, IFN-γ, IL-10, TNF-α), were measured using a cytokine immunoassay. Elevations in each cytokine were evaluated across diagnostic categories, and associations between individual cytokines were determined.

RESULTS: There was wide variation on all cytokines among compared groups. IL-6 was the most significantly elevated in the infection group (24766.1 pg/mL, 95% CI [11853.05, 33657.2 pg/mL]) compared to the non-infected group (204.35 pg/mL, 95% CI [67.38, 754.97 pg/mL], $p<0.001$). Similarly, IL-1β had significant elevation in the infection group (120.65 pg/mL, 95% CI [47.1, 276.6 pg/mL]) compared to the non-infected group (2.5 pg/mL, 95%CI [0.96, 6.98], $p<0.001$). Other cytokines are nonspecific for inflammation related with either OA or other conditions. Also, they are not specific with inflammation related with infection of non-infection.

CONCLUSIONS: Cytokine profiles between non-osteoarthritis, OA, and aseptic and septic joints vary considerably in the nine pro-inflammatory cytokines measured. IL-6 and IL-1β are specific markers for infection. This study characterizes different inflammatory conditions within the joint and provides useful cytokine profiles that can be used to improve the diagnosis of infection after arthroplasty.

In-Hospital Opioid Exposure and the Risk of Surgical Site Infections in Total Hip and Knee Arthroplasty

Abstract ID: Paper 215

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*Taylor D. Dennison, M.D.
Hilal Maradit Kremers, M.D.
Walter K. Kremers, Ph.D.
Christopher M. Duncan, M.D.
Elie F. Berbari, M.D.
Daniel J. Berry, M.D.
David G. Lewallen, M.D.
Rochester, MN

BACKGROUND: Opioids have immune-modulatory effects. Therefore, high doses of perioperative opioids may potentially increase the risk of surgical site infections (SSI). Few studies have explored the extent of in-hospital opioid use and the risk of SSI in total hip (THA) and knee (TKA) arthroplasty.

METHODS: The study included 11,950 primary THA and TKA procedures in adult patients (aged ≥18 years) performed at a large U.S. tertiary care hospital between 1/1/2003 and 12/30/2010. Data on patient, surgery characteristics, and complications were collected through registry and chart data. Details of all opioid administrations were retrieved electronically from the medication records. Opioids were converted into oral morphine equivalents using standard equivalence conversions. In cases where an exact dosage was unavailable, the lowest dosage with that particular opioid was used. Extreme values were verified through chart review. We defined opioid exposure as total cumulative dosage per day of hospitalization. Medical records of all cases of SSI were reviewed manually to validate diagnosis. Follow-up duration was limited to 1 year following surgery. Cox proportional hazard models were used to estimate hazard ratios (HR) for SSI associated with average daily opioid exposure adjusting for age, sex, calendar year, body mass index, type of surgery, ASA score, procedure duration, operative diagnosis, and diabetes status.

RESULTS: All patients received at least one opioid medication. 95% of the patients received oxycodone, 27% tramadol, 9% morphine, 8% hydromorphone, and 6% other opioids. The average oral morphine equivalent dose was 63 (±57) mg (IQR 34-74) per patient per day, but ranged from 1 to 1063. In univariate analysis, every 100 mg increase in daily oral morphine equivalent dose was associated with a 32% increase in risk of SSI (HR: 1.32, p=0.0001). The risk estimate was attenuated, but remained significant in age and sex-adjusted analyses (HR: 1.24, p=0.004) and upon adjustment for calendar year, BMI, prior surgery on the same joint, diabetes diagnosis, use of general anesthesia, procedure time, and ASA score, (HR: 1.20; p=0.019). After adjustment for diagnosis, risk was of similar magnitude and remained significant. (HR: 1.18, p=0.040). Comparison of patients with oral morphine equivalent of > 150 mg (5% of patients) vs. < 75 mg (76% of patients) yielded an (HR of 2.01, p=0.012).

CONCLUSION: We found a significant association between in-hospital opioid use and the risk of SSI in primary THA and TKA. Further study on type and mode of administration may be warranted.

How Accurate is Patient Specific Instrumentation? A Comparison of Preoperative Planning in Different PSI Software Programs Given Identical MRI

Abstract ID: Paper 216

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*Nitin Goyal, B.S.
S. David Stulberg, M.D.
Chicago, IL

INTRODUCTION: Patient specific instrumentation (PSI) generates customized guides from an MRI- or CT-based preoperative plan for use in total knee arthroplasty (TKA). Current literature has focused on coronal alignment, suggesting that PSI has comparable accuracy to conventional instrumentation in establishing neutral coronal alignment. Because PSI involves a multi-step planning process, the accuracy of each planned step needs to be assessed to understand the inherent accuracy of the technology. The purpose of this study was to quantify the inherent accuracy of PSI preoperative planning by comparing preoperative plans generated by two different PSI software programs applied to a single implant system using identical MR images.

METHODS: In this prospective comparative study, we evaluated PSI preoperative plans generated by two proprietary software programs for 40 consecutive knees. Both plans were generated from the same MRI, utilized a single implant system, and were approved by a single experienced surgeon blinded to the other software-generated preoperative plan. MRI reconstructions for both software programs were evaluated to identify differences in bony landmarks. Preoperative plans were evaluated to determine differences in preoperative alignment, component sizes, and resection depth.

RESULTS: Software programs displayed differences in identification of bony landmarks in the femur and tibia. Software 1 determined preoperative alignment to be 0.7° more varus ($p<0.001$) compared to Software 2. Differences in femoral component size selection occurred in 37.5% of cases ($p<0.001$) with 12 cases differing by one size and 3 cases differing by two sizes. Differences in tibial component size selection occurred in 30.0% of cases ($p<0.001$) with 12 cases differing by 1 size. In cases in which both software planned identical femoral component sizes, Software 1 planned significantly more bone resection compared to Software 2 in the medial posterior femur (0.8 mm;$p=0.004$) and lateral posterior femur (0.8 mm; $p=0.003$). The maximum difference in bone resection between software was within 2.2 mm to 5.1 mm.

DISCUSSION: The two PSI software programs showed notable differences with regard to component size selection and predicted bone resection, likely due to the use of different bony landmarks. Surgeons should be prepared to intraoperatively deviate from PSI selected size by 1 size. Differences in predicted bone resection among PSI software programs may be up to 2.2 mm to 5.1 mm. As a result, it may be necessary to fine tune soft tissue balancing when using a PSI system in order to establish a well aligned, balanced, stable TKA.

Trend in Primary and Revision Hip and Knee Arthroplasty Among the Orthopedic Surgeons Who Take the American Board of Orthopaedics Part 2 Exam

Abstract ID: Paper 217

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*Aidin Eslam Pour, M.D. / Ann Arbor, MI
Thomas L. Bradbury, M.D. / Atlanta, GA
Greg Erens, M.D. / Atlanta, GA
James R. Roberson, M.D. / Atlanta, GA
John Harrast, M.D. / Chicago, IL

INTRODUCTION: A certified list of all operative cases performed within a 6-month period is required of surgeons by the American Board of Orthopaedic Surgery (ABOS) as a prerequisite to taking the Part II oral examination. ABOS has collected and maintained data on these cases since 1999. This unique data set provides valuable information about changing practice patterns. The purpose of this study was to assess changing trends over time for primary and revision total hip arthroplasty and early postoperative complications for those who take the Part II examination.

METHODS AND MATERIALS: All data were entered into a secure Internet-based database (SCRIBE) by candidates who took the Part II examination. The database was searched for all procedures done between 2003 and 2013, with CPT codes for total hip and knee arthroplasty, hip resurfacing, hip hemiarthroplasty, revision hip and knee arthroplasty, conversion to total hip and knee arthroplasty, and removal of hip and knee implant (Girdlestone, static or dynamic spacer).

RESULTS: More than 33,000 hip surgeries and more than 28,000 knee cases were identified. Fellowship-trained surgeons performed 60% of the surgeries (average 28.1) and non-fellowship-trained surgeons did 40% (average 5.2) ($p < 0.001$). For total knee arthroplasty, these numbers were 55% (average 33.5) and 45% (average 7.4), respectively ($p < 0.001$). Fellowship-trained surgeons performed significantly more revision surgeries for infection (71% vs. 29%) ($p < 0.001$). High-volume surgeons had significantly fewer complications in both primary (11.1% vs. 19.6%) and revision surgeries (29% vs. 35.5% ($p < 0.001$). Those who passed the Part II exam reported a higher rate of complications (21.5% vs. 19.9%); however, there was no significant difference between the two groups regarding the total rate of complications, rate of infection, or hip dislocation. The overall trend is for more hip and knee arthroplasties performed by fellowship-trained surgeons.

CONCLUSION: In early practice, primary surgeries and many revision hip and knee arthroplasties are often done by surgeons without fellowship training. Complications are less frequently reported when either primary or more complex cases, including periprosthetic fractures or complex periprosthetic infections, are done by surgeons who perform a larger volume of joint replacement surgery.

MAOA BREAKOUT SESSION #14
SHOULDER
April 25, 2015

Body Mass Index Significantly Affects Characterization of Glenohumeral Wear Patterns in Shoulder Arthroplasty: Axillary Lateral Radiography vs. Computed Tomography

Abstract ID: Paper 218

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*Ryan P. Mulligan, M.D.
John F. Feldman, M.D.
William J. Weller, M.D.
Nicolas Bonnaig, M.D.
Robert H. Miller, III, M.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

BACKGROUND: Preoperative imaging is critical in shoulder arthroplasty for understanding pathoanatomy and preparing for glenoid component placement. The purpose of this study was to compare preoperative axillary lateral radiographs and axial CT slices for classification and measurement of glenoid wear, glenoid version, and glenohumeral subluxation as well as to determine the influence of BMI on characterization of glenoid wear patterns.

METHODS: The axillary lateral radiographs and CT imaging of 88 consecutive patients who underwent shoulder arthroplasty for glenohumeral osteoarthritis were reviewed. Observers reviewed the images to classify glenoid wear (Walch and Mayo classifications) and glenohumeral subluxation (Mayo classification). Glenoid version measurements were made using Friedman's technique. After a minimum two-week period, the process was repeated. Statistical analysis was performed to obtain intra- and interobserver reliabilities.

RESULTS: Of the 88 shoulders reviewed, 58 (66%) radiographs and 84 (95%) CT scans were of sufficient quality to perform each classification by all evaluators ($p<0.0001$). The average BMI of patients whose x-rays could not be entirely evaluated by each observer was 37 (vs. 31, $p=0.0003$). The average BMI of the four CT scans that could not be fully classified was 51 (vs. 32, $p<0.0001$). For measurement of glenoid version, 69 (78%) radiographs and all 88 CT scans were sufficient for evaluation by all observers ($p<0.0001$). Kappa values for intraobserver reliability for the Walch, Mayo glenoid wear, and subluxation classification on radiographs were 0.42, 0.46, and 0.47, and 0.50, 0.49, and 0.41 for CT imaging; all indicating fair agreement. Kappa values for interobserver reliability for the Walch, Mayo glenoid wear, and subluxation classifications on radiographs were 0.28, 0.21, and 0.21, and 0.27, 0.23, and 0.19 for CT imaging; all indicating poor agreement. The intraobserver reliability for measurement of glenoid version using x-ray was 0.66 (good agreement) and 0.88 (substantial agreement) for CT scan. The interobserver reliability for measurement of glenoid version using x-ray was 0.56 (fair agreement) and 0.78 (good agreement) for CT scan.

CONCLUSIONS: When readable, axillary lateral radiographs and axial CT imaging demonstrated similar intra- and interobserver agreement for all classifications of glenoid wear and glenohumeral subluxation. However, CT imaging was significantly more likely to provide

sufficient characterization of glenohumeral wear patterns by multiple observers. For images that were unable to be fully evaluated, increased BMI factored significantly in the observers' ability to judge classifications. Precise characterization of glenoid wear by measurement of glenoid version was more reliable with CT imaging.

Hypovitaminosis D in Patients Scheduled to Undergo Shoulder Arthroplasty: A Single-Center Analysis

Abstract ID: Paper 219

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*Bradley P. Inkrott, M.D.
Kiel J. Pfefferle, M.D.
Jessica Koberling, P.A.
Curt R. Noel, M.D.
Akron, OH

BACKGROUND: Vitamin D is recognized as an essential component in bone health, muscle function, and immune system regulation. It is estimated that greater than one billion people worldwide are vitamin D deficient. Although hypovitaminosis D has been reported in all patient populations, it is most common in females, increasing age, higher latitudes, darker skin pigmentation, and obesity. Retrospective studies in orthopedic elective arthroplasty populations reveal low preoperative vitamin D levels in 24-84% of patients. The role of sufficient vitamin D levels prior to orthopedic surgery has been explored in recent literature pertaining to fracture care, arthroplasty, and spine surgery. Furthermore, low Vitamin D levels have been implicated in complications such as insufficiency fracture risk, nonunion, aseptic loosening, and infection. A recent animal model demonstrated increased bony ingrowth of titanium implants with vitamin D supplementation alone. Our null hypothesis is that patients at our institution undergoing Total Shoulder Arthroplasty (TSA) and Reverse Total Shoulder Arthroplasty (RSA) will have normal vitamin D levels.

METHODS: Between September 2013 and June 2014, 122 patients undergoing TSA and RSA from a single surgeon meeting inclusion criteria were screened for hypovitaminosis D. Preoperative serum 25-hydroxyvitamin D (25[OH]D) levels were measured and retrospectively reviewed. Patients currently taking vitamin D supplementation were excluded. The protocol for vitamin D supplementation consisted of 4,000 IU daily for levels <25-30 ng/ml, and 50,000 IU weekly for 12 weeks for levels less than 24 ng/ml. Further follow-up was set up with primary care physicians.

RESULTS: Overall, 58 shoulder arthroplasty patients (48%) were vitamin D insufficient (<30 ng/ml). Of these, 14 patients (32%) were vitamin D deficient (<20 ng/ml). The prevalence of vitamin D insufficiency in obese patients (BMI>30) was 21% higher than non-obese individuals (p=0.019). Gender and ethnicity were not statistically significant. The average vitamin D level of all studied patients was 32 ± 14 ng/ml (normal reference range 30-80 ng/ml).

CONCLUSION: To our knowledge, this is the largest cohort of shoulder arthroplasty patients screened for hypovitaminosis D. Almost half of the study population was insufficient, comparable to previous studies. Given the extent of vitamin D involvement in normal musculoskeletal physiology, it is our opinion that routine preoperative evaluation is merited. Low vitamin D levels may influence the postoperative course when considering complications such as acromial stress fracture, aseptic loosening, and infection. We continue to prospectively collect data and future studies will assess the association of hypovitaminosis D, its treatment, and patient outcomes.

Two-Year Clinical and Radiographic Outcomes of Total Shoulder Arthroplasty Utilizing a Hybrid Glenoid Component with a Central Porous Titanium Post

Abstract ID: Paper 220

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*Marcus C. Ford, M.D.
Erin M. Meehan, M.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

INTRODUCTION: Glenoid component loosening remains one of the most common complications in total shoulder arthroplasty (TSA). Recently, hybrid glenoid components that supplement traditional cemented fixation with ingrowth technology have been introduced. We proposed to evaluate the two-year clinical and radiographic outcomes of a TSA system that utilizes a hybrid glenoid component employing a central porous titanium post to augment the cemented pegs.

METHODS AND MATERIALS: Thirty-two patients (35 shoulders) who underwent TSA for glenohumeral osteoarthritis were included. Patients were clinically and radiographically evaluated preoperatively and postoperatively at a minimum of two years. Patients were clinically evaluated using American Shoulder and Elbow Society (ASES) scores, Quick-DASH (QDASH) disability scores, and active shoulder range of motion. Postoperative radiographs at a minimum of 2-year follow-up were analyzed. Paired t-tests were used to determine statistical differences ($p<0.05$) in pre- vs. postoperative outcomes.

RESULTS: Thirty-five TSAs with a mean patient age of 69.5 years (range 51-93) and an average follow-up of 34 months (range 24-53 months) comprised the study group. The average ASES score improved from 39 to 80 ($p<0.0001$), and the average QDASH score improved from 52 to 19 ($p<0.0001$). Forward elevation (109° to 144°, $p<0.001$), internal rotation (42° to 55°, $p=0.01$) and external rotation (38° to 42°, $p=0.19$) all demonstrated improvement as well. Radiographic evaluation demonstrated that 17 implants had no evidence of glenoid component radiolucency, 5 had evidence of radiolucencies confined to the area under the glenoid faceplate, and 12 showed partial radiolucencies around the central post. One TSA demonstrated a circumferential radiolucent line only around the post. None of the implants showed multiple column involvement and no components were determined to be at risk. There were no cases of glenoid component failure or revision for loosening. Four complications were noted including two cases of glenohumeral subluxation, one proximal biceps rupture, and one case of postoperative arthrofibrosis.

CONCLUSION: These results demonstrate statistically significant improvements in clinical outcomes and function at two years in this TSA system utilizing a hybrid glenoid component with a central porous titanium ingrowth post. Radiographic evaluation demonstrated periprosthetic glenoid lucencies comparable to other reported series and no cases of glenoid component failure. Overall, this hybrid component shows favorable short-term results. But further intermediate and long-term evaluations will be needed to demonstrate the durability of these implants and to determine the significance and fate of the radiolucent lines, particularly relative to the central post.

The Impact of BMI on Short-Term Complications Following Total Shoulder Arthroplasty

Abstract ID: Paper 221

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*Jimmy J. Jiang, M.D.
Pranay B. Patel, M.D.
Jason L. Koh, M.D.
Douglas R. Dirschl, M.D.
Lewis L. Shi, M.D.
Chicago, IL

INTRODUCTION: Body Mass Index (BMI) is known to affect outcome in some orthopedic surgical procedures. We compared the 30-day complication rates and hospitalization outcomes following TSA among patients in different BMI classes.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database for the 2006-2012 years was queried to identify all patients who underwent a primary TSA (CPT=23472) for a diagnosis of osteoarthritis of the shoulder (ICD-9=715.x1). The ACS-NSQIP is a statistically representative sample of prospectively collected perioperative surgical data from participating hospitals across the United States. Exclusion criteria included revision TSA, infection, tumor, or fracture. Patients who underwent a TSA were divided into four BMI categories: normal (18.5-25 kg/m^2), overweight (25-30 kg/m^2), obesity class 1 (30-35 kg/m^2), and obesity class ≥ 2 (>35 kg/m^2). Perioperative hospitalization data and 30-day postoperative complications, as well as demographics, comorbidities, and preoperative laboratory values, were compared among different BMI classes.

RESULTS: There were a total of 3,200 patients from this database who underwent a TSA during 7 consecutive years. After implementing the exclusion criteria, we analyzed 2,121 patients who underwent a primary TSA for osteoarthritis of the shoulder. The average age of the patients decreased with increasing BMI ($p<0.001$), from 71.8 years in the normal BMI group to 66.9 years in the obesity class ≥ 2 group. The overall complication rates for the normal, overweight, obesity class 1, and obesity class ≥ 2 were 4.5%, 3.7%, 2.8%, and 3.9%, respectively ($p=0.59$). There was a statistical trend towards increased risk of DVT ($p=0.06$) with a higher BMI. There were no differences among the BMI groups in rates of wound complications ($p=0.33$), blood transfusions ($p=0.14$), return to the operating room ($p=0.81$), mortality ($p=0.87$), postoperative length of stay ($p=0.53$), and discharge to home ($p=0.13$). The operative time of surgery increased from 114.7 minutes in the normal BMI group to 122.1 minutes in the obesity class ≥ 2 group ($p=0.02$). General anesthesia rates increased from 93.5% in the normal BMI group to 98.7% in the obesity class ≥ 2 group ($p=0.001$). There were statistically significant differences between the distribution of gender ($p<0.001$) and race ($p<0.001$) among the different BMI groups.

DISCUSSION: While the surgical time increased for patients with greater BMI, the 30-day complication rates following TSA were not significantly different in patients with increased BMI levels.

Level of Evidence: Therapeutic Level III

Quantifying Survival and Complications in Shoulder Arthroplasty as a Function of Age

Abstract ID: Paper 222

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*Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
Joseph Statz, M.D.
Cathy D. Schleck, B.S.
W. Scott Harmsen, M.S.
Robert H. Cofield, M.D.
Bassem T. Elhassan, M.D.
John W. Sperling, M.D.
Rochester, MN

PURPOSE: Age is an important consideration when deciding to perform shoulder arthroplasties in patients. However, studies examining the effect on age have only examined it using thresholds. The purpose of this investigation was use age as a continuous variable to estimate implant survival and the risk of complications.

METHODS: 5,904 consecutive shoulder arthroplasties, from 1985-2012 were analyzed using prospectively collected data. Patients were followed routinely until revision or death. The average age was 67 years (18-97). The association between the age and the risk for each outcome was assessed using the Kaplan Meier Model Cox regression analysis. Smoothing splines were examined in assessing the association of age with each outcome. The hazard ratios (HR) reports for the curves are 5 years of age.

RESULTS: Older age was associated with a decreased risk of revision surgery, revision for mechanical failure, and reoperation, but a higher risk for thromboembolic events. The risk of revision surgery decreased in a linear fashion between the ages of 40 and 85, with a 3% decreased risk of revision per 5 years increase in age (HR 0.97 per 5 years, $p<0.01$). When compared to patients younger than 50 years, patients from 50-65 years (HR 0.65, $p<0.001$), and older than 65 (HR 0.45, $p<0.001$) have decreased risks of revision surgery. Older age also was associated in a greater than linear fashion with a decreased risk of revision surgery for mechanical failure in shoulder arthroplasties (HR 0.87 per 5 years, $p<0.001$). Reoperation rates also decreased in a linear fashion with older ages (HR 0.97 per 5 years, $p<0.001$). This same trend is also seen in a multivariate model taking into account diagnosis, gender, and BMI ($p<0.001$). There was a very subtle association between older age and decreased rates of infection (HR 0.99, $p=0.01$). Older age was strikingly associated with a higher rate of thromboembolic events (HR1.15, $p<0.001$). Of note, risks of shoulder instability or periprosthetic fractures were not associated with risk age. Furthermore, when examining each component individually (hemiarthroplasty, anatomic, and reverse), there was a significant association between older age and decreased rates of revision surgery, revision for mechanical failure, and reoperation ($p<0.05$).

SUMMARY POINTS: There is a strong association between older age decreased rates of revision surgery and reoperation after shoulder arthroplasty, with a striking correlation with decreased rates of mechanical failure. These are important considerations when counseling younger patients and for healthcare policy-makers when quantifying risk.

Click here to view Figure

Comparison of Outcomes and Complication Rates After Total Shoulder Arthroplasty and Reverse Shoulder Arthroplasty

Abstract ID: Paper 223

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*M. Mustafa Gombera, M.D.
Guido Marra, M.D.
Gordon N. Nuber, M.D.
Matthew D. Saltzman, M.D.
Chicago, IL

BACKGROUND: Total shoulder arthroplasty (TSA) is a frequently employed treatment option for end stage glenohumeral arthritis with an intact rotator cuff. The modern reverse shoulder arthroplasty (RSA) is increasingly utilized for cuff tear arthropathy and complex shoulder disorders. Historically, a higher complication rate has been reported following RSA compared to TSA.

METHODS: A consecutive series of 105 patients (114 shoulders) that underwent total or reverse shoulder arthroplasty by a single fellowship-trained shoulder surgeon were evaluated at an average of 29-month follow-up (range, 12-49). Pre- and postoperative range of motion and outcome scores including the simple shoulder test (SST), visual analog scale (VAS) pain, and patient satisfaction were recorded. The complication and reoperation rates were evaluated.

RESULTS: Seventy-seven shoulders underwent TSA and 37 shoulders underwent RSA. Following TSA and RSA, the postoperative SST, VAS, forward flexion, and external rotation values were significantly improved compared to preoperative values ($P < 0.001$). There were no significant differences in the postoperative SST, VAS, or satisfaction scores between TSA and RSA (Table 1). There was no significant difference in the complication rates (13.0 vs. 8.1%, $P = 0.44$) or reoperation rates (3.9 vs. 5.4%, $P = 0.71$) following either TSA or RSA.

CONCLUSIONS: TSA and RSA are successful treatment options that postoperatively relieve pain, improve shoulder function, and increase range of motion. Patients experienced similar improvements in SST scores and pain relief after either total or reverse shoulder arthroplasty. Patients reported similar satisfaction scores following both procedures. Complication and reoperation rates following either TSA or RSA in this series were similar in short-term follow-up.

Click here to view Table

Arthroscopic Tissue Culture for the Evaluation of Periprosthetic Shoulder Infection

Abstract ID: Paper 224

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*Matthew F. Dilisio, M.D. / Omaha, NE
Jon J. P. Warner, M.D. / Boston, MA
Lindsay R. Miller, M.S. / Boston, MA
Laurence D. Higgins, M.D. / Boston, MA

INTRODUCTION: Periprosthetic shoulder infections can be difficult to diagnose. The biologic milieu of the shoulder is unique relative to the hip and knee, which is evident by the bacteria that are commonly found in periprosthetic shoulder infections. Specifically, Propionibacterium acnes (P. acnes) is notoriously indolent and can often be present in patients with normal laboratory markers for infection and a negative fluoroscopic glenohumeral aspiration culture. The purpose of this study was to investigate the novel technique of arthroscopic tissue culture for the diagnosis of infected shoulder arthroplasty. Our hypothesis was that arthroscopic tissue culture of shoulder arthroplasty is a more reliable method to diagnose infection than fluoroscopic guided shoulder aspiration.

METHODS: A retrospective review was performed to identify patients that had undergone an arthroscopic tissue culture in the evaluation of possible chronic periprosthetic shoulder infection. The culture results of the arthroscopic biopsies were compared to the culture results of fluoroscopic glenohumeral aspirations and open tissue samples obtained at the time of revision surgery.

RESULTS: 19 patients had an arthroscopic biopsy to evaluate a painful shoulder arthroplasty for infection, and all of those patients subsequently underwent revision surgery. Positive culture at time of revision surgery was found in 41.2% of patients. P. acnes was identified in all patients. The arthroscopic biopsy culture results were consistent with the culture results obtained at the time of open revision surgery, resulting in 100% sensitivity, specificity, positive predictive value, and negative predictive value. In contrast, fluoroscopic glenohumeral aspirations yielded a sensitivity of 16.7%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 58.3%.

CONCLUSION: Arthroscopic tissue biopsy for the evaluation of prosthetic shoulder infection is a reliable method to diagnose infection and identify the causative organism. Glenohumeral aspiration has a low sensitivity for isolating P. acnes.

Body Mass Index as a Continuous Variable in Shoulder Arthroplasty

Abstract ID: Paper 225

Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
*Joseph Statz, M.D.
Cathy D. Schleck, B.S.
W. Scott Harmsen, M.S.
Robert H. Cofield, M.D.
John W. Sperling, M.D.
Bassem T. Elhassan, M.D.
Rochester, MN

PURPOSE: Morbid obesity has been linked to increased rates of complications in lower extremity arthroplasty. There is a paucity of studies in the upper extremity and those few studies have examined the effect of BMI using specific ranges. The purpose of this investigation was to quantify rate of revision surgery and complications after shoulder arthroplasty using BMI as a continuous variable.

METHODS: Using a single institution's total joint registry, 5,904 consecutive shoulders, treated with either hemiarthroplasty (1,388), anatomic (3,330), or reverse (806) shoulder arthroplasty from 1998-2013 were examined. The average BMI was 29.7 (14-66), with 1,622 (35%) shoulders with a BMI >30 and 297 (7%) with a BMI >40. BMI was parameterized using a smoothing spline model. The associations of patient factors with the risk of each complication were assessed using Cox hazard regression analysis, adjusting for correlated shoulders.

RESULTS: Increasing BMI was associated with an increased risk of revision surgery, reoperation, revision for mechanical failure, superficial infection, and periprosthetic fracture. Risk of revision surgery increased in a linear fashion with increasing BMI (HR 1.05, or a 5% increased risk per unit of BMI, $p=0.03$). Subgroup analysis revealed BMI was also associated with an increased revision for mechanical failure (HR 1.05, $p<0.01$). Each unit increase in BMI was also associated with a 5% increase in the risk for reoperations (HR 1.05, $p<0.02$). In a multivariate model incorporating gender and primary diagnoses, revision surgery, revision for mechanical failure, and reoperation maintained statistical significance ($p<0.01$). The most striking correlation between increasing BMI and any complication in shoulder arthroplasty was its association superficial wound infection (HR 1.09, $p=0.03$). There also was an increased risk of deep and all infections, but not statistically significant. Increasing BMI is also associated with an increased rate of periprosthetic fractures (HR 1.12 per unit of BMI, $p=0.01$). Alternatively, rates of shoulder instability and thromboembolic events were not significantly associated with BMI. When examining each of these outcomes by specific types of arthroplasty, increasing BMI in hemiarthroplasty, anatomic, and reverse arthroplasty each individually were correlated with higher rates of revision surgery, reoperation, superficial wound infection, and periprosthetic fracture ($p<0.05$).

SUMMARY POINTS: Increasing BMI is strongly associated with increased rates of revision surgery and postoperative complications after shoulder arthroplasty. Many of these complications increases in a greater than linear fashion across the range of BMIs. The increased complications are demonstrated in a greater than linear fashion across most BMIs.

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Radiographic and Clinical Outcomes Following Total Shoulder Arthroplasty with a Non-Cemented, Micro-Stem Humeral Component: A Retrospective Analysis at Least Two Years Postoperative

Abstract ID: Paper 226

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*Andrew A. Millis, M.D.
Keith Kenter, M.D.
Nicholas Sacksteder, B.S.
Robert Wissman, M.D.
Eric England, M.D.
Kaushal Mehta, M.D.
Cincinnati, OH

PURPOSE: Total shoulder arthroplasty (TSA) has provided predictable pain relief and shoulder function for degenerative joint disease of the glenohumeral joint. Traditional TSA implants have a long stem humeral implant that requires extensive reaming and broaching to remove humeral shaft bone for implant insertion. Theoretically, a shorter stemmed implant could reduce some complications of TSA by reducing the amount of humeral bone removed during primary TSA. Thus, the micro-stem humeral stem was developed. In this study, we hypothesized that using a micro-stem humeral implant would show good to excellent clinical results in most patients as analyzed with UCLA, Constant, DASH, and SANE shoulder scores. Additionally, we thought that the micro-stem patients would show good shoulder ROM and low concern for radiographic loosening at 2 years postoperative follow-up.

MATERIALS AND METHODS: This was a retrospective review of the first 25 micro-stem TSA done by a single surgeon (KK). We were able to get 13/25 to follow-up and obtained clinical outcomes data, ROM, and x-rays at least 2 years from initial surgery. The minimum follow-up was two years postoperative and average follow-up was 31.4 months. 7 male and 6 females followed up. Radiographs were interpreted by 3 radiologists at two time points two months apart. Complications data was obtained from medical records and patient interviews.

RESULTS: Through our clinical outcomes measures, more than 90% of patients reported good or excellent clinical outcomes. Postoperative shoulder function as assessed by UCLA shoulder score averaged 30.3, Constant score averaged 81.6, DASH averaged 15.9, and SANE averaged 81.6. Radiographic analysis showed low suspicion for radiographic loosening with only 1/13 patients having 2 mm or greater lucent lines in at least 3/8 radiographic zones of the implant-bone interface of the humerus. No shoulder radiographs were interpreted by 2 or more of the 3 radiologists as demonstrating significant humeral subsidence or tilt. We reported complications in 3/13 shoulders – one radial nerve palsy, one case of adhesive capsulitis and stiffness, and one medial cortex fracture perioperatively. Only 1/3, the adhesive capsulitis patient required repeat operation for the complication.

CONCLUSIONS: The micro-stem study group shows good to excellent clinical outcomes and low suspicion of radiographic loosening at 2 years. The results presented here, though limited by follow-up percentage and number, are comparable to those in the literature for conventional and mini-stem implants. The micro-stem humeral implant appears to be a safe and effective option for TSA.

Revision Surgery for Aseptic Glenoid Loosening After Total Shoulder Arthroplasty

Abstract ID: Paper 227

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*William R. Aibinder, M.D.
Bradley S. Schoch, M.D.
Cathy D. Schleck, B.S.
John W. Sperling, M.D.
Robert H. Cofield, M.D.
Rochester, MN

INTRODUCTION: Glenoid component loosening has long been recognized as a common indication for revision surgery after total shoulder arthroplasty. Previously, (redacted) reported on the outcome of a cohort of patients who underwent revision surgery for glenoid component loosening in regards to clinical and functional outcomes, risk factors for an unsatisfactory result, and rate of failure. The purpose of this study is to determine the long-term outcome of patients undergoing revision for aseptic glenoid component loosening only.

MATERIALS AND METHODS: Between 1985 and 2005, 34 revision shoulder arthroplasties were performed for aseptic glenoid loosening at a single institution. Shoulders were treated with placement of a new glenoid component (21) or removal of the glenoid component and bone grafting (13). Thirty-one shoulders had a minimum of two-year follow-up or until reoperation. Three shoulders were lost to follow-up. Outcome measures included pre- and postoperative pain, range of motion, and postoperative modified Neer ratings. All 34 shoulders were included in survivorship analysis, which was assessed using a Kaplan Meier survival analysis.

RESULTS: Thirty-one shoulders, with a mean age of 66 were analyzed at a mean follow-up of 8.3 years. Both the glenoid bone grafting and glenoid revision shoulders showed similar and significant improvements in pain scores ($p=0.004$ and <0.001, respectively). Active abduction, external rotation, and internal rotation all improved, but none reached statistical significance. 81% of patients undergoing glenoid removal and glenoid bone grafting rated their shoulder as much better or somewhat better than preoperatively, while only 67% of revision glenoids reported their shoulder to be better. Both groups had 55% excellent or satisfactory Neer ratings ($p=0.4$). Six shoulders (29%) with glenoid revision and 2 shoulders (15%) with glenoid removal and glenoid bone grafting underwent reoperation at a mean of 4.7 and 1.7 years, respectively. Radiographically, 4 of the revised glenoids were noted to be at risk of failure at the time of most recent follow-up.

CONCLUSION: Revision surgery for aseptic glenoid loosening following total shoulder arthroplasty often leads to pain relief and patient satisfaction. However, significant improvements in range of motion are less optimistic. 45% of patients in each group had unsatisfactory Neer ratings at final follow-up. Glenoid bone loss following total shoulder arthroplasty remains challenging and patients should be advised cautiously about expected functional outcomes when undergoing revision arthroplasty.

Primary and Revision Total Shoulder Arthroplasty: National Trends and Perioperative Outcomes

Abstract ID: Paper 228

Brian E. Schwartz, M.D.
David D. Savin, M.D.
*Peter D. McQueen, M.D.
David E. Mossad, B.S.
Ari R. Youdarian, M.D.
Benjamin A. Goldberg, M.D.
Chicago, IL

INTRODUCTION: Currently the third most replaced joint in the body, the demand for both primary and revision total shoulder arthroplasty (TSA) is expected to increase. The purpose of this study was to evaluate patient demographics, perioperative outcomes, and assess recent national trends in both primary and revision TSA.

METHODS: The National Hospital Discharge Survey (NHDS) database was searched using ICD-9 codes for patients admitted to U.S. hospitals for primary and revision TSA from 2001-2010. ICD-9 codes were used to identify demographics, in-hospital adverse events, and discharge disposition. Statistical analysis included linear regression with Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis with a significance level of $p<0.05$.

RESULTS: 1,297 patients who underwent primary TSA and 184 patients who underwent revision TSA were identified. After adjusting for fluctuations in annual hospital admissions, the rates of primary TSA ($r=0.88$) and revision TSA ($r=0.85$) both demonstrated a strong positive correlation with time. The mean patient age of the primary group was significantly higher than the revision group (69.0 vs. 65.2 years, $p<0.01$). Caucasians accounted for 68.9% of primaries vs. 72.3% of revisions ($p=0.402$). African Americans accounted for 3.3% of primaries vs. 4.3% of revisions ($p=0.615$). Revision TSA patients had a significantly longer average hospitalization (3.06 vs. 2.46 days, $p<0.01$) as well as significantly more medical co-morbidities than the primary TSA group (6.0 vs. 5.1 comorbidities, $p<0.01$). There was no significant difference between primaries and revisions in the rates of discharge to a rehabilitation facility (10.8% vs. 13.6%, $p=0.317$), DVT (0.08% vs. 0%, $p=0.706$), PE (0.15% vs. 0% $p=0.594$), and transfusion (5.6% vs. 7.6%, $p=0.367$), respectively. There were no deaths reported.

DISCUSSION: This study demonstrates that the rate of TSA is rapidly increasing in the U.S., with over a four-fold increase in revisions and five-fold increase in primaries over the 10 years studied. African Americans are noticeably under-represented in this population, accounting for only 3.3% of primaries and 4.3% of revisions, as the 2010 U.S. Census estimates the African American population at 12.4%. Aside from a longer length of hospitalization, this study failed to demonstrate worse in-hospital outcomes for revision TSA compared to primary TSA.

Comparison of Outcomes and Optimal Assessment Tools After Reverse Shoulder Arthroplasty

Abstract ID: Paper 229

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*Vani J. Sabesan, M.D. / Dearborn, MI
Vinay Sharma, B.S. / Kalamazoo, MI
Craig Beam, Ph.D. / Kalamazoo, MI
J. Michael Wiater, M.D. / Troy, MI

INTRODUCTION: With growing attention being paid to quality and cost effectiveness in healthcare, outcome evaluations are becoming increasingly important. This determination can be difficult to define in many reconstructive surgeries, and are especially difficult in RSA given the complex pathology and extensive disabilities in this patient population. The purpose of this study was to assess sensitivity and amount of variation between three validated questionnaires used to assess outcomes of RSA.

METHODS: 148 patients treated with RSA from 2006-2010 were included in the study with an average follow up of 30.7 months. Preoperative and postoperative Constant-Murley score (CMS), American Shoulder and Elbow Surgeons (ASES) score, Subjective Shoulder Values (SSV), visual analogue scale (VAS) for pain, range of movement, and strength were measured. Correlations between functional outcomes and patient reported outcome scores, as well as sensitivity and variance of each individual outcome score were performed.

RESULTS: No significant differences in the mean improvement of CMS, ASES, or SSV between groups as defined by diagnosis, prosthesis type, and glenosphere size ($P<0.05$). All of the outcome scales improvements were correlated with each other and improvement in forward elevation, but not with external rotation. Using canonical correlation analysis, the best combination of 3 outcome measures to predict improvement in functional outcomes was able to explain 38.9% of the variation in function (forward elevation improvement). This was only slightly greater than that provided by improvements in the outcome variable CS alone (this outcome variable explained 36.7% of variation in forward elevation improvement).

CONCLUSIONS: Our results show that the three shoulder outcome scores evaluated are equally sensitive in appropriately reflecting improvements after RSA, regardless of whether they were patient reported or physician assessed. For each of the 3 outcomes scores, the strongest correlation is seen for improvements in forward elevation. The optimal outcome score would be sensitive to detect change, with minimal variation, for a group of RSA patients. Using a combination of all 3 outcome scores (CMS, ASES, and SSV) does not significantly increase accuracy or decrease amount of variation seen compared to Constant Murley score alone when evaluating patients treated with RSA.

Optimal Baseplate Rotational Alignment in Reverse Total Shoulder Arthroplasty: A Three-Dimensional Computer-Aided Design Study

Abstract ID: Paper 230

Byron F. Stephens, M.D.
Casey T. Hebert, M.S.
Frederick M. Azar, M.D.
William M. Mihalko, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

(Presented by John J. Feldman, M.D., Memphis, TN)

INTRODUCTION: The number of shoulder arthroplasty procedures performed continues to increase and the indications for reverse total shoulder arthroplasty (RTSA) continue to expand. However, glenoid component loosening or failure remains a concern. Current recommendations are to place baseplate screws in the best possible bone to maximize fixation. We proposed to utilize 3D Computer-Aided-Design software to calculate optimal baseplate rotation for fixed angle locking screw placement in the 3 pillars of highest density bone in arthritic shoulders.

METHODS: 73 arthritic scapulae were reconstructed from CT images. Each scapula CAD file was then imported into AutoDesk Inventor Professional 2014. Baseplates were positioned centrally at the inferior aspect of the glenoid in 10° of inferior tilt. The baseplate was rotated around a fixed point and peripheral locking screw position was optimized in each of the three scapular pillars individually and then in all three pillars simultaneously. Rotation of the baseplate (internal rotation) and screw length measurements were then recorded. The position of combined maximum fixation was defined as the rotation that allowed for the longest combination of screws in all three pillars.

RESULTS: The mean position for optimal individual peripheral locking screw placement was 6°±2° (mean ±SEM) for the coracoid pillar, 198°±2° for the inferior pillar, and 295°±3° for the scapular spine pillar. Of note, 78% (57/73) of the screws attempting to obtain purchase in the scapular spine pillar were unable to be placed without an 'in-out-in' configuration. In contrast, 100% of coracoid screws and 99% (72/73) of inferior pillar screws achieved full purchase. The mean rotation for the position of combined maximum fixation was 11°±1°, but only 16% (12/73) of screws aiming for the scapular spine pillar were able to achieve full purchase in this position. Conversely, 99% of coracoid and inferior pillar screws gained full purchase.

CONCLUSIONS: These results suggest approximately 11° of internal rotation is the ideal baseplate position for maximum fixed angle peripheral locking screw fixation in RTSA. These rotational measurements can guide the shoulder arthroplasty surgeon to place peripheral screws in the best possible bone, primarily in the coracoid and inferior scapular pillars. In addition, these results highlight the difficulty in obtaining optimal purchase in the scapular spine, as 78% of screws aiming for that pillar were unable to achieve purchase without an “in-out-in” trajectory.

Cement-within-Cement Humeral Fixation in Revision Reverse Shoulder Arthroplasty

Abstract ID: Paper 231

Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
*Steven I. Pancio, M.D.
Bassem T. Elhassan, M.D.
Joaquin Sanchez-Sotel, M.D.
Robert H. Cofield, M.D.
John W. Sperling, M.D.
Rochester, MN

PURPOSE: When revising a failed cemented humeral component, complete removal of cement in order to obtain cementless fixation of the revision stem may be extremely difficult. Implantation of a new cemented revision component in a retained mantle of cement is commonly considered in revision hip surgery, but its performance in the shoulder is largely unknown. The purpose of this study was to determine the outcome of revision RSA using a cement-within-cement technique.

METHODS: Between 2005 and 2011, 187 revision RSAs were performed in our institution. Shoulders with >2 years of follow-up or those with an APC were excluded. In 30 shoulders, a cemented humeral component was revised to a cemented reverse humeral component using a cement-within-cement technique; in 5 shoulders, a cemented humeral component was revised to an uncemented reverse humeral component. The mean follow-up time was 3.5 (2-6) years.

RESULTS: Revision RSA led to significantly improved pain and shoulder range of motion ($p<0.01$). At most recent follow-up, ASES and simple shoulder test scores were 67.2, and 5.1, respectively. 77% of the patients were subjectively satisfied. There were no significant differences in clinical outcomes between the cement-within-cement and uncemented groups ($p>0.34$). The average operative time for the cement within cement technique was 153 minutes, compared to 265 minutes for the cementless group. A second revision surgery was performed in 2 patients in the cement-within-cement group (both for instability) and 2 patients in the cementless group (instability and humeral loosening). There were 5 additional postoperative complications not requiring surgery; hematoma (2), superficial infection (1), HO (1), and dislocation (1). The survival free revision for humeral loosening at 2 and 5 years was 100% in the cement-within-cement group, compared to 100% and 75% in the uncemented group ($p<0.02$). Humeral radiolucent lines were identified in 4 (17%) shoulders, 3 (10%) in the cement-within-cement group, and 1 (20%) in the uncemented group ($p>0.02$). Worse outcomes was observed in shoulders with a history of instability ($p<0.04$). History of a total SA had a negative impact on humeral loosening ($p<0.01$).

CONCLUSION: Cement-within-cement fixation of the humeral component in revision RSA seems to decrease operative time and is associated with equal or lower mechanical failure rates as compared to cementless fixation. Worse outcomes should be expected in patients with a history of prosthetic instability or a failed total shoulder arthroplasty.

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Vitamin E-Infused Highly Cross-Linked Polyethylene Demonstrates Less Volumetric Wear Than Standard Cross-Linked Polyethylene at Five Million Cycles in a Reverse Shoulder Arthroplasty

Abstract ID: Paper 232

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*Tyler J. Brolin, M.D. / Memphis, TN
Joshua B. Sykes, M.D. / Memphis, TN
Hani Haider, Ph.D. / Omaha, NE
John W. Sperling, M.D. / Rochester, MN
Thomas W. Throckmorton, M.D. / Memphis, TN

INTRODUCTION: Osteolysis from wear debris is an important mode of failure in total joint arthroplasty. As indications for the use of reverse total shoulder arthroplasty (RTSA) expand, there is concern for complications related to wear debris as follow-up extends into the mid and late term. The purpose of this study was to compare the wear rates of vitamin E-infused highly cross-linked polyethylene with standard cross-linked polyethylene in a wear simulation model.

METHODS: A 12-station AMTI hip simulator was adapted for this study. Six RTSA articulations were configured with vitamin E-infused highly cross-linked polyethylene and six with standard cross-linked polyethylene. Thirty-six millimeter glenospheres were used for all articulations. 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. Each elevation rise (twice per cycle) was accompanied by a rising and falling sinusoidal compressive load in the range 170N–1700N. Wear was gravimetrically measured at 250,000, 500,000, 1 million, and then every 1 million cycles up to 5 million. Wear rates were calculated as mm^3 per 1 million cycles. One-tailed t-tests were used to calculate differences in wear rates. Differences with $p<0.05$ were considered statistically significant.

RESULTS: The wear rates were significantly higher at all time points for standard cross-linked polyethylene compared to vitamin E-infused polyethylene (Table 1). The magnitude of the differences between groups increased with the number of cycles ($p_{0.25M}=4.5E^{-7}$, $p_{0.5M}=1.9E^{-7}$, $p_{1M}=1.2E^{-12}$, $p_{2M}=6.0E$<sup)-24< sup="">, $p_{3M}=2.9E^{-32}$, $p_{4M}=2.1E^{-40}$, $p_{5M}=2.3E^{-50}$). There were no mechanical polyethylene failures.

DISCUSSION: This study demonstrates vitamin E-infused highly cross-linked polyethylene has improved in vitro wear characteristics compared to standard cross-linked polyethylene at all time points up to 5 million cycles. There was approximately a 6-fold reduction in wear rates with vitamin E-infused highly cross-linked polyethylene, which may have clinical implications in the intermediate and late term for RTSA implants. Additionally, there was no evidence of fatigue failure in either type of polyethylene under this mode of wear testing. Clinical studies to examine the in vivo effectiveness of vitamin E-infused polyethylene are needed to further evaluate these wear test findings and explore other modes of failure.

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Recent National Trends and Outcomes for Surgical Management of Proximal Humerus

Abstract ID: Paper 233

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*Leland E. Gossett, B.S.
Sapan H. Shah, B.S.
Timothy D. Gossett, B.S.
Vincent M. Moretti, M.D.
Samuel J. Chmell, M.D.
Chicago, IL

INTRODUCTION: Proximal humerus fractures present challenges for management. Displacement and nonunion are common complications. Surgical management such as open reduction with internal fixation (ORIF) or shoulder arthroplasty is typically needed for severe cases. The goal of this study was to examine national trends in surgical management of these fractures and perioperative outcomes.

METHODS: International Classification of Disease-9th revision (ICD-9) diagnosis codes were used to search the National Hospital Discharge Survey (NHDS) for patients with proximal humerus fractures for the years between 2001 and 2010. Patients treated with arthroplasty were compared to those treated with ORIF. Data regarding demographics, hospitalization length, discharge, rate of deep vein thrombosis (DVT), pulmonary embolism (PE), blood transfusion, and mortality were gathered. Statistical comparisons were made using Student's t-test, Pearson's correlation coefficient (r), and chi-squared analysis with a significance level of 0.05.

RESULTS: A total of 4,273 patients were admitted with proximal humerus fractures from 2001 to 2010. 610 were treated with arthroplasty and 941 were treated with ORIF. Overall, an average of 94.1 ORIFs were performed per year vs. 61 arthroplasties ($p<0.01$). There was no significant correlation between year and numbers of each procedure performed ($r=0.13$, $p=0.72$) and ($r=0.54$, $p=0.09$), respectively. Patients treated with arthroplasty were 71.57 years old on average, while those treated with ORIF were 62.02 years ($p<0.01$). Men were relatively more likely than women to be treated with ORIF (70.95 vs. 56.13%), while women were more likely to receive arthroplasty (43.87 vs. 29.05%, $p<0.01$). Mortality was not significantly different between the two treatment groups ($p=0.56$). DVT and PE were rare in both treatment groups, and the rate was not significantly different between groups for either ($p = 0.83$) and ($p=0.32$). Patients receiving arthroplasty (19.67%) were significantly more likely to receive blood transfusions during their hospitalization than ORIF patients (10.83%, $p<0.01$). Arthroplasty and ORIF patients did not have significantly different length of hospital stays ($p=0.27$). Arthroplasty patients were discharged to home (55.9%) significantly less often than ORIF patients (64.51%, $p<0.01$). Arthroplasty patients (25.08%) were also more often discharged to long-term care institutions than ORIF patients (19.66%, $p=0.01$).

DISCUSSION/CONCLUSIONS: ORIF was the more commonly performed procedure from 2001 to 2010. Certain groups such as women and older patients were relatively more likely to be treated with arthroplasty. Perioperative complications such as mortality and thrombosis were similar in both groups; however, arthroplasties were more likely to require blood transfusions and non-home discharges.

Glenoid Version and Size: Does Gender, Ethnicity, or Body Size Play a Role?

Abstract ID: Paper 234

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*Domenic P. Esposito, M.D.
Vincent M. Moretti, M.D.
Joseph Karam, M.D.
Brian E. Schwartz, M.D.
Matthew Robinson, M.D.
David Mossad, B.S.
Stephen N. Schwartz, M.D.
Benjamin Goldberg, M.D.
Chicago, IL

INTRODUCTION: Proper component positioning in total shoulder arthroplasty, including glenoid version and size, is critical to avoid complications such as instability and impingement. The aim of this study was to evaluate whether glenoid version or size varies based on patient demographics, specifically gender, ethnicity, and body size.

PATIENTS AND METHODS: Computed tomography (CT) studies that included the shoulder were retrospectively reviewed over a six-year period for which IRB approval was obtained. The glenoid version, anteroposterior (AP) diameter, and glenoid height were measured. Statistical analysis was performed using Pearson's correlation coefficient (r), Student's t-test, and ANOVA with an alpha level of 0.05 for significance determination.

RESULTS: 108 patients (53 males, 55 females) were identified who had CT scans that included the shoulder. Mean patient age was 50.8 years (range 18-92 years). Mean patient height and weight were 168 cm (range 132-193 cm) and 80.4 kg (range 43.5-146.5 kg), respectively. 38 patients were Caucasian, 36 African-American, 13 Hispanic, 5 Asian, and 16 "other."

The mean glenoid version was -0.7° (range -40.6-23.1°). The mean glenoid AP diameter was 24.7 mm (range 15.6-34.1 mm). The mean glenoid height was 31.7 mm (range 23.4-44.9 mm). Females had an average version of 1.54° compared to males at -2.96° ($p=0.03$). Females had an average AP diameter of 22.9 mm compared to males at 26.5 mm ($p<0.001$). Females had an average glenoid height of 29.6 mm compared to males at 33.8 mm ($p<0.001$). Patients shorter than 168 cm were found to have a significantly smaller AP diameter (23.5 vs. 26.1 mm, $p<0.001$) and glenoid height (29.9 vs. 33.0 mm, $p<0.001$) than patients taller than 168 cm. Patients lighter than 80 kg were found to have a significantly smaller AP diameter (23.2 vs. 26.3 mm, $p<0.001$) and glenoid height (30.7 vs. 32.3 mm, $p=0.03$) than patients heavier than 80 kg. No strong correlations were found between the variables.

CONCLUSION: This study demonstrates that the average glenoid version is approximately -0.7°. Females had on average a smaller anteverted glenoid while males had a larger retroverted glenoid. Glenoid version, AP diameter, and height did not significantly vary based on ethnicity. Glenoid AP diameter and height tended to be smaller in shorter and lighter patients. This study demonstrates that consideration should be given to not only body size, but also gender when attempting to recreate native anatomy with a total shoulder arthroplasty.

Influence of Body Mass Index on Outcomes in Reverse Total Shoulder Arthroplasty

Abstract ID: Paper 235

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*Shannon R. Carpenter, M.D.
Brett P. Wiater, M.D.
Denise Koueiter, M.S.
David Marcantonio, M.D.
J. Michael Wiater, M.D.
Royal Oak, MI

PURPOSE: The purpose of this study was to compare outcomes of RTSA in normal weight, overweight, and obese patients for which there is a paucity of literature.

METHODS: A prospective, IRB-approved RTSA outcomes registry with 488 patients that underwent RTSA from 2006-2011 by a single surgeon was reviewed. Inclusion criteria were diagnosis of cuff tear arthropathy, osteoarthritis, or massive rotator cuff tear refractory to all other treatments, and minimum 2-year follow-up. Exclusion criteria were proximal humerus fractures, rheumatoid arthritis, revision arthroplasty, and incomplete follow-up. Patients were placed into one of three cohorts: normal weight (BMI < 25), overweight (BMI 25-30), and obese (BMI > 30). Outcome measures included Constant-Murley score, American Shoulder and Elbow Surgeons score, Subjective Shoulder Value, visual analogue pain scale, active forward elevation (aFE), active external rotation, and active internal rotation. Charts and radiographs were reviewed for evidence of complication.

RESULTS: The normal weight (n=29), overweight (n=50), and obese (n=51) cohorts demonstrated comparable gender and follow-up ($P > 0.05$). The overweight and obese cohorts had a significantly lower age at time of surgery than the normal weight cohort ($P < 0.001$). All cohorts demonstrated significant improvements from preoperative to most recent follow-up in CMS, ASES score, SSV, VAS, and aFE ($P < 0.05$). There was no significant difference in preoperative or postoperative CMS, ASES score, SSV, VAS, or aFE between cohorts ($P > 0.05$) and no significant difference in the degree of improvement from preoperative to most recent follow-up of any of these values ($P > 0.05$). The obese and overweight cohorts had a significantly lower preoperative aER ($P < 0.01$), and preoperative aIR ($P < 0.05$) than the normal weight cohort. However, there was no significant difference in the postoperative values or the degree of improvement from preoperative to most recent follow-up in aER or aIR between any cohorts ($P > 0.05$). There was no significant difference in the incidence of radiographic ($P = 0.3085$) or clinical ($P = 0.5247$) complications between cohorts.

CONCLUSION: Pain and function were significantly improved in all cohorts. All cohorts achieved similar improvements in all outcome measures without any significant difference in incidence of complications. The results of this study suggest that BMI has little influence on outcomes or risk of complication following RTSA. However, longer-term studies are needed to determine if these results are maintained over time.

Results of Closed Management of Acute Dislocation Following Reverse Shoulder Arthroplasty

Abstract ID: Paper 236

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*Matthew J. Teusink, M.D. / Omaha, NE
Ioannis P. Pappou, M.D. / Tampa, FL
Daniel G. Schwartz, M.D. / Seattle, WA
Benjamin J. Cottrell, B.S. / Tampa, FL
Mark A. Frankle, M.D. / Tampa, FL

BACKGROUND: While reverse shoulder arthroplasty has shown successful outcomes for a variety of shoulder pathologies, postoperative instability continues to be one of the most common complications limiting outcomes. In the literature, reports of instability range from 2.4%-31%. Many authors recommend an initial attempt at closed reduction followed by a period of immobilization for management of the initial dislocation episode while others may seek to rule out infection or other secondary causes; however, there is little data to support either practice. The purpose of this study was to evaluate the outcomes of patients with postoperative dislocation following reverse shoulder arthroplasty managed with closed reduction.

METHODS: A retrospective review of all reverse shoulder arthroplasties performed by a single surgeon from 5/2002-2/2010 was performed to identify all patients treated for postoperative dislocation treated with closed reduction. A total of 21 patients were identified. Preoperative patient characteristics, implant selection, and time to initial dislocation episode were recorded. Final outcomes including recurrent instability need for revision surgery, ASES outcome score, and range of motion were evaluated.

RESULTS: There were 9 male and 12 female patients. The average time to first dislocation was 200 days (range: 2-961 days), with 62% (13/21) occurring in the first 90 days. At average follow-up of 28 months following the dislocation episode, 62% of these shoulders remained stable (13/21). Six shoulders (29%) required revision surgery for recurrent instability. All of these patients remained stable at final follow-up (average 25.5 months). In those cases successfully treated with closed reduction, the average time to dislocation was 188 days, whereas the average time to initial dislocation in cases requiring revision surgery was 224 days (p=0.82). All of these patients remained stable at final follow-up. Two shoulders (9%) remained unstable and either declined or were medically unfit to undergo revision surgery. The average ASES score in patients treated with closed reduction for instability was 68.0, and 62.7 for those treated with revision surgery (p=0.64).

CONCLUSION: This study shows that an initial dislocation episode following reverse shoulder arthroplasty can be successfully managed with closed reduction and temporary immobilization in over half of cases. The time to dislocation is not related to the likelihood of a successful closed reduction. Given that outcomes following revision surgery are not different from closed treatment, we would continue to recommend an initial attempt at closed reduction in all cases of postoperative reverse shoulder arthroplasty dislocation.

Allograft-Prosthetic Composite Reconstruction for Proximal Humerus Bone Loss in Reverse Shoulder Arthroplasty

Abstract ID: Paper 237

Matthew T. Houdek, M.D. / Rochester, MN
Eric R. Wagner, M.D. / Rochester, MN
Joel M. Post, D.O. / Grand Rapids, MI
*Brian T. Samuelsen, M.D. / Rochester, MN
Robert H. Cofield, M.D. / Rochester, MN
Bassem T. Elhassan, M.D. / Rochester, MN
John W. Sperling, M.D. / Rochester, MN
Joaquin Sanchez-Sotelo, M.D. / Rochester, MN

BACKGROUND: Reverse total shoulder arthroplasty performed in the setting of massive proximal humerus bone loss oftentimes requires special reconstructive techniques. Restoration of the proximal humerus with an allograft provides support for implant fixation, tensions the deltoid, and provides the opportunity for repair of the posterior cuff for strength in external rotation and the subscapularis for stability. The purpose of this study was to determine the outcome of APC reconstruction in primary and revision reverse shoulder arthroplasty.

METHODS: Between 2005 and 2012, 838 primary and 230 revision reverse arthroplasties were performed at our institution. An APC reconstruction was performed in 11 primary (1%) and 15 revision (7%) arthroplasties. The mean age of these 26 patients was 63 years, and their mean BMI was 29.7. The indications for primary APCs included severe bone loss after trauma (n=6) and reconstruction after tumor resection (n=5). Failed implants revised included hemiarthroplasty (n=10), reverse (n=3), and anatomic total shoulders (n=2). The most common reason for revision was instability (n=10). The average clinical follow-up was 2.3 years.

RESULTS: Reverse APCs resulted in substantial improvements in pain (p=0.001), elevation (p=0.0001), and external rotation (p=0.004). All patients were subjectively satisfied with the procedure. There were no differences in clinical outcomes between primary and revision cases. No patients required a revision surgery for a nonunion, with the mean time to union of the host/allograft junction of 10.5 months. Patients undergoing an APC for revision reverse total shoulder had a significantly increased time to union compared to those undergoing a primary surgery (14.3 months vs. 6.1 months, p=0.001). The 2- and 5-year revision free survival rate was 96 ± 3%, respectively. Radiographic evidence of allograft resorption was observed in 4/11 (36%) of primary and 6/14 (43%) of revision APCs, with little influence on outcome. There was an increased risk of graft resorption in patients where dual compression/locking plates were not used (OR 15.6, p=0.008).

CONCLUSIONS: Reconstruction of missing proximal humerus with an allograft at the time of primary or revision reverse arthroplasty is safe and effective, with a relatively low complication rate. Union at the host-graft junction seems to occur reliably.

Reverse Total Shoulder Arthroplasty for Fracture: A Standard of Care Survey

Abstract ID: Paper 238

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*David D. Savin, M.D. / Chicago, IL
Ina Zamfirova, B.S. / Park Ridge, IL
Joseph P. Iannotti, M.D. / Cleveland, OH
Ari R. Youderian, M.D. / Morton Grove, IL

INTRODUCTION: Proximal humerus fractures (PHF) are among the most common fractures in the elderly population. The role of reverse total shoulder arthroplasty (RTSA) for Neer 3 and 4 part proximal humerus fractures is evolving; however, there does not appear to be a clear consensus amongst surgeons. We present the results of a distributed survey to assess surgeon preference for management of these fractures.

METHODS: Members of American Shoulder and Elbow Surgeons and Orthopaedic Trauma Association were surveyed on their training and experience regarding management of 3 or 4 part proximal humerus fractures. The survey also consisted of six representative cases to assess surgeon management preference. Analysis of both surgeon and patient specific factors were evaluated to determine significance.

RESULTS: In total, 166 surgeons responded to the survey with fellowship training in shoulder and elbow surgery (71.4%), orthopedic trauma (10.3%), and sports medicine (17.7%). 41% have been in practice for greater than 21 years and 57% worked in an academic center. There was no difference between respondents in regards to years in practice and comfort level with RTSA. Surgeons preferred RTSA for management of 3-4 part fractures in patients over age 65, however, trended to also favor hemiarthroplasty with higher co-morbidities. Physicians with more than 11 years of experience were more likely to choose hemiarthroplasty for older and high comorbidity patients ($p = 0.006$). RTSA was not the preferred treatment method for younger, active patients. Patient age and fracture pattern had a high impact on the surgeon's decision. 41% have been in practice for greater than 21 years and 57% worked in an academic center. There was no difference between respondents in regards to years in practice and comfort level with RTSA. Physicians working in an academic setting were more likely to be comfortable performing a RTSA ($P = 0.029$). Surgeons with less than 10 years in practice were more likely to agree that RTSA is superior to hemiarthroplasty for management of PHF ($P = 0.028$). There was significant correlation regarding surgeon's experience with RTSA and their preference of RTSA over hemiarthroplasty for PHF.

DISCUSSION: There appears to be an increasing consensus amongst orthopedic surgeons that RTSA is the preferred treatment for Neer 3 and 4 part proximal humerus fractures for elderly patients with patient age and fracture pattern being the most important factor in making management decisions. Surgeon experience and comfort level plays a large role in choice of treatment.

MAOA BREAKOUT SESSION #15
PEDIATRICS/TUMOR/RESIDENT EDUCATION
April 25, 2015

Long-Term Results of Tibialis Anterior Tendon Transfer in Relapsing Idiopathic Clubfoot Treated with the Ponseti Method: A 50-Year Follow-Up

Abstract ID: Paper 239

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*Joshua B. Holt, M.D.
David E. Oji, M.D.
John Yack, Ph.D.
Jose A. Morcuende, M.D., Ph.D.
Iowa City, IA

BACKGROUND: Relapse of deformity, a concern in the treatment of idiopathic clubfoot, can be effectively treated with repeat casting and tibialis anterior tendon transfer (TATT) during early childhood. Although short-term results show persistent correction, the long-term effects on adult foot function after TATT for relapsed deformity in idiopathic clubfoot during childhood have not been reported.

METHODS: Thirty-five patients (60 clubfeet) in whom idiopathic clubfoot was treated by the Ponseti method between 1950 and 1967 were followed. At an average age of 47 years, patients underwent a detailed musculoskeletal examination, radiographic evaluation, pedobarographic analysis, surface electromyography testing, and completed three quality-of-life patient questionnaires (AAOS Foot and Ankle Baseline Questionnaire, Laaveg–Ponseti Clubfoot Scale, and Foot Function Index).

RESULTS: Fourteen patients (25 clubfeet, 42%) had required repeat casting and TATT in childhood for relapsed clubfoot deformity after initial casting and served as the study group. Twenty-one patients (35 clubfeet, 58%) were successfully treated with initial casting without relapse (control group). No patients in either group had subsequent relapse or required additional operative intervention associated with clubfoot deformity. Mean ankle dorsiflexion was similar between groups. Radiographically, the TATT group showed a smaller mean AP talocalcaneal angle and slightly more talar flattening than the control group with no associated clinical differences. Peak pressures, total force distribution, and surface electromyography (EMG) results were not statistically different between the groups. Outcome questionnaires demonstrated no statistical difference between patients in each group.

CONCLUSION: Tibialis anterior tendon transfer is very effective at preventing further relapse of deformity without affecting long-term foot function in idiopathic clubfoot.

Guided Growth for Correction of Angular Deformity in Fibular Deficiency

Abstract ID: Paper 240

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*Joshua S. Griffin, M.D.
Kevin M. Smith, M.D.
Allison C. Scott, M.D.
Houston, TX

BACKGROUND: Fibular deficiency is the most common congenital long bone deficiency with an incidence of 7.4 to 20 per 1 million births. Genu valgum is a common deformity in this population with potential surgical treatment option of hemiepiphysiodesis. Limited literature exists in regards to results of hemiepiphysiodesis in the fibular deficiency population. The primary aim of this study was to evaluate our experience of guided growth for correction of genu valgum in fibular deficiency.

METHODS: A retrospective study was performed with review of medical records and radiographs of 31 fibular deficiency patients treated with hemiepiphysiodesis to correct genu valgum. Preoperative and final tibiofemoral angle, timing and method of hemiepiphysiodesis, and recurrence/overcorrection requiring intervention were recorded.
<0.003).

CONCLUSIONS: Hemiepiphysiodesis is an effective method for treatment of genu valgum in fibular deficiency. We recommend consideration of waiting until 11 years old to perform hemiepiphysiodesis due to high risk of recurrent deformity.

Closed Treatment of Shoulder Subluxation in Children with Birth Brachial Plexus Injuries♦

Abstract ID: Paper 241

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*Jennifer K. Wozniczka, M.D.
Ann E. Van Heest, M.D.
Minneapolis, MN

BACKGROUND: Birth brachial plexus injuries are associated with progressive glenohumeral deformity, glenoid retroversion and posterior humeral head subluxation, and eventual dislocation due to the muscle imbalance. Open shoulder reductions and tendon transfers have traditionally been used to prevent worsening glenohumeral dysplasia[1,2].

HYPOTHESIS: Early identification and closed treatment of patients with birth brachial plexus injuries and shoulder subluxation can prevent worsening deformity and open reduction.

METHODS: Retrospective review of 17 patients with birth brachial plexus injuries who underwent closed shoulder reductions with or without botulinum toxin injections at a mean age of 7.2 months (range 4-11 months). Patients with shoulder subluxation were identified clinically. After closed reduction, patients were casted with a shoulder spica in external rotation (ER). Ultrasound measurements of humeral head coverage pre- and postoperatively were used along with clinical findings to assess postoperative outcomes. Statistical analysis was performed by a statistician using two sample t-tests and rank sum tests.

RESULTS: 53% of patients (n=9) did not require further open shoulder reduction. 18% of patients (n=3) had repeat botulinum toxin injections. 12% (n=2) had repeat closed reductions. 12% (n=2) had nerve transfers after primary procedure. 18% (n=3) had no additional procedures. 47% (n=8) went on to have an open shoulder reduction with tendon transfer at an average of 8 months (range 2-22 months) after primary procedure. Passive ER increased from a mean of 17° preoperatively to 57° postoperatively ($p < 0.001$). Humeral head coverage increased from 22% preoperatively to 63% postoperatively ($p < 0.001$).

There was a trend showing that decreased preoperative humeral head coverage ($p = 0.11$), decreased intraoperative humeral head coverage ($p = 0.13$), decreased preoperative ER ($p = 0.09$), and postoperative ER ($p = 0.08$) were associated with more open shoulder procedures. Age, birth weight, botulinum toxin amount, or active movement score did not correlate with the need for additional procedures.

CONCLUSIONS: Early closed reductions of shoulder subluxation in patients with birth brachial plexus injuries improves passive ER, increases humeral head coverage, and can prevent the need for later open reduction, with 53% of patients not requiring further open shoulder reduction.

[1]Van Heest et al, Glenohumeral Dysplasia Changes After Tendon Transfer Surgery in Children with Birth Brachial Plexus Injuries. J Pediatr Orthop 2010; 20: 371-378.
[2]Waters et al, Effect of Tendon Transfers and Extra-Articular Soft-Tissue Balancing on Glenohumeral Development in Brachial Plexus Birth Palsy. JBJS 2005; 87: 320-325. ♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (botulinum toxin).

Click here to view Figure

Pediatric Pelvic Ring Injuries: How Benign Are They?

Abstract ID: Paper 242

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*Christiane G. Kruppa, M.D. / Bochum, Germany
Justin D. Khoriaty, B.S. / Grand Rapids, MI
Debra L. Sietsema, Ph.D., R.N. / Grand Rapids, MI
Marcel Dudda, M.D. / Grand Rapids, MI
Clifford B. Jones, M.D. / Grand Rapids, MI

PURPOSE: Historically, conservative treatment was mainly performed, but has changed to more operative treatment of unstable fractures. The purpose of this study was to determine clinical and radiographic outcome following pediatric pelvic ring injuries.

METHODS: Between 2002 and 2011, 33 pediatric pelvic ring fractures were retrospectively analyzed. Fractures were classified according to AO/OTA classification as 2 A2, 3 B1, 16 B2, 10 B3, and 2 C2 fractures. Mechanism of injury, associated injuries, transfusion requirement, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and length of hospital stay were recorded. Treatment of the pelvis injury, infection, and nonunion rates were determined. Deformity, low back/SI joint pain, LLD, and hip range of motion were evaluated on final follow-up.

RESULTS: Age averaged 12.6 years (4-16). 91% (30) injuries were caused by traffic accidents. GCS averaged 13.6 (3-15) and ISS averaged 26 (4-66). Length of hospital stay averaged 6 days (1-39). 10 (30%) children required blood transfusion. 30 (91%) children had associated injuries, of whom 11 (33%) required surgery. Two (6%) required interventional embolization for intra-pelvic bleeding. Clinically, unstable fractures were treated operatively in 16 children and conservatively in clinically stable fractures in 17 children. Follow-up averaged 25.6 months (6-84). One superficial wound infection and, in one case, repeat debridement for Morel Lavalle lesion was documented. No nonunion was recorded. 20 (74%) children had a sacral or ischial height difference of 5-10 mm on follow-up (Outlet). 18 (67%) children had a sacral or iliac height difference of 5-10 mm (Inlet). 67% complex, unstable fractures had a permanent ischial height difference >5 mm vs. 42% less complex, stable fractures. Unstable, operative treated fractures had a higher permanent pelvic asymmetry (12.3 mm vs. 6.6 mm) (p=0.15) and ring width difference (6.9 mm vs. 3.9 mm) as compared to stable, non-operative treated fractures. All children returned to full, unrestricted activity. 13 children (39%) had low back or SI joint pain on their final follow-up, which was significantly higher in the operatively-treated group (p=0.008), and in children with 5-10 mm sacral height difference (Inlet) compared to children with 0-4 mm (p=0.034). 3 (9%) children had a LLD of 5-15 mm. One child had persistent neurological symptoms. One (3%) demonstrated rotational limitation on final follow-up.

CONCLUSIONS: The majority of pediatric pelvic ring fractures are caused by traffic accidents, with associated major injuries. Radiographic deformity persisted without remodeling. Deformity occurs more commonly with complex unstable ring injuries, which may plastically deform the ring, are mostly operatively treated, and have continued associated low back or SI joint pain, but no limitations.

How Bad Are Pediatric and Adolescent Sacral Fractures?

Abstract ID: Paper 243

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*Christiane G. Kruppa, M.D. / Bochum, Germany
Debra L. Sietsema, Ph.D., R.N. / Grand Rapids, MI
Justin D. Khoriaty, B.S. / Grand Rapids, MI
Marcel Dudda, M.D. / Grand Rapids, MI
Clifford B. Jones, M.D. / Grand Rapids, MI

PURPOSE: The purpose of this study was to analyze pediatric sacral fractures concerning injury and fracture pattern, treatment, and outcome.

METHODS: Between 2002 and 2011, 52 children (<16 years) presented with a sacral fracture with (51) or without (1) other associated pelvic ring injuries. Records were retrospectively reviewed at a Level I teaching trauma center. Sacral fracture patterns were analyzed and classified by Denis and pelvic ring injury patterns were classified by OTA/AO classification.

RESULTS: There were 22 (42.3%) boys and 30 (57.7%) girls with 25 (48.1%) right, 15 (28.8%) left, and 12 (23.1%) bilateral sacral fractures. Age averaged 12.2 years (range 3.0-16.0). 39 (75.0%) fractures involved zone 1 and were crush injuries to the anterior sacral ala, 11 (21.2%) were zone 2, and 2 (3.8%) were zone 3. Both zone 3 fractures were transverse sacral fractures, one below S3 and one lambda-shaped above. 20 (38.5%) children were skeletally immature, 32 (61.5%) mature. The most frequent mechanism of injury in 42 (80.8%) children was a traffic accident including car occupant (28) or pedestrian vs. car (14). Operative stabilization was performed in nine (17.3%) children with sacroiliac screw fixation. 4 (7.7%) children had neurologic symptoms. One child with a lambda-shaped transverse sacral fracture had decreased sensation of the proximal thigh, another child with a Zone 2 sacral fracture had a sciatic nerve paresthesia, another one with a Zone 2 sacral fracture had a lumbar plexus injury demonstrated with pelvic floor dyssynergia and partial fecal incontinence, and one child with a Zone 1 sacral fracture had a lumbar 5 nerve root paresthesia. All four children had a pelvic ring injury OTA B3 or B2 without injury of extremities. All fractures healed and had an average time to weight bearing as tolerated at 1.8 months (range 0.1-3.6). One child died because of associated injuries. 11 (45.8%) children had low back or SI joint pain in final follow-up. 7 (29.2%) had a superior sacral displacement of 5-10 mm in their final radiographic outlet view, 9 (37.5%) had a posterior sacral displacement of 5-10 mm in their final inlet view. 4 of the 7 malunited fractures had pain while 3 did not have pain. All children returned to normal activities without gait or limp problems. All paresthesias resolved, but the one child with lumbar plexus injury had persistent neurologic symptoms with incontinence.

CONCLUSIONS: Most pediatric sacral fractures occur in the sacral alar region. More complex and unstable sacral fractures with neurologic symptoms occur and potentially benefit from stabilization. Persistent pelvic pain and deformity in this pediatric sample are present, do not remodel, and do not correlate.

Fracture Displacement and Neurological Injury in Supracondylar Humerus Fracture in Children

Abstract ID: Paper 244

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*Evan Sheppard, M.D.
Brian E. Etier, Jr., M.D.
Joseph G. Khoury, M.D.
Shawn R. Gilbert, M.D.
Birmingham, AL

PURPOSE: The purpose of this study was to evaluate the rate of nerve injury with supracondylar humerus fracture and relate to direction of fracture displacement.

METHODS: The database of surgical procedures for five pediatric orthopedic surgeons at a single institution was queried for operative treatment of supracondylar humerus fractures from 2009-2012. Four hundred patients were identified who underwent open or closed reduction and pinning. Records were reviewed for patient age, gender, weight, mechanism of injury, time to reduction, nerve injury, and time to resolution. Radiographs were used to classify fracture type and direction of displacement.

RESULTS: Of the 400 patients, 216 (54%) were male. Average age was 5.8 years. Forty-three patients (11%) had preoperative nerve injury, (mean age 5.7 years, 56% male, mean weight-for-age percentile 75.8). The anterior interosseous nerve was most commonly injured (28 patients, 7%). Twenty-one of these patients had posterolateral fracture displacement, six had posterior fracture displacement, and one patient had posteromedial fracture displacement. Twelve patients (3%) had posterior interosseous nerve palsies; all had posteromedial fracture displacement. Two patients (0.5%) had radial nerve palsies, both with posteromedial fracture displacement. One ulnar nerve palsy (0.25%) was identified in a patient with anterior medial fracture displacement. Thirty-seven patients with nerve injury (86%) had clinical neurologic improvement at last clinical follow-up. The average time to improvement was 42 days (median 32 days, range 6-88 days). Six patients (14%) had no clinical improvement before being lost to follow-up at an average of 34 days. Twenty-nine patients (67%) had complete neurologic recovery at an average of 88 days (median 81 days, range 6-284 days). Fourteen patients (32%) did not have full recovery at last clinic evaluation at an average of 47 days following surgery. Only one patient without documented resolution of nerve injury had follow-up over 90 days.

CONCLUSION: Anterior interosseous nerve palsy is the most common nerve injury with supracondylar fractures and usually occurs with posterolateral fracture displacement. Posterior interosseous and radial nerve palsy occurred exclusively with posteromedial fracture displacement. Ulnar nerve palsy occurred with anterior medial fracture displacement. Most patients with nerve injury had improvement or resolution by three months.

SIGNIFICANCE: This is the largest series of supracondylar fractures studied to document nerve injuries and correlate with direction of nerve displacement. The overall rate of nerve injuries is consistent with meta-analyses. Information on time to nerve recovery may aid in counseling patients.

Do Deficits Exist Following Nonoperative vs. Operative Treatment of Shortened Midshaft Clavicular Fractures in Adolescents?

Abstract ID: Paper 245

Joshua A. Parry, M.D.
Meegan G. Van Straaten, P.T.
A. Noelle Larson, M.D.
T. David Luo, M.D.
Anne-Laure Simon, M.D.
Kenton R. Kaufman, Ph.D.
*William J. Shaughnessy, M.D.
Rochester, MN

INTRODUCTION: Recent clinical studies in adults have reported a higher incidence of symptomatic malunions in conservatively treated shortened midshaft clavicular fractures. We sought to determine whether functional deficits are found in adolescents following operative vs. nonoperative treatment of clavicle fractures.

METHODS: Patients with displaced and shortened midshaft clavicle fractures between the age of 10 and 16 years at the time of injury were identified and recruited. Consenting subjects completed a QuickDASH Score, Constant Shoulder Score (CSS), and questions regarding their satisfaction with treatment. Quantitative isometric strength testing, range of motion, and abduction endurance was performed on the involved and uninvolved side for bilateral comparison.

RESULTS: Twelve patients met inclusion criteria and consented to testing. Five received non-operative treatment and seven underwent open reduction and internal plate fixation. Average time from injury was 25 ± 10 months. Average fracture shortening was 26 ± 5 mm. The treatment groups did not differ in terms of time from injury ($p < 0.5$) or fracture shortening ($p < 0.8$). The operative group tended to be older (15 vs. 13 years old) ($p = 0.07$), with more comminuted injuries (71% vs. 40%). QuickDASH and CSS were zero in all but one patient who was actively complaining of symptomatic hardware. Two patients treated with plate fixation required hardware removal. There were no symptomatic malunions in the nonoperative group. All subjects reported being satisfied with their received treatment. Four patients, two in each treatment group, were unsatisfied with the appearance of the clavicle. All patients had full symmetric range of motion. The involved side's isometric strength and abduction endurance strength, expressed as a percent of the uninvolved side, did not differ from the uninvolved side in either treatment group or between treatment groups.

CONCLUSIONS: No differences in subjective or objective outcome scores were observed in this sample of adolescents with shortened midshaft clavicular fractures treated either operatively or nonoperatively.

Preoperative Fears in Pediatric Orthopedic Surgery Patients

Abstract ID: Paper 246

Lauren Rife, B.S. / Akron, OH
*Kenneth T. Bono, M.D. / Akron, OH
Amy Krahe, M.S. / Akron, OH
Melanie A. Morscher, B.S. / Akron, OH
Michelle Peterson / Akron, OH
M. David Gothard, M.S. / East Canton, OH

INTRODUCTION: Preoperative anxiety in children has been linked to adverse outcomes such as increased pain and behavioral changes. By understanding preoperative fears, the orthopedic surgeon may be able to minimize this anxiety and improve outcomes. The aim of this study is to identify and analyze preoperative fears in pediatric orthopedic surgery patients.

METHODS: This prospective study was approved by the Institutional Review Board at a single pediatric institution. Any orthopedic surgery patient less than 18 years of age, who saw a certified child life specialist (CCLS) prior to surgery could participate. In six months, 258 patients (122 females, 136 males) enrolled in the study. No changes were made to the CCLS intervention; however, the CCLS did document the child's primary and all secondary fears and whether CCLS intervention reduced these fears. Pearson chi-square and Fisher's exact tests were used to identify significant factors ($p < 0.05$) that could affect childhood fear including age, gender, previous surgical experience, and type of surgery. Additional statistical analyses included a univariate odds ratio and logistic regression model.

RESULTS: Of the 258 patients enrolled in the study, 70% expressed some fear prior to surgery. The most commonly expressed fears included fear of needles (33%), pain (17%), and general anxiety (18%). Significant factors that led to increased childhood fears were age greater than or equal to 6 years and a negative prior surgical experience. Children less than 6 years had more separation anxiety and unspecified fears, while older children had more fears associated with physical harm and loss of control. Females greater than or equal to 6 years with no previous surgery or a negative prior surgical experience were 9.57 times more likely to have fears. CCLS intervention reduced the child's anxiety in 69% of the cases.

CONCLUSION: This is the first study to report on fears expressed by children prior to orthopedic surgery. Since 70% of children expressed some type of preoperative fear, further studies on interventions that can reduce these fears are warranted. In the meantime, orthopedic surgeons should be aware that children expressed different fears based on age, a child with a negative prior surgical experience has increased fears, and females greater than or equal to 6 years of age with no previous surgery or a negative prior surgical experience are 9.57 times more likely to have preoperative fears.

Arthroscopic Treatment of Traumatic Hip Dislocations in Children and Adolescents

Abstract ID: Paper 247

Andrew C. Morris, M.D.
Johnathan Yu, M.D.
*Shawn R. Gilbert, M.D.
Birmingham, AL

INTRODUCTION: Traumatic hip dislocations in children and adolescents require prompt concentric reduction. Intra-articular osteochondral fragments and or failure to obtain concentric reduction by closed means can lead to long-term complications if not properly addressed. Traditionally, open treatment has been performed. We report on the use of arthroscopy to remove loose bodies and reduce enfolded soft tissues to obtain concentric reduction in the pediatric and adolescent population. We specifically examined underlying pathology and treatment with arthroscopic intervention.

METHODS: After obtaining IRB approval, we identified patients by searching our surgical database. We performed a retrospective review of clinical data to identify patients under the age of 19 who were treated with hip arthroscopy following hip dislocation reduction at a single children's hospital from 2006-2013. Clinic notes, operative reports, radiographic images, and arthroscopic photos were reviewed.

RESULTS: Seven patients were identified from ages 8-17 years old that underwent hip arthroscopy after a hip dislocation. All acute dislocation patients had undergone previous closed reduction emergently and had a follow-up CT scan. One patient presented late after a subluxation or transient dislocation from football. All other patients required a hip reduction after their dislocation. Intra-articular fragments were found in 6 of 7 patients, and 5 of 7 patients had an incongruent hip joint identified by imaging prior to surgery. A predominant pattern of avulsion of a small bony fragment attached to the capsular labral soft tissue complex which became enfolded and blocked concentric reduction was identified in 5 of 7 patients. In all cases, the enfolded soft tissue was reduced without suture or bone repair. Remaining loose osteochondral fragments were removed and in two cases an avulsed ligamentum teres was debrided. Average follow-up was 10 months. No AVN or recurrent instability was identified in any case.

CONCLUSION: When incongruent hip joints were arthroscopically evaluated after traumatic dislocation with arthroscopy, a consistent pattern was found of interposed labral capsular complexes attached to bony fragments within the hip joint. Contrary to one prior report of open reduction and repair through a surgical dislocation approach, simple reduction of the capsulolabral complex without repair provided satisfactory short-term outcomes. Arthroscopic treatment of such cases should lead to considerably less surgical morbidity.

Orthopedic Complications of Linear Morphea

Abstract ID: Paper 248

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*Jennifer J. Schoch, M.D. / Rochester, MN
Bradley S. Schoch, M.D. / Rochester, MN
Jean David Werthel, M.D. / Rochester, MN
Dawn M. R. Davis, M.D. / Rochester, MN
Amy L. McIntosh, M.D. / Dallas, TX

BACKGROUND: Linear morphea is a variant of localized scleroderma which predominately affects the skin. It most commonly affects children and, in contrast to other forms of localized scleroderma, extracutaneous manifestations are common. Though the orthopedic surgeon is often paramount in the care of these patients, there remain limited reports outlining the impact of orthopedic complications in this population. The purpose of this study is to better understand the orthopedic complications and surgical treatment options in linear morphea of the limb.

METHODS: Between January 1999 and May 2014, 51 children presented to our institution for evaluation of linear morphea (linear scleroderma) of an extremity. All charts were reviewed to confirm the diagnosis and to document orthopedic complications and presentation. Outcome measures included limb length discrepancies, angular malalignment, limb atrophy, and orthopedic surgical intervention.

RESULTS: Of the 51 children diagnosed with linear morphea, 26 had documented orthopedic manifestations of their disease (51%). Patients were initially diagnosed at an average age of 9 years (range 2-17 years). Females were more commonly affected (18 vs. 8). Joint contractures were the most common manifestation, affecting 23 of 26 patients (88%), followed by limb atrophy (31%). Eleven patients with contractures had multiple joints affected, with four ultimately requiring surgical intervention in an effort to improve function. Angular deformities were present in 9 patients (5 required surgical intervention). Limb length discrepancies were present in 8 patients, requiring surgical intervention in 2. Other manifestations included scoliosis (1). A total of 8 patients (16%) ultimately required surgical intervention. The vast majority of patients had received systemic treatment, including methotrexate (59%), hydroxychloroquine (22%), and corticosteroids (20%).

CONCLUSION: Approximately half of patients with linear morphea of an extremity experience orthopedic complications of their disease, despite increasing use of systemic immunosuppressive therapy. Though only a minority require surgical intervention, surgery can be complicated by poor quality soft tissue and may require free soft tissue transfers. Early involvement of the orthopedist is crucial to improve limb alignment and preserve function.

Cause-Specific Survival and Prognostic Factors for Survival in High-Grade Osteosarcoma Using the Surveillance, Epidemiology, and End Results (SEER) Program Database

Abstract ID: Paper 249

Kyle R. Duchman, M.D.
Yubo Gao, Ph.D.
*Benjamin J. Miller, M.D.
Iowa City, IA

INTRODUCTION: Osteosarcoma is the most common primary bone sarcoma. Predicting survival after diagnosis of osteosarcoma is important for clinicians as well for the patient and family. The current study aims to identify both modifiable and non-modifiable risk factors for cause-specific survival in patients with osteosarcoma of bone.

METHODS: The Surveillance, Epidemiology, and End Results (SEER) Program database was used to identify all patients diagnosed with high-grade osteosarcoma from 1991 to 2010. Patient and tumor characteristics including age, sex, race, tumor location, tumor size, presence of metastatic disease, tumor histology, and county-level socioeconomic measures were analyzed to determine differences in cause-specific survival at 2, 5, and 10 years. Univariate and multivariate survival analyses were performed to determine prognostic factors for survival.

RESULTS: A total of 2,849 patients with high-grade osteosarcoma were identified. Cause-specific survival for patients with local/regional disease at diagnosis was 83.8%, 70.3%, and 64.1% at 2, 5, and 10 years, respectively, while survival for patients with metastatic disease at diagnosis was 45.7%, 27.5%, and 22.5%, respectively. Univariate analysis revealed metastatic disease at diagnosis, axial location, increased tumor size, increased patient age, male sex, and low socioeconomic status were associated with significantly decreased cause-specific survival. Multivariate analysis revealed patients aged 25-59 years, (Hazard Ratio at 10 years [HR] = 1.549), age ≥ 60 years (HR = 3.121), axial tumor location (HR = 1.863), tumor size ≥10 cm (HR = 1.742), and metastatic disease at the time of diagnosis (HR = 3.347) as statistically significant independent risk factors for decreased cause-specific survival at 2, 5, and 10 years. Patients with the lowest socioeconomic status were found to have a significantly increased frequency of metastatic disease at presentation as compared to the most affluent patients (29.1% vs. 21.70%, p = 0.0472). When eliminating metastatic disease from the multivariate analysis, low socioeconomic status was an independent risk factor for decreased cause-specific survival at 10 years (HR = 1.519).

CONCLUSIONS: Patients with high-grade osteosarcoma have decreased cause-specific survival at 2, 5, and 10 years when metastatic at diagnosis, patient age ≥25 years, axial tumor location, and tumors measuring ≥10 cm. Metastatic disease at presentation was significantly associated with the lowest socioeconomic status.

Osteoclast Inhibition Impairs Chondrosarcoma Growth and Bone Destruction♦

Abstract ID: Paper 250

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*Jesse E. Otero, M.D. / Iowa City, IA
Jeff W. Stevens, Ph.D. / Iowa City, IA
Allison E. Malandra, Ph.D. / Iowa City, IA
Douglas C. Fredericks, M.S. / Iowa City, IA
Paul R. Odgren, Ph.D. / North Worcester, MA
Joseph A. Buckwalter, M.D. / Iowa City, IA
Jose Morcuende, M.D., Ph.D. / Iowa City, IA

BACKGROUND: Chondrosarcoma (CHS) is an aggressive primary tumor of bone that is resistant to chemotherapy and radiation. Surgery is the mainstay of treatment, and survival is poor in patients with recurrent and metastatic disease. Basic mechanisms of pathogenesis in CHS remain elusive. Recent research has implicated microenvironmental factors in the behavior of chondrosarcoma in bone. We hypothesized that osteoclasts (OCs) play a crucial role in bone resorption and growth of CHS. The Swarm rat chondrosarcoma (SRC) is a transplantable chondrogenic tumor with biological behavior that mimics CHS in bone.

OBJECTIVE: Our objective was to document the presence and characterize the activity of osteoclasts at the bone tumor interface, to determine the local effect of tumor on bone, and to study the effect of inhibition of osteoclasts on tumor behavior.

METHODS: Three groups of rats were utilized in the study. One group received PBS injections and then underwent SRC tumor implantation into the tibia. Another group of rats received IV zoledronic acid (ZA), an osteoclast inhibitor, before implantation of tumor into the right tibia. The control group received PBS injection and sham surgery consisting of corticotomy and wound closure. Animals were euthanized at day 21 postoperatively. Tibiae were analyzed by peripheral quantitative computed tomography (pqCT) and were evaluated histomorphomerically for tumor growth, osteoclast activation, and bone destruction. We also tested these parameters after tumor implantation in a group of osteopetrotic rats, compared with normal littermate controls.

RESULTS: Implantation of SRC into tibia induced a massive osteolytic response. There was an increase in osteoclast number and size compared with sham tibiae. Osteoclast surface and resorbed surface was statistically greater in the presence of tumor than in sham tibiae. Furthermore, pqCT showed a significant reduction in local bone mineral density (BMD) in SRC-implanted tibiae than sham tibiae ($p=0.008$). ZA increased BMD and inhibited bone destruction in the presence of SRC tumor. Osteoclasts appeared rounded and dysfunctional, and resorbed bone surface was reduced compared with PBS-treated tumor-bearing tibiae. There was a significant reduction in tumor volume in ZA-treated tumor bearing tibiae than those treated with PBS. Additionally, tumor growth was impaired in tibiae of osteopetrotic rats compared with littermate controls.

CONCLUSION: Data from our in vivo model suggests that osteoclasts contribute to local bone destruction induced by CHS and enhance growth of CHS in bone. Modulation of OC activity represents an attractive therapeutic strategy for local control of CHS growth.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (zoledronic acid).

Survival in Mesenchymal Chondrosarcoma: An Analysis of 205 Cases Utilizing the SEER Database

Abstract ID: Paper 251

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*Brian A. Schneiderman
Lukas M. Nystrom, M.D.
Stephanie Kliethermes, Ph.D.
Maywood, IL

INTRODUCTION: Mesenchymal chondrosarcoma is a rare malignancy which occurs in both skeletal and extraskeletal locations. It is believed to have a poor prognosis; however, previous literature consists of only case reports and small series. The aim of this investigation was to analyze all cases of mesenchymal chondrosarcoma encountered in the Surveillance, Epidemiology, and End Results (SEER) database to examine survivorship characteristics of this disease.

METHODS: The SEER database was used to identify all patients diagnosed with mesenchymal chondrosarcoma from 1973 to 2011. For each case, disease origin and location were each identified, and designated as skeletal or extraskeletal and cranial, axial, or appendicular, respectively. Overall survival (OS) and disease specific survival (DSS) were determined for the entire series as well as each group. Median survival was calculated using Kaplan-Meier methods. Cox proportional hazards regression was utilized to determine whether demographic and tumor location variables affected survival.

RESULTS: 205 cases, including 82 skeletal and 123 extraskeletal, of mesenchymal chondrosarcoma were identified. Of the skeletal tumors, 25.6% were appendicular, 34.2% were axial, 32.9% were cranial, and 7.3% were not classified. For the extraskeletal sites, the numbers were 38.2%, 37.4%, 24.4%, and 0%, respectively. OS for mesenchymal chondrosarcoma was 51% at 5 years and 43% at 10 years, and DSS was 54% and 47%, respectively. OS for extraskeletal cases was 52% at 5 years and 44% at 10 years, and DSS was 57%, and 50%, respectively. For skeletal cases, OS was 49% at 5 years and 41% at 10 years, and DSS was 50% and 43%, respectively. OS by origin and location is summarized in Table 1. In Cox regression analysis, increasing age ($p<0.001$), male gender ($p=0.01$), and axial (compared to appendicular) location ($p=0.03$) were associated with an increased probability of death.

DISCUSSION: This represents the largest survival analysis, to our knowledge, of this rare disease. The results of this investigation indicate that extraskeletal involvement by mesenchymal chondrosarcoma is more common than skeletal. Extraskeletal tumors had a higher predilection for appendicular sites in comparison to skeletal tumors, while the latter was more common cranially. This data indicates that OS and DSS of mesenchymal chondrosarcoma is low, although not as dismal as previously reported. Axial tumors of both skeletal and extraskeletal origin are associated with a worse prognosis, as are increasing age and male gender.

Click here to view Table

Wide Re-Excision of Unplanned Surgery for Synovial Sarcoma of the Upper Extremity Demonstrates Good Outcomes

Abstract ID: Paper 252

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*Joel M. Post, D.O. / Grand Rapids, MI
Benjamin K. Wilke, M.D. / Rochester, MN
Matthew T. Houdek, M.D. / Rochester, MN
Andrew L. Folpe, M.D. / Rochester, MN
Sanjeev Kakar, M.D. / Rochester, MN
Peter S. Rose, M.D. / Rochester, MN

INTRODUCTION: Synovial sarcoma is a high grade soft tissue sarcoma with significant metastatic potential. Prognostic variables have been previously reported. Most studies have grouped all anatomic sites or combined upper and lower extremity sarcomas. The aim of this study was to examine synovial sarcoma of the upper extremity (SSUE) to identify recurrence rates, recurrence free and overall survival, and associated prognostic variables.

METHODS: We retrospectively reviewed the records of all SSUE treated with definitive surgery at our institution between 1992 and 2014. Age, gender, anatomic location, tumor size, histologic type, stage, neoadjuvant and adjuvant treatments, previous surgery, disease status at latest follow-up, and major complications were reviewed. Cox hazard ratios were used to assess prognostic variables. Recurrence-free survival (RFS) and overall survival (OS) were estimated using Kaplan Meier survival curves.

RESULTS: Twenty-six patients (14F: 12M) were included for analysis with a median age at time of diagnosis of 31 years (6-60) and median follow-up of 60 months (2-248). The most common location was the hand/wrist (31%). Seventeen patients (65%) were AJCC stage IIA and only one patient presented with pulmonary metastases (4%). Fifteen patients (58%) had had a non-oncologic excision/“unplanned surgery” at an outside hospital prior to presentation at our institution.

Ten patients received neoadjuvant chemotherapy (38%). 69% of patients underwent neoadjuvant external beam radiation with a median dose of 50 Gy. All patients underwent surgical resection with curative intent. Five patients underwent amputation and a wide or radical margin was obtained in 77%. Negative margins were obtained in all patients.

Local recurrence was observed in 3 patients (12%) and distant metastases in 2 patients (8%). The 5 and 10 year RFS for unplanned excisions was 92% and 79%, respectively. The 5 and 10 year RFS for planned excisions was 87% and 43%, respectively. OS for all patients was 91% at both 5 and 10 years. Age, neoadjuvant therapies, intraoperative radiation, brachytherapy, tumor depth, wide resection, histologic subtype, and unplanned surgery did not affect RFS.

There were six patients (23%) with reported treatment complications including soft tissue contracture, wound infection, and neuroma formation.

CONCLUSION: There was no difference between RFS and OS between patients undergoing unplanned and planned excisions. Wide re-excision of previously unplanned excisions of SSUE was associated with a low rate of local recurrence and good RFS and OS.

Factors Affecting Outcomes and Survival of Primary Sarcomas of the Hand

Abstract ID: Paper 253

Joel M. Post, D.O. / Grand Rapids, MI
*Benjamin K. Wilke, M.D. / Rochester, MN
Matthew T. Houdek, M.D. / Rochester, MN
Brian E. Walczak, D.O. / Rochester, MN
Allen T. Bishop, M.D. / Rochester, MN
Alexander Y. Shin, M.D. / Rochester, MN

INTRODUCTION: Soft tissue and osseous sarcomas of the hand are exceedingly rare. Prior studies are contradictory with regard to the most common subtype as well as prognostic variables. The aim of this study was to review our institution's experience with sarcomas of the hand to identify factors affecting outcomes and survivorship.

METHODS: We retrospectively reviewed the records of all hand osseous and soft tissue sarcomas (SSS) treated with definitive surgery at our institution between 1992 and 2014. Age, gender, anatomic location, tumor size, subtype, stage, neoadjuvant and adjuvant treatments, previous surgery, surgical procedure, and disease status at latest follow-up were reviewed. Cox hazard ratios were used to assess prognostic variables. Recurrence free survival (RFS) and overall survival (OS) were estimated using Kaplan Meier survival curves.

RESULTS: Forty-four patients (26 males, 18 females) were included for analysis. Median age at diagnosis was 40 years (11 – 69) with a median follow-up of 58 months (1 - 255). There were 36 SSS and 8 of osseous origin. The most common subtypes were epithelioid (9) and synovial sarcoma (8). 50% were superficial in location. Three patients presented with metastases. Twenty-four (55%) patients had had a non-oncologic resection/"unplanned excision" prior to definitive surgical treatment at our institution.

Fourteen patients (9 neoadjuvant and 5 adjuvant) received radiation therapy with a mean dose of 51 Gy. All patients underwent surgical treatment with curative intent and negative margins were obtained in all cases. Twenty-six (59%) patients underwent a limb salvage procedure and 18 patients had an amputation.

Local recurrence was observed in 3 patients (7%) and distant metastases in 10 patients (23%). The average time from surgical resection to recurrence was 39 months (2-104). The 10 year RFS and OS was 63% and 67%, respectively, for the entire cohort. The 5- and 10-year RFS for SSS was 77% and 61%, respectively. The OS for SSS was 76% at 5 years and 70% at 10 years.

Univariate analysis revealed statistically significant adverse variables associated with OS in advanced presenting stage (AJCC III/IV) ($p=0.0001$), size > 3 cm ($p=0.0005$), metastases at presentation ($p=0.04$), and prior unplanned excisions ($p=0.01$).

CONCLUSION: The majority of hand sarcomas presented at an early stage with epithelioid sarcoma presenting as the most common subtype. Local recurrence after a wide excision was observed infrequently. Prior unplanned surgery was a poor prognostic factor. Similarly, tumors that were >3 cm were associated with a worse RFS and OS.

Prognostic Factors of Early Mortality in Patients Undergoing Spinopelvic Tumor Resection

Abstract ID: Paper 254

Grigoriy Arutyunyan, M.D.
Arjun Sebastian, M.D.
Nathan Murdoch, M.D.
Peter S. Rose, M.D.
Doris Wenger, M.D.
Bradford L. Currier, M.D.
Franklin H. Sim, M.D.
*Michael J. Yaszemski, M.D., Ph.D.
Rochester, MN

INTRODUCTION: To achieve local control and maximize potential for cure in patients with spinopelvic malignancies, surgical treatment requires en bloc resection. Aggressive surgical resection is associated with a high morbidity and mortality.

METHODS: We performed a retrospective review of 69 patients, with a minimum of two years follow-up, who underwent surgical treatment for spinopelvic tumors between 1996 and 2012. Data was collected regarding patient demographics, tumor characteristics, operative factors, and perioperative complications. All preoperative imaging was reviewed by a senior oncologic musculoskeletal radiologist for degree of vascular involvement. Patients were separated into an early mortality group that died within 12 months postoperatively and an early survival group that did not. The two groups were compared utilizing univariate analysis to identify predictors of early mortality.

RESULTS: Of the 69 patients identified, en bloc resections were performed for primary bone sarcoma (n = 27), chordoma (n = 21), rectal carcinoma (n = 12), and soft tissue sarcoma (n = 9). The mean age was 42.6 years with 59.4% of patients being male. 18 (26.1%) patients died within 12 months postoperatively including five in hospital (two intraoperative) deaths. Comparing the early mortality group to the early survival group there was a significant difference in tumor burden (12.3 cm vs. 8.4 cm, $p = .020$), amputative resection (61% vs. 29%, $p = .024$), preoperative radiation (72.2% vs. 23.5%, $p < .001$), transfused red blood cell units (59.4 vs. 21.8, $p = .004$), transfused fresh frozen plasma (31.9 vs. 7.8, $p = .025$), soft tissue sarcoma (27.8% vs. 7.8%, $p = .045$), and chordoma (0% vs. 41.2%, $p < .001$). There was a significant difference in red blood transfusion in the irradiated group (53.0 vs. 19.4, $p< .001$). Vessel involvement was observed in all of the early mortality cases compared to 49% in the early survival group ($p < .001$), including both abutment and encasement (<50% and >50%). There was no significant difference in patient demographics, operative return, surgical reconstruction, or recurrence.

CONCLUSIONS: A 26.1% 12-month mortality rate was observed in this cohort of patients undergoing en bloc resection for spinopelvic tumors. Several factors were prognostic of early mortality including amputative resection, large tumor burden, preoperative radiotherapy, soft tissue sarcomas, higher transfusion requirement, and vascular involvement. Select groups at risk for early mortality may benefit from more conservative treatment approaches.

Evaluation of the ABOS Surgical Skills Module 7: Compartment Syndrome Diagnosis and Treatment

Abstract ID: Paper 255

Saran Tantavisut, M.D.
*Brian O. Westerlind
Ryan Ilgenfritz, M.D.
Matthew D. Karam, M.D.
J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: Post Graduation Year 1 (PGY1) residents must be able to quickly and correctly diagnose acute compartment syndrome when presented, as rapid diagnosis and treatment best prevents impairment. The purpose of this study was to use construct and face validity to assess the American Board of Orthopaedic Surgery's (ABOS) Surgical Skills Module 7: Compartment Syndrome: Diagnosis and Treatment.

MATERIALS AND METHODS: 6 PGY1 residents completed the faculty led 4-hour ABOS educational module. Instructors coached learners using computer and paper-based cognitive education, both synthetic and cadaveric model instruction, and time for practice. Construct validity was assessed with a standard small group of tests pre-, post-, and 1 month following the module. The test set evaluated: lower leg anatomy knowledge (Anatomy 1), accuracy of placing a needle into correct compartments of the Sawbone's® Compartment Syndrome Model (Needle Placement 2), and ability to measure compartment pressure using low cost simulation (Pressure Measurement 3). The 6 PGY5s took the tests only one time for comparison. Face validity of Needle Placement 2 and Pressure Measurement 3 were assessed using a structured questionnaire given to all 12 participants and 3 additional surgeons who trialed the setup.

RESULTS: The PGY1 demonstrated a significant improvement from pre- to immediate post-training in all 3 tests; (Anatomy 1, Needle Placement , Pressure Measurement 3 [$P_{1,2,3} < 0.05$]). Improvements were indistinguishable from PGY5 performance, and were maintained by PGY1s >1 month post-training.

Face validity was assessed by 15 surgeons, who highly rated Needle Placement 2 for realism (11/15), as effective tool for teaching (13/15), and agreed it should be available throughout surgical training (12/15). The Pressure Measurement 3 module was only highly rated as an effective teaching tool (9/15), with less than half agreement in all other categories.

CONCLUSIONS: The ABOS skills module improves junior resident knowledge and performance of compartment syndrome diagnosis to the level of a PGY5 using simulation. Results indicate the module is an effective method for instructing these skills, although criterion validity is necessary to expand these conclusions to surgical practice. Additionally, adaptation of the simulations, such as incorporating the skills taught in Pressure Measurement 3 into the Needle Placement 2 exercise may improve the module. These results encourage future development and validation of simulation training, as it often effectively teaches difficult skills in a limited time frame.

Surgical Coaching from Head-Camera Video for Fluoroscopically-Guided Articular Fracture Surgery

Abstract ID: Paper 256

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*Daniel M. Koehler, M.D. / Iowa City, IA
Geb W. Thomas, Ph.D. / Iowa City, IA
Matthew D. Karam, M.D. / Iowa City, IA
Paul M. Lafferty, M.D. / Minneapolis, MN
Gary Ohrt, M.S. / Iowa City, IA
J. Lawrence Marsh, M.D. / Iowa City, IA
Ann Van Heest, M.D. / Minneapolis, MN
Donald D. Anderson, Ph.D. / Iowa City, IA

INTRODUCTION: The objective of this investigation was to study the effect of personalized surgical coaching as directed by head camera-derived video on resident performance on a validated articular fracture simulation trainer.

METHODS: A prospective, multi-institutional study was completed with randomization of 15 junior level (PGY1 and PGY2) residents to intervention or control cohorts. Both cohorts initially completed fracture reduction and provisional Kirschner wire fixation for a standardized three-part, intra-articular tibial plafond model with employment of fluoroscopic guidance via a limited anterior approach. The intervention group received personalized one-on-one performance feedback with an attending orthopedic traumatologist during a single 15-minute session as directed by video captured via a head-mounted camera and saved fluoroscopic images. Final simulation assessment was repeated for both groups six weeks following the pre-test session. Outcome metrics obtained included time to completion, radiation dose, and blinded objective structured assessment of technical skills (OSATS).

RESULTS: The control vs. intervention cohorts as randomized within each training level demonstrated no significant difference in OSATS outcome metrics at the pre-test assessments. Following intervention, both the PGY1 and PGY2 intervention groups demonstrated a significant net interval improvement compared to the non-intervention controls (PGY1: 24.75 ± 9.25 vs. 5.33 ± 5.13, $p = 0.023$; PGY2: 16.25 ± 4.99 vs. 6.75 vs. 1.71, $p = 0.011$). The post-intervention PGY1 cohort demonstrated a proficiency superior to the PGY2 baseline performance ($p<0.05$). Both intervention cohorts demonstrated a net interval decrease in fluoroscopy utilization as compared to controls (PGY1: -3.75 ± 17.21 vs. 6.67 ± 9.07, $p = 0.390$; PGY2: -7.00 ± 4.08 vs. 4.25 ± 6.34, $p = 0.025$). Post-test time to completion was similar across all groups.

CONCLUSION: Personalized video-based feedback is demonstrated to be efficacious in improving resident performance on a standardized articular fracture trainer. The described technique produces comparable results across institutions, and, thus, it may be broadly incorporated into laboratory-based simulation exercises to further enhance resident surgical skills education.

A Low Cost Simulation that Improves Basic Fracture Fixation Skills

Abstract ID: Paper 257

Saran Tantavisut, M.D.
Brian O. Westerlind
*Matthew D. Karam, M.D.
J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: This study assesses the effectiveness of a low cost technology surgical simulation module for PGY1 learners –Basics of Open Reduction and Internal Fixation (ORIF). We hypothesized that with high-face validity, these simulations can quickly improve PGY1 skills and knowledge of basic screw techniques to the level of the PGY5.

MATERIALS AND METHODS: Six PGY1s participated in a 6-hour educational module teaching basics of fracture fixation. Prior to the course, the PGY1s participated in a pre-test including: written test to assess knowledge of instruments (Instrument Knowledge test), written test of surgical technique (Lag Screw Technique test), and an OSATS graded syndesmotic screw fixation using a cadaveric ankle (Cadaveric Syndesmotic Screw Fixation test). Following the pre-test, the 3-hour morning half of the course used low cost simulation to teach directional drilling and screw fixation techniques in PVC pipe wrapped with insulation (PVC Pipe Training). An identical mid-course test minus Instrument Knowledge was then performed, followed by a 3-hour afternoon training utilizing cadaver models. The day concluded with a full post-course test, repeated >1 month late for retention. Six PGY5s performed the tests one time without participation in training course and served as a more experienced control. A structured questionnaire from all participants and 4 faculty who trialed the models assessed for face validity of the PVC Pipe Training module.

RESULTS: The PGY1s demonstrated significant improvement following the mid-course Cadaveric Syndesmotic Screw Fixation test (p 0.0052) (after training with PVC pipe alone), improving to a level indistinguishable from PGY5 performance (p 0.23). The improvement was maintained, but not further improved at the post course evaluation test and 1 month post evaluation. Maintained at >1 month, PGY1 scores for the Instrument Knowledge and Lag Screw Technique written tests improved to the PGY5 level from the pre- to the post-course test ($P < 0.0001$ and P 0.003 respectively). Reviewers rated the PVC Pipe Training module highly for: realism (75%), haptic feedback (75%), effective teaching tool (75%), and the need for model availability throughout training (75%), although retention of skill (50%) waned.

CONCLUSIONS: In a short period of time and retained >1 month, this training improves PGY1 residents knowledge and skill placing a syndesmotic screw in cadavers to the level of the PGY5. Supported by high face validity, low tech simulation training can be an effective means of training basic surgical skills.

Implementation of a Service-Specific Template Integrating OSCE (Objective Structured Clinical Examination) and ACGME (Accreditation Council for Graduate Medical Education) Milestones: One Institution's Experience

Abstract ID: Paper 258

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*David J. Ruta, M.D.
Mark S. Morris, M.D.
Todd A. Irwin, M.D.
James R. Holmes, M.D.
Ann Arbor, MI

PURPOSE: The Accreditation Council for Graduate Medical Education (ACGME) has developed milestones by which residency program accreditation may be based on outcomes, specifically residents' observable progression from entry to graduate-level skills. This new system requires appropriate methods of evaluation, expected to be more time- and cost-intensive. Further, literature has shown that clinic time alone provides insufficient opportunity for teaching and learning physical examination skills. The Objective Structured Clinical Examination (OSCE) is "a measure of clinical competence that focuses on outcomes through observable behaviors" and is used extensively in various medical curricula. Only recently has the orthopedic community identified the OSCE as a tool by which the ACGME's competency-based requirements may be addressed. Efforts encouraging OSCE development for this purpose remain ongoing in orthopedic literature.

We present a single institution's OSCE implementation, with specific methodology to assist establishing similar low-cost models at other institutions. While OSCE examples exist for several orthopedic subspecialties, we are not aware of any such description for foot and ankle. We, therefore, also propose a novel subspecialty-specific foot and ankle OSCE.

METHODS: OSCE components included obtaining a history and performing a physical examination with a standardized patient; radiographic interpretation; leading diagnosis development; knowledge of treatment options, surgical planning, complications, and controversies; and a short written multiple-choice examination. Clinical vignettes were developed with fellowship-trained subspecialty staff to represent typical presentations of common foot and ankle pathologies. Radiographs were copied from textbooks or obtained from our hospital system and de-identified. Written questions were derived from free sources including Orthobullets.com and OrthoQuiz, housed on the AAOS OrthoPortal site. ResStudy by AAOS is a paid self-assessment tool, which provided further material. Subspecialty faculty served as evaluators. To encourage objectivity, evaluation forms were binary, listing all evaluated components with "Yes" or "No" options to indicate performance. Completed tasks were summed and a performance level assigned.

RESULTS: Our novel foot and ankle OSCE has been successfully implemented via objective, low-cost modalities. This provides opportunity for early identification of deficiencies in knowledge and physical examination skills, as well as a system by which to satisfy many ACGME milestone requirements. Incorporation of this model is planned for our other orthopedic divisions.

CONCLUSION: The ACGME's new competency-based milestones require revised assessment tools, with disparities noted between requirements and opportunities for evaluation. OSCEs

have been identified to bridge this gap in orthopedic residency, with successful implementation possible using resources already available to many programs.

Improving Resident Performance in Knee Arthroscopy: A Prospective Value Based Assessment of Cadaveric Skills Labs

Abstract ID: Paper 259

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*Christopher L. Camp, M.D.
Aaron J. Krych, M.D.
Michael J. Stuart, M.D.
Terry D. Regnier
Karen M. Mills
Norman S. Turner, M.D.
Rochester, MN

INTRODUCTION: Cadaveric skills labs and high fidelity virtual reality simulators are two of the most common methods used to improve resident performance in knee arthroscopy outside of the operating room. The educational value of the two methodologies has not yet been compared head to head. This prospective randomized trial assesses the efficacy of these training methods, compares rates of improvement, and provides value data to programs looking to implement such technologies.

METHODS: Orthopedic surgery residents were randomized to one of three groups: Control (CG), Cadaveric Training (CTG), or Simulator Training (STG). All residents completed pre- and post-test diagnostic knee arthroscopies that were timed and video recorded. Between the pre- and post-tests, the CG performed no arthroscopy, the CTG performed four hours of cadaveric practice, and the STG trained for four hours on a simulator. All tests were scored in a blinded, randomized fashion by two expert knee arthroscopists using the validated Arthroscopy Surgical Skill Evaluation Tool (ASSET). Mean improvement in ASSET score and time to complete the procedure was compared for each group.

RESULTS: Forty-five residents (15 per group) completed the study. Mean ASSET score improvement was -0.40 (p=0.776) for CG, +4.27 (p=0.002) for CTG, and +1.92 (p=0.096) for STG (p=0.015). Mean time improvement from pre- to post-test was 0:07 (p=0.902) for CG, 3:01 (p=0.002) for CTG, and 0:28 (p=0.708) for STG (p=0.044). Residents in the CTG improved performance at a mean of 1.1 ASSET points per hour spent training while those in the STG improved 0.5 ASSET points per hour of training.

CONCLUSIONS: Cadaveric skills labs and simulators improved resident performance in knee arthroscopy compared to matched controls. Residents practicing on cadaveric specimens improved twice as fast as those utilizing a high fidelity simulator; however, based on cost modeling specific to our institution, the simulator is more cost effective if it is used at least 300 hours per year. Similar analysis can be performed for individual institutions based on their specific monetary arrangements.

HAND

Complications Following Upper Extremity Amputation or Replantation: A Review of 14,481 Cases

Abstract ID: Poster 001

Arjun S. Sebastian, M.D.
Rajaie Hazboun, M.D.
Amy E. Wagie, B.S.
Elizabeth B. Habermann, Ph.D.
Sanjeev Kakar, M.D.
Rochester, MN

(Presented by Benjamin K. Wilke, M.D., Rochester, MN)

INTRODUCTION: While the epidemiology and economics of upper extremity replantation and amputation surgery have been defined in the literature, the causes of injury, incidence of complications, and risk factors for complications are not well understood.

METHODS: The Nationwide Inpatient Sample was used to identify 14,481 patients who underwent either amputation or replantation for upper extremity injuries between 2002 and 2011. ICD-9 procedure codes were used to separate patients into groups that underwent amputation or replantation. Data was collected regarding patient demographics, comorbidities, hospitalization characteristics, and postoperative complications. Univariate testing and multivariable logistic regression analysis was then performed to identify significant risk factors.

RESULTS: Of the 14,481 patients, 12,502 (86.3%) underwent upper extremity amputation and 1,979 (13.7%) underwent replantation. The mean age of the cohort was 44.1 years with 86.5% of the patients being male. The most frequent causes of injury were machinery accidents (58.2%), motor vehicle accidents (10.7%), and crush injuries (9.0%). Of the patients who underwent replantation, 106 (5.4%) suffered a complication related to the reattached extremity or part. In the group that underwent amputation, 83 (0.7%) suffered a complication related to the amputation stump. Independent risk factors for complications following replantation included peripheral vascular disease (OR 8.89, $p < .001$), recent weight loss (OR 8.51, $p = .028$), iatrogenic injuries (OR 5.29, $p = .003$), and admission to a trauma center (OR 3.67, $p = .003$). Independent risk factors for complications following amputation included discharge against medical advice (OR 7.10, $p = .017$), Medicare or Medicaid as a secondary payer (OR 5.28, $p = .007$), pulmonary circulation disorders (OR 4.79, $p = .032$), and renal failure (OR 3.50, $p = .022$). Of note, upper quartile hospital charges (OR .394, $p = .021$) and weekend admissions (OR .411, $p = .009$) were protective.

DISCUSSION: Complications are more frequent following replantation. In this cohort, patients with peripheral vascular disease were at increased risk for complications following replantation.

The importance of postoperative amputation care is highlighted by the increased complication rate in patients with unanticipated discharges. Further studies are needed to identify why certain payer status and admission characteristics were predictive of and protective against complications.

Venous Bridge Arterial Grafting for Thumb Replantation

Abstract ID: Poster 002

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*Eric R. Wagner, M.D.
Allen T. Bishop, M.D.
Alexander Y. Shin, M.D.
Rochester, MN

PURPOSE: Microsurgical replantation in thumb avulsion injuries is challenging, especially when the proximal digital arteries are not available. The purpose of this study is to describe a novel technique using an interposition vein graft for thumb replantation.

METHODS: Over a 10-year period, 8 patients underwent interposition venous bridge grafting from the dorsal radial artery at the anatomic snuffbox to the proper ulnar digital artery (PUDA) of the thumb. All patients had a traumatic thumb amputation with a severe injury to the proximal digital arteries precluding primary arterial repair. Given the difficulty in repairing or grafting vessels on the palmar side of the thumb, this novel technique enables easy access to the repair. The hand rests palm down on the table with the forearm pronated, enabling easy exposure to the proper ulnar digital artery and snuffbox radial artery. The reconstruction is carried out with an end-to-side connection of the vein graft to the radial artery, followed by a subcutaneous tunnel to the thumb incision via a mid-lateral incision, and an end-to-end anastomoses of the PUDA.

RESULTS: All 8 patients who underwent the bridge grafting were male, with average age of 42 years, 2 smokers and 7 laborers. All were avulsion-type injuries. The average time to the operating room was 7.4 hours (4-14) and the average time to reperfusion was 9.5 hours (6-16). At 3.1 years follow-up, all 8 thumbs remained viable, without any need for revision procedures. The only complication was a metacarpal shaft nonunion treated successfully with autlogous bone grafting. Additional injuries required a FTSG in 2 patients and a free muscle and STSG in another. Of the 5 patients with >1 year of follow-up, all were able to return to work full-time. All patients reported no or mild pain at last follow-up, with an average MCP range of motion of 46.5°. All patients had intact, but diminished 2-point discrimination compared to the other thumb.

CONCLUSIONS: Due to the challenging nature of thumb avulsion injuries, novel salvage alternatives techniques are very important. Additionally, the pronated position of the thumb compared to other digits makes positioning under the microscope and palmar-sided repairs challenging. We describe a novel technique when no proximal vessels are available, using a vein to bridge the dorsal radial artery to the PUDA of the thumb through a dorsal approach. This novel arterial reconstruction has shown promise in thumb replantation associated with severe avulsion injuries.

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SPORTS

High Tibial Osteotomy Accuracy: Computer Navigation vs. Conventional Techniques

Abstract ID: Poster 003

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*Justin T. Chang
Greg Scallon, M.D.
Mitch W. Beckert
Jeff C. Zavala
John P. Albright, M.D.
Iowa City, IA

INTRODUCTION:The accuracy of correction has been shown to be an important determinate in long-term outcomes of patients who suffer from unicompartmental osteoarthritis and were treated with a medial open-wedge high tibial osteotomy (HTO). The goals of surgical treatment were to correct the mechanical axis (MA) a varus to a valgus alignment and to shift the weight-bearing line (WBL) from the medial to the lateral compartment within established guidelines that have been shown to provide good lasting results. Conventional surgical procedures include preoperative planning, similar to the one proposed by Dugdale et al., or intraoperative fluoroscopic guidance with a metal rod.

Computer navigation systems, such as OrthoPilot, have the potential to improve surgical precision. The purpose of our study was to compare the radiological outcomes between patients treated with OrthoPilot and those treated through conventional methods.

METHODS: 104 patients were retrospectively evaluated. 41 patients were treated using OrthoPilot, and 63 patients were treated using conventional methods. Preoperative and postoperative single-leg, long-leg standing alignment films were used to determine the extent of varus deformity and the correction outcome. It has been documented that the target ranges for good long lasting outcomes for the MA and WBL were 2° to 8° and 50% to 75%, respectively. Anterior-posterior and lateral views of the knee were also obtained to calculate the posterior tibial slope in the sagittal plane.

RESULTS: Postoperative radiological results were statistically significant for MA and WBL ($p=0.007$ and $p=0.007$, respectively). In the OrthoPilot group, 32 out of 41 (78.0%) patients achieved a MA between 2° and 8° and 32 out of 41 (78.0%) patients achieved a WBL between 50% and 75%. In the conventional group, 33 out of 63 (52.4%) patients achieved a MA between 2° and 8° and 37 out of 63 (58.7%) patients achieved a WBL between 50% and 75%. The percentage of under-corrected patients (WBL <50%) was greater in the conventional group (20/63, 31.7%) than the OrthoPilot group (4/41, 10.0%).

The preoperative and postoperative changes in tibial slope were not statistically significant between the two groups ($p=0.376$).

CONCLUSION: For coronal plane corrections, the computer navigation system was shown to have greater success in achieving the desired correction value and in having fewer patients who were under corrected. For sagittal plane corrections, sagittal navigational plane guidance did not appear to be more effective than conventional techniques.

Lateral Tibiofemoral Contact Pressure Following Meniscectomy and Transplantation

Abstract ID: Poster 004

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*Sami Jaafar, M.D.
William Kesto, M.D.
Amanda Esquiel, Ph.D.
Allison Cracchiolo, B.S.
Todd J. Frush, M.D.
Detroit, MI

BACKGROUND: The meniscus is a vital structure to load bearing and contact area distribution for the tibiofemoral joint. Numerous studies have examined alterations in knee biomechanics with healthy meniscus to that of torn, repaired, and removed. In recent years past, new techniques have evolved for both repair and replacement of meniscal tissue as a means to delay or avoid degenerative tibiofemoral changes known to develop in meniscal deficient knees. In this study, we tested how well lateral meniscal transplantation was able to restore normal meniscal parameters compared to simulated meniscal deficiency.

METHODS: We obtained 11 fresh frozen cadaveric adult knees. The knees were x-rayed to determine lateral meniscal dimensions and screen for any radiographic signs of arthritis. The knees were potted and prepared. Each knee underwent sequential testing at 0°, 15°, 30°, 45°, and 60° of flexion with a Tekscan pressure and contact pressures were tested in the intact meniscus, menisectomy, and meniscal transplantation state.

Three separate techniques were used to secure the lateral meniscal bone block.

RESULTS: We found that menisectomy significantly increased peak pressure, peak force, and decreased contact area. There were no significant differences in peak pressure, peak force, and contact area between an intact meniscus and a meniscal transplant. Comparison between the meniscal transplant groups showed no significant differences between fixation techniques with respect to peak pressure, peak force, and contact area.

CONCLUSIONS: Lateral meniscal transplantation seems to successfully restore contact pressure, force transduction and contact area across the tibiofemoral joint to the parameters of an intact native meniscus. This study demonstrates the detrimental effect of menisectomy on contact pressure, force transduction, and contact area. Method of bone block fixation did not seem to have a significant effect on restoration of peak pressure, peak force, and contact area after lateral meniscal transplantation.

Level of Evidence: Biomechanical Study

MRI Findings in Patients with Symptomatic Synovial-Plical Complex of the Knee

Abstract ID: Poster 005

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*Michael J. Nieto
Christopher Anthony, M.D.
Dylan Crebs
Peter McCunniff, M.D.
Mitchell Beckert
Lee Bennett, M.D.
Kevin Berbaum, Ph.D.
John P. Albright, M.D.
Iowa City, IA

BACKGROUND: Plica formations in the knee are part of normal anatomical development, and it is believed that plicae are embryological remnants that once divided the knee into separate compartments: lateral, medial, suprapatella, and infrapatella. Of the four compartments, the medial plicae are most often associated with symptomatic synovial-plical complex (SPC). Once embryologic growth of plicae terminates, the plicae transform into synovial folds, which remain throughout adult life. Historically, plicae have been very difficult to make definitive objective confirmation as the causation of pathology of anterior knee pain. McCunniff et al. have established a relationship between the clinical examination findings in patients with recalcitrant SPC and relief provided by the excision of the SPC. There has not been a prior radiographic objective criteria set for clinically diagnosing and accessing the extent and severity of plica related pain. Symptomatic synovial-plica affect patients of all ages, sex, and backgrounds, which means that there is a large distribution of the population that can benefit from further knowledge about the syndrome.

HYPOTHESES: The primary aim of this study is to determine the specificity and sensitivity of the tesla 1.8 MRI in determining the existence of pathologic synovial-plical complex of the knee in a study group of patients who have benefitted from surgical removal of the symptomatic tissue compared to a group of “control” patients with MRIs taken for other reasons. We hypothesize the clinical diagnosis of anterior knee pain secondary to the SPC can be verified by radiographic criteria

METHODS USED: This retrospective study will analyze 78 patients (39 case, 39 control) preoperative MR images for the purpose of identifying the size and locations of the symptomatic synovial plicae in relation to the patellofemoral joint. The 39 case patients have already undergone successful surgery to resect the symptomatic SPC, which had been recalcitrant to nonsurgical treatment protocols. The location of the plica tissue was defined on sagittal and axillary views of MR images relative to the trochlear groove and the patella. The repeatability of these measurements was taken as reference marks so they can be used clinically for identification of the pathological plica. The control group is patients without anterior knee pain, who are void of osteoarthritis, rheumatoid arthritis, lupus, and any other inflammatory disease process. Impingement will be defined as locations within the knee where the synovial-plical complex lies in between articulating cartilage of both the patella and the trochlea.

RESULTS: The presence of impinging femoral and infrapatella SPC was significantly greater in the case group (P=0.0015, P=0.0549). The axial view of the distance that the SPC extended into the trochlear groove relative to the medial edge of the patella was also significantly greater

in the case group (P=0.0004). This group also had thicker plicae compared to the control group (P<0.0001). The case group had more prominent plicae according to the Sakakibara measurement scale on the axial MR images (P=5.937E-05). The sensitivity and specificity of the impinging femoral synovium were found to be 66.67% and 69.23%. The positive and negative predictive values for the impinging femoral synovium were 68.42% and 67.50%. The sensitivity and specificity for the impinging infrapatellar synovium were 69.23% and 35.9%. The positive and negative predictive values for the infrapatellar synovium were 51.92% and 53.85%.

CONCLUSIONS/DISCUSSION: Anterior knee pain associated with the synovial-plical complex can be contributed to the thickness of the synovial-plical complex and distance that the complex travels towards the trochlear groove. This study also found that the impingement of the synovial-plical complex between the patella and trochlear groove plays a significant role in the pain associated with anterior knee pain.

Comparison of Tibial Tubercle-Trochlear Groove and Tibial Tubercle-Posterior Cruciate Ligament Distances

Abstract ID: Poster 006

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*Mark J. Heidenreich, B.S.
Christopher L. Camp, M.D.
Paul L. Sousa, B.S.
Aaron J. Krych, M.D.
Diane L. Dahm, M.D.
Rochester, MN

INTRODUCTION: Increased TT-TG is a risk factor for recurrent patellar instability. Patients with a TT-TG ≥ 20 mm may require surgical correction. It has been proposed that TT-PCL may be more accurate for assessing tubercle lateralization, and that a TT-PCL ≥ 24 mm may be considered pathologic[1]. We sought to: (1) assess reliability of measuring TT-PCL compared to TT-TG on MRI, (2) establish baseline TT-PCL values in patients with patellar instability, and (3) determine the predictive value of a TT-PCL ≥ 24 mm on recurrent patellar instability compared to a pathologic TT-TG distance of ≥ 20 mm.

METHODS: Patients with symptomatic patellar instability who underwent knee MRI at our institution were included in the study. A total of 59 patients with a mean follow-up of 6.6 years met inclusion criteria. The TT-TG and TT-PCL distances were calculated on all patients by two observers in a blinded and randomized fashion. Interobserver reliability was assessed using interclass correlation coefficients (ICC). Agreement greater than 0.75 was considered excellent. The TT-PCL distances were compared to a previously published cohort of 58 patients[1] to establish baseline values in a total of 117 patients with patellar instability. The ability of TT-PCL and TT-TG distances to predict recurrent instability was assessed by comparing the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of pathologic TT-PCL (≥ 24 mm) and TT-TG (≥ 20 mm) distances.

RESULTS: In our 59 patients with patellar instability, interobserver reliability was excellent for calculating both TT-PCL (ICC=0.932) and TT-TG (ICC=0.978). Mean TT-PCL was 21.7 mm (range 9.1-29.5), and mean TT-TG was 15.4 mm (range 0.7-29.7). Combined with the previously published cohort of 58[1], the mean TT-PCL in 117 patients was 21.8 mm (range 9.1 to 32.0), with a discrepancy of 0.2 mm (21.7 vs. 21.9) between the two groups (p=0.798). The sensitivity for pathologic TT-PCL to predict recurrent instability was 0.298 and the specificity was 0.583, while the sensitivity and specificity for pathologic TT-TG was 0.213 and 1.000, respectively. PPV and NPV were 0.737 and 0.175 for TT-PCL while the PPV and NPV for TT-TG were 1.000 and 0.260.

CONCLUSION: Overall, both TT-PCL and TT-TG can reliably be measured on MRI between raters. The mean TT-PCL value in patients with patellar instability is 21.78 mm, but the range is broad. A pathologic TT-PCL distance (≥ 24 mm) is less predictive of recurrent instability than TT-TG ≥ 20 mm.

[1]Seitlinger G, Scheurecker G, Jogler R, Labey L, Innocenti B, Hofmann S. Tibial Tubercle-Posterior Cruciate Ligament Distance: A New Measurement to Define the Position of the Tibial Tubercle in Patients with Patellar Dislocation. *The American Journal of Sports Medicine*. 2012;40(5):1119-1125.

Inter- and Intra-Observer Reliability in the Measurement of the Tibial Tubercle-Trochlear Groove Distance and Trochlea Morphology

Abstract ID: Poster 007

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*Nathan W. Skelley, M.D.
Michael Friedman, M.D.
Mark McGinnis, M.D.
Christopher Smith, M.D.
Travis Hillen, M.D.
Matthew J. Matava, M.D.
St. Louis, MO

BACKGROUND: The tibial tubercle-trochlear groove (TT-TG) distance and trochlear morphology have become important radiographic measurements in the evaluation and management of patients with patellar instability. Many orthopedists, however, do not have access to musculoskeletal radiologists and, therefore, must make such measurements independently.

PURPOSE: The purpose of this study was to determine the inter- and intra-observer reliability in the measurement of the TT-TG distance and the determination of trochlear dysplasia (TD) between musculoskeletal radiologists and orthopedic surgeons in patients with patellar instability and a control group.

METHODS: 1.5 Tesla magnetic resonance images of the knee were evaluated in 116 patients between 2011 and 2013. Images were obtained from 63 patients with the clinical diagnosis of patellar instability based on history and physical examination (Instability group) and from 53 patients without patellar instability (Control group). Two musculoskeletal fellowship-trained radiologists and two orthopedic surgeons blinded to the group assignment independently measured the TT-TG distance and determined the TD index, a measure of trochlear dysplasia, from the MRI based on published criteria. Each MRI was measured on two occasions separated by at least one week. Intra-class correlation coefficients (ICC) were calculated to determine the intra- and inter-observer reliability.

RESULTS: Mean age in the Instability group was 20 years (range: 12-48) with 34 females and 29 males. Mean age in the Control group was 22 years (range: 12-50) with 23 females and 30 males. The mean TT-TG distances were 18.2 +5.6 mm and 14.1 +5.6 mm for the Instability and Control groups, respectively ($p<.001$). The mean TD index was 2.2 +1.7 mm and 4.6 +1.3 mm for the Instability and Control groups, respectively ($p<.001$). There was excellent intra-observer reliability for both the TT-TG and TD index measurements between the two time points for all observers (TT-TG ICC: >0.86, $p<.001$; TD ICC: >0.88, $p<.001$). The inter-observer reliability was very strong between the orthopedists and radiologists for both the TT-TG distance (ICC: 0.85, 95% C.I.: 0.82-0.88 $p<.001$) and TD index (ICC: 0.84, 95% C.I.: 0.79-0.88, $p<.001$). The two radiologists diagnosed TD in the Instability group 57% and 54% of the time. The two orthopedists diagnosed TD in the Instability group 68% and 71% of the time ($p<.001$).

CONCLUSION: The results of this study suggest that the intra- and inter-observer reliability in the MRI measurement of the TT-TG distance and TD index is high for both orthopedic surgeons and musculoskeletal radiologists.

High Risk of Second Anterior Cruciate Ligament Injury for Female Soccer Players

Abstract ID: Poster 008

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*Alexander H. King, B.S.
Aaron J. Krych, M.D.
Paul L. Sousa, B.S.
Bruce A. Levy, M.D.
Michael J. Stuart, M.D.
Diane L. Dahm, M.D.
Rochester, MN

OBJECTIVE: Female athletes are an at-risk population for anterior cruciate ligament (ACL) injury, with rates of injury significantly higher than the general population. Few studies have reported on a second ACL injury for female athletes. The purpose of this study was to (1) report the rate of ACL graft rupture and contralateral ACL tear in competitive female soccer players and (2) determine potential risk factors for reinjury, including mechanism of injury and patient age.

METHODS: The medical record at our institution was reviewed for patients treated with primary ACL reconstruction between 1998 and 2013. Female patients injured on the soccer field were included for further review. Patients were excluded for prior ACL reconstruction on the ipsilateral leg; however, patients with prior contralateral ACL tears remained included. Patients' medical records were reviewed at an average of 29 months postoperatively (range 2–133 months). Kaplan-Meier survivorship and Chi-square analysis were used to compare rate of graft rupture and rate of contralateral ACL injury, respectively, for noncontact and contact injuries. Wilcoxon rank-sum test was used to compare rate of graft rupture to patient age.

RESULTS: 103 patients met our inclusion/exclusion criteria with a mean age of 19.6 ± 6.7 years. There were 9 (8.7%; 95% CI 0.05–0.16) patients who tore their ACL graft at a mean of 14.6 ± 7.3 months postoperatively. Additionally, 12 (11.7%; 95% CI 0.06–0.18) patients suffered a contralateral ACL rupture. Mechanism of injury was contact in 22 (21.4%) patients and noncontact in 81 (78.6%) patients. Patients with contact and noncontact mechanisms had similar rates of graft rupture (p=0.40) and contralateral tear (p=0.25). Patients who tore their ACL graft were significantly younger than patients who did not (mean 15.6 and 20.0 years, respectively; p=0.01). However, age was not significantly different between patients who had a contralateral tear and patients who did not (p=0.70).

CONCLUSION: Female soccer players treated with ACL reconstruction had a high rate of second ACL injury, with both graft rupture (9%) and contralateral ACL injury (12%). In addition, younger female soccer players may be at a higher risk for ACL reinjury.

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PCLF as a Backbone for Chondrocyte Attachment and Proliferation Augmented by Platelet Lysate

Abstract ID: Poster 009

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*Eric R. Wagner, M.D. / Rochester, MN
Mahrokh Dadsetan, Ph.D. / Rochester, MN
Dalibel Bravo, M.D. / New York, NY
Andre van Wijnen, M.D. / Rochester, MN
Michael J. Yaszemski, M.D., Ph.D. / Rochester, MN
Sanjeev Kakar, M.D. / Rochester, MN

PURPOSE: Management of chondral injuries is a difficult problem. Our goals are to (1) create a biodegradable polymer scaffold with the capabilities of sustaining chondrocyte growth and proliferation, (2) enable cell-cell communication and tissue regeneration via large pores, and (3) assess the biological augmentation of the scaffold capabilities using a cocktail of platelet secretion products known as platelet lysate.

METHODS: We synthesized biodegradable polycaprolactone fumarate (PCLF) scaffolds to allow cell communication via large interconnected pores. Molds were printed on a SolidScape 3D printer and scaffolds synthesized via UV crosslinking. Chondrocytes were isolated from rabbits 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), toxicity and viability (Live/Dead immunostaining), differentiation (GAG, ALP, and Total Collagen), and immunostaining for chondrogenic markers collagen II and Sox 9 (with collagen I as a negative control).

RESULTS: The large interconnected pores (500 and 750 micrometers) enable cell-cell communication and cellular infiltration into the scaffolds. After dynamic cell seeding of the progenitor cells on the PCLF, the cells remained viable for 2 weeks cultured on in vitro culture plates, invading throughout the pores and body of scaffolds. Chondrocytes cultured in the presence of PL did have increased rates of proliferation when compared to FBS. The chondrogenic markers glycosaminoglycan (GAG) and total collagen contents increased over 2 weeks at each time point ($p<0.05$), while the osteogenic marker alkaline phosphatase (ALP) did not significantly change ($p<0.15$). Immunostaining at 2 and 4 weeks for the expression of chondrogenic markers Collagen II and Sox-9 was significantly increased when compared to control human fibroblasts.

CONCLUSION: Our results show that the PCLF polymer scaffold enables chondrocytes to attach, proliferate, and retain their chondrogenic phenotypes. This novel scaffold and material has promise in chondrocyte engineering and cartilage regeneration.

Olecranon Physeal Abnormalities in the Adolescent Athlete: A Case Series

Abstract ID: Poster 010

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*Rachel M. Frank, M.D.
Brett A. Lenart, M.D.
Mark S. Cohen, M.D.
Chicago, IL

INTRODUCTION: Injury to the olecranon physis is a recognized cause of elbow pain in the adolescent, overhead athlete. Significant controversy exists with respect to nomenclature, etiology, and appropriate treatment of these injuries. The purpose of this study is to present the clinical and radiographic outcomes of a cohort of patients undergoing surgical management of persistent, symptomatic olecranon physes. Two distinct patterns were observed.

METHODS: We identified 13 elbows in 12 patients undergoing surgical management for a symptomatic persistent olecranon physis. Demographic data including radiographs taken preoperatively, and at follow-up were collected. Standardized clinical outcomes assessments included the DASH, Mayo Elbow, and the Likert scores. An independent examiner evaluated all patients for the purposes of this study.

RESULTS: A total of 13 elbows (12 patients) were identified. All patients (100%) were male and were pitchers at either the high school or college level. The average age at presentation was 18 ± 4 years. Eleven of 13 (85%) elbows involved the dominant arm; one patient had bilateral involvement. Two unique radiographic patterns were identified, including 9 cases (69%) of an irregular sclerotic lucency at the site of the olecranon physis. Four cases (31%) involved a lucency exiting proximal to the triceps insertion at the site of an accessory ossification center that failed to unite. Surgical management included debridement, autograft supplementation, and internal fixation using either a tension band construct (n=11), an intramedullary nail (n=1), or a headless screw (n=1). There were 2 reoperations, including irrigation and debridement with removal of hardware for infection (n=1), and removal of hardware for irritation (n=1); 4 other patients experienced transient hardware irritation. All patients achieved successful radiographic union at an average 8 ± 2 weeks. The average postoperative DASH score was 2 ± 2. The average postoperative Mayo Elbow score was 99 ± 3. The average Likert score for satisfaction was 9.9 ± 0.2. There were no significant differences in strength, range of motion, or stability postoperatively comparing the operative to the non-operative elbow ($P>0.05$).

DISCUSSION AND CONCLUSIONS: Two unique patterns of olecranon physeal abnormalities in young, overhead throwing athletes have been identified. Open reduction and internal fixation is clinically and radiographically successful in obtaining union and symptom resolution in these patients. Further studies are needed to elucidate the role of conservative treatment of these injuries and to identify the natural history of each pattern.

All-Arthroscopic Suprapectoral vs. Open Subpectoral Tenodesis of the Long Head of the Biceps Brachii

Abstract ID: Poster 011

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*M. Mustafa Gombera, M.D.
Cynthia A. Kahlenberg, B.S.
Rueben Nair, M.D
Matthew D. Saltzman, M.D.
Michael A. Terry, M.D.
Chicago, IL

BACKGROUND: Pathology of the long head of the biceps tendon is a recognized source of shoulder pain in adults that can be treated with tenotomy or tenodesis when non-operative measures are ineffective. It is not clear whether arthroscopic or open biceps tenodesis has a clinical advantage. The purpose of this study was to determine whether a difference in outcomes and complications exists between matched cohorts after biceps tenodesis utilizing an open subpectoral vs. an all-arthroscopic suprapectoral technique.

METHODS: A prospective database was reviewed for patients undergoing an all-arthroscopic suprapectoral or open subpectoral biceps tenodesis. Adult patients with a minimum 18-month follow-up were included. Patients undergoing a concomitant rotator cuff or labral repair were excluded. The groups were matched to age within 3 years, sex, and time to follow-up within 3 months. Pain improvement, development of a popeye deformity, muscle cramping, postoperative ASES scores, satisfaction scores, and complications were evaluated.

RESULTS: Forty-six patients (23 all-arthroscopic, 23 open) patients with an average age of 57.2 years (range, 45-70) were evaluated at a mean 28.7 months (range, 18-42) follow-up. No patients in either group developed a popeye deformity or complained of arm cramping. There was no significant difference in mean ASES scores between the open and all-arthroscopic groups (92.7 vs. 88.9, P = 0.42, Table 1). Similarly, there was no significant difference between patient satisfaction scores (8.9 vs. 9.1, P = 0.73). There were no complications in the all-arthroscopic group. There were two complications in the open group (superficial incisional erythema, and brachial plexopathy) that resolved by final follow-up.

CONCLUSIONS: Open subpectoral and all-arthroscopic suprapectoral are two commonly used techniques to reattach the biceps tendon distal to the bicipital groove. In this study, patients undergoing an all-arthroscopic tenodesis experienced similar pain relief, shoulder function, and return to athletic activity as patients undergoing an open tenodesis. An open subpectoral technique may increase the risk of complications secondary to a larger incision and increased surgical dissection.

Click here to view Table

Meniscal and Articular Cartilage Damage in Multiligament Knee Dislocation

Abstract ID: Poster 012

Paul L. Sousa, B.S.
Aaron J. Krych, M.D.
*Alexander H. King, B.S.
William M. Engasser, B.A.
Michael J. Stuart, M.D.
Bruce A. Levy, M.D.
Rochester, MN

BACKGROUND: A knee dislocation can result in significant damage to intra-articular knee structures, but there is limited data on the prevalence and extent of articular cartilage and meniscal injury in this setting. The purpose of this study is to (1) report the rate of concomitant intra-articular injuries at the time of multi-ligament reconstruction for knee dislocation, (2) determine if the pattern of ligament injury correlates with the presence of associated chondral and meniscal injuries, and (3) determine if chondral and meniscal injuries are less common in patients treated with early ligament reconstruction compared to those treated with delayed (> 1 year) ligament reconstruction.

METHODS: The records of patients who underwent surgical treatment for a multi-ligament knee injury, defined as a PCL-based multi-ligament knee injury or a minimum of three reconstructed ligaments, between 2007 and 2013 were retrospectively reviewed. Patient demographics, ligament injury patterns, the presence of meniscal tears, chondral injuries, and the interval from injury to surgery were recorded. Data analysis included correlation of ligament injury pattern with chondral and meniscal injury, as well as comparison between early vs. delayed multi-ligament reconstruction.

RESULTS: 133 patients were included (98 males, 35 females) with a mean age of 32 (range, 14-62) years. 102 patients (77%) had associated chondral or meniscal injury. 71 knees (53%) presented with meniscal tears (44 medial tears, 44 lateral tears, 17 both). 64 knees (48%) had chondral damage, more commonly in the medial compartment (44 knees). The pattern of ligament injury did not correlate with the presence of intra-articular pathology. Medial femoral condyle chondral lesions (42% vs. 21%; p = 0.04) and patellar chondral lesions (38% vs. 18%; p = 0.03) were more common in the delayed surgical group when compared to the early surgical group.

CONCLUSION: Meniscal tears and chondral damage occur frequently in patients who sustain a knee dislocation. A longer interval from injury to surgical reconstruction is associated with higher risk of articular cartilage lesions, particularly in the medial and patellofemoral compartments. Further research is necessary to determine if these injuries negatively affect outcome in these already severe injuries.

Click here to view Figure

Pre-Season Ultrasound Evaluation of the Ulnar Collateral Ligament and Elbow in High School Baseball Pitchers

Abstract ID: Poster 013

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*Nathan E. Marshall, M.D.
Robert A. Keller, M.D.
Hafeez Ahmed, M.D.
Courtney E. Scher, M.D.
Marnix Van Holsbeeck, M.D.
Vasilios Moutzouros, M.D.
Detroit, MI

INTRODUCTION: Baseball pitchers place large valgus stresses on the elbow, and adaptive changes to the soft tissues of the throwing arm have been shown in previous studies in the professional and collegiate pitcher. Current literature lacks information regarding when in the career of competitive pitchers these adaptive changes occur. Therefore, the purpose of our study was to use dynamic ultrasound (DUS) to evaluate the elbows, particularly the ulnar collateral ligament (UCL), of high school pitchers. Our hypothesis is that there is evidence of early changes in the UCL, such as UCL thickening, UCL heterogeneity, and increased ulnohumeral joint laxity at this young age.

METHODS: Twenty-two asymptomatic male high school pitchers were recruited before the start of their spring season. Pitchers underwent standard physical examination of the shoulder and elbow as well as dynamic ultrasound examination of the throwing and non-throwing elbow. UCL substance consistency and thickness, ulnohumeral joint space both unstressed and stressed, as well as all osteoarticular, ligamentous, musculotendinous, and neural structures about the elbow were evaluated. The images were then randomized, blinded, and evaluated by two fellowship-trained musculoskeletal radiologists.

RESULTS: Mean age was 16.86 years. There were 19/22 (86%) pitchers who pitched for both high school and travel teams with 9/22 (41%) playing in more than 70 games a year. The throwing elbow showed no significant difference in UCL consistency, thickness, or dynamic joint laxity when compared to the non-throwing arm. UCL substance heterogeneity was found in 7/22 pitchers (32%) in the throwing elbow vs. 8/22 (36%) in the non-throwing elbow ($p=0.11$). UCL thickness in the throwing arm was found to be 6.5 mm vs. 6.7 mm in the non-throwing arm ($p=0.48$). There was no difference in medial joint line widening at rest (throwing arm, 3.13 mm vs. non-throwing, 3.17 mm; $p=0.835$) and with dynamic stressing (throwing arm, 3.87 mm vs. non-throwing arm, 4.11 mm; $p=0.304$). Throwing elbows showed posteromedial olecranon spurring in 40% and effusions in 29%, as compared with 26% spurring ($p>0.99$) and 16% effusions ($p>0.99$) in the non-throwing arm.

CONCLUSIONS: High school pitchers have changes in their throwing arms that can be seen on DUS evaluation including posteromedial olecranon spurring and effusions. However, these younger athletes lack findings seen in professional and collegiate pitchers such as UCL thickening, UCL substance heterogeneity, and increased ulnohumeral joint space laxity. Our findings suggest that these changes may have not yet developed in the high school pitcher.

Combined ACL/MPFL Tears in Pediatric and Adolescent Patients Rarely Lead to Recurrent Patellar Instability

Abstract ID: Poster 014

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*T. David Luo, M.D. / Rochester, MN
Amy L. McIntosh, M.D. / Dallas, TX
Mark S. Collins, M.D. / Rochester, MN
Diane L. Dahm, M.D. / Rochester, MN

INTRODUCTION: Anterior cruciate ligament (ACL) tears are often associated with other knee injuries in adolescent patients, including medial patellofemoral ligament (MPFL) tears. The purpose of this study was to quantify the incidence of combined ACL/MPFL tears in pediatric and adolescent patients and to compare outcomes to patients who sustained isolated ACL tears.

METHODS: We identified all patients 18 years of age or younger who underwent primary ACL reconstruction between 1999 and 2010 at our institution. Patients with combined ligament injuries (MCL, LCL, PCL) requiring repair or reconstruction were excluded. Preoperative MRI scans were reviewed by a board-certified musculoskeletal radiologist for the presence, location, and severity of MPFL tears and for associated injuries to the superficial and deep MCL. Outcomes were assessed using the Kujala score and the IKDC pediatric knee score at most recent follow-up. Physical examination findings were documented for signs of recurrent patellar instability.

RESULTS: During the study period, 228 patients met inclusion criteria (87 males, 141 females), with a mean age of 16.1 years, (range 11.4-18.0). Of these, 63 patients (28%) had evidence of MPFL injury on MRI, including 45 low-grade partial (71%), 16 high-grade partial (25%), and 2 full-thickness tears (3%). All of the tears involved the MPFL femoral third, while 12 of the tears (19%) extended to the MPFL mid-substance. None of the MRI scans showed signal abnormalities in the lateral femoral condyle or medial patellar articular surface indicative of patellar dislocation. On MRI, the superficial MCL was injured in all patients (37 low-grade partial, 22 high-grade partial, and 4 full-thickness tears) in the MPFL group. Of the 165 patients with no evidence of MPFL injury, 19 (12%) had tears of the superficial MCL ($p<0.001$). The deep MCL was injured in 57 patients (90%) in the MPFL group and in 27 (16%) in the non-MPFL group, all involving the meniscofemoral component ($p<0.001$). At mean follow-up of 2.8 years, only 2 of 63 patients (3.2%) with MRI evidence of MPFL injury had documented recurrent patellar instability. There was no significant difference in the Kujala score (out of 100 points) and IKDC pediatric knee score (out of 92 points) between patients with and without MPFL tears (96.5 vs. 96.9, $p=0.25$; 88.9 vs. 89.3, $p=0.37$).

DISCUSSION AND CONCLUSION: MPFL tears are commonly associated with ACL tears in pediatric and adolescent patients, but rarely cause clinical patellar instability. No difference in Kujala or IKDC pediatric knee scores are seen between patients with and without MPFL tears in the setting of ACL reconstruction.

The Anteromedial and Posterolateral Bundles of the Human ACL Have Different Material and Microstructural Properties

Abstract ID: Poster 015

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*Nathan W. Skelley, M.D.
Ryan M. Castile, B.S.
Timothy York, Ph.D.
Viktor Gruev, Ph.D.
Spencer P. Lake, Ph.D.
Robert H. Brophy, M.D.
St. Louis, MO

BACKGROUND: Previous biomechanical studies of the anterior cruciate ligament (ACL) did not evaluate microstructural material properties of the ligament during dynamic testing. The current study utilizes a novel polarized light technique to simultaneously map the material and microstructural properties of the anteromedial (AM) and posterolateral (PL) bundles of the ACL under dynamic mechanical testing to test the hypothesis that tissue properties vary between bundles.

METHODS: Sixteen intact human cadaver ACLs (11 male, 5 female) average age of 41 (Range: 24-53) were dissected to isolate the AM and PL bundles. Samples were taken from 3 regions in each bundle and individually loaded in uniaxial tension. During testing, a custom-built polarized light imaging camera was used to quantify collagen fiber alignment in real-time. The mechanical test protocol consisted of preconditioning, stress-relaxation, and a quasi-static ramp-to-failure. Peak/equilibrium stress values and percent relaxation were computed for the stress-relaxation tests. A bilinear curvefit was applied to the stress–strain data of the ramp-to-failure to quantify the modulus in the toe and linear regions. Fiber alignment was quantified at zero-strain, at the transition point of the bilinear fit, and in the linear portion of the stress-strain curve by computing the degree of linear polarization (DoLP) and angle of polarization (AoP), measures of the strength and direction of collagen alignment, respectively. Data were compared using t-tests.

RESULTS: The AM bundle had a significantly higher peak stress (.37MPa vs. .26MPa, p=.02) and equilibrium stress (.25MPa vs. .17MPa, p=.01) than the PL bundle, but lower relaxation percentage (32.7% vs. 36.2%, p<.01). AM samples exhibited significantly larger toe- (11.0MPa vs. 4.6MPa, p<.001) and linear-region moduli (47.1MPa vs. 25.2MPa, p=.006) than PL samples. DoLP values were similar at low strain, but were significantly larger (i.e., more uniform alignment) for the AM bundle in the linear region (.22 vs. .19, p=.04). AoP standard deviation values were larger for the PL samples at both transition (p=.04) and linear-region strain (p=.01), demonstrating more disperse fiber orientation than the AM samples.

CONCLUSION: We discovered significant differences between the material and microstructural properties of the AM and PL bundles of the ACL. The AM bundle possessed greater tissue strength and stiffness while the PL bundle demonstrated more stress relaxation. The AM bundle also exhibited greater fiber alignment under load. These insights provide greater understanding of functional tissue anatomy, may help optimize surgical techniques, and can assist in the design of novel grafts and bioscaffolds for ACL reconstruction.

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TRAUMA

IVC Filter Placement for Pulmonary Embolism Prophylaxis in Patients with Pelvic Fractures

Abstract ID: Poster 016

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*Hariharan V. Iyer, B.S.
David E. Mossad, B.S.
Leslie E. Schwindel, M.D.
Rajeev Garapati, M.D.
Chicago, IL

INTRODUCTION: Pelvic fractures are considered orthopedic emergencies due to the extensive bleeding and trauma associated with this type of injury. Patients who have sustained pelvic fractures have been found to have an increased risk of deep venous thrombosis (DVT). Associated pulmonary embolisms (PE) have been found in 0.5 to 8.3 percent of patients according to various studies. It has been postulated that preventing PEs using anticoagulation or IVC filters may improve morbidity and mortality associated with pelvic fractures. The purpose of this study was to compare outcomes of patients with IVC filters placed after sustaining a pelvic fracture against patients who did not.

METHODS: The population in the National Hospital Discharge Survey (NHDS) database was searched using International Classification of Diseases - Ninth Revision (ICD-9) procedure codes for patients admitted to U.S. hospitals for pelvic fractures for the years 2001-2010. Patients were then separated into two groups: patients who received IVC filters and those who did not. ICD-9 diagnosis and procedure codes were used to identify patient demographics, hospital length of stay (LOS), development of DVTs and PEs, and discharge disposition. Statistical comparisons were made using Student's t-test and chi-square analysis for proportions with a significance level of 0.05.

RESULTS: 7,475 patients were identified, consisting of 217 with IVC filters and 7,258 without IVC filters. The IVC filter group had a significantly higher percentage of males (40.1% vs. 35.1%, $p=0.02$) and was significantly younger (60.0 vs. 64.5, $p<0.01$). The average LOS was longer for the IVC filter group (12.1 days vs. 7.3 days, $p<0.01$). The IVC filter group had a significantly higher rate of DVT (2.3% vs. 0.8%, $p=0.03$) and transfusions (18.4% vs. 7.8%, $p<0.01$). There was no significant difference in PE between the IVC filter (1.4%) and non-IVC filter (0.7%) group. In the IVC filter group, less people went home (21.7% vs. 32.8%, $p<0.01$), less people went to rehabilitation (35.0% vs. 42.7%, $p=0.03$), and more people suffered mortality (18.0% vs. 2.7%, $p<0.01$).

CONCLUSIONS: While not statistically significant, there was interestingly a higher incidence of PE in the IVC filter group. With respect to discharge disposition, higher percentages of patients in the IVC group suffered fatal complications and fewer patients went home or to rehabilitation. This data suggests that IVC filters are of no added benefit to patients at risk for PEs, and that it is better to pursue other methods of anticoagulation if they are available.

Anatomic Reduction of Acetabular Fractures – When is the Best Time to Operate?

Abstract ID: Poster 017

Steven K. Dailey, M.D. / Cincinnati, OH
Caleb Phillips, Ph.D. / Boulder, CO
Joseph M. Radley, M.D. / Cincinnati, OH
*Michael T. Archdeacon, M.D. / Cincinnati, OH

INTRODUCTION: Quality of reduction following surgical intervention for displaced acetabular fractures correlates with functional outcomes. The purpose of this study was to stratify the timing of surgical intervention as it relates to quality of reduction for acetabular fractures.

METHODS: This is an IRB-approved evaluation of a prospectively-collected acetabular fracture database from a single surgeon. Acetabular fractures treated via ORIF between 2001 and 2014 were assessed using postoperative radiographs (AP and Judets) and intraoperative fluoroscopy. Displacement of ≤ 1 mm was considered an anatomic reduction, 2-3 mm imperfect (IMP), and > 3 mm poor (PR). A total of 729 acetabular fractures were treated with ORIF, of which 79 underwent percutaneous fixation in situ and were excluded, leaving a cohort of 650. The primary outcome measurement was quality of reduction vs. the interval from injury to ORIF (OR interval). Secondary outcome measurements included demographic and injury characteristics. Statistical analysis was performed using the pairwise Wilcoxan rank-sum test and logistic regression analysis.

RESULTS: There were no statistically significant differences between anatomic reductions and non-anatomic reductions (IMP, PR) in regards to gender, body mass index, mechanism of injury, use of skeletal traction, marginal impaction, wall comminution, or femoral head injury ($p>0.05$). Non-anatomic reduction was related to increased age, increased injury severity score, fracture pattern, surgical approach, no hip dislocation, and increased OR interval ($p<0.05$). Anatomic reductions were observed in 85% (n=553) of cases, IMP reductions in 11% (n=74), and PR reductions in 4% (n=23). Anatomic reductions had significantly shorter OR intervals (median, 3 days) when compared to either IMP (median, 4.5 days, $p=0.02$) or PR reductions (median, 7 days, $p<0.001$). The OR interval of IMP reductions was also significantly shorter than that of PR reductions ($p=0.02$). The greatest decrease in the probability of achieving anatomic reduction occurred within the first five days from injury. Logistic regression analysis demonstrated that OR interval was the most significant factor affecting quality of reduction with an effect of -0.12, meaning that the log odds of anatomic reduction decrease by 0.12 each day from injury to operative intervention. Using a combined model to compare all significant numerical variables, OR interval had a 4X greater log odds effect for predicting reduction quality (anatomic vs. non-anatomic).

CONCLUSION: The OR interval of acetabular fractures affects quality of reduction: earlier intervention (<5 days) improves the probability of achieving an anatomic reduction.

CT Scan After Acetabulum Fracture ORIF – Is There Value?

Abstract ID: Poster 018

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*Michael T. Archdeacon, M.D.
Steven K. Dailey, M.D.
Kaylan N. McClary, B.S.
Cincinnati, OH

INTRODUCTION: The purpose of this study was to evaluate the efficacy of routine postoperative computed tomography (CT) scan following open reduction and internal fixation of acetabular fractures. We hypothesized that postoperative CT scan following acetabular fracture fixation would identify surgically correctable factors not identified with intraoperative fluoroscopy or plain radiographs.

METHODS: A total of 606 consecutive patients that underwent surgical fixation of 612 acetabular fractures were identified from a prospectively-collected acetabular fracture database. All patients were evaluated with intraoperative fluoroscopy in addition to three standard plain radiographs (AP pelvis and two 45° oblique Judet views). Reduction and fixation were felt to be adequate and definitive prior to exiting the operative suite based on these imaging modalities. Routine postoperative CT scan of the pelvis was obtained in 563 (93%) of the patients following 569 operative cases. Medical records were reviewed to determine whether postoperative CT scan results prompted revision surgery.

RESULTS: There were no significant differences between index and revision surgery groups in regards to age, gender, body mass index, fracture pattern, mechanism of injury, or surgical approach ($p > 0.05$). Evaluation of 563 postoperative CT scans of the pelvis resulted in revision acetabular surgery for 2.5% of patients (n= 14). There were six (1.1%) cases of intra-articular hardware not recognized on the intraoperative fluoroscopy or pelvic radiographs. Four (0.7%) patients had residual intra-articular osteochondral fragments deemed too large to leave in the hip joint. There were three (0.5%) cases of unacceptable malreduction, and one (0.2%) case of both malreduction and an intra-articular osteochondral fragment.

CONCLUSION: A small percentage (2.5%) of patients will benefit from a routine CT scan following acetabular fracture fixation.

The Effect of Acetabular Fracture Pattern on Short-Term Complications After Operative Treatment

Abstract ID: Poster 019

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*George Ochenjele, M.D.
Shobhit V. Minhas, B.S.
Bryant Ho, M.D.
Paul J. Switaj, M.D.
Michael D. Stover, M.D
Anish R. Kadakia, M.D.
Chicago, IL

INTRODUCTION: Operative treatment of acetabular fractures is associated with a high rate of complications. We sought to clarify how these complications varied based on specific fracture patterns in isolated operative acetabular fractures.

METHODS: A retrospective review of all isolated closed acetabular fractures treated with open reduction internal fixation from 2006 to 2012 was conducted using the American College of Surgeon's National Surgical Quality Improvement Program (NSQIP) database. Patients were categorized into three subgroups based on the Current Procedural Terminology (CPT) codes consisting of acetabular wall fractures (group 1), single column or transverse fractures (group 2), and fractures involving both columns, including T-type, single column or transverse fracture with associated wall fracture (group 3). Demographic data, total operative time, medical complications, postoperative transfusion requirement, reoperation, and death were evaluated and compared between subgroups using Pearson chi-squared analysis and analysis of variance (ANOVA).

RESULTS: A total of 233 patients were analyzed. Complications included surgical site infection or dehiscence (3.43%), major medical complications (11.16%, including pulmonary embolus rate of 1.29%), postoperative transfusion requirement (26.61%), reoperation (3.00%), and death (4.72%). Patients with anterior or posterior wall fractures were significantly younger (p=0.024) and had significantly shorter average operative times (p=0.002). Patients with single column or transverse fractures had the highest rates of postoperative transfusion (p=0.049) while patients with fractures involving both columns; single column or transverse fracture with associated wall fracture had the highest rates of death (p=0.025). Medical complications, surgical site complications, and reoperation did not differ between fracture types. Increased operative time was independently associated with postoperative transfusion requirement (P=0.015), but not with medical complications or death.

CONCLUSION: While single column or transverse fracture patterns were associated with the highest postoperative transfusion requirements and the longest operative time, both column fractures were associated with the highest 30-day mortality. Additionally, operative time was independently associated with increased postoperative transfusion requirements, but not with medical complications or mortality.

‘Two Finger Tightness’: What Is It?

Abstract ID: Poster 020

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*William B. Acker, II, M.D.
Bruce Tai, Ph.D.
Barry Belmont, M.S.
James R. Holmes, M.D.
Albert Shih, Ph.D.
Ann Arbor, MI

PURPOSE: Optimal torque application to properly seat screws is an integral step in the process of applying hardware constructs that maximize fracture stabilization to promote fracture healing. Residents in training are often directed to insert screws utilizing ‘two-finger tightness’ to impart adequate torque, but minimize the chance of a screw stripping in bone. This study seeks to quantify and describe ‘two finger tightness’ and assess the variability of its application by residents in training.

METHODS: Cortical bone was simulated using a polyurethane foam block (30 pcf density) that was prepared with pre-drilled holes for tightening 3.5 mm by 14 mm long cortical screws and mounted to a custom built apparatus on a load cell to capture torque data. 32 residents in training, ranging from the first through fifth years in residency, along with eight staff members, were directed to tighten six screws to ‘two-finger tightness’ in the test block and peak torque values were recorded. The participants were blinded to their torque values.

RESULTS: Averaged torques (N-m) and standard deviations as a function of year in residency are shown in Fig. 1a (the number of participants is noted in each level). Stripping torque, (2.73±0.56 N-m) was determined from 36 trials and served as a threshold for failed screw placement. The averaged torques varied substantially with regard to absolute torque values, thus poorly defining ‘two-finger tightness.’ Fig. 1b shows the coefficient of variation (CoV), or ability to reliably reproduce equal torque. Junior residents were less consistent reproducing torque (0.29 and 0.32, respectively) compared to other groups.

CONCLUSIONS: This data quantifies absolute values of ‘two finger tightness’ ,but demonstrates considerable variability in absolute torque values, percentage of stripping torque, and in ability to consistently reproduce given torque levels. Increased years in training are weakly correlated with reproducibility, but experience does not appear to affect absolute torque levels. This data calls into question the usefulness of ‘two-finger tightness’ as a teaching tool and highlights the need for improvement in resident motor skill training and development within a teaching curriculum. Torque measuring devices may be a useful simulation tool for this purpose.

Figure 1. The (a) torques and (b) coefficients of variation for residents by years in training.

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Antegrade vs. Retrograde Femoral Bone Graft Acquisition Using the Reamer-Irrigator-Aspirator

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Abstract ID: Poster 021

Richard L. Davis, II, M.D.
*Jason R. Ferrel, M.D.
Nathan Johnson, B.S.
Joaquin A. Castaneda, M.D.
Benjamin C. Taylor, M.D.
Columbus, OH

INTRODUCTION: Autologous bone graft harvesting using the reamer-irrigator-aspirator (RIA) has been proposed as an alternative to using iliac crest bone graft (ICBG). The currently described benefits include the potential to obtain a large volume of graft with less morbidity to the patient as compared with ICBG. The purpose of this study was to compare retrograde vs. antegrade femoral bone graft acquisition using the RIA system to investigate whether there was any difference in intraoperative, postoperative, or patient outcome variables.

METHODS: We retrospectively reviewed 94 (62 antegrade and 32 retrograde procedures) consecutive adult patients who underwent femoral autologous bone graft harvesting using the Synthes RIA system between April 2008 and March 2013. Multiple demographic, intraoperative, postoperative, and follow-up variables were collected.

RESULTS: There was no significant difference between sex, age, employment status, tobacco use, or medical comorbidities between the antegrade and retrograde groups. There was no significant difference in the side of the graft harvest, graft volume, hospital length of stay, or the ability to ambulate on postoperative day one. No wound complications were seen from the donor site. Graft acquisition from an ipsilateral extremity injury was seen in approximately half of the patients. There was a significantly increased incidence of iatrogenic fracture or prophylactic nailing with antegrade reaming (4 vs. 0, p=0.01). Average length of follow-up was 500 days for the antegrade group and 378 days for the retrograde group. The antegrade group had a non-significant increased incidence of hip pain (8.1% vs. 3.1%, p=0.66). The retrograde group likewise had a significantly higher incidence of knee pain (15.6% to 1.6%, p=0.02). All complaints of hip and knee pain resolved during the follow-up periods and did not seem to produce any long-term sequelae. No cases of delayed femur fracture, infection, or abductor and/or antalgic gait involving the donor extremity were seen at final follow-up.

CONCLUSION: The current study provides support to the safety and efficacy of femoral bone graft harvesting using both antegrade and retrograde techniques. Both techniques provide reliable, high-volume, nonstructural autologous bone graft with minimal associated morbidity.

An Assessment of Mortality in Patients with Pelvic Fractures: A Population-Based Study

Abstract ID: Poster 022

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*Alesha Scott, D.O.
Rahul Vaidya, M.D.
Frederick E. Tonnos, D.O.
Ian Hudson, D.O.
Paul J. Dougherty, M.D.
Bryant W. Oliphant, M.D.
Detroit, MI

PURPOSE: We sought to investigate timing of mortality in patients with pelvic fractures to determine the cause of death, similarities in demographic data, fracture patterns, and evaluate how management of these patients fits in with the current Journal of the American Academy of Orthopaedic Surgeons recommendations for treatment at our institution.

METHODS: There were 867 total patients with pelvic fractures that were treated at our Level I trauma center from 1999 to 2013, 130 of whom died. Thirty-eight patients were listed as dead on arrival (DOA). Twenty-three patients suffered a pelvic fracture secondary to gunshot wound and died due to hemorrhage associated with vascular and abdominal injuries. These patients were excluded from the study. Sixty-nine patients who arrived to the ER with blunt trauma in addition to a pelvic fracture, and died during their hospital admission were included in our analysis. Fractures were classified using the AO/OTA system.

RESULTS: 69 with pelvic fracture (8%) died a median of 24 hours and 37 minutes after admission. The leading cause of death within 6 hours was thoracic, abdominal, and pelvic bleeding (22/26), between 6 and 24 hours was head injury (8/11), and after 24 hours was Multiple Organ Dysfunction Syndrome (14/32). The most common methods of injury were automobile vs. pedestrian collision and motor vehicle collision. The fracture patterns were consistent with AO/OTA Types 61-C2 (30%), 61-C3 (17%), 61-A2 (16%), 61-C1 (14%), 61-B1 (4%), 61-B2 (1%), and 16% were unclassifiable due to massive hemorrhage and emergent operative treatment. Other risk factors for mortality we found were male gender and mean ISS score 34±11.3. Patients who died due to thoracic, abdominal, and pelvic bleeding (159 mins) were found to have a shorter survival time as compared to head injury (1101 mins) ($P<0.0035$) or MSOF which was statistically significant. Survival time was not found to be significantly different between OTA fracture groups ($p<0.12$) or ISS scores. Only 2 patients died of isolated Pelvis Hemorrhage which was a relatively rare event.

CONCLUSIONS: We conclude that our trauma center's acute management for closed pelvic fractures follows the standardized guidelines proposed by the JAAOS. Patients who present with pelvic fractures and die usually have additional injuries to the head, solid organ damage, or vascular injuries.

Combined Total Hip Arthroplasty with Open Reduction and Internal Fixation of Acetabular Discontinuity

Abstract ID: Poster 023

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*Clayton E. Strong, M.D.
David W. Anderson, M.D., M.S.
John M. Sokja, M.D.
Kansas City, KS

INTRODUCTION: Elderly patients with acetabular discontinuity due to acute fracture or bone loss from previous untreated fractures present a unique clinical challenge because of medical comorbidities, decreased physiological reserve, reduced healing capacity, osteopenic bone, and atypical fracture patterns. There are many treatment options, including combined total hip arthroplasty and open reduction and internal fixation of acetabular discontinuity. Advantages of single-stage procedure include faster recovery and the potential avoidance of problems that can occur with delaying THA. The primary disadvantages include simultaneously obtaining both implant and fracture stability, in addition to the comorbidity expected with a longer, more complex procedure. This study aims to retrospectively review patients who underwent a combined ORIF of the acetabulum and THA procedures at the same setting and to compare them to the cost difference and outcomes of a staged procedure.

METHODS: A retrospective chart review was performed on 56 consecutive patients undergoing combined THA and acetabular ORIF for pelvic discontinuity at a Level I trauma center. Patients were assessed for comorbidities, mortality, length of hospital stay, transfusion rate, both 90-day and 1-year reoperation rate, and discharge disposition. Cost difference was assessed using CPT coding and average total billing for procedure and hospital stay. Comparison was made using comparable single stage procedures (conversion from previous hip surgery, revision THA, and acetabular ORIF) performed by the same surgeons in the same institution.

RESULTS: Four patients were lost to follow-up. Results of the combined procedure were similar to published results of revision THA in terms of blood loss, transfusion rate, mortality, nerve injury, dislocation, periprosthetic fracture, and infection. Loss of implant stability and deep implant failure occurred in three patients. There appears to be three times higher cost difference between a two stage vs. single stage procedures when including procedure cost and associated hospital charges.

CONCLUSION: Short-term results of combined total hip arthroplasty and ORIF suggest that it is a safe and cost-effective option for elderly patients with acetabular discontinuity due to fracture or acetabular bone loss.

A Single-Person Reduction and Splinting Technique for Lower Extremity Injuries

Abstract ID: Poster 024

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*Nathan W. Skelley, M.D.
William M. Ricci, M.D.
St. Louis, MO

OBJECTIVES: Ankle injuries are one of the most common orthopedic conditions treated in the emergency department. Initial reduction and splinting techniques of these injuries is variable and can place undue stress on the physician and cause patient discomfort. Novice and experienced practitioners have had to repeat splint application because of poor preparation, variable assistant experience, loss of fracture reduction, and improper application. We present a single-person reduction and splinting technique that can be utilized to facilitate lower extremity trauma care.

SETTING: Level I Trauma Center.

PATIENTS: Population included 51 patients (25 female, 26 male) with age range 11-85, seen in the emergency department at a Level I trauma center with ankle or foot injuries requiring reduction and/or splinting of the injured extremity.

INTERVENTION: A modified Quigley's technique for ankle reduction and splinting that can be performed by a single-physician without assistance.

MAIN OUTCOME MEASUREMENTS: Outcome measures included patient demographics, injury type, pain scores, satisfactory reduction on radiographs, toe perfusion, need for re-splinting, and pain medication utilization.

RESULTS: No patients slipped from the suspension construct. The technique was successful in reducing 96% (49/51) of injuries. Patients pain was appropriately controlled with pain medications during the procedure. No neurovascular issues were reported with this technique.

CONCLUSIONS: This technique can be safely performed entirely by one practitioner, places the patient in a comfortable position, and is applicable to the wide range of ankle and foot injuries.

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Using Physiologic Age to Predict Clinical Outcome and Activity Level After Acetabular Fracture Fixation

Abstract ID: Poster 025

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*Ong-art Phruetthiphat, M.D.
Chamnanni Rungprai, M.D.
Nathan A. Nicholson, M.D.
Matthew D. Karam, M.D.
Brian O. Westerlind, B.S.
Yubo Gao, Ph.D.
J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: There are multifactorial for prediction outcomes in patients with acetabular fracture. Age group is considered to be an important factor due to the quality of bone stock. The primary purpose of this study was to compare functional outcomes and level of activity between young and old age patients following acetabular fixation. The secondary purpose was to demonstrate the correlation of fracture patterns and functional outcomes in each age group.

METHODS: A retrospective chart review of 117 hips who underwent acetabular fixation between 2007 and 2013 was obtained regarding age, sex, BMI, pre/post-injury activity level by METS; Metabolic Equivalents in Exercise Testing, fracture patterns, functional outcomes (SF-36, WOMAC score, Visual Analogue Score [VAS]), and complications. The young age was defined as age was less than 55 years old while old age was 55 or older than 55 years old. Pre-injury activity level was mainly moderate in both groups according to METS (74.7% vs. 71.4%).

RESULTS: Length of hospital stay was 3 days longer in the young age (12 vs. 9 days). Average VAS in young age was higher than old age at 1 year follow-up (4.17 vs. 3.38, p=0.281). Mean SF-36 of both physical (PCS, p=0.655) and mental component (MCS, p=0.247) in old age (32.5 and 46.9) were higher than young age (30.8 and 43.1). Mean affected hip score (p=0.172) and post functional score (p=0.754) of WOMAC in old age (67.59 and 55.10) were higher than young age (58.97 and 53.27). Conversely, mean stiffness score (p=0.701) of WOMAC in old age (52.44) were lower than young age (54.46). Postoperative level of activity by METS at 1-year follow-up was mainly low in both groups (62.7% vs. 51.7%). Both SF-36 (PCS; 33.1 vs. 29.9 and MCS; 47.2 vs. 38.9) and mean affected hip score (71.3 vs. 56.4), stiffness (69.3 vs. 48.1), and post functional score (64.6 vs. 51.4) of WOMAC in Associated fractures were higher than Elementary fractures in young age. Conversely, PCS (29.1 vs. 37.4) of SF-36 and mean affected hip score (54.7 vs. 79.2), stiffness (50 vs. 53.2), and post functional score (46.9 vs. 64.5) of WOMAC in Associated fractures were lower than Elementary fractures in old age.

CONCLUSION: Most of postoperative functional outcome in old age was slightly better than young age, except stiffness of hip. Both groups were mainly in low level of activity at final follow-up. Fracture patterns can predict functional outcome only in old age patients in mid-term follow-up.

Extra-Articular Gunshot Wounds to the Tibia and Fibula

Abstract ID: Poster 026

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*Jeffrey J. Sundblad, M.D.
Anish Abrol, B.S.
Rahul Vaidya, M.D.
Paul J. Dougherty, M.D.
Detroit, MI

BACKGROUND: Fractures secondary to gunshot wounds continue to be a significant burden on our healthcare system. Gunshot tibia fractures (GST) are the second most common gunshot long bone fracture. There are limited reports within the last 20 years concerning the use of intramedullary rods for GST. The purpose of this study is to compare surgically stabilized GST with those treated with casting.

METHODS: We reviewed our prospective trauma database from 1999 to 2012 for all patients with a diagnosis of gunshot and tibia or fibula fracture. There were a total of 135 extraarticular fractures in 132 patients. We performed a retrospective review of the medical records for patient demographics, associated injuries, soft-tissue injuries, operative details, infections, and complications. Imaging was reviewed for fracture level, associated fibula fracture, fracture description, quality of reduction, and healing. Infection was defined as requiring a return to the operating room for irrigation and debridement. Healing was judged as bridging callus of at least 3 of 4 cortices on orthogonal views. Acceptable fracture alignment was <5° of varus/valgus, <10° procurvatum/recurvatum, >50% cortical apposition, <10° of malrotation, and <1 cm of shortening.

RESULTS: There were 100 tibia fractures and 35 isolated fibula fractures. Operative stabilization was used to treat 70/100 tibial fractures. There was an 18% incidence of compartment syndrome in GST, and 22.9% in isolated fibula fractures. There were more compartment syndromes in combined tibia and fibula injuries than in isolated GST (p=0.0349). There were 14 total nerve injuries and 11 arterial injuries. 6 of 11 patients with a vascular injury developed a compartment syndrome (p=0.0057). 18/136 patients (13.2%) developed wound infections. Average BMI was higher in those who developed an infection (33.6) than in those who did not (26.44, p=0.0195). There were 52 comminuted fractures treated with either an IMN (36/52) or nonoperatively (16/52). There were 18 segmental GST in the IMN group and 0 in the nonoperative group (p=0.0004). The IMN group had 3 malunions, all of which were initially malreduced, while 1 of 2 malunions in the nonoperative group lost an initially acceptable reduction. Patients rarely followed up to radiographic union.

CONCLUSIONS: This study contains a larger group of patients treated operatively for GST than any other known series in the literature. Our surgeons tended to operate more frequently on more severely comminuted fractures. Malunions in the IMN group were due to unacceptable alignment at the time of definitive fixation.

Outcome of Periprosthetic Femoral Fractures with Retained Total Hip Arthroplasty Treated with a Polyaxial Locking Plate

Abstract ID: Poster 027

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*Martin F. Hoffmann, M.D.
Sebastian Lotzien, M.D.
Thomas A. Schildhauer, M.D.
Bochum, Germany

According to the AAOS, more than 193,000 total hip replacements are performed each year in the U.S. Femoral fractures are not common, but occur in 0.1% to 6% of all patients who have THR. Therefore, approximately 10,000 periprosthetic femur fractures need treatment annually with the majority (75%) occuring at the tip of the stem (Vancouver type B1). Most recently, plates that allow for angling of the screws around the implant shaft proximally have been introduced. The purpose of this study was to evaluate a large series of polyaxial locking plate treatment of periprosthetic femoral fractures after THR.

METHODS: Over an 8-year period, 2005-2012, 77 consecutive periprosthetic femoral fractures (AO/OTA 32) following THR from one academic trauma center were retrospectively identified as having been treated with polyaxial locked plate fixation. Of these, 51 fractures in 51 patients (62.7% female) met the inclusion criteria. 26 patients (33.7%) were excluded due to the prevalence of additional TKR. Patients had an age of 76.0 years (range 44-93 years) and a BMI of 27.1kg/m^2 (19.5-38.9kg/m^2). Fourteen patients (27.4%) previously had a revision THA. Fixation constructs for plate and working length were delineated. Demographics were assessed. Nonunion, infection, and implant failure were used as complication variables.

RESULTS: All patients were treated operatively. 43 fractures (84.3%) healed after the index procedure. 9/51 (17.6%) underwent additional surgeries related to infection (5) 9.8%, nonunion (2) 3.9%, one hardware failure (2.0%), and one patient with plate removal due to symptomatic hardware (2.0%). Additional surgeries were performed after 177 days. Hospital stay was 15.5 days. Operative time was 124 minutes (20–258 minutes). For technical aspects, 30 patients (58.8%) were treated with distal femur plates, 20 patients (39.2%) were treated with periprosthetic plates, and in 1 patient (2.0%), a periprosthetic distal femur plate (NCB-PP-DF) was utilized. Plate length was 307.8 mm (238-363 mm). Working length averaged 62.3 mm (0-170.6 mm) with additional lag screws (8%) and cerclages (54%). A submuscular technique was utilized in 12%. Fourteen patients (27.4%) previously had a revision THA with 5 patients (35.7%) requiring additional surgeries related to infection (3) in 21.4%.

CONCLUSION: Modern periprosthetic plates offer a wide variety of fixation techniques. Polyaxial locking plates allow for screw angling around intramedullary implants and lead to reliable union rates (84.3%). Previous revision THR double the incidence of infections and redo-surgeries. We believe that the outcomes in this series justify the continued use of this treatment method for Vancouver Type-B1 periprosthetic fractures.

Modern periprosthetic plates offer a wide variety of fixation techniques. Polyaxial locking plates allow for screw angling around intramedullary implants and lead to reliable union rates (84.3%). Previous revision THR double the incidence of infections and redo-surgeries.

We believe that the outcomes in this series justify the continued use of this treatment method for Vancouver Type-B1 periprosthetic fractures.

Articular Fractures of the Distal Humerus: Results of Internal Fixation

Abstract ID: Poster 028

Suenghwan Jo, M.D.
Jose Jimenez Almonte, M.D.
Mark E. Morrey, M.D.
*Joaquin Sanchez-Sotelo, M.D.
Rochester, MN

BACKGROUND: Fractures of the articular surface of the distal humerus without extension into the humeral columns range in severity from isolated fractures of the capitellum to more complex patterns extending into the trochlea or epicondyles. Controversy remains regarding exposure, fixation methods, overall outcome, and risk of avascular necrosis, nonunion, or post-traumatic arthritis. The purpose of this study was to define the epidemiology and outcome of internal fixation for articular fractures of the distal humerus without extension proximal to the olecranon fossa.

METHODS: Between 1993 and 2012, 1101 consecutive distal humerus fractures were treated at our institution. Review of the medical records and imaging studies identified 42 fractures of the articular surface of the distal humerus with no extension into either the medial or the lateral column proximal to the olecranon fossa that were treated with open reduction and internal fixation. There were 36 females and 6 males with a mean age of 51.3 years (range 16 to 85 years). Thirty-four patients sustained injuries after a fall from a standing height while 8 fractures occurred as a result of high-energy trauma. Isolated fractures of the capitellum were the most common fracture type (43%); 21 fractures were multifragmentary. Associated injuries occurred in 12 elbows (28%), including ligamentous injuries (5), radial head fractures (5), olecranon fractures (4), and one coronoid fracture. Internal fixation was performed using screws in 19 elbows and plates in 23 elbows. Fractures were exposed laterally in 31 elbows and through an olecranon osteotomy in 11 elbows. The ulnar nerve was transposed in 14 elbows. Patients were followed for a mean of 10.5 years.

RESULTS: Articular fractures of the distal humerus accounted for 3.9% of all distal humerus fractures. At most recent follow-up, union had been achieved in all elbows. The average range of motion including a flexion-extension arc of 108°, and a pronation-supination arc of 163°; 16 elbows failed to achieve a functional arc of motion. Complications included infection (3), transient neuropathy (6), heterotopic ossification (4), hardware irritation (3), and avascular necrosis (1).

CONCLUSIONS: Articular fractures of the distal humerus represent approximately 4% of all distal humerus fractures. About 40% of these fractures involve only the capitellum, but many injuries are more extension and multifragmentary, and associated injuries may be identified in up to one third of the elbows. Internal fixation leads to union reliably, but a functional arc of motion is not universally restored.

Total Elbow Arthroplasty for the Salvage of Persistent Instability After Trauma

Abstract ID: Poster 029

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*Matthew C. Kergosien, M.D. / Beaumont, TX
Mark E. Morrey, M.D. / Rochester, MN
Bernard F. Morrey, M.D. / Rochester, MN
Shawn W. O'Driscoll, M.D. / Rochester, MN
Joaquin Sanchez-Sotelo, M.D. / Rochester, MN

BACKGROUND: Elbow fracture dislocations may result in persistent elbow instability despite surgical treatment, due to a combination of radial head, coronoid, and ligamentous deficiencies. Reconstructive procedures for elbows presenting with static subluxation are seldom successful. Previous studies looking at elbow arthroplasty for instability have mainly included flail elbows or instability resulting from distal humerus nonunions. The purpose of this study was to determine outcomes and complications of total elbow arthroplasty when used specifically for persistent instability after elbow fracture-dislocations.

METHODS: Between 1999 and 2009, nine linked semiconstrained elbow arthroplasties were performed at our institution for persistent ulnohumeral instability following a terrible triad or trans-olecranon fracture dislocation. There were 6 females and 3 males with an average age of 62 years (range, 48-79). The average time between injury and elbow arthroplasty was 8 months. Six injuries were classified as terrible triads, one of which was open; and 3 were classified as trans-olecranon fracture dislocations, two of which were open. The average number of procedures prior to elbow arthroplasty was 1.9 (range, 0-4). Three patients underwent a primary two-stage elbow arthroplasty due to significant concern for infection. The average follow-up time was 7 years (range, 2 to 13 years).

RESULTS: At most recent follow-up, 3 elbows required a reoperation which included implant revision or removal in all 3. These 3 elbows required a total of 6 additional procedures. One patient required a one-stage revision of all components for aseptic loosening, the second patient required a two-stage revision for acute septic elbow 28 months after elbow arthroplasty, and the third has required 3 bushing exchanges during the 13 years since his initial implantation. The mean MEPS score was 90 points with 6 patients having an excellent result. 87.5% reported mild to no pain, and 62.5% considered their elbow much better. Flexion increased from 103°to 121° and extension increased from 39° to 32°. The overall infection rate was 11%.

CONCLUSIONS: Total elbow arthroplasty is a reliable salvage procedure for patients with persistent ulnohumeral instability, resulting in improved pain, motion, and outcome scores. However, reoperation rates remain high at 33%, and this condition represents a challenging problem due to mechanical failure and infection.

Suture Anchor Fixation of Displaced Olecranon Fractures in the Elderly

Abstract ID: Poster 030

Dexter Bateman, B.S. / Philadelphia, PA
*Jonathan D. Barlow, M.D. / Hudson, WI
Corinne VanBeek, M.D. / Philadelphia, PA
Joseph A. Abboud, M.D. / Philadelphia, PA

INTRODUCTION: Olecranon fractures are common in elderly patients, causing significant morbidity and functional impairment. Traditional surgical treatments are often complicated by hardware failure and prominence, frequently requiring reoperation. To address these concerns, a suture anchor fixation technique was developed and clinically evaluated.

METHODS: A consecutive series of elderly patients treated with this technique from January 1, 2006, to December 31, 2013, at a single institution was studied. All cases were surgically repaired using biocomposite fully threaded suture anchors in a double row fashion. Each patient was evaluated with a physical examination, radiographs, and the following clinical outcome measures: the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score; the Oxford Elbow Score (OES); and the Short-Form Health Survey (SF-12).

RESULTS: Nine female patients with Mayo IIA or IIB fractures were identified. The mean patient age at time of operation was 73.6 ± 10.0 years (range 59.3 – 88.8 years). The average time from injury to operation was 5.2 days ± 3.4 days. The average time from operation to long-term follow-up was 5.1 years ± 2.5 years (range: 0.8 – 7.4 years). Six patients were available for long-term follow-up. One patient had deceased, and two patients were unable to be contacted despite multiple attempts. There were no intraoperative complications or reoperations. Eight of nine patients healed uneventfully in acceptable position without displacement. Postoperatively, the average Oxford Elbow Score (OES) was 47.17 ± 2.04; the average QuickDASH score was 6.43 ± 9.47; and the average Short-Form Health Survey (SF-12) scores were 49.02 ± 16.59 and 55.38 ± 4.05 for the physical and mental component scales, respectively.

DISCUSSION AND CONCLUSION: Suture anchor fixation of olecranon fractures in the elderly population provides excellent long-term radiographic and clinical outcomes. Importantly, this technique reduces complications and reoperations for symptomatic hardware, as compared with traditional surgical treatments.

Plating of Pilon Fractures Based on the Orientation of the Fibular Shaft Component: A Biomechanical Study Evaluating Plate Stiffness in Cadaveric Fracture Models

Abstract ID: Poster 031

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*Gennadiy A. Busel, M.D.
J. Tracy Watson, M.D.
St. Louis, MO

BACKGROUND: The purpose of this study was to evaluate mechanically superior method of pilon fracture fixation by comparing axial stiffness between anterolateral and medial tibial locking plates in a cadaveric fracture model.

METHODS: Eight matched pairs of fresh frozen cadaver specimens (lower limb after through-knee disarticulation) were used to eliminate confounder of bone quality. Simulated pilon fractures were created so that each pair represented either varus or valgus fracture pattern (AO 43-A2) with associated fibular fractures (transverse or comminuted). Specimens were plated with anterolateral or medial locking plate and axial load applied, measuring displacement at the fracture site. Each lower extremity was tested with a fracture wedge in place and removed to mimic comminution. Average force at which failure occurred was compared between the two fixation methods, for varus and valgus fracture pattern respectively, with the use of a Mann-Whitney U test.

RESULTS: On average, medial plate fixation of varus fractures resulted in 2.27 times (range of 1.6-3.9) greater load prior to failure as compared to anterolateral plate. Similarly, valgus simulated fractures tolerated 1.6 times (range 1.12-2.34) higher force prior to failure if anterolateral plate was applied vs. medial plate. Analysis utilizing the Mann-Whitney U test for fracture patterns vs. plate configuration approached statistical significance ($p=0.081$ varus failure and $p=0.386$ valgus failure).

CONCLUSIONS: Lateral plate fixation is biomechanically superior for pilon fractures resulting from valgus force as evident by comminuted fibular fracture. Similarly, medial plate location resulted in improved stiffness in compression for varus type fractures, evident by transverse fibular fracture. We approached statistical significance; however, our lack of power regarding adequate sample size is an issue that is consistent with other biomechanical studies in this area. We demonstrated that surgical approach and plate location is crucial to provide superior biomechanical stability of the fracture construct. Proper plate location is another factor to help lower complications such as nonunion, malunion, and hardware failure in these complex injury patterns.

Narcotic Pain Medication Usage After Operative vs. Nonoperative Treatment of Proximal Humerus Fractures

Abstract ID: Poster 032

Cory M. Stewart, M.D.
Harpreet Bawa, M.D.
Lewis L. Shi, M.D.
*Douglas R. Dirschl, M.D.
Chicago, IL

INTRODUCTION: Fractures of the proximal humerus are some of the most commonly encountered fractures in orthopedics. Depending on the fracture pattern and patient factors, both operative and nonoperative treatments can yield good outcomes. This study seeks characterize pain control after operative and non-operative management of proximal humerus fractures. Secondary investigations include effect of adjuvant medications, treatment trends, and complications.

METHODS: A retrospective review of data from commercially insured patients was performed using Truven Health Marketscan® Research Databases. This is a national collection of paid inpatient, outpatient, and pharmaceutical claims for between 20 to 40 million patients per year. Data was reviewed for patients treated between 2003 and 2011. Patients were identified using Common Procedural Terminology (CPT) and International Classification of Diseases (ICD) codes.

RESULTS: Proximal humerus fractures were identified in 274,080 patients over the age of 16; 38,001 of these patients had complete prescription drug information and 6 months of follow-up data for assessing complications. Median durations of narcotic pain medication were 14 or 15 days in all operative groups and 7 days in the non-operative group ($p<0.0001$). In adjusted models of narcotics users, all operatively treated patients had significantly longer mean narcotic pain medication use (41.1-43.5 d) when compared to non-operative treatment (30.8 d, $p<0.0001$). Patients receiving adjuvant medications such as tramadol or gabapentin concomitant to narcotic pain medications had significantly higher adjusted days of narcotic use (51.0, 95% CI=[41.2-63.2] vs. 29.9 [24.2-36.9], $p<0.0001$). For modeling, patients were subdivided into <1 day of narcotic use, 1-7 days of narcotic use, and ≥8 days of narcotic use. Patients with longer narcotics use were more likely to have all-cause 30-day readmissions (OR for 1-7 days of narcotic use=1.27 [1.15-1.40] and OR for ≥8 d=2.00 [1.82-2.20]) and reoperations (OR for 1-7 d=2.29 [2.05-2.55] and OR for ≥8 d=3.55 [3.19-3.94]). Longer narcotic use was also associated with increased odds of deep venous thrombosis (OR for ≥8 d=1.29 [1.01-1.65]) and infection (OR for ≥8 d=4.12 [2.19-7.72]).

DISCUSSION AND CONCLUSION: Treatment of proximal humerus fractures remains a controversial subject. Recent literature demonstrates similar functional outcomes in patients treated either non-operatively or operatively with certain fracture patterns. From this study, patients treated operatively had significantly higher narcotic usage. Prolonged use of narcotics was associated with risk of readmission, reoperation, lower extremity deep venous thrombosis, and infection.

Total Hip Arthroplasty vs. Hemiarthroplasty for Displaced Femoral Neck Fractures: An Analysis of Complication Rates in 216,715 Patients from a National Database

Abstract ID: Poster 033

Min Lu, M.D.
*Jimmy J. Jiang, M.D.
Joseph B. Cohen, M.D.
Douglas R. Dirschl, M.D.
Hue H. Luu, M.D.
Chicago, IL

INTRODUCTION: Displaced femoral neck fractures can be surgically treated with either hemiarthroplasty or acute total hip arthroplasty (THA). Using a validated national database, the complication rates were compared between patients who underwent these two procedures.

METHODS: The International Classification of Diseases, 9th Revision (ICD-9) codes were used to identify patients who underwent hemiarthroplasty (ICD-9=81.52) or THA (ICD-9=81.51) for treatment of femoral neck fractures (ICD-9=820.0 or 820.8) from the Nationwide Inpatient Sample (NIS) database for years 2002-2011. The NIS database, developed as part of the Healthcare Cost and Utilization Project, is the largest all-payer hospital database in the United States and represents approximately 20% of all inpatient stays. The in-hospital complication rates, as well as demographics and comorbidities, were compared between patients treated with hemiarthroplasty and THA. Multivariate analysis was then performed to adjust for confounding patient characteristics and comorbidities in order to identify whether the type of surgical treatment was independently associated with a difference in postoperative complications. Statistical significance was defined as $p < 0.05$. A clinically significant difference was defined as a relative risk (RR) < 0.9 or > 1.1.

RESULTS: This retrospective analysis identified 196,854 patients who underwent a hemiarthroplasty and 20,861 patients who underwent a THA over ten consecutive years. The average age of the patients was 80.0 years for the hemiarthroplasty group and 75.7 years for the THA group ($p < 0.001$). Patients in the THA group incurred higher hospitalization costs ($57,443 vs. $48,919, $p < 0.001$), but were more likely to go home (20.9% vs. 10.4%, $p < 0.001$). Average length of stay was 6.50 days for the hemiarthroplasty group and 4.49 days for the THA group ($p = 0.049$). The average number of preoperative comorbidities was significantly higher in the hemiarthroplasty group (2.77 to 2.50, $p < 0.001$). After incorporating multivariate analysis to adjust for confounding factors, having a THA was associated with clinically and statistically significant differences in risk for dislocation (RR=3.721, 95% Confidence Interval [CI]=2.126-6.512), blood transfusion (RR=1.358, 95% CI=1.314-1.403), hematoma (RR=1.186, 95% CI=1.049-1.339), DVT (RR=1.156, 95% CI=1.010-1.323), and MI (RR=0.885, 95% CI=0.805-0.973).

CONCLUSION: We found that the higher incidence of postoperative medical complications in the hemiarthroplasty patients can be largely attributed to older age and higher comorbidity rates. When controlling for differences in these preoperative factors, having a THA was independently associated with higher risk of dislocation, blood transfusion, hematoma and DVT, and lower risk of myocardial infarction.

The Role of Fibular Fixation Following Plate Osteosynthesis in Distal Metaphyseal Tibia Fractures

Abstract ID: Poster 034

Ikemefuna Onyekwelu, M.D.
*Brent J. Sinicrope, M.D.
Craig S. Roberts, M.D., M.B.A.
John T. Riehl, M.D.
Michael J. Voor, Ph.D.
Louisville, KY

INTRODUCTION: Little data exists on the biomechanical role of fibular fixation when treating distal metaphyseal tibia fractures. Some believe it may be possible to stabilize a distal tibia fracture without fixing a concomitant fibula fracture. Others believe that fixing the fibula provides rotational stability. Our aim was to determine the effect of the fibula on distal metaphyseal tibia fracture stability after modern locked plating of the tibia under axial and torsional loading.

METHODS: Ten cadaveric legs (5 matched pairs) with a mean age of 74 years old (range 68-84) were used for this study. Distal tibia and fibula fractures were simulated via distal osteotomies, 3–5 cm above the tibial plafond, leaving a 1.0–1.5 cm defect to simulate an unstable fracture. Two coronal and two sagittal pins were placed above and below the fracture site to measure relative motion and displacement. An MTS machine applied simultaneous axial (70 N) and torsional (0.3 N-m) loads to simulate combined load at toe-off under rehab conditions. The displacements measured were: Axial Displacement, Axial Rotation, Coronal Plane Bending, and Sagittal Plane Bending. Measurements were taken under 6 conditions (numbered 0-5): 0. intact specimen, 1. tibial osteotomy with intact fibula, 2. plated tibia with intact fibula, 3. plated tibia and osteotomized fibula, 4. plated tibia and plated fibula, and 5. tibia and fibula osteotomies without fixation. Each of four motions were compared using ANOVA and post hoc t-tests.

RESULTS: The most motion occurred in conditions 1 and 5. Relatively little motion occurred when the tibia was intact or fixed. This was true regardless of the condition of the fibula. In Axial Displacement, the motion of Condition 1 was 2.7 ± 1.9 mm, and the motion of Condition 5 was 3.9 ± 4.1 mm. These were statistically different (average: 0.13 ± 0.31 mm). In rotation, the motion with the tibial osteotomy and the intact fibula (Condition 1) was 3.6°± 2.8° and the motion with both bones osteotomized (Condition 5) was 5.3° ± 4.7°. These were statistically significant (average: 0.35° ± 0.27°). There were no significant differences between the coronal or sagittal bending motions in any condition ($p>0.05$).

CONCLUSION: Under the conditions tested, there was no mechanical benefit from plating the fibula. For grossly unstable distal metaphyseal tibia fractures, the locked plate used recreated mechanical stability. The clinical effects of fixing the fibula in distal tibia fractures remain unknown at this time.

Suprapatellar Intramedullary Nailing for Tibial Shaft Fractures

Abstract ID: Poster 035

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*Robert E. Van Demark, III, M.D.
Eric R. Wagner, M.D.
Matthew T. Houdek, M.D.
S. Andrew Sems, M.D.
Rochester, MN

INTRODUCTION: The tibial intramedullary nail (IMN) remains the gold standard treatment for displaced tibial shaft fractures in adults. The most common complication following tibial nailing is anterior knee pain, with an incidence up to 50%. In recent years, the suprapatellar technique has been developed as an alternative to the standard medial and lateral parapatellar techniques. However, there is a paucity of information on the outcomes and incidence of knee pain after suprapatellar IMN. The purpose of this study was to examine the outcomes after suprapatellar approach for IMN of tibial shaft fractures.

MATERIAL AND METHODS: A review of all adult patients who underwent the suprapatellar technique for IMN of a tibial shaft fracture between the years 2009 and 2014 was performed. We identified and contacted 30 patients who underwent consecutive suprapatellar IMN. To prevent confounding factors underlying patients reported knee pain, patients were excluded if they had prior knee surgery or antecedent knee pain, ipsilateral polytrauma in the femur or pelvis, or fasciotomies for compartment syndrome. The average age at the time of the procedure was 50.4 years in patients, the average BMI was 29.8 kg/m^2, and 12 (40%) patients were female. The average clinical follow-up was 13.6 months. Patients completed the Oxford knee score, visual analog score, and questionnaires on overall satisfaction and whether they would remove the nail for anterior knee pain.

RESULTS: Four (13%) patients underwent a reoperation for removal of prominent and painful interlocking screws (5 proximal screws and 1 distal interlocking screw). One patient required removal of distal interlocking screws at 7 months postoperatively to dynamize a symptomatic nonunion. There were no other patients who experienced nonunions. No patients required revision surgery or IMN exchange. All 30 patients reported that they were very satisfied with their outcome at last follow regardless of secondary procedures. The average Oxford knee score of 44.9. Overall, patients reported minimal to no knee pain, with the average VAS pain rating of 1 out of 10. When surveyed, none of the patients would undergo a procedure to remove the nail to treat anterior knee pain.

CONCLUSIONS: Suprapatellar IMN is a successful procedure for tibial shaft fractures. The fractures have a high rate of union, while patients are very satisfied and do not report anterior knee pain. The lack of knee pain is an important finding to consider when counseling patients and deciding the appropriate treatment for these fractures.

A Comparison of Standard vs. MotionLoc Diaphyseal Screws Following Periprosthetic Fracture Fixation

Abstract ID: Poster 036

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*Kimberly A. Jacobsen, M.D.
Jeffrey B. Whiting, M.D.
Heidi Israel, Ph.D.
Lisa K. Cannada, M.D.
St. Louis, MO

INTRODUCTION: The incidence of periprosthetic fractures in the population continues to rise. This is likely due to the increase in the number of people undergoing total joint arthroplasty and the increase in life expectancy. Locked plates have been used because of poor bone quality in this population and need for rigid fixation. However, retrospective reviews have shown that these locked plates may be too stiff leading to hardware failure or nonunion. As these patients are elderly and likely to have co-morbid medical conditions, it is necessary to design a stable fixation that will allow a single operative approach that facilitates bone healing. Our aims for this project was to demonstrate a periprosthetic model for future studies and to biomechanically evaluate a cadaveric construct stiffness and fracture gap motion using periprosthetic plates using standard locking vs. MotionLoc screws.

METHODS: 10 paired cadaveric femurs were obtained. All femurs were osteopenic. Specimens had a femoral component placed with a 9-hole periprosthetic plate with either standard locking screws or MotionLoc screws in the diaphysis. All plates were fixed distally with 5 standard locking screws. A standard distal osteotomy was then made to recapitulate an extra-articular fracture. Specimens were then loaded on the MTS machine and loaded to failure; stiffness of the construct and micromotion was recorded at the fracture gap.

RESULTS: The standard screw construct stiffness was statistically significantly higher when compared to the MotionLoc group ($p = 0.00$). The average micromotion in the MotionLoc group was 1.12 times higher than the standard locking group, but did not reach statistical significance ($p = 0.476$). All MotionLoc constructs failed at the far cortice of the most distal diaphyseal screw. All standard constructs also failed at the distal most diaphyseal screw; however, 6/10 failed on the side of the locked plate. Location of primary failure was significant between the two groups ($p=0.010$).

DISCUSSION AND CONCLUSION: Our periprosthetic fracture model shows that the MotionLoc construct was significantly less stiff than standard locked plating. Recent literature has suggested that by decreasing the rigidity of the construct it may aid fracture healing by allowing micromotion at the fracture site. In our model, no statistical significance was noted in micromotion, though the average motion at the fracture gap was higher in the MotionLoc construct than the standard locking screw construct which could potentially aid in callous formation and, thereby, fracture healing.

Utility of Three-Dimensional Computed Tomography for the Surgical Management of Rib Fractures

Abstract ID: Poster 037

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*Benjamin R. Pulley, M.D.
T. Ty Fowler, M.D.
Thai Q. Trinh, M.D.
Benjamin C. Taylor, M.D.
Columbus, OH

BACKGROUND: Surgical stabilization of flail chest is increasingly recognized as a valid approach to improve pulmonary mechanics in selected trauma patients. The use of two-dimensional (2D) computed tomography (CT) has become almost universal in the assessment of blunt chest trauma and multiple rib fractures.

METHODS: We hypothesized that three-dimensional (3D) CT adds valuable information to the preoperative plan for fixation of rib fractures. Utilizing a retrospective cohort of 50 consecutive adult patients with multiple rib fractures requiring surgery, we evaluated the diagnostic accuracy, as well as the intra- and interobserver reliability of plain x-ray, 2D CT, and 3D CT for the identification of rib fractures. We identified how often the hypothetical surgical plan changed with the addition of the information provided by the 3D CT. Two fellowship-trained orthopedic trauma surgeons who regularly operate on rib fractures in their clinical practice and were not involved in the treatment of the study population evaluated the radiographic data.

RESULTS: 2D CT had the highest diagnostic accuracy for detecting rib fractures as compared to plain x-ray and 3D CT. Intra- and interobserver reliability for 2D and 3D CT was excellent; it was substantial for plain x-ray. 3D CT changed the surgical plan in 65.7% of cases.

CONCLUSION: 3D CT is an important tool for preoperative planning of rib fracture fixation.

GENERAL

Integrating a Student-Run Smoking Cessation Clinic with an Orthopedic Department at a Level I Trauma Center

Abstract ID: Poster 038

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*Brandon J. Kelly, B.S. / Minneapolis, MN
Joshua T. Olson, B.S. / Minneapolis, MN
Michael T. Torchia, B.S. / Minneapolis, MN
Peter A. Cole, M.D. / St. Paul, MN

INTRODUCTION: Orthopedic surgeons feel pressure to see more patients, decrease costs, and affect the value-to-cost ratio through improved patient experience and surgical outcomes. Despite the fact that nearly 75% of patients who use tobacco are interested in quitting, over 50% of surgeons do not currently counsel patients about cessation. Only 5% of patients currently quit tobacco in the perioperative period, despite current research showing increases in bone/wound healing complications by over 50%.

A free medical student-run tobacco cessation program was developed for an orthopedic surgery department at a Level I trauma center. The program aimed to reduce or eliminate tobacco use amongst patients undergoing either total joint arthroplasty, fracture ORIF, or malunion surgery.

METHODS: Medical students were trained in basic orthopedic knowledge, tobacco-related complications of surgery, and pharmacological interventions for smoking cessation. In addition, students underwent guided practice in motivational interviewing from a behavioral psychologist during a 4-hour training session, with an additional 5 hours of online education. An electronic medical record interface was developed for the program and students received training in its use for clinic.

Weekdays from March 31-May 12, 2014, medical students rendered tobacco interventions with patients referred by orthopedic surgeons. Patient follow-up was by phone every 2 weeks.

RESULTS: 20 patients (11 males and 9 females) were referred to the program during the 6-week pilot. Mean age was 46.7 years. Nine patients (45%) agreed to enrollment. Of the 9 patients enrolled, 5 patients received both nicotine replacement and behavioral therapy, 4 received only behavioral intervention. 7 of 9 enrolled patients reported a nicotine reduction of at least 50% at the 2-week mark. At an average of 5 weeks follow-up, 8 patients reported smoking cessation or reduction, with 7 of the 8 reporting at least 50% reduction. Of the 8 patients who reported a reduction in smoking at latest follow-up, all were “highly” or “moderately” motivated to quit smoking, compared to “minimal” motivation for the patient who did not report smoking reduction.

DISCUSSION/CONCLUSION: To our knowledge, this is the first reported medical student-run tobacco cessation program integrated into a surgical subspecialty, and the first time a medical student-centered curriculum has been developed to address both perioperative behavioral and pharmacological aspects of tobacco cessation and demonstrate efficacy. The promising results of this pilot can be used to launch a larger cohort study, and provide a treatment model that could extend to other pathology and surgical disciplines.

Are Shoes Used in the Operating Room a Source of Bacteria?

Abstract ID: Poster 039

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*Eric J. Mancini, M.D.
David C. Markel, M.D.
Jeffrey C. Flynn, Ph.D.
Nancy M. Jackson, Ph.D.
Joseph Karpinsky, B.S.
Southfield, MI

INTRODUCTION: Infection as a cause of total joint revision surgery is a major problem. The morbidity and mortality is significant, as well as increased cost to treat. Many studies have looked at ways to decrease bio-contamination including bio-exhaust suits, laminar flow, and UV lighting. However, to our knowledge, no one has looked at footwear as a potential source of contamination or evaluated different types of footwear for their bacteria-carrying ability.

METHODS: For this pilot study, the operating room shoes of 40 associates were swabbed at 2 hospitals. All surfaces, including the sole, were evaluated as they entered the semi-sterile operative corridor. The shoe type was noted as tennis shoe, hybrid shoe (Dansko, clog), or new shoe cover (one person had used shoe covers). Our clinical laboratory cultured the samples to evaluate for various organisms.

RESULTS: Most people wore tennis shoes (21/40) compared to hybrid shoes (9/40) or shoe covers (9/40). Bacteria were identified on most (36/40) shoes. Tennis shoes carried 47 different types of bacteria while hybrid shoes had 4 and shoe covers had 6. However, no pathogenic bacteria were identified. The average number of bacterial colonies/shoe was highest for tennis shoes (25.7), followed by hybrid shoes (14.8) and new shoe covers (2.6). These differences were not statistically significant by one-way analysis of variance because of the large amount of variability between the groups; however, new shoe covers had fewer bacteria when using the nonparametric Kruskal-Wallis test ($p=0.043$). Tennis shoes had an average of 13 Gram negative colonies/shoe while hybrid had 2 Gram negative colonies/shoe and shoe covers had none. The average number of Staphylococcus aureus colonies/shoe was highest in hybrid shoes (9) followed by tennis shoes (7) and shoe covers (2).

CONCLUSION: Tennis shoes as a group seem to contain more bacteria than other shoe options. Hybrid shoes, while less contaminated than tennis shoes in total bacteria counts, still were not as good as shoe covers. As shoe covers are a cheap and easy hospital-provided item, more emphasis needs to be placed on using them.

Current Quality Measurement Tools are Insufficient for Orthopedic Surgery

Abstract ID: Poster 040

Arjun S. Sebastian, M.D.
Amy E. Wagie, B.S.
Elizabeth B. Habermann, Ph.D.
Sanjeev Kakar, M.D.
Rochester, MN

(Presented by Benjamin K. Wilke, M.D., Rochester, MN)

BACKGROUND: There is increasing pressure in orthopedic surgery to measure outcomes and improve quality. Measurement of quality can vary markedly based on the methodologies used. The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) is a clinically-derived, validated tool to track outcomes in surgery. The Agency for Healthcare Research and Quality Patient Safety Indicators (AHRQ-PSI) are a set of computer algorithms run on administrative data to identify adverse events. The purpose of this study is to compare complications following orthopedic surgery identified by ACS-NSQIP vs. AHRQ-PSI.

METHODS: Patients who underwent orthopedic procedures (arthroplasty, spine, trauma, foot and ankle, hand, and upper extremity) at our tertiary academic institution between 2010 and 2012 were identified (n=3374). Identification of adverse events by AHRQ-PSI in the cohort was compared to events identified by ACS-NSQIP. Included adverse events common to both AHRQ-PSI and ACS-NSQIP were infection, sepsis, venous thromboembolism, bleeding, respiratory failure, wound disruption, and renal failure. Using ACS-NSQIP as the clinical standard for identification of events, sensitivity and specificity of AHRQ-PSI were calculated.

RESULTS: A total of 650 adverse events (19.3%) were identified in the cohort using ACS-NSQIP methodology and 35 adverse events (1.0%) were found using AHRQ-PSI. Only 12 events were identified by both methodologies. The most common complication was bleeding in ACS-NSQIP (18.1%) and respiratory failure in AHRQ-PSI (0.53%). Using ACS-NSQIP as the standard, sensitivities for the recorded adverse events ranged from 0% to 72.7% and specificity ranged from 0-100%. The overlap was highest for venous thromboembolic events with a sensitivity of 72.7% and a specificity of 100%. There was no overlap in adverse events for five of the seven categories of adverse events.

DISCUSSION: A large discrepancy between adverse events reported in ACS-NSQIP and AHRQ-PSI was observed. A large percentage of clinically significant adverse events identified in ACS-NSQIP were missed in AHRQ-PSI algorithms. The sensitivity of AHRQ-PSI for detecting adverse events varied widely with ACS-NSQIP. AHRQ-PSI algorithms currently are insufficient to assess outcomes in orthopedic surgery.

Patient Factors Systematically Influence Hospital Length of Stay in Common Orthopedic Procedures

Abstract ID: Poster 041

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*J. Joseph Gholson, M.D.
Yubo Gao, Ph.D.
Nicolas O. Noiseux, M.D.
Iowa City, IA

INTRODUCTION: As the United States healthcare system evolves towards improved value delivery, metrics regarding patient outcomes and healthcare costs are increasingly being used to evaluate physicians and provider organizations. One such metric is hospital length of stay, which has the potential to be influenced by a variety of patient characteristics and comorbidities. This investigation represents the first large, multicenter, multivariate analysis to determine which patient factors systematically influence length of stay in orthopedic surgery.

METHODS: The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database (2006-2012) was utilized to identify a cohort of 92,266 patients having 1 of 14 common procedures representative of the orthopedic subspecialties. Generalized linear regression was completed to identify patient demographic characteristics and comorbidities that independently impacted hospital length of stay.

RESUTS: Nine different variables were independently associated with increased hospital length of stay. Non-white race increased length of stay by 0.69 days, and age was found to increase length of stay by 0.02 days for each additional year. The presence of congestive heart failure led to the greatest increase in length of stay, at 1.46 days. Other comorbidities also increased length of stay, including chronic obstructive pulmonary disease by 0.50 days, diabetes mellitus by 0.25 days, and hypertension by 0.10 days. Underweight patients had an increased length of stay of 1.01 days, while morbidly obese patients had an increased length of stay of 0.23 days. General anesthesia use increased length of stay by 0.19 days.

CONCLUSIONS: Patient comorbidities, such as congestive heart failure, and patient characteristics, such as body mass index, independently increase hospital length of stay across a broad spectrum of orthopedic procedures. This data can be used to counsel patients and their families regarding anticipated duration of hospitalization. Systematic targeting of patient factors known to increase length of stay offers an opportunity for cost reduction and improved value delivery. When utilizing hospital length of stay as a metric for evaluation, it is important to recognize that multiple patient factors impact length of stay, and that specific orthopedic surgeons and provider organizations should be evaluated on the basis of unique patient population characteristics.

Analyses of Distribution of 26,287 U.S. Orthopedic Surgeons Based on Population Density and Per Capita Income

Abstract ID: Poster 042

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*Mohammed S. Hussain / Chicago, IL
Waqas M. Hussain, M.D. / Moline, IL
Haroon M. Hussain M.D. / Cincinnati, OH
Hristo Piponov / Sofia, Bulgaria
J. Martin Leland, III, M.D. / Chicago, IL
Douglas R. Dirschl, M.D. / Chicago, IL
Lewis L. Shi, M.D. / Chicago, IL

INTRODUCTION: With a rising and an aging population, it is imperative to meet the growing need for orthopedic care in the United States. There are personal and societal factors that affect the geographic distribution of orthopedic surgeons. We analyze the distribution of all active U.S. orthopedic surgeons based on population density and per capita income to see if surgeon supply is meeting patient demand.

METHODS: A directory of 26,287 active U.S. orthopedic surgeons was studied that included name, mailing address, county, state, gender, and board certification. Using the most recent U.S. Census data, information was gathered about each surgeon's county: population, per capita income, and population density (population/mile^2). The population of a county was divided by the number of surgeons in that county as a proxy for work demand per surgeon (population/surgeon), which is an inverse measurement of surgeon density. Pearson coefficients were obtained at baseline and stratified for each demographic factor. Differences between Pearson coefficients were tested via Fisher r-toz transformation for significance.

RESULTS: When comparing population/surgeon to per capita income, there is a statistically significant inverse relationship ($r = 0.0303$, $p < 0.0001$). In counties with lower income, work demand per surgeon is higher; a $5,000 decrease in per capita income increases population/surgeon by 1001. Also, comparing population/surgeon to population density, there is an inverse relationship ($r = 0.0197$, $p = 0.0014$), suggesting in less densely populated counties, the work demand per surgeon is higher. Different demographic factors enhance these correlations. Younger surgeons (<48 years) are more likely to be in areas with higher per capita income and population density ($r = 0.0840$, $p<0.0001$; $r = 0.0539$, $p=0.01$). When examining Census regions separately, orthopedic surgeons are concentrated within wealthier and more densely populated counties of each Census region than is seen nationally, with exception of the Midwest, where per capita income and population density do not affect surgeon geographic distribution as much (income $p=0.0324$; population density $p=0.02$). Female surgeons tend to practice in areas with higher population density, although not significantly ($p = 0.06$), and they are evenly distributed based on per capita income ($p=0.47$).

DISCUSSION: U.S. orthopedic surgeons choose to practice in areas with higher per capita income and higher population density. These effects are more significant among younger surgeons, suggesting the pattern may intensify in the future which can exacerbate the imbalance between patient demand and surgeon supply in lower income and less densely populated areas.

An Analysis of Orthopedic Research Produced During the Conflicts in Iraq and Afghanistan: The Top 20 Most Cited Articles

Abstract ID: Poster 043

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*George C. Balazs, M.D. / Bethesda, MD
Jonathan F. Dickens, M.D. / Bethesda, MD
Alaina M. Brelin, M.D. / Bethesda, MD
Jared A. Wolfe, M.D. / Bethesda, MD
John-Paul H. Rue, M.D. / Annapolis, MD
Benjamin K. Potter, M.D. / Bethesda, MD

OBJECTIVE: The recent conflicts in Iraq and Afghanistan have produced thousands of American casualties and tens of thousands of combat wounded. Military orthopedic surgeons have published a significant amount of original research based on our care of wounded warriors. We sought to identify the 20 most commonly-cited orthopedic literature from the wars in Iraq and Afghanistan, and characterize its impact on the larger practice of medicine in both military and civilian settings.

METHODS: In May 2014, we searched the Web of Science Citation Index Expanded using the terms Iraq, Afghanistan, “Operation Iraqi Freedom,” “Operation Enduring Freedom,” military, combat, war, casualty, Army, solidier, Navy, Marine, or wounded, associated with extremity, musculoskeletal, or amputation. The resulting list was sorted by the number of times each reference was cited, and was manually searched for relevant original research performed by United States military orthopedic surgeons relating to the care of musculoskeletal trauma sustained in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). Review articles that did not include original research were excluded. The 20 most-commonly cited studies were identified. Articles citing these studies were reviewed using both Web of Science and Google Scholar data.

RESULTS: The initial citation report identified 8,507 articles. The 20 most cited articles meeting the above criteria were identified. Five studies examined the injury characteristics of combat casualties in various locations in the MEDEVAC chain, including the overall rate of traumatic amputation in OIF/OEF as compared to previous conflicts. Eight studies dealt with the basic science of wound management, wound dehiscence, and formation of heterotopic ossification. Two studies examined the infectious complications of combat trauma including the characteristics of osteomyelitis after open lower extremity fractures. Two studies defined the clinical characteristics and risk factors for the formation of heterotopic ossification. Three studies described the long-term outcomes of combat injury including return to duty rates and degree of disability. Other research citing these studies has appeared in 450 different journals covering 28 different medical and surgical subspecialties from authors in 44 different countries.

DISCUSSION/CONCLUSIONS: Research based on casualties in Iraq and Afghanistan has broadened our understanding the epidemiology of combat wounded in modern warfare, the biological underpinnings of normal and pathological wound healing, proper management of severe soft tissue wounds, and the long-term disabilities associated with combat injuries. This research has had significant impact on a range of specialties in both the civilian and military medical communities.

FOOT AND ANKLE

Fixed Bearing vs. Mobile Bearing Total Ankle Replacement: A Comparative Study

Abstract ID: Poster 044

Chamnanni Rungprai, M.D.
Phinit Phisitkul, M.D.
Joshua N. Tennant, M.D.
*John E. Femino, M.D.
Annunziato Amendola, M.D.
Iowa City, IA

BACKGROUND: Fixed and mobile bearing total ankle replacements are commonly used for treatment of end-stage ankle arthritis; however, there is a lack of comparative research to demonstrate outcomes and complications between the two types of total ankle replacement.

MATERIAL AND METHODS: Retrospective study of 179 consecutive patients (192 ankles) who were diagnosed with end-stage ankle arthritis and underwent total ankle replacement using fixed (SALTO, n=90 patients/97 ankles) and mobile (STAR, n = 89 patients/95 ankles) bearing type total ankle arthroplasty between October 1997 and December 2012. The STAR implant was initially used in 1997 while SALTO was first used in 2007. Data was collected prospectively, and minimum follow-up was 1 year to allow comparison of early complications and longer-term survival in both fixed and mobile bearing groups (mean, 29.77 months; range, 12 to 66 months and mean, 77.01 months; range, 12 to 162 months respectively). The primary outcome was FFI, SF-36, VAS, and the secondary outcomes included 5-year survival rate, tourniquet time, the length of hospital stay, time to return to work, sport activity, and activity daily living, ankle range of motion, and complications. Independent t-test, Wilcoxon Rank Sum Test, and Chi-square Test were used to assess outcomes and complications.

RESULTS: Both groups showed significant improvement in the FFI, SF-36, VAS, and ankle dorsiflexion and plantarflexion. There was significantly greater improvement in shorter hospital stay, lesser time to return to daily activities, and increased ankle dorsiflexion in the fixed bearing group ($p<0.05$ all), but significantly longer tourniquet time and lesser ankle plantarflexion at end of follow-up and significant requirement of gastrocnemius lengthening procedure ($p<0.05$ all). However, FFI, SF-36, VAS, time to release to work, time to return to sport activities, 5-year survival rate, and ankle plantar flexion immediately postoperatively were similar between the two groups. Gutter impingement and talar component subsidence were significantly more frequent in mobile bearing group ($p<0.05$), but the remainder of complications were similar.

CONCLUSION: Both fixed and mobile bearing total ankle replacements demonstrated significant improvement in FFI, SF-36, and VAS scores for treatment of end-stage ankle arthritis. The fixed bearing prosthesis group had shorter length of hospital stay, shorter time to return to daily activities, greater ankle dorsiflexion, and overall complications. The mobile bearing prosthesis group had shorter tourniquet time, lesser requirement of gastrocnemius lengthening procedure, and more ankle plantar flexion at end of follow-up. Further prospective clinical study is indicated.

Outcomes of Neuroma Resection and Implantation into the Muscle in Lower Extremity

Abstract ID: Poster 045

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*Chamnanni Rungprai, M.D.
Ong-art Phruetthiphat, M.D.
Phinit Phisitkul, M.D.
Iowa City, IA

BACKGROUND: The simple neurectomy is a standard treatment of neuroma after failure of conservative treatment. Recently, neurectomy with implantation of proximal nerve stump into the muscle claimed to be an effective method with significantly pain improvement. However, there remains little evidence demonstration of the functional outcomes and complications of implantation technique. The purpose of this study was to report functional outcomes and complications of neurectomy intramuscular implantation for treatment lower extremity neuroma.

MATERIAL AND METHODS: Retrospective chart review of 108 consecutive patients (110 feet, mean age 47.2; range, 16-81) who were diagnosed with neuroma (superficial peroneal nerve 35 patients / 36 feet, deep peroneal nerve 1 patients / 1 feet, sural nerve 18 patients / 18 feet , saphenous nerve 3 patients / 3 feet, common peroneal nerve 7 patients / 7 feet, interdigital nerve 37 patients / 38 feet, plantar nerve 5 patients / 5 feet, and sciatic nerve 1 patients / 1 feet) in the lower extremities and underwent neurectomy intramuscular implantation between 2008 and 2013. The minimum follow-up to be included in the study was 6 months (mean, 17.5 months; range, 6 to 150 months for simple neurectomy and mean, 19.1 months; range, 6 to 66 months). The primary outcome was Foot Function Index (FFI); pain, disability, activity limitation, and total score, Short Form-36 (SF-36); physical and mental component scores, and Visual Analogue Scale (VAS). Pre- and postoperative SF-36, Foot Functional Index (FFI), and pain (Visual Analog Scale) were obtained and compared using pair t-test.

RESULTS: Neurectomy with intramuscular implantation demonstrated significant improvement of postoperative functional outcomes (FFI, SF-36, and VAS [$p < 0.05$ all]) compared to preoperative period. Persistent pain (4/110, 2.7%), painful scar (2/110, 1.8), and CRPS (1/110, 0.01%) were the complications after the surgery.

CONCLUSION: Neurectomy intramuscular implantation demonstrated significant improvement in terms of functional outcomes as measured with the FFI, SF-36, and VAS in patients with lower extremity neuroma. This technique was feasible and effective for treatment of patients with lower extremity neuroma.

Outcomes of Open and Percutaneous Endoscopically-Assisted Calcaneal Osteotomy in Patients with Varus and Valgus Hindfoot: Comparative Study

Abstract ID: Poster 046

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*Chamnanni Rungprai, M.D.
Biagio Zampogna, M.D.
Sebastiano Vasta, M.D.
Ong-art Phruetthiphat, M.D.
John E. Femino, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
Iowa City, IA

Calcaneal osteotomy is a procedure for realignment of hindfoot deformity in patients with cavovarus and planovalgus foot deformities. Oblique incision is the standard open approach which runs across the sural nerve distribution risking a nerve injury. In addition, superficial infection and injury to medial neurovascular structures are possible complications as were described in previous studies. Percutaneous calcaneus osteotomy technique has been introduced as a minimally invasive effective method. However, there is lack of evidence in literature comparing outcomes and complications of open vs. percutaneous techniques.

Retrospective study of 234 consecutive patients (240 feet) who were diagnosed with planovalgus and cavovarus foot deformities between January 2006 and June 2013. The patients underwent calcaneal osteotomy using an open technique (193 patients / 198 feet; medial slide 86 patients / 88 feet, lateral slide 28 patients / 30 feet, and lateral closing-wedge (Dwyer) 79 patients / 80 feet). Percutaneous technique was used in 59 patients / 60 feet (medial slide 18 patients / 18 feet, lateral slide 41 patients / 42 feet). The minimum follow-up was 6 months (mean, 19.1 months; range, 6 to 96 months for open medial slide; mean, 27.5 months; range, 6 to 81 months for open lateral slide, mean, 17.6 months; range, 6 to 72 months for open lateral closing-wedge and mean, 22.2 months range, 6 to 38 months percutaneous medial slide, mean, 16.9 months range, 6 to 37 months percutaneous lateral slide). The primary outcome measures were FFI, SF-36, and VAS. The secondary outcomes included operative time and complications. Pair t-test and Chi-square test were used to access the outcomes and complications.

Both groups demonstrated significant improvement of postoperative functional outcomes compared to preoperative status. Dwyer was significantly longer operative time among all techniques. Percutaneous technique demonstrated lower rate of complications including wound infection, sural nerve dysesthesia, and painful scar, but no significant differences. Plantar nerve symptom was higher in lateral slide and lateral-closing wedge calcaneal osteotomy in both techniques while painful hardware requiring a removal was higher in medial slide calcaneal osteotomy in both techniques, but no significant difference.

Both open and percutaneous techniques demonstrated significant improvement in terms of functional outcomes as measured with the FFI, SF-36, and VAS for hindfoot realignment surgery in patients with cavovarus and planovalgus foot deformities. Percutaneous group resulted in lower rate of wound infection, sural nerve injury, and painful scar, but other complications were comparable to the open group.

Comparison Outcomes of Total Ankle Replacement With and Without Achilles Tendon Lengthening

Abstract ID: Poster 047

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*Chamnanni Rungprai, M.D.
Phinit Phisitkul, M.D.
John E. Femino, M.D.
Annunziato Amendola, M.D.
Iowa City, IA

BACKGROUND: Pre-existing ankle equinus contracture is an important determinant for postoperative motion and can alter biomechanics of ankle joint after total ankle replacement. Simultaneous total ankle replacement with Achilles tendon lengthening is considered when intraoperative ankle dorsiflexion is inadequate. However, no current literature demonstrated the outcomes of patients with Achilles tendon lengthening and comparing patients with or without Achilles tendon lengthening. The purpose was to compare functional outcomes and complications between total ankle replacement with and without Achilles tendon lengthening.

MATERIAL AND METHODS: Retrospective study of 212 consecutive patients (221 legs) who were diagnosed with end-stage ankle arthritis and underwent total ankle replacement surgery with Achilles tendon lengthening or gastrocnemius lengthening (110 patients / 112 legs; percutaneous Achilles tendon lengthening (Hoke technique) 77 patients / 79 legs and endoscopic gastrocnemius recession (EGR) (33 patients / 33 legs) between January 1997 and December 2013. The minimum follow-up to be included in the study was 6 months in (mean, 62.0 months; range, 6 to 162 months for without Achilles tendon lengthening; mean, 30.5 months; range, 6 to 133 months for Hoke technique, mean, 16.7 months; range, 6 to 43 months for EGR). The primary outcome was Foot Function Index (FFI), Short Form-36 (SF-36), Visual Analogue Scale (VAS), ankle dorsiflexion and the secondary outcomes included operative time and complications. Pair t-test, independent t-test, Wilcoxon Rank Sum Test, and Chi-square test were used to assess the outcomes and complications.

RESULTS: All three groups demonstrated significant improvement in FFI, SF-36, VAS, and ankle dorsiflexion compared to preoperative status; however, there was no statistically significant difference between the three techniques. Total ankle replacement with Achilles tendon lengthening showed greater dorsiflexion at the end final follow-up, but it did not reach statistical significance. There was significant increased operative time when performed total ankle replacement with EGR compared to Hoke and without Achilles tendon lengthening procedure. Hoke demonstrated significant weakness of plantar flexion compared to without Achilles tendon lengthening and higher than EGR, but did not reach statistical significance. Implant failure and polyethylene wearing or fracture were higher in total ankle without Achilles tendon lengthening, but did not reach statistical significance.

CONCLUSION: Total ankle replacement with and without Achilles tendon lengthening demonstrated significant improvement in terms of outcomes as measured with the FFI, SF-36, VAS, and ankle dorsiflexion. Hoke technique demonstrated significantly weakness of plantar flexion when compared to without Achilles tendon release.

Outcomes of Open and Minimally Invasive Gastrosoleus Lengthening Techniques: A Comparative Study

Abstract ID: Poster 048

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*Chamnanni Rungprai, M.D.
Ong-art Phruetthiphat, M.D.
John E. Femino, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
Iowa City, IA

BACKGROUND: Open gastrocnemius/gastrosoleus lengthening and percutaneous triple hemisections of Achilles tendon are considered standard techniques for the treatment of equinus contracture while Baumann and endoscopic techniques have been gaining in popularity in the past decade. There has been no comparative study to demonstrate clinical outcomes and complications between open, percutaneous, and endoscopic techniques.

MATERIALS AND METHODS: Retrospective chart review of 610 consecutive patients (640 feet) diagnosed with ankle equinus contracture and underwent isolated gastrocnemius, gastrosoleus, and Achilles tendon lengthening using open Valpius or Strayer (VSO) 200 patients / 206 feet, Baumann 38 patients / 38 feet, percutaneous triple hemisections (Hoke) 52 patients / 52 feet, and endoscopic gastrocnemius recession (EGR) (320 patients/ 344 feet), between January 2006 and June 2013 were conducted. The minimum follow-up to be included in the study was 6 months in all groups (mean, 23.9 months; range, 6 to 90 months for open VSO; mean, 24.0 months; range, 6 to 44 months for Baumann procedure mean, 27.5 months; range, 6 to 81 months for Hoke procedure, and mean, 17.6 months range, 12 to 53 months for endoscopic technique). Primary outcomes included Foot Function Index (FFI); pain, disability, activity limitation, and total score, Short Form-36 (SF-36); physical and mental component scores, Visual Analogue Scale, ankle dorsiflexion. Secondary outcomes included operative time and complications. Pre- and postoperative functional outcome scores were obtained and compared using Wilcoxon Rank Sum Test, and Chi-square Test.

RESULTS: All groups demonstrated significant improvement in FFI, SF-36, VAS, and ankle dorsiflexion (all p-value < 0.001). Hoke technique demonstrated significantly shorter operative time, lower rate of wound complication, but higher rate of plantar flexion weakness than VSO, Baumann, and EGR. EGR group demonstrated lower rate of wound complication compared to VSO and Bauman and also demonstrated statistically significant improvement of ankle dorsiflexion at both immediate postoperative and final follow-up with lower rate of plantar flexion weakness compared to Hoke technique. Other complications were similar between groups.

CONCLUSION: All techniques for gastrocnemius/gastrosoleus lengthening demonstrated significant improvement in outcomes as measured with the FFI, SF-36, VAS, and ankle dorsiflexion for treatment of tightness of gastrocnemius and gastrosoleus muscle. Minimally invasive techniques resulted in lower rate of wound complications and painful scar while Hoke technique lead to more frequent plantar flexion weakness.

Comparison of Perioperative Complications and Hospitalization Outcomes After Ankle Arthrodesis vs. Total Ankle Arthroplasty from 2002-2011

Abstract ID: Poster 049

Oliver N. Schipper, M.D. / Chicago, IL
*Jimmy J. Jiang, M.D. / Chicago, IL
Lan Chen, M.D. / Evanston, IL
Brian C. Toolan, M.D. / Chicago, IL

BACKGROUND: The aim of this study was to analyze a validated, nationally representative admissions database in order to compare perioperative complications and hospitalization outcomes associated with ankle arthrodesis (AAD) vs. ankle arthroplasty (TAA).

METHODS: Using the Nationwide Inpatient Sample (NIS) database from 2002-2011, 12,250 patients who underwent AAD and 3,002 patients who underwent TAA were identified based on International Classification of Diseases, Ninth Revision (ICD-9) codes. The demographics, comorbidities, and perioperative outcomes during the index hospital stay were compared between patients that underwent AAD and patients that underwent TAA. Multivariate analysis was performed to adjust for differences in demographics and comorbidities between the two groups.

RESULTS: Multivariate analysis demonstrated that TAA was independently associated with a decreased risk of blood transfusion (relative risk [RR]=0.53, $p<0.001$), non-home discharge (RR=0.70, $p<0.001$), and overall complication (RR=0.79, $p<0.03$). There were similar rates of pneumonia, deep vein thrombosis, pulmonary embolus, cerebrovascular accident, myocardial infarction, and mortality. TAA was also independently associated with a significantly higher hospital charge (difference=$24,431, $p<0.001$). There was no significant difference in the adjusted length of stay between the two groups ($p=0.13$).

CONCLUSION: TAA was independently associated with a lower risk of blood transfusion, non-home discharge, and overall complication when compared to AAD during the index hospitalization period. TAA was also independently associated with a higher hospitalization charge, but length of stay was similar between the two groups. Until long-term comparative studies are performed, the optimal treatment for end-stage ankle arthritis remains controversial, but this study provides greater clarity with regard to hospitalization outcomes between the two procedures and shows no significant difference in risk for the majority of medical perioperative complications.

A Novel Algorithm for Isolated Weber B Ankle Fractures: A Retrospective Review of 51 Nonoperatively Treated Patients

Abstract ID: Poster 050

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*William B. Acker, M.D.
Todd A. Irwin, M.D.
Amy McKinney
Joshua Murphy, M.D.
James R. Holmes, M.D.
Ann Arbor, MI

INTRODUCTION: Stability of isolated Weber B fractures is typically determined by stress radiographs (either manual or gravity stress), or even magnetic resonance imaging. In clinical practice, initial weight bearing (WB) ankle radiographs are frequently utilized and are thought to be predictive of stability in these injuries. We describe a cost-effective and reliable method, using WB ankle radiographs, to determine stability of isolated Weber B fractures and a functional treatment for these injuries.

METHODS: A retrospective review of prospectively collected patients was performed. Weber B ankle fractures with medial clear space (MCS) <7 mm on initial injury gravity stress radiographs and normal mortise relationship on initial weight bearing ankle radiographs were defined as stable injuries. 51 consecutive patients meeting these criteria were treated nonoperatively with a functional weight bearing treatment plan and serial radiographs. Functional scores were obtained at 1 year.

RESULTS: All 51 patients completed 1 year of treatment. Average functional scores were as follows: American Orthopaedic Foot and Ankle Society Ankle & Hindfoot (90.4), Foot and Ankle Ability Measure (93.2), Olerud and Molander Ankle Score (85.9), and Visual Analog Scale (0.57). Despite mean initial gravity stress MCS of 4.42 mm (15 patients >5 mm), no patient demonstrated MCS widening on any weight-bearing ankle radiographs during their treatment course. Mean MCS on 1-year follow-up standing radiograph was 2.64 mm. Fracture union rate was 100%.

CONCLUSION: Initial weight-bearing ankle radiographs are predictive of stability in isolated Weber B fractures. Gravity stress radiographs using traditional measurement criteria may overestimate instability in these injuries, potentially leading to unnecessary surgical intervention. These very common injuries can be successfully treated with immediate functional protected weight bearing.

Cadaveric Analysis of the Distal Tibiofibular Syndesmosis

Abstract ID: Poster 051

Michael B. Lilyquist, M.D.
*Adam F. Shaw, M.D.
Kevin H. Latz, M.D.
Brock T. Wentz, M.D.
Kansas City, MO

BACKGROUND: Currently, only two articles exist describing the distal tibiofibular syndesmosis using cadaveric specimens. However, these studies used embalmed cadavers and neither described the osseous landmarks for ligamentous insertion. Moreover, Ebraheim et al. described the inferior transverse ligament in detail, whereas, Bartonicek stated he does not believe it exists. Lastly, there are no anatomical studies describing the distance of ligamentous insertion from an anatomic constant, such as the articular surface, which would be imperative for anatomic ligamentous reconstruction. For these reasons, we feel this is an anatomical area needing further investigation.

METHODS: Twenty-four non-paired, fresh-frozen cadaveric ankles, without previous trauma or surgery, were used to study the osseous and soft tissue anatomy of the distal tibiofibular syndesmosis. Twelve specimens were dissected to expose the ligamentous structures. Another 12 paired tibia and fibula already stripped of all soft tissue were used to analyze the osseous structures. These were then measured using the FASTRAK electromagnetic three-dimensional tracking sensor system. Measurement of each ligament length, width at origin and insertion, and distance from the distal articular surface of the tibia was performed. Color photographs and pictorial drawings are used to further describe the distal tibiofibular syndesmosis.

RESULTS: While we found similar ligament length and insertion width on the tibia and fibula of the anterior inferior tibiofibular ligament (AITFL), posterior inferior tibiofibular ligament (PITFL), and the interosseous ligament, we had several important findings, which are listed below:

The superior and inferior insertions of the AITFL measured 21.2 mm and 3.9 mm proximal to the distal articular surface of the tibia, respectively.

The superior and inferior insertions of the PITFL measured 18.5 mm and 7.2 mm proximal to the distal articular surface of the tibia, respectively.

The superior and inferior insertions of the interosseous ligament measured 30.7 mm and 10.2 mm proximal to the distal articular surface of the tibia, respectively.

Interestingly, the inferior transverse ligament was found to be a prominent identifiable structure in 8 of 12 specimens, measuring a total length 34.1 mm.

CONCLUSIONS: This study provides a clear description of ligamentous insertion with respect to the distal articular surface of the tibia, which can provide a consistent anatomic landmark for reconstruction. We also found the inferior transverse ligament was an identifiable structure in 66% of specimens studied.

Level of Evidence: Basic science study of anatomy, Level IV evidence.

The Association Between Medial Malleolar Fracture Geometry, Injury Mechanism, and Syndesmotic Disruption

Abstract ID: Poster 052

Nabil A. Ebraheim, M.D.
*Jiayong Liu, M.D.
John T. Weston, M.D.
Todd Ludwig, M.S.
Jingwei Zhang, M.D.
Toledo, OH

PURPOSE: Precise correlations between medial malleolar fracture geometry and fracture mechanism have not been thoroughly described. This study sought to determine the prevalence of different medial malleolar fracture types and to elucidate the association between fracture geometry and fracture mechanism.

METHODS: The records of 112 medial malleolar ankle fractures were reviewed. For each fracture, the direction of the fracture line in the medial malleolus (transverse, oblique, vertical, or comminuted), the Lauge-Hansen classification, and the presence or absence of syndesmotic injury was recorded. Bivariate correlation analysis was performed to determine if correlations existed.

RESULTS: Transverse fractures were the most prevalent type of medial malleolar fracture (n= 64 [57%]), and they correlated with supination-external rotation injuries. These were followed by oblique fractures (29 [26%]), which correlated with pronation-external rotation injuries (29 [26%]), and vertical fractures (7 [6%]), which correlated with supination-adduction injuries (9 [8%]). Comminuted fractures (12 [11%]) and pronation-abduction injuries (22 [20%]) did not correlate with any other categories. Syndesmotic injuries were correlated with transverse fractures, bimalleolar fractures, and pronation-external rotation injuries.

CONCLUSIONS: Medial malleolar fractures can be divided into four fracture types: transverse fractures, which correlated with supination-external rotation injuries; oblique fractures, which correlated with pronation-external rotation injuries; vertical fractures, which correlated with supination-adduction injuries; and comminuted fractures, which did not correlate with a particular type of injury. Syndesmotic injury was positively correlated with transverse fractures of the medial malleolus, bimalleolar fractures, and pronation-external rotation injuries.

SHOULDER

Shoulder Arthroplasty for Post-Traumatic Avascular Necrosis of the Humeral Head

Abstract ID: Poster 053

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*Bradley S. Schoch, M.D. / Rochester, MN
Jonathan D. Barlow, M.D. / Columbus, OH
Robert H. Cofield, M.D. / Rochester, MN
John W. Sperling, M.D. / Rochester, MN

INTRODUCTION: Avascular necrosis (AVN) of the humeral head is a less common indication for shoulder arthroplasty, representing less than 5% of cases. Depending on the condition of the cartilage, hemiarthroplasty (HA) and total shoulder arthroplasty (TSA) can be considered. To date, the peer-reviewed literature offers limited direction as to the best form of treatment for this population.

METHODS: Between August 1973 and November 2010, 90 shoulder arthroplasties were performed for operatively confirmed post-traumatic AVN of the humeral head. 41 HAs and 49 TSAs were followed for at least 2 years (mean 9.2 years) or until reoperation. Indications for surgery included imaging confirmed AVN in a patient who had failed conservative treatment modalities.

RESULTS: Both HA and TSA provided significant improvements in pain ($p<0.001$), abduction ($p<0.01$), and external rotation ($p<0.01$). However, the TSA group had significantly less pain at final follow-up compared to the HA group (2.1 vs. 3.1, $p=0.001$). Shoulders treated with TSA were more satisfied (69% vs. 54%) and had more excellent/satisfactory Neer ratings (55 vs. 37%). Nine HA and 6 TSAs underwent reoperation for various reasons, with an estimated 15-year survivorship of 81% and 82%, respectively.

DISCUSSION: In patients with post-traumatic AVN of the humeral head, both HA and TSA provide lasting improvements in range of motion. However, TSA provides superior pain relief with better patient-reported satisfaction. Serious consideration should be given to replacing the glenoid for most patients with post-traumatic AVN of the humeral head.

Septic Arthritis of the Shoulder: A Comparison of Treatment Methods

Abstract ID: Poster 054

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*Jimmy J. Jiang, M.D.
Lewis L. Shi, M.D.
Daniel P. Mass, M.D.
Jovito G. Angeles, M.D.
Chicago, IL

INTRODUCTION: Septic arthritis of the shoulder can be treated with serial aspirations, open irrigation and debridement (I&D), and arthroscopic I&D. The objective of this study is to compare the perioperative comorbidities, complications, and hospitalization data among patients who underwent these procedures.

METHODS: Data from all cases of native shoulder septic arthritis extracted from the Nationwide Inpatient Sample (NIS) database between 2002-2011 were analyzed. The NIS is a statistically representative sample of hospitals from across the United States and includes data on approximately 8 million inpatient admissions (about 20% nationwide) per year. International Classification of Disease, 9th revision (ICD-9) procedure codes were used to classify the method of treatment for shoulder septic arthritis as arthrocentesis (81.91), open I&D (80.11, 80.41, or 80.81), and arthroscopic I&D (80.21) of the shoulder. Patient demographics, comorbidities, and perioperative outcomes and complications were compared.

RESULTS: Inpatient hospitalization data from 1,223 patients who underwent serial shoulder aspirations, 799 patients who underwent an arthroscopic shoulder I&D, and 5,154 patients who underwent an open shoulder I&D were analyzed. Rates of medical comorbidities and complications were higher in the nonoperative group compared to the open I&D group. Rates of comorbidities were similar between the two surgical groups with the exception of higher rates of coagulopathies in the arthroscopic group ($p<0.001$). There was no significant difference ($p=0.21$) in the proportion of patients requiring at least one repeat I&D between the open (12.6%) and arthroscopic groups (11.0%). Average length of stay (10.6 days, $p=0.37$), hospital charges ($64,398, $p=0.19$), blood transfusion rates (15.1%, $p=0.30$), and repeat I&D rates (12.4%, $p=0.21$) were also similar between the two surgical groups. The arthroscopic I&D group had higher incidences of perioperative septicemia ($p=0.02$) and urinary tract infection ($p=0.03$), but lower incidences of osteomyelitis ($p<0.001$). There was no difference in rates of pneumonia ($p=0.53$), deep venous thrombosis ($p=0.92$), pulmonary embolism ($p=0.52$), myocardial infarction ($p=0.54$), cerebrovascular accident ($p=0.34$), and death ($p=0.21$) between the open and arthroscopic I&D groups.

DISCUSSION: Perioperative comorbidities and complications rates were significantly higher in the nonoperative group compared to the surgical groups. However, short-term inpatient hospitalization data and complications were similar between the patients who underwent an arthroscopic vs. open I&D for septic arthritis of the shoulder.

Level of Evidence: Therapeutic Level III

Reverse Total Shoulder Arthroplasty Patients with a Proximal Humerus Fracture Have Worse Perioperative Outcomes: An Analysis of 5,644 Cases

Abstract ID: Poster 055

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*Jimmy J. Jiang, M.D.
Aneet S. Toor, M.D.
Lewis L. Shi, M.D.
Jason L. Koh, M.D.
Chicago, IL

BACKGROUND: Proximal humerus fracture is becoming an increasingly common indication for reverse total shoulder arthroplasty (RTSA). We compared the immediate perioperative complications and hospitalization data of 5,644 patients who underwent a RTSA between those with a fracture vs. nonfracture diagnosis (osteoarthritis, rotator cuff disease, avascular necrosis, or rheumatoid arthritis).

METHODS: The Nationwide Inpatient Sample (NIS) database was evaluated from 2010-2011 for all patients who underwent a RTSA (ICD-9 procedure code = 81.88). The NIS is a statistically representative sample of hospitals from across the United States that includes data on approximately 20% or 8 million inpatient admissions per year. A total of 5,644 patients were included in our retrospective study and all proximal humerus fracture patients were identified based on ICD-9 coding (812.0x-812.1x). The demographic data, comorbidities, complications, and perioperative inpatient data were compared between patients with a fracture diagnosis vs. those without a fracture diagnosis.

RESULTS: Fracture was the indication for RTSA in 10.4% of patients (n= 567) compared to 89.6% of patients (n=4899) with a nonfracture diagnosis. The overall perioperative complication rate following RTSA was 16.8% in the fracture group and 5.1% in the nonfracture group. Patients with a fracture had a statistically significant longer hospital stay (4.5 vs. 2.4 days, $p<0.001$) and hospital charge ($82,887 vs. $63,135, $p<0.001$). They were also significantly older (75.6 vs. 72.3 years, $p<0.001$) and more likely to be female (83.2% vs. 61.8%, $p<0.001$) compared to patients without a fracture diagnosis. Patients with fractures also had significantly increased rates of comorbidities. Multivariate analyses, which adjusted for all significant differences in preoperative variables and comorbidities, showed that having a fracture was independently associated with increased risk of overall perioperative complication (Relative risk (RR) =3.2, $p<0.001$), pneumonia (RR=4.6, $p<0.001$), myocardial infarction (RR=4.6, $p=0.01$), deep venous thrombosis (RR=4.6, $p=0.001$), pulmonary embolism (RR=3.9, $p=0.04$), cerebrovascular accident (RR=6.4, $p=0.02$), and urinary tract infection (RR=2.9, $p<0.001$). Having a proximal humerus fracture was also independently associated with increased length of stay (difference = 1.95 days, $p<0.001$), higher proportion of non-routine discharge (RR=3.0, $p<0.001$), blood transfusion rates (RR=2.2, $p<0.001$), and increased total hospitalization charges ($20,782, $p<0.001$).

DISCUSSION AND CONCLUSION: Adjusted comparison showed that fracture patients were independently associated with having longer hospital stay, higher hospitalization charges, and higher perioperative complication following RTSA.

Long-Term Outcomes of Glenohumeral Arthrodesis

Abstract ID: Poster 056

Eric R. Wagner, M.D.
Shumaila Sarfani, B.S.
*O. Brant Nikolaus, M.D.
Joaquin Sanchez-Sotelo, M.D.
Bassem T. Elhassan, M.D.
Rochester, MN

PURPOSE: Glenohumeral (GH) arthrodesis is a salvage option for patients with advanced arthritis, shoulder tumors, or severe trauma. There is a paucity of studies in the literature examining the outcomes of GH arthrodesis. The purpose of this investigation was to examine the long-term clinical outcomes of glenohumeral arthrodesis.

METHODS: We examined all patients who underwent GH arthrodesis between 1992 and 2009, excluding any patient lost to follow-up (<2 years follow-up). Thirty-seven shoulders were included with average age of 42.5 years. There were 30% females, with the dominant extremity involved in 62% cases. Surgical indications included post-traumatic arthritis (32%), rotator cuff arthropathy (19%), brachial plexus injuries (38%), with proximal humerus or shoulder girdle tumors (11%). Surgical technique included 26 shoulder arthrodesed with plates and screws, while 11 were fused with only screws. Bone graft was used in 70% of cases, with autograft in 19 of those 26. The average position of fusion was 24° abduction, 24° flexion, and 34° of internal rotation.

RESULTS: At a mean follow-up of 11.1 (2.0-21.3) years, patients experienced good overall pain relief, with 95% patients reporting moderate/severe pain preoperatively compared with only 38% postoperatively ($p<0.01$). The average postoperative shoulder subjective value was 32.1 (0-80), DASH was 58.6 (13-96), and SF-36 was 51.8 (1-86). Eighty-five percent of patients reported postoperative limitations, with the most significant limitations involving overhead activities, sporting activities, washing one's back, and hammering. There were 24 (65%) postoperative complications, including 3 periprosthetic fractures, 9 nonunions, 3 infections, 5 cases of prominent hardware, 1 pneumothorax, 1 thoracic outlet syndrome, and 2 internal rotation contractures. Eighteen (49%) patients required additional surgeries after fusion, including revision internal fixation for GH arthrodesis nonunions (9), release of internal rotation contracture (2), irrigation and debridement with antibiotic treatment for deep infections (2), and symptomatic hardware removal (5). Patients with prior brachial plexus injuries and those who underwent fusion after tumor resection had worse clinical and functional outcomes ($p<0.04$). No factors had a significant impact on the rate of postoperative complications.

SUMMARY POINTS: Glenohumeral arthrodesis is associated with a high rate of complications (65%), revision arthrodesis for nonunion (24%), and reoperations (49%). Although patients experience good pain relief and shoulder stability, they experience significant limitations in their upper extremity function. Patients with prior brachial plexus injuries or tumor resections have worse clinical and functional outcomes.

Generic Targeting Guides vs. Traditional Instrumentation for Glenoid Component Placement in Shoulder Arthroplasty

Abstract ID: Poster 057

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*Ryan P. Mulligan, M.D.
Frederick M. Azar, M.D.
Thomas W. Throckmorton, M.D.
Memphis, TN

BACKGROUND: Glenoid component positioning is a critical step in shoulder arthroplasty. The purpose of this study was to compare postoperative glenoid component version in primary shoulder arthroplasty using traditional instrumentation compared with a generic glenoid targeting guide.

METHODS: The postoperative radiographs of 184 shoulders undergoing primary shoulder arthroplasty were retrospectively reviewed in a randomized fashion by an independent reviewer not involved with the surgical cases and without knowledge of operative technique. 109 components were placed using traditional instrumentation and 75 were placed with a non-custom targeting guide. Glenoid component version was measured on the best available postoperative axillary lateral radiograph using Friedman's method. Absolute deviation of implant placement from anatomic version and standard deviations (SD) were calculated. Statistical analysis was performed with t-tests and F-tests. Differences with $p<0.05$ were considered statistically significant.

RESULTS: The average mean deviation in component version from anatomic for the traditional technique group was 10° (SD 7°), compared to 9° (SD 6°) in the targeting guide group ($p= 0.37$). The difference in standard deviation between the two groups also did not reach statistical significance ($p=0.12$). There was not a significant difference in deviance from anatomic version or standard deviation based on operation type, body mass index, preoperative version, or operative indication. For the last 30 shoulders in the targeting group, absolute mean deviance in version from anatomic was 6° vs. 11° in the first 30 of the targeting group ($p<0.01$) and 10° in the entire traditional group ($p=0.01$). The standard deviation in the last 30 shoulders in the targeting group was 5° compared with 7° in the first 30 in the targeting group ($p=0.04$) and 7° in the traditional group ($p<0.01$).

CONCLUSIONS: There was not a significant overall difference in component accuracy regarding version when comparing traditional glenoid instrumentation technique with a generic targeting guide. The narrower standard deviation in the targeting group, while not statistically significant, suggests the guide may be useful in reducing the number of components placed in the extremes of version. A learning curve is seen with the targeting guide. With more experience, an improved and more reproducible outcome is seen with component positioning compared to traditional instrumentation.

Shoulder Arthroplasty in Patients with Osteo-Chondrodysplasia

Abstract ID: Poster 058

Bradley S. Schoch, M.D.
Jean-David Werthel, M.D.
*Benjamin J. Allen, M.D.
Robert H. Cofield, M.D.
John W. Sperling, M.D.
Mark E. Morrey, M.D.
Rochester, MN

BACKGROUND: Osteo-chondrodysplasias as a group are a rare cause of limb malalignment, deformity, and degenerative joint disease. Earlier in life, deformities may be managed with bony realignment and soft tissue releases; however, as degenerative changes progress, arthroplasty may be the last remaining treatment option. Shoulder arthroplasty can be challenging in this population with soft tissue contractures and abnormal bony anatomy, which can limit prosthetic options. There are limited reports examining the outcomes after shoulder arthroplasty in this population. This study aims to assess pain relief, function, and reoperation rate of shoulder arthroplasty in patients with osteo-chondrodysplasias.

METHODS: Between January 1975 and December 2011, 10 shoulders in 8 patients that were performed for end stage arthritis secondary to an underlying diagnosis of osteo-chondrodysplasia and had at least 4 years of clinical follow-up (or revision) were reviewed. All operations were performed at a single institution. Three shoulders were treated with a hemiarthroplasty (HA); seven with an anatomic total shoulder (TSA). Outcome measures included pain, range of motion, patient satisfaction, Neer ratings, and survivorship.

RESULTS: Ten arthroplasties in seven female patients and one male patient were included in the study, with a mean age of 48 years (mean follow-up 8.7 years [Range 4.5-20]). Two shoulders required custom humeral prostheses to accommodate altered humeral anatomy As a group, shoulders showed significant improvements in pain ($p<0.001$), abduction ($p<0.01$), and external rotation ($p=0.005$). All shoulders considered their arm to be better than preoperatively; however, no shoulder received an excellent Neer rating. This was most commonly due to loss of external rotation. At final follow-up, 8 shoulders had satisfactory Neer ratings, and 2 had unsatisfactory Neer ratings. No shoulder had undergone reoperation. One shoulder had a loose glenoid component which had shifted in position. All humeral components appeared well fixed without radiolucencies or a noted shift in position.

DISCUSSION: Reports on shoulder arthroplasty for the treatment of osteochondrodysplasias remain limited. Pain relief and improved function can be expected in this population despite challenging anatomy. Unlike the only previous case series reporting a 31% revision rate, our series shows the incidence of failure to be much lower. With the advent of smaller humeral components, the need for custom implants will likely not be necessary. This may ultimately allow surgeons to intervene earlier more confidently in this population who can be expected to have significantly improved pain and range of motion.

Shoulder Arthroplasty for Atraumatic Avascular Necrosis of the Humeral

Abstract ID: Poster 059

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*Bradley S. Schoch, M.D. / Rochester, MN
Jonathan D. Barlow, M.D. / Columbus, OH
Robert H. Cofield, M.D. / Rochester, MN
John W. Sperling, M.D. / Rochester, MN

INTRODUCTION: Avascular necrosis (AVN) of the humeral head represents less than 5% of the shoulder arthroplasty population. Depending on the stage of disease, surgeons must decide between hemiarthroplasty (HA) and total shoulder arthroplasty (TSA). To date, the peer reviewed literature offers minimal insight into the best form of treatment of this patient population.

METHODS: Between August 1973 and November 2010, 141 shoulder arthroplasties were performed for operatively confirmed AVN of the humeral head. 67 HAs and 71 TSAs were followed for at least 2 years (mean 9.3 years) or until reoperation. Indications for surgery included imaging confirmed AVN in a patient who had failed conservative treatment modalities. Outcome measures included pain, range of motion, postoperative modified Neer ratings, and survivorship.

RESULTS: Shoulder arthroplasty provided significant improvements in pain scores ($p<0.001$), abduction ($p<0.01$), and external rotation ($p <0.01$) for both the HA and TSA populations. However, the HA group had significantly better postoperative abduction (147 vs. 133, $p=0.05$). Both groups showed similar patient reported satisfaction (>75%) and excellent/satisfactory Neer ratings (>65%). Eight HA and 11 TSAs underwent reoperation for various reasons, with an estimated 15-year survivorship of 87% and 78%, respectively.

DISCUSSION: In patients with atraumatic AVN of the humeral head, both HA and TSA can be expected to provide lasting pain relief and improved range of motion. However, HA provides similar pain relief and improved abduction despite longer follow-up. Whenever possible, hemiarthroplasty should be considered in patients with AVN of the humeral head and preserved glenoid cartilage.

Wear Rates of Retentive vs. Nonretentive Reverse Total Shoulder Arthroplasty Liners in an In Vitro Wear Simulation

Abstract ID: Poster 060

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*Shannon R. Carpenter, M.D.
Daphne Pinkas, M.D.
Michael Newton, B.S.
Michael Kurdziel, M.S.
Kevin Baker, Ph.D.
J. Michael Wiater, M.D.
Royal Oak, MI

PURPOSE: Retentive polyethylene liners in reverse total shoulder arthroplasty (rTSA) have been utilized to increase rTSA system constraint, lowering the risk of postoperative instability. The purpose of this study was to quantify the wear rates of nonretentive and retentive polyethylene liners using a multi-station wear simulation incorporating both glenohumeral flexion and abduction loading motion profiles.

METHODS: Utilizing a previously-developed motion and loading profile, a 12-station hip wear simulator was converted to a rTSA wear simulator. Six conventional ultra-high molecular weight polyethylene (UHMWPE) nonretentive rTSA liners and 6 conventional UHMWPE 65° retentive rTSA liners (36 mm) were utilized for testing. Liners were subjected to abduction-adduction and flexion-extension loading and motion profiles alternating every 250,000 cycles for a total of 4.5 million cycles. At each 250,000 cycle interval, liners were removed and measured gravimetrically according to ISO Standard 14242-2 for determination of total volume loss (mm^3), volumetric wear rates (mm^3/million cycles [MC]), and linear wear rates (mm/MC). Liners were then scanned via micro-computed tomography (μCT) to characterize dimensional changes between worn and control bearing surfaces. Wear particles isolated from test serum were imaged using environmental scanning electron microscopy to characterize particle size and morphology.

DISCUSSION AND CONCLUSION: Extended bedding-in phase of liners was noted, likely due to cross-shear associated with multiple motion profiles utilized in this simulation. Minimal differences in wear rates between liners were observed early in the simulation. However, this difference became significant in later stages of the simulation. This is likely due to greater contact area with the glenosphere in retentive liners. Increased penetration of the glenosphere into the bearing surface seen on the μCT distance maps of retentive liners also suggests that the more constrained articulation may accelerate focal wear. Surgeons should weigh the benefits of retentive liners against the potential for increased polyethylene wear over extended implantation times.

Humeral Stem Revision vs. Retention in the Conversion of Failed Shoulder Arthroplasty to Reverse Total Shoulder Arthroplasty: The Utilization of a Platform System

Abstract ID: Poster 061

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*Matthew F. Dilisio, M.D. / Omaha, NE
Lindsay R. Miller, M.S. / Boston, MA
Elana J. Siegel, M.S. / Boston, MA
Laurence D. Higgins, M.D. / Boston, MA

INTRODUCTION: Many commercially available shoulder arthroplasty systems now offer a platform humeral stem that utilized the same humeral stem for both anatomic shoulder arthroplasty and reverse total shoulder arthroplasty (TSA). This feature affords the theoretical advantage of converting a failed shoulder arthroplasty to a reverse TSA without revising the humeral component. However, there is little published literature on the clinical advantage of retaining the humeral stem in the revision shoulder arthroplasty setting. The purpose of this study is to investigate whether retaining the humeral stem in the conversion of a failed shoulder arthroplasty to a reverse TSA is advantageous over revision of the humeral stem.

METHODS: 26 patients (mean age 68.46 years) with a failed shoulder arthroplasty underwent conversion to a reverse TSA. Patients that had undergone retention of the humeral stem were compared to patients that hand undergone stem revision. 21 patients completed clinical outcome scores, including the Subjective Shoulder Value, American Shoulder and Elbow Surgeons Score, and Simple Shoulder Test with a minimum 2-year follow-up (mean: 34.38 months). Patient demographics, complications, and intraoperative data were also compared.

RESULTS: Humeral stem retention was associated with a significantly shorter operative time (178.92 minutes vs. 237 minutes, p=0.02). Decreased blood loss, fewer complications, and length of hospitalization was observed, but the differences were not statistically significant. There were minimal differences observed for patient reported outcomes. 21.4% of patients undergoing humeral stem removal sustained an intraoperative humeral shaft or tuberosity fracture, compared with none in the stem retention group.

CONCLUSION: Humeral stem retention is associated with decreased operative time when compared to humeral stem revision in the conversion of a failed shoulder arthroplasty to a reverse TSA. Utilizing a platform shoulder arthroplasty system may be beneficial to failed shoulder arthroplasty patients undergoing conversion to reverse TSA by avoiding humeral stem revision.

TOTAL JOINT ARTHROPLASTY

Disclosing Agents for the Intraoperative Identification of Occult Biofils on Orthopedic Implants

Abstract ID: Poster 062

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*Joshua A. Parry, M.D.
Melissa Karau, B.S.
Robin Patel, M.D.
Rochester, MN

INTRODUCTION: In dentistry, disclosing agents are dyes that colorize plaque (biofilm). Methylene blue (MB) effectively stains biofilm, has little antimicrobial action, and is used safely in orthopedic applications. Injection of MB into acutely infected prosthetic knees before surgery may offer a way to identify the presence of biofilm intraoperatively, helping surgeons decide between a liner exchange or a two-stage revision.

METHODS: Polymethylmethacrylate (PMMA) discs, Teflon discs, and polyethylene liners from prosthetic knee implants were placed in tryptic soy broth (TSB) inoculated with Staphylococcus epidermidis (S. epidermidis), incubated for 24 hours at 37°C to establish a biofilm, and then placed in sterile saline for an additional 48 hours to allow biofilm maturation. After incubation, half of the specimens were rinsed and dyed with 0.05% MB, followed by counterstaining with crystal violet as a control. The other half of specimens underwent sonication and quantitative culture to estimate the bacterial density on positively staining specimens. In the next experiment, PMMA discs were placed in TSB, inoculated with S. epidermidis, incubated at 37°C for three hours to establish a biofilm, and then placed in saline for 24 hours of incubation. One group of discs was exposed to 0.05% MB during its incubation. A second group was exposed to 0.05% MB for 30 seconds after incubation. A control group was not exposed to MB. After observing for biofilm staining, the discs underwent sonication and quantitative culture to determine the antimicrobial effect of MB staining.

RESULTS: MB stained supraphysiologic levels of biofilm on Teflon discs, PMMA discs, and polyethylene liners. Sonication and quantitative culture of the undyed specimens found an estimated bacterial density of 6.5 $\log_{10}$cfu/cm^2 on the cement discs, 5.1 $\log_{10}$cfu/cm^2 on the Teflon discs, and an estimated log bacterial density of 600 CFU/10 ml on the polyethylene liners. Quantitative culture of PMMA discs demonstrated a bacterial density of 4.9 $\log_{10}$cfu/cm^2 on discs incubated with 0.05% MB for 24 hours, compared to 5.3 $\log_{10}$cfu/cm^2 on discs exposed to 0.05% MB for 30 seconds, and 4.6 $\log_{10}$cfu/cm^2 on discs unexposed to MB.

CONCLUSION: Methylene blue stains biofilm on polyethylene liners, PMMA discs, and Teflon discs. Staining did not interfere with sonication and culture. The bacterial density stained in this study was supraphysiologic, 600 CFU/10 ml on liners vs. the 20 CFU/10 ml considered positive clinically. Future studies need to show the ability of MB to stain physiologic levels of biofilm for it to be used clinically.

Complications and Readmissions After Revision Hip Arthroplasty: Analysis of ACS-NSQIP 2006-2012

Abstract ID: Poster 063

Arjun S. Sebastian, M.D.
Sanjeev Kakar, M.D.
Daniel Ubl, B.S.
Elizabeth B. Habermann, Ph.D.
Mark W. Pagnano, M.D.
Rochester, MN

(Presented by Cahd D. Watts, M.D., Rochester, MN)

INTRODUCTION: Total hip arthroplasty (THA) is becoming increasingly common in the U.S. and as a result, the rate of revision hip arthroplasty has also risen. With the increased emphasis on health care quality, surgical outcomes following orthopedic surgery need to be better defined. While outcomes following primary THA are reported in the literature, further work is needed to determine outcomes following revision THA.

METHODS: The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) Participant Use File was used to identify 4,133 patients who underwent revision THA from 2006-2012. Patient demographics, comorbidities, and operative factors were recorded as well as 30-day postoperative complications. Readmissions data from 2011-2012 was also collected. Univariate testing and multivariable logistic regression analysis was used to identify independent risk factors for postoperative complications.

RESULTS: Of the 4,133 patients, the mean (SD) age of the patients was 66.3 (13.1). 39.8% of patients were obese (BMI ≥ 30), 12.5% were diabetic, and 55.4% were ASA class 3 or greater. The 30-day mortality rate was 1.0% with 12.7% of patients suffering postoperative complications. The 30-day unplanned readmission rate was 7.8%. BMI >40 (OR 1.92, $p < .001$), smoking (OR 1.47, $p = .015$), hematocrit <33 (OR 1.35, $p = .050$), functional dependence (OR 1.61, $p = .002$), bleeding transfusions (OR 1.64, $p < .001$), and length of stay (LOS) (OR 1.35, $p < .001$) were all independent predictors of major systemic complications. Age >70 (OR 2.00, $p < .001$), hematocrit < 33 (OR 1.75, $p = .011$), and LOS (OR 1.20, $p < .001$) were all independent predictors of minor systemic complications. Hematocrit < 33 (OR 1.61, $p = .044$), functional dependence (OR 1.75, $p = .019$), and LOS (OR 1.20, $p < .001$) were all independent predictors of major local complications. BMI >40 (OR 4.97, $p<.001$) and LOS (OR 1.18, $p < .001$) were predictors of minor local complications. BMI >40 (OR 1.82, $p = .016$), WBC > 12 (OR 1.88, $p = .026$), and hematocrit < 33 (OR 1.52, $p = .028$) were predictors of unplanned readmission.

DISCUSSION: The overall 30-day complication rate is high following revision THA (12.7%). Obesity, preoperative anemia, functional dependence, and length of stay were predictive of both systemic and local complications. Obesity and anemia were also predictive of unplanned readmissions (7.8%). Patients with these factors should be risk stratified accordingly.

SPINE

Cumulative Radiation Exposure with EOS® Imaging Compared to Standard Spine Radiographs

Abstract ID: Poster 064

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*T. David Luo, M.D.
Anthony A. Stans, M.D.
Beth A. Schueler, Ph.D.
A. Noelle Larson, M.D.
Rochester, MN

INTRODUCTION: EOS® is a slot-scanning x-ray system designed to reduce radiation exposure in orthopedic imaging. There are few independent studies comparing EOS® PA, AP, and lateral films vs. standard films for children with spinal deformity. We sought to estimate the total radiation exposure to scoliosis patients during the course of treatment using standard imaging techniques vs. EOS® PA and AP views.

METHODS: 42 skeletally immature patients presented with idiopathic scoliosis and were followed to skeletal maturity. Treatment included bracing only (21) and spinal fusion (21). The number of scoliosis x-rays (PA and lateral) for each patient was recorded. A computerized dosing model assuming a 15-year-old patient (weight 56 kg, height 168 cm, trunk thickness 19.6 cm, width 29.7 cm) was used to calculate estimated patient and organ doses for PA and lateral scoliosis x-rays taken with EOS®, computed radiography with and without filter (CR and CRF respectively), and intraoperative x-rays. Assuming that each x-ray taken delivered the same radiation as the phantom calculation, we estimated the total effective and organ dose that each child would have received using either EOS®, CR, or our institution's standard CRF technique. For reference, annual background radiation is 3 mSv.

RESULTS: Mean number of radiographs per patient was 20.9 (range 8-43). Patients who underwent surgical treatment had a significantly greater number of x-rays than patients who were braced (27.3 vs. 14.5, $p<0.001$). Assuming CR technique for all films, mean effective dose is estimated to be 5.38 mSv. Assuming EOS® PA and lateral films were used during the treatment course, the mean cumulative estimated dose is 2.66 mSv, a decrease of 50.6%.

DISCUSSION AND CONCLUSION: The EOS® imaging system moderately reduced the total radiation exposure to skeletally immature patients with idiopathic scoliosis during their treatment course. Over the entire course of treatment, this represents 2.72 mSv mean reduction or 0.91 years of background radiation. Surgical patients had more exposure than bracing patients. PA films significantly reduced breast and thyroid dose. Consider using PA radiographs to reduce breast and thyroid radiation exposure.

Switching to a Pediatric Dose O-Arm Protocol in Spine Surgery Significantly Reduced Patient Radiation Exposure

Abstract ID: Poster 065

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*T. David Luo, M.D. / Rochester, MN
Amy L. McIntosh, M.D. / Dallas, TX
Beth A. Schueler, Ph.D. / Rochester, MN
Jennifer A. Winkler, B.S. / Rochester, MN
Anthony A. Stans, M.D. / Rochester, MN
A. Noelle Larson, M.D. / Rochester, MN

INTRODUCTION: The use of the O-arm imaging system during spine surgery improves the accuracy of screw placement. Radiation exposure to the patient, however, remains a primary drawback. Abul-Kasim et al. described accurate pedicle measurements on cadaveric pig spines using a low radiation dose O-arm technique. We recently adopted these settings in clinical use for all pediatric O-arm imaging. We sought to compare the estimated O-arm radiation doses for the manufacturer default acquisition technique, our previous low dose protocol, and the new pediatric dosing technique.

METHODS: This is a cohort study of consecutive patients under the age of 18 years who underwent an intraoperative O-arm scan. Techniques (kV and mAs) for the manufacturer default were manually adjusted based on spinal level and weight. Similarly, a low dose technique chart developed at our institution adjusted kV and mAs values for spinal level and weight. Pediatric dose techniques (per Abul-Kasim et al.) were 80kV/80mAs with no adjustment for level or weight. Adequacy of image quality was assessed by the treating surgeon. The mean estimated effective dose between the three protocols was compared.

RESULTS: 68 scans were performed in 37 patients (manufacturer default - 11, low dose - 21, pediatric dose - 36). Diagnoses included spondylolisthesis, kyphosis, scoliosis, and congenital deformity. Patient weight in the pediatric dose cohort ranged from 19-108 kg. For reference, the mean annual natural background radiation from all sources for the U.S. is approximately 3 mSv (chest x-ray examination approximately 0.1 mSv). Use of the manufacturer default technique resulted in a mean dose per scan of 4.65 mSv, while low dose settings resulted in 2.37 mSv. The pediatric dose protocol reduced the mean dose to 0.65 mSv per scan ($p<0.0001$). Accounting for multiple scans per patient, the mean dose per surgery was: pediatric dose - 1.17 mSv, low dose – 3.83 mSv, and manufacturer - 12.79 mSv. All scans were found to have satisfactory image quality. There were no neurologic complications or screw-related complications.

DISCUSSION AND CONCLUSION: The estimated radiation dose received by the pediatric patient during an O-arm scan was reduced by nearly 75% by using a low dose protocol without compromising surgeon satisfaction. Never use the manufacturer default O-arm techniques in pediatric spine imaging.

Risk Factors for Surgical Site Infection After Posterior Cervical Spine Surgery: Analysis from ACS-NSQIP 2005-2012

Abstract ID: Poster 066

Arjun S. Sebastian, M.D.
Sanjeev Kakar, M.D.
Elizabeth B. Habermann, Ph.D.
Amy E. Wagie, B.S.
Paul M. Huddleston, M.D.
Michael J. Yaszemski, M.D., Ph.D.
Ahmad Nassr, M.D.
Rochester, MN

(Presented by Benjamin K. Wilke, M.D., Rochester, MN)

INTRODUCTION: Surgical site infection (SSI) is more common following posterior cervical spine surgery when compared to anterior approaches. Few large studies have specifically examined risk factors for SSI following posterior cervical procedures. Given the higher SSI rate, it is possible that there are unique risk factors for SSI following posterior cervical surgery.

METHODS: The American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) Participant Use Data File was utilized to identify 5,441 patients who underwent posterior cervical spine surgery by CPT codes between 2005-2012. Multiple patient characteristics were identified utilizing the NSQIP database including demographics, comorbidities, laboratory values, and operative factors. Thirty-day readmission data was obtained for 2011-2012. The incidence and timing of superficial and deep SSI were determined. Univariate testing and multivariable logistic regression analysis was then performed to identify significant risk factors.

RESULTS: Of the 5,441 patients identified as having undergone posterior cervical surgery, 3,724 had a posterior cervical decompression, 1,310 had a posterior cervical fusion, and 407 underwent cervical laminoplasty. SSI within 30 days was identified in 160 patients (2.94%) with 80 of those cases being superficial SSI. The average time for diagnosis of SSI was 17.0 ± 7.7 days for deep SSI and 15.5 ± 7.1 days for superficial SSI. In 2011-2012, 36.9% of the patients with SSI were readmitted within 30 days. Several significant predictors of SSI were identified in univariate analysis including BMI > 35, recent weight loss, chronic steroid use, albumin < 3, hematocrit < 33, platelets < 100, higher ASA class, longer operative time, and longer hospital admission. Independent risk factors including BMI > 35 (OR 1.78, p =.003), chronic steroid use (OR 1.73, p = .049), and operative time > 197 minutes (OR = 2.08, p = .005) were identified in multivariable analysis.

DISCUSSION AND CONCLUSION: We report an SSI rate of 2.94% in the 30 days following posterior cervical spine surgery. The average diagnosis was over 2 weeks following surgery and resulted in a significant 36.9% readmission rate in 2011-2012. Several modifiable risk factors were identified. Optimization of preoperative nutritional status, serum blood cell counts, and operative efficiency may lead to a reduction in SSI rates. Obese patients and patients on chronic steroid therapy should be counseled regarding elevated postoperative infection risk.

Proximal Junctional Kyphosis in Spinal Deformity Surgery Involving Pelvic Fixation: Does the Metal Matter?

Abstract ID: Poster 067

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*Michael D. Hellman, M.D.
Bryan D. Haughom, M.D.
Mark F. Kurd, M.D.
Gregory L. Cvetanovich, M.D.
Nicholas M. Brown, M.D.
Christopher J. DeWald, M.D.
Chicago, IL

INTRODUCTION: There has been a significant trend towards using titanium (Ti) and cobalt chromium (CoCr) implants for spinal deformity correction. Spinal constructs utilizing pelvic instrumentation via bilateral iliac screws results in high stress loads to the posterior instrumentation. The surgeon must choose a rod that allows for a stable construct to promote fusion and limit complications. Stainless steel (SS) has been the standard for many years with titanium constructs using titanium (Ti) or cobalt-chrome (CoCr) rods have been used more recently. Proximal junctional kyphosis (PJK) is a known complication that increases morbidity to longer spinal fusion constructs to the pelvis. We hypothesize that stainless steel has lower rates of PJK in the setting of spinal deformity correction utilizing bilateral iliac screw pelvic fixation.>br>
METHODS: A retrospective cohort study analyzed all long spinal fusions greater than five levels for significant deformity fixed to the sacrum and requiring pelvic fixation between January 2007 and November 2011. Preoperative and final follow-up radiographs were reviewed. Proximal junctional angles (PJA) were measured from the caudal endplate of the upper instrumented vertabrae to the cephalad endplate 2 vertebrae proximal. PJK was defined as PJA > 10° and change in PJA > 10°. The 3 groups were matched for sex, age, fused levels, and osteotomies. A chi-squared test was performed to compare the rate of PJK in titanium and cobalt chromium fixation versus stainless steel.

RESULTS: 63 patients were included (52 women) with an average age of 56.5 years. The average follow-up was 3.34 yrs (2.00 - 6.45). The average levels fused included 10.71 ± 4.53 levels. 23 patients had Ti, 20 patients had CoCr, and 19 patients had SS rods. The overall rate of PJK was 30.2% (CoCr - 45%, Ti - 34.8%, SS - 15.8%). SS had a significantly lower rate of PJK compared to CoCr ($p = 0.048$). No difference was found between SS and Ti ($p = 0.16$).

DISCUSSION AND CONCLUSION: No previous studies have compared PJK rates between these metal alloys in the setting of pelvic fixation. There has been a trend towards using titanium and cobalt chromium rods for spinal deformity correction. We show that stainless steel rods have a lower rate of PJK when compared to cobalt chromium. While titanium and cobalt chromium have inherent advantages, our data suggests that stainless steel should be considered for deformity correction involving long complex fusions with pelvic fixation.

Comparison of Intraoperative Stitched Fluoroscopic Images to Postoperative Standing Full Spine Radiographs

Abstract ID: Poster 068

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*Erica J. Petersen, M.D.
Jonathan N. Sembrano, M.D.
Sharon C. Yson, M.D.
David W. Polly, Jr., M.D.
Minneapolis, MN

INTRODUCTION: Spinal deformity surgery requires assessment of correction achieved intraoperatively. Long cassette x-rays have been used in the past. Recent advances include availability of 3D scanners (e.g., O-arm). These are also able to take 2D images which can be stitched together to simulate full length x-rays. The process of "stitching" can be performed quickly and may potentially save time compared to conventional x-ray film developing. This is the first study to look at correlation between stitched O-arm fluoroscopic images and postoperative standing x-rays.

METHODS: Patients who underwent fusion of ≥3 levels for coronal/sagittal deformity and who had intraoperative stitched O-arm images were identified. The intraoperative images and postoperative full-spine x-rays were reviewed. Coronal and sagittal curves and balance were measured by and averaged between two independent observers. Correlation between intra- and postoperative parameters was tested by computation of Pearson's coefficient.

RESULTS: Between March 2011 and June 2013, 80 patients met inclusion criteria. Mean age was 27 years (range 6-85). Correlation between intraoperative stitched images and postoperative full-length films was very strong for focal curve measurements at the operative levels (major curve Cobb r=0.90, lordosis/kyphosis across instrumented levels r=0.74, T5-T12 kyphosis r=0.88). However, global balance parameters and regional lordosis were found to either have poor correlation (shoulder-pelvis balance 0.41, L1-S1 lordosis 0.62) or not measurable on the stitched images (T1-pelvic angle).

CONCLUSION: Intraoperative AP and lateral stitched O-arm images correlated strongly with postoperative full-spine standing x-rays for focal angular measurements such as major curve coronal Cobb angles, instrumented level lordosis, and mid-thoracic (T5-T12) kyphosis. However, global balance parameters, such as shoulder-pelvis balance and T1-pelvic angle, cannot be reliably measured on stitched images. This may be either due to differences between prone and upright positioning, image quality, technique of stitching, or inability to include the entire spine and pelvis in the images.

Renal Impairment as a Continuous Variable in Short-Term Morbidity Risk Following Lumbar Spine Surgeries

Abstract ID: Poster 069

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*Christopher T. Martin, M.D.
Andrew J. Pugely, M.D.
Yubo Gao, Ph.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

BACKGROUND: Renal impairment is associated with an increased risk of morbidity following lumbar spine surgery. However, no study has investigated renal impairment as a continuous variable, and the degree to which increasing levels of renal dysfunction are associated with morbidity has not been well defined.

METHODS: The National Surgical Quality Improvement Program is a large, multi-center clinical registry. Data collections is performed prospectively by onsite personnel for 30-days postperatively. We queried this database for all adult patients undergoing lumbar spine surgery in 2012, and 13,576 cases were identified. An estimated glomerular filtration rate (eGFR) was calculated for each patient. Propensity scores were used to match patients based on preoperative comorbidities and the procedure type performed, and we then compared the incidence of 30-day morbidity between patients with none or mild renal impairment (eGFR ≥60 mL/min/1.73 m2), against those with moderate or severe disease (eGFR<60 mL/min/1.73 m2). Separately, the morbidity risk associated with eGFR was analyzed as a continuous variable.

RESULTS: The risk of morbidity increased logarithmically with worsening eGFR (R2=0.74). There was a 35% relative increase in morbidity for patients with moderate to severe renal impairment, as compared to the propensity score matched cohort of patients with no or mild disease (8.5% vs. 11.5%, p=0.0038). Wound complications, (3% vs. 2.1%,) re-operation rates (4.6% vs. 3.3%), and need for blood transfusions (16.3% vs. 12.8%) all trended higher in patients with moderate or severe disease. Patients with preoperative moderate or serve renal impairment were 10 times more likely to develop acute renal failure postoperatively (0.6% vs. 0.06%, p=0.01).

CONCLUSIONS: Morbidity risk following lumbar spine surgery is strongly associated with renal impairment, and the magnitude of risk increases markedly for patients with an eGFR below 60. This data may be useful for preoperative patient counseling and risk stratification, and surgeons should consider the relative magnitude of risks and benefits before operating on a patient with severe renal disease, particularly in elective cases.

Incidence and Risk Factors for Early Wound Complications After Spinal Arthrodesis in Children: Analysis of 30-Day Follow-Up Data from the ACS-NSQIP

Abstract ID: Poster 070

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*Christopher T. Martin, M.D.
Andrew J. Pugely, M.D.
Yubo Gao, Ph.D.
Ryan M. Ilgenfritz, M.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

BACKGROUND: While multiple prior studies have reported on wound complications in pediatric spine surgery, the majority have been single center retrospective case series, and recent studies have called for additional high level evidence.

METHODS: The National Surgical Quality Improvement Program (NSQIP) employs onsite personnel to prospectively collect 30-day morbidity data from 50 pediatric hospitals in the United States. 2012 was the first year of data collection, and 1,915 cases of pediatric thoracic or lumbar spinal fusion were enrolled. Patients were divided into cohorts of those with and without a wound complication. A univariate analysis was used to identify associations between risk factors and the incidence of complication. A multivariate logistic regression analysis was used in an attempt to identify independent risk factors for complication. A $p<0.05$ was considered significant.

RESULTS: Wound complications occurred in 67 patients (3.5%), at a mean of 16.7-20.2 days after the index procedure. The incidence was significantly higher in patients with congenital (4.35%) or neuromuscular (4.67%) diagnoses, as opposed to idiopathic (2.7%) or infantile (1.61%). Procedures with fusions extending to the pelvis (9.91%) or an osteotomy (4.99%) were associated with significantly higher risk. Longer hospital lengths of stay, increased operative time, increased patient BMI, and patients with cardiac, gastrointestinal, or pulmonary comorbidities were also associated with a higher risk of infection. In the multivariate analysis, a BMI over 30 kg/m^2, patients with cardiac risk factors, and fusions extending to the pelvis were independent risk factors for wound complication.

CONCLUSIONS: Data from this large prospective multicenter study confirms that the incidence of early wound complications in pediatric spine surgery is low. Patients with a fusion extending to the pelvis, obese patients, and patients with significant cardiac conditions were independently associated with higher risk for this complication. This data should be useful for patient counseling and for preoperative risk stratification. Interventions for minimizing infection risk may be most applicable to the high-risk groups identified here.

Surgical Management of Scoliosis in Pediatric Jehovah's Witness Patients

Abstract ID: Poster 071

Jane Hoashi, M.D.
*Joel D. Kolmodin, M.D.
Olubusola Brimmo, M.D.
Thomas E. Kuivila, M.D.
David P. Gurd, M.D.
Alan R. Gurd, M.D.
Ryan C. Goodwin, M.D.
Cleveland, OH

BACKGROUND: Blood loss is a major cause of morbidity in pediatric scoliosis surgery, with postoperative transfusion rates reported to be as high as 37 to 85%. Jehovah's Witnesses pose a unique challenge to the spinal deformity surgeon, as their religious convictions restrict them from receiving blood products under any circumstance. There is a paucity of literature regarding management of the pediatric Jehovah's Witness patient undergoing surgery to address scoliosis. Thus, the objective of this project is to retrospectively evaluate one institution's experience with the adolescent Jehovah's Witness patient undergoing scoliosis surgery.

METHODS: The medical records of 10 consecutive Jehovah's Witness patients who underwent spinal deformity surgery to address scoliosis between 1995 and 2013 were evaluated. Patients were included if they were under 21 years of age and refused blood products due to religious preference. Cases were assessed for blood conservation techniques employed, estimated blood loss, operative time, hemoglobin levels, and postoperative complications.

RESULTS: The mean age of the patient population was 15 years (12-21); five males and five females. Diagnoses included 5 idiopathic scoliosis, 3 syndromic scoliosis, and 2 neuromuscular scoliosis. All patients underwent posterior spinal fusion, with an average of 11.5 levels fused and 58% deformity correction. The average operative time was 325 minutes. Commonly employed blood conservation techniques included electrocautery (100%), cell saver (70%), supplemental iron (70%), and epinephrine-soaked gauze (60%). Anti-fibrinolytics were consistently used in four cases, and the bipolar sealer device in five cases, since 2010 and 2007, respectively. Hemodilution was used in two cases and hypotensive anesthesia was used in one case. Intraoperative blood loss averaged 544 ml (200-1500 ml). Preoperative hemoglobin levels averaged 14.1 g/dL, and nadir postoperative levels averaged 9.8 (7.1 – 12.7 g/dL). In no circumstance was a surgery aborted due to blood loss. There were 4 postoperative complications, though none were related to blood loss. At an average follow-up of four years (2 months – 14 years), all patients were stable and fusion rate was 100%.

CONCLUSION: Posterior spinal fusion can be successfully and safely performed in a standard fashion in the pediatric Jehovah's Witness population using a variety of blood conservation measures. The number of implemented techniques has increased over recent years. Though necessary in some situations, aggressive techniques such as hemodilution and hypotensive

Causes and Risk Factors for 30-Day Unplanned Readmissions After Pediatric Spinal Deformity Surgery

Abstract ID: Poster 072

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*Andrew J. Pugely, M.D.
Christopher T. Martin, M.D.
Yubo Gao, Ph.D.
Ryan M. Ilgenfritz, M.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

INTRODUCTION: The rising costs associated with spinal surgery and related peri-operative complications have received national attention, and recently, the government has chosen to target 30-day readmissions as a quality measure. Few studies have specifically analyzed the incidence, causes, and risk factors for readmission in a multi-center pediatric cohort.

METHODS: A large, multi-center clinical registry specifically designed to collect pediatric surgical outcomes was queried for all patients undergoing spinal deformity surgery in 2012. CPT codes were used to select patients undergoing multilevel anterior, posterior, and combined fusions. Detailed patient and case characteristics were analyzed. Thirty-day unplanned readmission rates were calculated. Univariate and multivariate logistic regression analysis was used to identify patient characteristics, comorbidities, and operative variables predictive of readmission. Statistical models demonstrated excellent discrimination (C-Index = 0.76).

RESULTS: In total, 79 of 2,005 pediatric patients undergoing deformity spinal fusion had an unplanned 30-day readmission (3.94%). Readmissions were highest in the Neuromuscular group (6.83%) and lowest in the Idiopathic cohort (2.66%, $p < 0.01$). The top reasons for unplanned readmission included wound infections/disruptions (70.8%) and gastrointestinal disturbances (15.4%). SMA syndrome (0.15% overall incidence) accounted for 4.6% of readmissions. Univariate analysis identified multiple patient and procedural factors associated with readmission, including but not limited to elevated ASA Class ($p < 0.01$), operative time >4 hours ($p=0.03$), and fusions extending to the pelvis (rate: 11.01% vs. 3.30%, $p < 0.01$). Multivariate analysis identified structural airway/pulmonary abnormalities ($p=0.003$) and cognitive impairment ($p=0.014$) as risk factors for readmission.

DISCUSSION AND CONCLUSION: The overall rate of 30-day unplanned readmissions following pediatric deformity spinal surgery was low, but not insignificant. Both patient and procedural characteristics are associated with an increased readmission risk. Surgeons should focus on methods to reduce surgical site infections as they accounted for the majority of readmissions.

The Incidence and Risk Factors for Short-Term Morbidity and Mortality in Pediatric Deformity Spinal Surgery

Abstract ID: Poster 073

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*Andrew J. Pugely, M.D.
Christopher T. Martin, M.D.
Yubo Gao, Ph.D.
Ryan M. Ilgenfritz, M.D.
Stuart L. Weinstein, M.D.
Iowa City, IA

INTRODUCTION: Pediatric deformity spinal surgery is generally considered a safe and effective treatment option. The rising costs associated with spinal surgery and related peri-operative complications have received national attention. Few studies with standardized definitions and data collection methods exist. Thus, the purpose of this study was to determine the incidence and risk factors for 30-day morbidity and mortality following pediatric deformity spinal surgery.

METHODS: A large, multi-center clinical registry specifically designed to collect pediatric surgical outcomes was queried for all patients undergoing spinal deformity surgery in 2012. CPT codes were used to select patients undergoing anterior, posterior, and combined fusions. Detailed patient and case characteristics were analyzed. Thirty-day morbidity and mortality rates were calculated. Univariate and multivariate logistic regression analysis was used to identify patient characteristics, comorbidities, and operative variables predictive of complication.

RESULTS: In total, 2,005 pediatric patients undergoing deformity spinal fusion were included. The rate of 30-day complications was 10.0%; with a mortality rate of 0.15% (3 patients), a morbidity rate of 8.4%, reoperation rate of 3.74%, and readmission rate of 3.94%. Morbidity was highest in the Neuromuscular group (13.09%) and lowest in the idiopathic cohort (5.69%), $p < 0.01$). Compared to posterior fusions, anterior fusions and those extending to the pelvis were associated with higher complication rates ($p < 0.01$). Risk factors for complication included hepatobiliary disease ($p=0.03$), cognitive impairment ($p=0.02$), elevated ASA Class ($p<0.01$), and prolonged operative time ($p<0.01$).

DISCUSSION AND CONCLUSION: The overall rate of 30-day morbidity after pediatric spinal deformity surgery was 10%. Both patient and procedural characteristics are associated with an increased complication risk. This data may aid in the informed consent process, facilitate patient risk assessment, and allow quality comparisons between surgeons and institutions.

Causes and Risk Factors for 30-Day Unplanned Readmissions After Cervical Spine Surgery

Abstract ID: Poster 074

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*Andrew J. Pugely, M.D.
Christopher T. Martin, M.D.
Yubo Gao, Ph.D.
Christopher M. Graves, M.D.
Sergio A. Mendoza-Lattes, M.D.
Iowa City, IA

INTRODUCTION: The rising costs associated with spinal surgery have received national attention. Recently, the government has chosen to target 30-day readmissions as a quality measure. Few studies have specifically analyzed short-term readmissions in a multi-center patient cohort. Thus, the purpose of this study was to determine the incidence, causes, and risk factors for 30-day unplanned readmissions after cervical spine surgery.

METHODS: A large, multi-center clinical registry was queried for all patients undergoing cervical spine surgery in 2012. CPT codes were used to select patients undergoing anterior cervical fusions, total disc arthroplasty, corpectomy, and posterior axial and posterior subaxial fusions. Thirty-day readmissions rates and causes were identified and analyzed. Univariate and multivariate logistic regression analysis was used to identify patient characteristics, comorbidities, and operative variables predictive of readmission.

RESULTS: Overall, 206 of 5,758 patients undergoing cervical spine surgery had unplanned 30-day hospital readmissions (3.6%). When separated by procedure type, readmissions were lowest after TDA, 0.7%, and highest after posterior cranial-cervical surgery, 10.9% ($p < 0.001$). Readmission rates after ACDF were 2.8%, and 7.0% after sub-axial posterior cervical fusions. The top causes for readmission were wound-related (37.4%), systemic infections (13.0%), thromboembolic (9.8%), and pain related (8.9%). Predictors of readmission included advanced patient age 70-80 years (OR 3.5, 95% CI: 2.1-5.9), age > 80 (OR 3.2, 95% CI: 1.6-6.4), recent weight loss (OR 3.4, 95% CI: 1.1-10.7), COPD (OR 2.1, 95% CI: 1.3-3.5), dialysis (OR 5.3, 95% CI: 2.2-12.8), elevated ASA Class 3/4 (OR 1.6, 95% CI: 1.2-2.3), and prolonged hospital length of stay> 4 days (OR 1.7, 95% CI: 1.2-2.5). Regression modeling demonstrated excellent discrimination and calibration, with a C-index of 0.73 and HL statistic of 0.98.

DISCUSSION AND CONCLUSION: Thirty-day unplanned readmission rates after cervical spine surgery were generally low, but increased with procedure invasiveness and posterior surgery. Both medical and surgical reasons contributed to readmission, many unavoidable. Surgeons should explore optimization measures for those at risk of early, unplanned readmission.

Lumbar Dorsal Root Ganglia Location: An Anatomic and MRI Assessment

Abstract ID: Poster 075

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*Michael P. Silverstein, M.D. / Cleveland, OH
Lynn J. Romrell, Ph.D. / Tallahassee, FL
Edward C. Benzel, M.D. / Cleveland, OH
Nicolas Thompson, Ph.D. / Cleveland, OH
Sandra Griffith, Ph.D. / Cleveland, OH
Isador H. Lieberman, M.D. / Plano, TX

OBJECTIVE: To determine dimensions of lumbar foramina, dorsal root ganglion (DRG), and its relationship to the neuroforamina through anatomic and magnetic resonance imaging (MRI) evaluation. Agreement between MRI and anatomic assessment of DRG location was determined.

BACKGROUND: The DRG is a key structure in the mechanism of symptomatic radicular pain, weakness, and change in sensation. DRG localization can assist in the decision-making process of which areas require decompression, and type of procedure that should be performed to treat radicular symptoms.

METHODS: Sixteen embalmed cadavers, 10 females and 6 males, aged 68 to 106 years had an MRI of the thoracolumbar spine followed by dissection. Measurements were made including foraminal height and width, DRG size, and nerve root take off angle. The center of the DRG and its relationship to the foramina were measured and the probability of agreement between anatomic and MRI assessment was made.

RESULTS: The greatest width of the DRG was 6.5 mm bilaterally at L5 (range 3.2-6.5 mm). The nerve root take off angle was largest at L5 on the left (range 50.5°-58.8°) and L4 on the right (range 50.5°-57.2°). The center of the DRG was found bilaterally in the medial zone of the foramen of L1-4 and lateral zone at L5. Foramina size increased from L1 to L5 in the ventral to dorsal and cephalad to caudal direction. Pedicle width increased from L1 to L5. The estimated overall probability of agreement between anatomic and MRI DRG location was 86.3% (95% confidence interval = 77.5% − 92.0%).

CONCLUSION: The percentage of overall agreement between MRI and anatomic evaluation of lumbar DRG location significantly exceeded our pre-defined threshold of 70% ($p = 0.0013$). Our results can aid in surgical decision-making as true anatomic position can be directly correlated to what is seen on MRI.

A Classification System for Adjacent Segment Disease Following Lumbar Spine Fusion

Abstract ID: Poster 076

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*Eric B. Sundberg, M.D.
Blaine T. Manning, B.S.
Howard S. An, M.D.
Chicago, IL

BACKGROUND CONTEXT: Adjacent-level pathology is a well-known problem after lumbar spine fusion. Adjacent segment disease (ASD) is a comprehensive term that is applied to symptomatic patients with a multitude of adjacent-level pathologies including spondylosis, degenerative disc disease, stenosis, herniated nucleus pulpus, spondylolisthesis, scoliosis, and fracture. Patients with ASD may require subsequent surgery ranging from a single-level decompression to a multi-level fusion depending on the nature of the ASD and the severity of the symptoms. Although methods for the classification of other lumbar spine pathologies have been developed, we are unaware of any well accepted methods categorizing ASD.

PURPOSE: To develop a classification system for ASD following lumbar fusion.

STUDY DESIGN: Descriptive study.

METHODS: We retrospectively reviewed 56 patients with a prior lumbar fusion who underwent a subsequent procedure for ASD by a single surgeon between 2008 and 2013. There were 22 men and 34 women with a mean age of 63.8 years (range, 36 to 84 years). We reviewed the specific preoperative diagnoses and determined the etiology of the ASD.

RESULTS: Of the 56 patients, 28 (50%) underwent surgery for neurogenic claudication or radiculopathy with a diagnosis of either stenosis or herniated nucleus pulpus at the adjacent-level. Eleven patients (19.6%) had a diagnosis of spondylolisthesis or instability and 2 patients (3.6%) required revision surgery for adjacent-level kyphosis or scoliosis. Fifteen patients (30%) had multiple diagnoses that included a combination of those listed previously. Based on this data and a literature review, we developed a classification system with the following categories: degenerative (degenerative disc disease or spondylosis), neurologic (herniated nucleus pulpus or stenosis), instability (spondylolisthesis, rotatory subluxation), deformity (scoliosis or kyphosis), complex (fracture or infection), or combined.

CONCLUSIONS: This simple, yet inclusive classification system allows patients with similar pathologies to be grouped together. It will potentially allow surgeons to be more specific with their preoperative diagnoses and could provide a foundation for treatment principles. Finally, sub-classifying ASD will also allow for more accurate outcome analyses in the future.

PEDIATRICS

Outcomes of Treatment in Complex Idiopathic Clubfoot

Abstract ID: Poster 077

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*Joshua B. Holt, M.D.
Heather A. Campion, M.D.
Lori A. Dolan, Ph.D.
Jose A. Morcuende, M.D., Ph.D.
Iowa City, IA

Complex idiopathic clubfoot (CCF) has been described as a foot that does not respond to the standard Ponseti method of manipulation, requiring a modified manipulation technique to fully correct the deformity. Early results have demonstrated good initial correction and no need for surgical releases; however, mid-term outcomes have not been reported. We hypothesize that children with complex idiopathic clubfoot treated with a modified manipulation technique and serial casting (study group) will have similar results as patients with typical clubfoot treated with standard Ponseti manipulation and casting (control group) at least four years after treatment. Functional and radiographic evaluation was performed in 28 patients with CCF using questionnaires, physical examination, gait analysis, and radiography and results were compared to age-matched controls and contralateral normal feet when appropriate. No significant difference was seen in satisfaction or function when comparing the two groups. On physical examination, the affected feet and calf circumference were smaller, their Achilles tendon was longer, and dorsiflexion was less in comparison to the unaffected, contralateral feet. Gait analysis showed similar characteristics to idiopathic clubfoot patients, but overall shorter step length and slower gait velocity. Radiographic evaluation showed no significant differences between the groups. CCF patients experienced more relapses (68%) and required more tibialis anterior tendon transfers (46%) than patients with typical clubfoot. In conclusion, complex clubfoot patients have similar satisfaction and functional outcomes in the medium term when compared to typical clubfoot patients despite an increased rate of deformity relapse and a higher need for tibialis anterior tendon transfer to maintain correction.

Epiphysiodesis for Correction of Leg Length Discrepancy in Fibular Deficiency

Abstract ID: Poster 078

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*Joshua S. Griffin, M.D.
Allison C. Scott, M.D.
Houston, TX

BACKGROUND: Fibular deficiency is the most common congenital long bone deficiency with an incidence of 7.4 to 20 per 1 million births. Leg length discrepancy (LLD) is common in this population with potential surgical treatment option of epiphysiodesis. Limited literature exists in regards to results of epiphysiodesis in the fibular deficiency population. The primary aim of this study was to evaluate our experience of epiphysiodesis in treatment of Birch 1A and 1B fibular deficiency.

METHODS: A retrospective study was performed with review of medical records and radiographs of 20 fibular deficiency patients treated with epiphysiodesis to correct LLD. Preoperative and final LLD at skeletal maturity, timing and method of epiphysiodesis, and requirement of shoe lift were recorded.

RESULTS: 20 patients were studied with an average preoperative age of 12.1 years and average follow-up to skeletal maturity of 3.9 years. Average LLD was 3.89 cm preoperatively and 2.3 cm at final follow-up. A significant improvement of LLD was found ($p<.001$). No significant difference in correction method was shown. Shoe lifts were required at skeletal maturity in 65% (13/20) of patients. No significant difference in age at surgery was seen in patients with final LLD ≤ 2 cm compared to those with final LLD > 2 cm. Patients with final LLD ≤ 2 cm showed a preoperative LLD of 3.43 cm compared to a preoperative LLD of 4.35 cm in patients with final LLD > 2 cm ($p=0.045$).

CONCLUSIONS: Epiphysiodesis is an effective method for treatment of leg length discrepancy in fibular deficiency. Consideration of earlier intervention with epiphysiodesis may be necessary in patients with a preoperative LLD greater than 4 cm.

Interleukin-6 in Pediatric Musculoskeletal Infection: A Pilot Study

Abstract ID: Poster 079

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*Byron F. Stephens, M.D.
Jeffrey R. Sawyer, M.D.
William C. Warner, Jr., M.D.
James H. Beaty, M.D.
David D. Spence, M.D.
Alice A. Moisan, B.S.
Richard A Smith, Ph.D.
Derek M. Kelly, M.D.
Memphis, TN

BACKGROUND: Pediatric musculoskeletal infection represents a diagnostic challenge and the clinical consequences of delayed treatment can be devastating. While many institutions utilize the criteria identified by Kocher et al. in evaluating patients with suspected musculoskeletal infection, others have called the validity of this model into question. In addition, interleukin-6 (IL-6) has recently been identified as the most sensitive marker of prosthetic joint infection. Our study seeks to evaluate the utility of IL-6 as a (1) diagnostic tool and (2) marker of therapeutic response to treatment in pediatric patients presenting with suspected musculoskeletal infection.

METHODS: After obtaining IRB approval and informed consent, IL-6 serum levels were collected prospectively in 12 pediatric patients with suspected musculoskeletal infection. Patients with known immunodeficiency were excluded. These samples were then assayed in triplicate using a Quantikine ELISA assay. Additional data collected included demographic information, symptom duration, number of Kocher criteria, number of physicians seen prior to presentation, traditional inflammatory markers, temperature, final diagnosis, treatment procedures, and any organisms identified via intraoperative cultures.

RESULTS: 8 patients were diagnosed with suppurative musculoskeletal infection. 4 patients were diagnosed with “other” etiologies (3 with transient synovitis and 1 with superficial cellulitis). The mean IL-6 level for patients with musculoskeletal infection was 214.5 pg/ml, vs. 68.63 pg/ml in patients with “other” diagnoses ($p = 0.107$). Descriptive analysis of trendline data reveals that IL-6 has the steepest slope, possibly indicating that it is a more sensitive marker of therapeutic response than the traditional markers.

CONCLUSION: In this small pilot study, we have identified preliminary evidence to support the clinical utility of IL-6 in pediatric musculoskeletal infection. Continued research in this area is justified and necessary before definitive conclusions can be made regarding the clinical benefit of using this new inflammatory marker. Our preliminary results justify further research efforts in this area. The use of IL-6 in the diagnosis and treatment of pediatric musculoskeletal infection could provide physicians with added confidence with both the initial diagnosis and efficacy of the treatment course.

Temperature Changes When Drilling Near the Distal Femoral Physis in a Skeletally Immature Ovine Model

Abstract ID: Poster 080

Allison M. Tenfelde, M.D.
Amanda O. Esquivel, Ph.D.
Allison M. Cracchiolo, B.S.
*Stephen E. Lemos, M.D., Ph.D.
Warren, MI

BACKGROUND: The possibility of physeal injury during ACL reconstruction in the pediatric population is a concern. The purpose of this study was to determine whether drilling at or near the physis could cause a temperature increase that could trigger chondrolysis.

METHODS: Skeletally immature cadaveric lamb distal femurs were used for this study and randomly placed in one of six groups (n=10 in each group). We examined the 8 and 10 mm Flipcutter® at a distance of 0.5 mm from the physis and an 8 and 10 mm acorn tipped reamer at a distance of 0.5 mm and 3.0 mm from the physis. During drilling, temperature change at the distal femoral physis was continuously measured until the temperature decreased to the original value.

RESULTS: An inter-reamer comparison yielded a significant difference when drilling 0.5 mm from the physis ($p=0.001$). Pairwise Mann-Whitney post-hoc tests were performed to further evaluate the differences among the groups. The 8 mm FlipCutter® had a significantly higher maximum temperature (39.8°C +/- 1.4°C) compared with the 10 mm FlipCutter® (38.0°C +/- 0.6°C, $p=0.001$), 8 mm acorn tipped reamer (38.1°C +/-0.9°C, $p=0.007$), and 10 mm acorn tipped reamer (37.5°C +/- 0.3°C, $p<0.001$).

CONCLUSION: The risk of thermal-induced injury to the physis is low with an all epiphyseal drilling technique, when a traditional acorn tipped reamer over a guide pin is utilized, even if the drilling occurs very close to the physis. Additionally, the risk of drilling with a FlipCutter® is low, but may be greater than a traditional reamer.

Operative Management of Displaced Pediatric Acetabular Fractures

Abstract ID: Poster 081

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*Nathan A. Nicholson, M.D.
Ong-Art Phruetthiphat, M.D.
Michael C. Willey, M.D.
Todd O. McKinley, M.D.
Matthew D. Karam, M.D.
J. Lawrence Marsh, M.D.
Iowa City, IA

INTRODUCTION: Pediatric acetabular fractures are rare injuries occurring in 1 in 100,000 patients per year. Previous literature has shown increased pain and deformity (low back pain, leg length discrepancy, pelvic asymmetry) following nonoperative care resulting in many surgeons to recommend operative management. Furthermore, recent data has shown good clinical outcomes for pediatric acetabular fractures that had been treated operatively. However, very little information is available in the literature regarding operative treatment of pediatric acetabular fractures. To the authors knowledge, the largest study to date involving operative management includes only 18 patients. The purpose of our study was to review the clinical and radiographic results of pediatric patients who had undergone operative management of acetabular fractures at the University of Iowa.

METHODS: An IRB-approved retrospective review was performed to identify patients less than age 18 who had undergone open reduction internal fixation of acetabular fractures at our institution between 1999-2013. 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: 25 patients under the age of 18 were found to have underwent open reduction internal fixation for an acetabular fracture. There were 17 males and 8 females with an average age of 16.0 years (range 12-18). The most common mechanism of injury was motor vehicle collision (22, 88%) followed by sports injury (2, 8%) and falls (1, 4%). The most common fracture patterns were posterior wall (6, 24%), transverse posterior wall (5, 20%) and anterior column/T type (4, 16%). 48% of the patients had additional injuries. 18 patients (72%) had either no or minimal pain on the Visual Analog Score at a minimum of 1-year follow-up. 21 patients (84%) had no limitations of activity. 2 patients had wound hematomas, and 1 patient sustained a peroneal nerve palsy.

CONCLUSION: To our knowledge, this is the largest number of pediatric patients who have undergone open reduction internal fixation for displaced acetabular fractures that have been reported in the literature. Similar to previous literature, our data suggest that open reduction internal fixation is a valid treatment option of pediatric patients with displaced acetabular fractures that results in good to excellent in outcomes with minimal complication in the majority of patients. Given the lack of literature, further research is needed to further investigate this treatment modality.

TUMOR

Does Radiation Therapy Affect Survival and Functional Outcome of Non-Hodgkin Lymphoma of Bone?

Abstract ID: Poster 082

Ishaq Ibrahim, B.S.
*Bryan D. Haughom, M.D.
Yale A. Fillingham, M.D.
Steven Gitelis, M.D.
Chicago, IL

INTRODUCTION: Non-Hodgkin Lymphoma (NHL) of bone accounts for less than 7% of bone tumors. Excellent survival outcomes with modern medical treatment have lead physicians to question the role of radiotherapy. We evaluated the survival and functional outcomes, as well as complications of radiotherapy in a large cohort of patients with NHL of bone.

METHODS: We performed a retrospective analysis of all primary and secondary NHL of bone diagnosed at our institution between 1985 and 2013. Overall survival (OS) was estimated by Kaplan-Meier analysis, and a log-rank test was used to compare survival between patients receiving combined-modality therapy (chemotherapy and radiation) and those treated without radiation. Rate of fracture was compared between treatment groups, and Musculoskeletal Tumor Society (MSTS) scores were calculated for living patients with appendicular tumors.

RESULTS: The study population included 70 patients (42 males) with mean age of 53.5±18.0 years. Sixty-two patients (88.6%) presented with appendicular tumors and 8 with axial lesions. Radiation was employed in 24 patients (34.3%; mean 39.4±6 Gy). There were no differences ($p>0.05$) observed between cohorts with respect to demographic factors.

Survival: OS was 96% at 5 years and 75% at 10 years with no difference observed between combined-modality therapy and patients treated without radiation (94% vs. 97% at 5 years, and 71% vs. 80% at 10 years; $p=0.321$).

Complications: Twenty-one patients (30.0%) presented pathological fractures. Eight (38.1%) of these pathological fractures underwent surgical stabilization. Five of the pathological fractures (23.8%) were radiated including one patient who also underwent surgery. Of the five radiated fractures, 4 (80%) experienced delayed union (1), malunion (1), or nonunion (2). The remaining 8 fractures (38%) were treated nonoperatively and healed uneventfully.

Nineteen patients presented without fracture and were treated with radiation. Five patients (26.3%) in this group sustained fractures after treatment, while no fractures occurred in the non-radiated group ($p=0.004$).

Function: Patients with appendicular tumors had an average MSTS score of 25.9±4.8 at an average follow up of 52.8±46.7 months. Patients experiencing radiation-related complications reported poorer outcomes (n=7; mean: 18.6±5.53; 61.9%) compared to those without complications (n=35; average 27.3±3.0, 91.1%, $p=0.008$).

CONCLUSION: Prior studies examining the role of radiation therapy have yielded mixed results.

Our data demonstrates no survival benefit to radiation therapy and a significant increase in the rate of orthopedic complications. We demonstrate the first functional evaluation of treated NHL of bone, which demonstrates excellent functional scores in the absence of bony complications.

Cause-Specific Survival and Prognostic Factors for Survival in Ewing Sarcoma Using the Surveillance, Epidemiology, and End Results (SEER) Program Database

Abstract ID: Poster 083

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*Kyle R. Duchman, M.D.
Yubo Gao, Ph.D.
Benjamin J. Miller, M.D.
Iowa City, IA

INTRODUCTION: Ewing sarcoma is the second most common primary sarcoma of bone in children, adolescents, and young adults. Predicting survival after diagnosis of Ewing sarcoma is important for clinicians as well as for the patient and family. The current study aims to identify both modifiable and non-modifiable risk factors for cause-specific survival in patients with Ewing sarcoma.

METHODS: The Surveillance, Epidemiology, and End Results (SEER) Program database was used to identify all patients diagnosed with Ewing sarcoma from 1991 to 2010. Patient and tumor characteristics including age, sex, race, tumor location, tumor size, presence of metastatic disease, and county-level socioeconomic measures were analyzed to determine differences in cause-specific survival at 2, 5, and 10 years. Univariate and multivariate survival analyses were performed to determine prognostic factors for survival.

RESULTS: A total of 1,163 patients with Ewing sarcoma were identified. Of these, 373 (32.1%) patients presented with metastatic disease at the time of diagnosis. Cause-specific survival for patients with local/regional disease was 87.2%, 71.6%, and 65.9% at 2, 5, and 10 years, respectively, while survival for patients with metastatic disease at diagnosis was 55.5%, 34.9%, and 27.3%, respectively. Univariate analysis revealed metastatic disease at diagnosis, increased tumor size, patient age ≥20 years, axial tumor location, and male sex to be associated with decreased cause-specific survival at 2, 5, and 10 years. Multivariate analysis revealed metastatic disease at the time of diagnosis (Hazard Ratio at 10 years [HR] = 2.867; 95% confidence interval [95% CI], 2.178-3.774), patient age ≥20 years (HR = 1.730; 95% CI, 1.312-2.281), and tumor size ≥10 cm (HR = 2.085; 95% CI, 1.398-3.109) as statistically significant independent risk factors for decreased cause-specific survival at 2, 5, and 10 years.

CONCLUSIONS: We identified metastatic disease at presentation, patient age ≥20 years, and tumor size ≥10 cm as significant risk factors for decreased cause-specific survival at 2, 5, and 10 years after diagnosis of Ewing sarcoma. Metastatic disease at presentation had the greatest influence on survival at all time points, with nearly a three-fold decrease in survival when metastatic disease was present at the time of diagnosis.

Chordoma of the Spine and Sacrum: Outcomes and Risk Factors for Survival Using the SEER Program Database

Abstract ID: Poster 084

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*Kyle R. Duchman, M.D. / Iowa City, IA
Andrew J. Pugely, M.D. / Iowa City, IA
Yubo Gao, Ph.D. / Iowa City, IA
Christopher T. Martin, M.D. / Iowa City, IA
Michael P. Kelly, M.D. / St. Louis, MO
Benjamin J. Miller, M.D. / Iowa City, IA

INTRODUCTION: Chordoma is the most common primary osseous tumor of the mobile spine and sacrum. Chordomas are often locally destructive and have a propensity to recur after surgical intervention. The purpose of this study is to describe cause-specific survival as well as determine risk factors for cause-specific survival in patients with chordoma of the mobile spine and sacrum.

METHODS: The Surveillance, Epidemiology, and End Results (SEER) Program database was used to identify all patients diagnosed with chordoma of the mobile spine and sacrum from 1973 to 2011. Patient, tumor, and treatment characteristics were analyzed to determine differences in cause-specific survival at 2 and 5 years. Univariate and multivariate survival analyses using Kaplan-Meier methods were employed to determine prognostic factors for survival. Additionally, 5-year cause-specific conditional survival, which measures the change in risk of cause-specific mortality given that a patient has survived a defined period of time since diagnosis, was calculated.

RESULTS: In total, 541 patients (252 mobile spine, 289 sacrum) with chordoma of the mobile spine and sacrum were identified. Cause-specific survival for patients with local/regional disease was 95.4%, 83.0%, and 64.9% at 2, 5, and 10 years after diagnosis, respectively, while cause-specific survival for patients with metastatic disease at the time was diagnosis was 75.8%, 64.6%, and 41.4%. Univariate analysis revealed patient age ≥ 60 years ($p < 0.0001$), metastatic disease at the time of diagnosis ($p < 0.0001$), and the absence of surgical intervention other than biopsy ($p = 0.0002$) were associated with significantly decreased cause-specific survival at 2 and 5 years. Multivariate analysis identified patient age ≥ 60 years (Hazard Ratio at 5 years [HR] = 2.658), metastatic disease at the time of diagnosis (HR = 3.683), and the absence of surgical intervention other than biopsy (HR = 1.648) as independent risk factors for decreased cause-specific survival. Cause-specific conditional survival analysis revealed that survival conditional on have survived 5 years after diagnosis was relatively unchanged as compared to baseline (70.4% vs. 76.0%, $p > 0.05$).

CONCLUSIONS: Metastatic disease at the time of diagnosis and patient age ≥ 60 years were independent risk factors for decreased cause-specific survival in patients with chordoma of the mobile spine and sacrum. Surgical intervention was associated with significantly improved cause-specific survival. Our findings of unchanged cause-specific conditional survival for each additional year of survival after diagnosis is consistent with the indolent nature of chordoma.

Reamer/Irrigator/Aspirator (RIA) and Intramedullary Fixation for Impending Pathologic Femur Fracture♦

Abstract ID: Poster 085

John W. Munz, M.D.
*Andrea L. Gale, M.D.
Rex A. W. Marco, M.D.
Houston, TX

PURPOSE: The purpose of our study is to evaluate the use of the Reamer/Irrigator/Aspirator (RIA) with intramedullary prophylactic fixation in impending pathologic femur fractures. The RIA is used to function as a type of “closed curettage” in debulking the tumor burden.

METHODS: Retrospective review. Data collection included: age, sex, location of lesion, pathology, number of lesions, presence of lung metastasis/brain metastasis, type of pain, estimated blood loss, operative time, implant size, ASA class, Mirels’ score, intraoperative complications, length of hospital stay, discharge disposition, perioperative complications (30 day), survival, ambulation method, pain relief (visual analog scale), duration of follow-up, implant failure, and status of healing. Patients were followed in clinic at 2, 6, 12, 24 week, and 1 year increments. If patients could not follow up, then telephone interviews were conducted. All patients per protocol received postoperative radiation therapy.

RESULTS: 8 patients with impending pathologic femur fractures. 7 female and 1 male with a mean age of 61.5 years (range 34-74). The pathology consisted of 1 colon, 1 breast, 1 renal cell, 1 squamous cell, and 2 non-small cell lung carcinomas, with 2 multiple myeloma. The location of lesions included: 3 subtrochanteric, 2 diaphyseal, 1 distal 1/3, and 2 entire shaft. The majority of the lesions were lytic (7), with 1 mixed. All patients presented with rest pain and the average Mirels’ score was 11 (range 10-12). Operative time averaged 62.3 minutes (range 31-133). The estimated blood loss averaged 212.5 cc (range 100-600). Implant diameters ranged from 11-14 mm with RIA diameters ranging from 12-15 mm. No intraoperative complications occurred. Postoperative hospital length of stay averaged 9.1 days (range 2-24) with discharge disposition to rehab in 3 patients, home in 4, and skilled nursing facility in 1 patient. Perioperative (30 day) complications included: chemotherapy reaction, ileus, vaginal bleeding, and thrombocytopenia. No patients had decline in pulmonary or neurologic status in perioperative period. Pain relief by visual analog scale averaged 9 preoperatively with 2 postoperatively. The patients were followed for a mean of 24.2 months (range 13-37 months). No implant failures had occurred. Overall survival averaged 10.1 months (range 2-23 months).

CONCLUSION: In our small retrospective series, use of the RIA (reamer-irrigator-aspirator) as an adjuvant therapy appears to be safe and beneficial by potentially reducing pulmonary and neurologic complications. The impending pathologic lesion, with intact femoral cortices, could present an ideal area of application to further minimize risks in an already compromised patient population.

♦The FDA has not cleared the drug and/or medical device for the use described in this presentation (Reamer/Irrigator/Aspirator [RIA]).

KNEE

Does Obesity Affect Short-Term Complication Rates and Length of Hospitalization Following Unicompartmental Knee Arthroplasty?

Abstract ID: Poster 086

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*Bryan D. Haughom, M.D. / Chicago, IL
William W. Schairer, M.D. / New York, NY
Michael D. Hellman, M.D. / Chicago, IL
Benedict U. Nwachukwu, M.D. / New York, NY
Brett R. Levine, M.D. / Chicago, IL

INTRODUCTION: The impact of obesity on long-term outcomes in unicompartmental knee arthroplasty (UKA) is debated, but the effect on short-term complications is not well described. We aimed to determine the risk factors for complications and prolonged length of stay (LOS) after UKA, hypothesizing that obesity independently affects both complication rates and LOS.

METHODS: All primary UKA (n=2,316) from the National Surgical Quality Improvement Database (2005-2012) were evaluated. Preoperative comorbidity, laboratory, operative, and postoperative data were included. Short-term (30-day) complications were classified as major systemic (e.g., pulmonary embolism), major local (e.g., deep infection), minor systemic (e.g., UTI), and minor local (e.g., wound dehiscence). Multivariate logistic regression was used to determine the independent risk factors for postoperative complications and prolonged LOS (>4 days).

RESULTS: Patients in this cohort were generally older (63.8±10.7 years), female (54.4%), Caucasian (77.0%), and obese (BMI:31.4±6.3 kg/m^2). 86.7% UKAs were performed as inpatients. Operative time averaged 89.4±37.1 minutes and the LOS was 2.23±2.0 days. One-third of cases involved resident surgeons. Postoperative transfusion was observed in 1.2% of cases. The overall complication rate was 3.2% (major system: 0.5%, minor systemic: 1.4%, major local: 0.7%, minor local: 0.9%), with no deaths. Rates of readmission (2.1%) and reoperation (0.9%) were low. Independent risk factors for complications included BMI (OR=1.24 per 5 point increase, CI: 1.03-1.51, p=0.027) and chronic obstructive pulmonary disease (COPD, OR=3.77, CI: 1.33-10.72; p=0.013). Resident involvement was associated with a reduced risk of complications (OR=0.29, CI: 0.10-0.82; p=0.02). Independent risk factors for increased LOS included BMI (OR=1.26 per 5 point increase, CI: 1.05-1.51; p=0.001), ASA>3 (OR=1.96, CI: 1.08-3.57; p=0.027), COPD (OR=3.64, CI: 1.37-9.66; p=0.010), recent operation (within 30 days; OR:8.91, CI: 1.42-55.98; p=0.020), and transfusion (OR:3.96, CI: 1.15-13.68; p=0.030).

CONCLUSIONS: Obesity's long-term impact on UKA outcomes remains unsolved; however, our data highlight the short-term impact. Obesity was shown to independently affect short-term complications and prolonged LOS, underscoring the importance of preoperative optimization and patient education. Chronic obstructive pulmonary disease was also shown to be an independent risk factor for complications as well as increased length of stay, while ASA class greater than 3, recent operation, and transfusions were both shown to be independent risk factors for increased length of stay.

Total Knee Arthroplasty After 3:00 p.m. Increases Operative Time and Cost

Abstract ID: Poster 087

Arjun S. Sebastian, M.D.
*Chad D. Watts, M.D.
Thomas O'Byrne, B.S.
Dawn Finnie, B.S.
James Naessens, M.P.H., M.T. (ASCP)
David G. Lewallen, M.D.
Rochester, MN

INTRODUCTION: Given the increasing incidence of total knee arthroplasty (TKA) and overall associated healthcare cost, TKA will come under increasing scrutiny to define both quality metrics and high value surgical practices. An operating room scheduling target for TKA cases to be completed by 3:00 p.m. was set at our institution to minimize overtime and improve resource utilization. The effect of TKA cases extending past 3:00 p.m. on patient outcomes is unknown.

METHODS: From 2008-2011, 4,493 primary TKA cases were performed at our institution with 695 cases (15.5%) taking place after 3:00 p.m. Several patient demographics were identified including age, gender, diagnosis, number of medical comorbidities, BMI, and ASA class. The Technical Expert Panel (TEP) risk-standardized complication rate was determined for all patients as well as 30- and 90-day readmission rates. Information was also collected regarding length of stay, cost to the payer, operating room time, and use of specific operating teams. Analyses were performed to determine differences between cases extending past 3:00 p.m. and those that did not.

RESULTS: TKA cases performed after 3:00 p.m. had a significant trend towards higher ASA class ($p = .009$). An increased frequency of bilateral cases performed after 3:00 p.m. (8.9% vs. 3.7%, $p < .001$) was also observed. Late TKA cases were less likely performed by high volume surgeons (32.7% vs. 40.1%, $p < .001$), and with the customary operating team (54.0% vs. 65.4%, $p < .001$). After adjusting for comorbidities, bilateral surgery, and other covariates, it was determined that cases taking place after 3:00 p.m. had 34.3 minutes of additional operating room time ($p < .001$), cost an average of 4.7% more ($p < .001$), and were 54.2% more likely to include blood product utilization ($p < .001$). When surgeons worked without their customary surgical technician, this added 7 minutes of additional operating room time ($p < .001$). No significant difference was observed in overall TEP complication rate (0.6%, $p = .597$). The overall 30-day and 90-day related readmission rates were 1.2% ($p = .807$) and 4.7% ($p = .512$) with no significant difference between groups.

DISCUSSION: Later TKA cases were more likely to be performed by low volume surgeons and without customary operating teams. Despite similar complication and readmission rates, later cases had longer operative times, increased blood product utilization, and higher average costs.

Is Selective Patellar Resurfacing an Acceptable Practice in Patients Undergoing Primary Total Knee Arthroplasty?

Abstract ID: Poster 088

Omar Haque
*Hilal Maradit Kremers, M.D.
Walter K. Kremers, Ph.D.
Daniel J. Berry, M.D.
David G. Lewallen, M.D.
Robert T. Trousdale, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Patellar resurfacing remains controversial in total knee arthroplasty (TKA). Some surgeons opt for a “selective patellar resurfacing (i.e., choosing to not resurface those that are considered poor candidates), but the results of such practice compared to resurfacing the patella in a large cohort of patients has not been reported previously. Thus, the objective of this work was to assess the long-term clinical outcomes associated with selective patellar resurfacing in primary TKA.

METHODS: This study included 15,497 patients with 21,371 primary TKA procedures. Within this cohort, there were 402 (1.9%) knees with unresurfaced patellae and 20,969 knees with all-polyethylene patellae designs. Reasons stated for not resurfacing were normal cartilage (226, 56%), surgeon choice for other reasons (93, 23%), thin patella (53, 13%) and young patient (30, 8%). Statistical analyses were performed in two ways: (a) multivariable Cox regression analysis and (b) matched cohort analysis.

RESULTS: In the Cox regression analyses, the risk of complications (Hazards Ratio: 1.25, 95% Confidence Interval: 1.06, 1.46) and all-cause revisions (HR: 1.39, 95% CI: 1.02, 1.89) were significantly higher following TKA with unresurfaced patellae. Revisions performed specifically for patellar complications did not reach statistical significance (HR: 0.32, 95% CI: 0.08, 1.32) and the results of the matched cohort analyses revealed similar findings. The risk of all complications (HR: 1.28, 95% CI: 1.04, 1.56) was higher without patellar resurfacing, but the overall risk of revisions (HR: 1.23, 95% CI: 0.85, 1.79) was not significantly different with or without patellar resurfacing. In subgroup analyses, the only group of patients that showed increased risk of complications (HR: 2.66, 95% CI: 1.70, 4.17) and revisions (HR: 5.94, 95% CI: 2.35, 15.02) was the group with thin patellae, but this seemed to be related to preoperative diagnosis and not related to the patella. We did not observe an excess risk of revisions when patellae were not resurfaced due to normal cartilage (HR: 0.77, 95% CI: 0.45, 1.31), surgeon choice (HR: 1.04, 95% CI: 0.48, 2.12), or young patients (HR: 1.78, 95% CI: 0.43, 7.32).

DISCUSSION AND CONCLUSION: These findings suggest that selective patellar resurfacing provides similar complication and revision rates when compared to routine resurfacing if a patella-friendly femoral component is used. Although the “thin unresurfaced patella” group had higher overall revision and complication rates, these were not specifically associated with patellar problems, but more likely related to the underlying diagnosis leading to TKA.

The Impact of Total Joint Arthroplasty on Return to Sexual Function in Young, Active Patients

Abstract ID: Poster 089

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*Ryan M. Nunley, M.D. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Ravi K. Bashyal, M.D. / Evanston, IL
Craig J. Della Valle, M.D. / Chicago, IL
William G. Hamilton, M.D. / Arlington, VA
Michael E. Berend, M.D. / Mooresville, IN
Javad Parvizi, M.D. / Philadelphia, PA
John C. Clohisy, M.D. / St. Louis, MO
Robert L. Barrack, M.D. / St. Louis, MO

INTRODUCTION: Return to sexual function remains a high priority for patients following total joint arthroplasty (TJA), but limited information is available regarding the rate of return, frequency, and quality of sexual activity postoperatively. The purposes of this study were to (1) evaluate young, active patients to assess return to sexual function following TJA,(2) identify potential differences based on implant type, and (3) between TKA, THA, and “control” patients without hip or knee disease, and (4) to determine the effect of gender, age, ethnicity, and activity level on return to sexual function.

METHODS: We conducted a retrospective, multicenter study of subjects under 60 years old, with a pre-symptomatic University of California at Los Angeles (UCLA) activity score of > 6, who underwent elective total hip (THA) or total knee arthroplasty (TKA) for noninflammatory arthritis at a minimum of one year postoperatively. Patients were excluded if they had undergone revision for any reason following their index procedure. An independent, third party survey center was used to question subjects about their return to sexual function, and changes in sexual frequency and quality. Multivariate logistic regression analyses were performed to confirm the association between TJA and outcomes of interest, adjusting for age, sex, ethnicity, and presymptomatic UCLA score.

RESULTS: 806 THA (66% male; mean age 49.5 + 7.2 years), 542 TKA (52% male; mean age 54.2 + 5.3 years), and 181 “control” patients (48% male; mean age 48.1 + 4.1 years) were included. 89.5% of THA and 84.3% of TKA patients were sexually active since surgery, with only 1.3% and 1.6% not sexually active due to their hip or knee. Multivariate analysis showed no difference in sexual function based on THA femoral head size. There was no difference in return to sexual activity following THA vs. TKA (OR 1.10, $p=0.38$). Both THA (OR 10.60, $p<0.0001$) and TKA patients (OR 3.61, $p<0.0001$) reported improved sexual quality versus controls. Male gender (OR 3.88, $p<0.001$) and an age less than 49 years old (OR 6.23, $p=0.003$) significantly increased the odds of return to sexual activity following TJA.

CONCLUSION: The majority of young, active patients can expect to return to baseline or higher-level sexual activity following TJA. This information will prove useful for surgeons when counseling patients regarding their return to sexual activity following TJA.

Post-Traumatic Total Knee Arthroplasty Continues to Have Worse Outcome Total Knee for Osteoarthritis

Abstract ID: Poster 090

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*Matthew T. Houdek, M.D.
Chad D. Watts, M.D.
Eric R. Wagner, M.D.
Steven F. Shannon, M.D.
Matthew P. Abdel, M.D.
S. Andrew Sems, M.D.
Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: Periarticular fractures around the knee are potentially devastating injuries. Previous studies have shown that patients who undergo a total knee arthroplasty (TKA) following a distal femur and/or tibial plateau fracture may have inferior results. The purpose of this study was to evaluate the long-term outcomes of patients undergoing TKA following periarticular knee fractures.

METHODS: Using our institutions total joint registry, we identified 548 patients who underwent a TKA with a previous distal femur or tibial plateau fracture from 1990-2013. Kaplan-Meier survival outcomes were assessed with a focus on need for reoperation, infection, and revision total knee arthroplasty at an average follow-up of 6.2 years. Overall revision free survival was compared to 20,643 patients undergoing TKA for osteoarthritis (OA) during the same time period. Mean age was 62 years at the time of the TKA, with 60% being female. Sixty percent of fractures were treated with open reduction internal fixation; 51% were classified as obese.

RESULTS: The mean 5-, 10-, 15-, and 20-year survival for a TKA following a periarticular knee fracture was 91%, 88%, 74%, and 66%. This was significantly worse ($p<0.0001$) than patients undergoing TKA for OA, where 5-, 10-, 15-, and 20-year survivals were 97%, 93%, 86%, and 75%. There was no difference ($p=0.71$) in the overall survival when comparing patients with a previous tibial plateau or distal femur fracture. The mean time to revision total knee, reoperation, and postoperative infection were 4.6, 2.5, and 1.6 years, respectively. Revision total knee, reoperation for any reason, and infection occurred in 11%, 19%, and 6% of patients. Age <60 and postoperative complications increased risk of revision and reoperation, while morbid obesity; previous nonunion/malunion and postoperative wound complications increased the risk for infection

DISCUSSION: TKA following a periarticular fracture have worse overall revision free survival compared to those undergoing TKA for OA. Younger patients and those with a postoperative wound complication, instability, or limited motion are at increased risk of reoperation and revision surgery. Our study shows that rates of complications in this cohort of patients are high, with 1 in 4 patients requiring revision total knee by 15 years.

Eliminating Blood Transfusion in Primary Total Knee Arthroplasty: An Achievable Goal?

Abstract ID: Poster 091

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*Joshua B. Holt, M.D.
Benjamin J. Miller, M.D.
John J. Callaghan, M.D.
Charles R. Clark, M.D.
Melissa D. Willenborg, M.D.
Nicolas O. Noiseux, M.D.
Iowa City, IA

INTRODUCTION: Surgical blood loss requiring transfusion in knee arthroplasty remains a major concern despite advances in blood conservation. We introduced a multimodal approach to perioperative blood management aimed at eliminating blood transfusions in primary total knee arthroplasty. The algorithm includes (1) preoperative hemoglobin optimization through a novel multi-disciplinary approach including non-invasive hemoglobin screening, (2) minimization of peri-operative blood loss through administration of tranexamic acid (TXA), and (3) utilization of strictly defined transfusion triggers. Our hypothesis was that adherence to this algorithm could eliminate blood transfusions after uncomplicated primary total knee arthroplasty.

METHODS: Our institutional registry of prospectively-collected data on 490 consecutive patients undergoing primary total knee arthroplasty was reviewed after the initiation of a new multimodal perioperative blood management algorithm (May 2012). Transfusion rates were determined and compared to the immediately previous patient cohort (Feb 2009-April 2012, 898 cases). Detailed chart evaluation of adherence to the algorithm was then performed in all patients requiring allogeneic blood transfusion.

RESULTS: There was a significant reduction in the overall transfusion rate (5/490 [1.0%] vs. 108/898 [12.0%], $p<0.0001$) for all patients undergoing primary knee arthroplasty after introduction of our algorithm, when compared to the historic cohort. None of the patients (0%) who successfully followed our protocol required transfusion. Reasons for nonadherence to our algorithm in the five patients requiring transfusion included transfusion for a hemoglobin >7 g/dL (2 patients), failure to receive intraoperative TXA (1 patient), inadequate preoperative hemoglobin screening, and a combination of the above (2 patients).

CONCLUSION: Adoption of a multimodal, multi-disciplinary blood management algorithm resulted in a significant reduction in allogeneic blood transfusions after primary total knee arthroplasty. The authors believe there is potential to eliminate blood transfusions in uncomplicated primary knee arthroplasty with full implementation of this algorithm.

Total Knee Arthroplasty in the Medicaid Population

Abstract ID: Poster 092

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*Brian E. Schwartz M.D.
David E. Mossad, B.S.
Vincent M. Moretti, M.D.
Alfonso Mejia, M.D.
Chicago, IL

INTRODUCTION: The Affordable Care Act (ACA), signed into law in 2010, is expected to widen health insurance coverage to include the 32 million uninsured Americans, more than half of which will be covered under Medicaid. The ACA is expected to expand ways for patients to compare physicians online. These statistics may be unfairly skewed for orthopedic surgeons whose practice consists of a large portion of Medicaid patients, as certain outcomes may be worse in this population. The purpose of this study was to evaluate patient demographics and perioperative outcomes for Medicaid patients who underwent a total knee arthroplasty (TKA).

METHODS: The National Hospital Discharge Survey database was searched ICD-9 codes for patients admitted to U.S. hospitals for primary TKA for the years 2001-2010. Patients were then separated into two groups based on their principal expected source of payment: Medicaid and all other types of insurance (Medicare, worker's compensation, Blue Cross/Blue Shield, HMO/PPO, self-pay, no charge, other). ICD-9 codes were used to identify patient demographics, in-hospital adverse events, and discharge disposition. Statistical analysis included Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis with a significance level of 0.05.

RESULTS: 33,066 primary TKA patients (727 Medicaid, 32,339 other) were identified. From 2001-2005, Medicaid accounted for 2.11% of all TKAs performed, increasing insignificantly to 2.37% between 2006-2010 ($p=0.114$). The Medicaid group was younger (56.6 vs. 67.0 years, $p<0.01$) and had a less percentage of males (22.1% vs. 35.4%, $p<0.01$) than the other insurance group. The rates of obesity (17.9% vs. 1.4%, $p<0.01$), morbid obesity (8.1% vs. 3.4%, $p<0.01$), and diabetes (19.1% vs. 15.7%, $p=0.014$) were significantly higher in Medicaid patients. The Medicaid group had on average more medical co-morbidities (5.2 vs. 5.0, $p=0.002$) and a longer LOS (4.2 vs. 3.7 days, $p<0.01$). There was no significant difference in the rate of DVT ($p=0.94$), PE ($p=0.98$), blood transfusion ($p=0.63$), postoperative wound infection ($p=0.25$), or mortality ($p=0.76$).

DISCUSSION: While the rate of Medicaid in primary TKA was relatively unchanged through 2010, the rate is expected to rise significantly with the rollout of the ACA. Orthopedic surgeons who treat a significant amount of Medicaid patients may be unfairly judged in the upcoming online comparisons, specifically in terms of LOS after TKA. Medicaid patients were found to be significantly more likely to be obese, diabetic, and have more medical co-morbidities, which places them at an increased risk of developing a periprosthetic infection.

Orthopedic Surgeons Rank Low in Total Medicare Payments

Abstract ID: Poster 093

Daniel A. Belatti, B.S.
*Andrew J. Pugely, M.D.
Annunziato Amendola, M.D.
Phinit Phisitkul, M.D.
John J. Callaghan, M.D.
Iowa City, IA

PURPOSE: Orthopedic surgery is often perceived as a high cost area of medicine. As Medicare payments to individual providers are now in the public domain, we sought to explore what this new data reveals about total Medicare payments to orthopedic surgeons.

METHODS: We used the new Medicare Provider Utilization and Payment Database to record demographic, procedure volume, and Part B payment information for all orthopedic surgeons nationwide accepting Medicare in 2012 (n=20,381). We calculated per surgeon averages for available metrics, and sought to characterize the variation we observed.

RESULTS: Orthopedic surgeons received a total of $2.1 billion in Medicare payments in 2012, while caring for 6.6 million unique patients. The average orthopedic surgeon received $104,085 from Medicare, substantially less than the average paid out to several other specialties. The distribution of payments was highly variable (σ = $119,128) and positively skewed; only 1.2% of surgeons received greater than $250,000 in Medicare payments. The total amount a surgeon received was significantly correlated with patient volume (r =.83). The vast majority (95.8%) of surgeons were male, and female surgeons averaged significantly lower payments per Medicare patient (p<.001).

CONCLUSION: Medicare payments to individual orthopedic surgeons remain low. Because of high inpatient hospital costs, orthopedic surgery is often pegged as a major driver of Medicare spending. This study confirms that reimbursements to individual surgeons are generally reasonable. Further reductions in these payments, which only account for a very small proportion of the Medicare budget, are unlikely to result in significant cost savings, and may significantly restrict patient access to care. Individual surgeons should be aware of the increasing information about their clinical practice becoming available to the public.

Low Socioeconomic Status Increases Risk for 30-Day Readmission Following Total Knee Arthroplasty

Abstract ID: Poster 094

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*James A. Keeney, M.D. / Columbia, MO
Ryan M. Nunley, M.D. / St. Louis, MO
Staci R. Johnson, M.S. / St. Louis, MO
Denis Nam, M.D. / St. Louis, MO
Robert L. Barrack, M.D. / St. Louis, MO

INTRODUCTION: While lower socioeconomic status has been attributed to higher rates of knee stiffness and poorer functional outcomes for patients undergoing total knee arthroplasty (TKA), it has not been associated with increased risks for hospital readmission. We performed this study to assess the influence of socioeconomic factors on the rate of 30-day hospital readmission following total knee arthroplasty.

METHODS: We retrospectively assessed 3,384 consecutive TKA procedures performed at our institution between 2006 and 2013. We identified 137 readmissions (4.0%) that occurred within 30 days of hospital discharge following TKA. Demographic features were evaluated to determine whether there were significant differences in 30-day readmission rates following TKA that were potentially related to patient socioeconomic status. The study interval was divided into 4-year increments to determine whether measures introduced to decrease hospital readmission rates after 2010 had been effective and whether their influences had similar effects on patients with lower socioeconomic status.

RESULTS: African-American patients were significantly more likely than non-minority patients to be readmitted for both management of medical conditions (3.6% vs. 1.4%, $p=0.003$) or surgical complications (5.3% vs. 2.3%, $p<0.001$) within 30 days of hospital discharge. Surgical readmissions were significantly higher for patients with Medicaid insurance (10.5% vs. 2.1%, $p<0.001$) or Medicare Insurance (4.1% vs. 2.1%, $p<0.01$) compared with patients covered by private insurance plans. However, medical readmissions were not different for either Medicaid ($p=0.44$) or Medicare ($p=0.18$) patients compared with privately insured patients. Discharge to a skilled nursing or inpatient rehabilitation facility was more likely to result in a surgical readmission (6.7% vs. 2.9%, $p<0.001$) with a trend for higher medical readmission rate ($p=0.08$) compared with patients discharged home with engaged health care services. Institutional 30-day readmission rates had decreased significantly between 2006-2009 and 2010-2013 (7.7% vs. 2.7%, $p=0.0001$) which was related to decreases in both medical readmission (2.4% vs. 1.3%, $p=0.03$) and surgical readmission (5.3% vs. 1.4%, $p=0.0001$) rates. However, while 30-day readmission rates also improved for minority patients, their readmission rates remained significantly higher for both surgical (3.1% vs. 1.2%, $p=0.04$) and medical (3.6% vs. 1.0%, $p<0.01$) concerns than non-minority patients.

CONCLUSION: Patients with lower socioeconomic status are at an increased risk for 30-day readmission following total knee arthroplasty. Consideration should be given for targeted post-discharge surveillance for patients with minority status, Medicaid insurance coverage, or inability for early discharge to home in order to decrease their risk for hospital readmission following TKA.

HIP

Complications Related to a Novel Limited Oblique Incision in the Direct Anterior Approach for Primary THA

Abstract ID: Poster 095

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*Scott Vizzi, M.D.
Thomas J. Otto, M.D.
St. Louis, MO

BACKGROUND: The purpose of this retrospective clinical study is to identify if the limited oblique direct anterior approach (DAA) has similar wound complications, need for secondary procedures, and deep infection rates compared to the traditional longitudinal direct anterior approach (DAA) for primary THA.

METHODS: Patient charts at two different hospitals were retrospectively reviewed for 257 patients who underwent a primary THA with a limited oblique incision from November 2008 to August 2013. A single surgeon performed all procedures. Data pertaining to wound complications, deep infection, and need for secondary procedures was recorded. Additionally, patient data including co-morbidities, BMI, and presence of lateral femoral cutaneous nerve symptoms (LFCN) was recorded and analyzed.

RESULTS: Deep infection was defined as requiring at least one formal irrigation and debridement in the operating room or requiring a two-staged removal of hardware with re-implantation. Wound complications were defined by non-operative treatment with local wound care. These included persistent wound drainage requiring extended dressing changes, eschar at the wound site, and delayed healing at the incision. There were 7 total deep infections (2.7%) and 9 total wound complications (3.5%) out of a total of 257 patients. The hospital in which surgery was performed was not associated with either deep infection or wound complications ($p>.05$). Co-morbidities and BMI were not associated with deep infection or wound complications ($p>0.05$). LFCN neuropraxia symptoms were found in 4.3% of patients on follow-up. These were transient and resolved.

CONCLUSIONS: The limited oblique incision for the direct anterior approach (DAA) is safe and effective for use in primary THA. We found that deep infection and wound complication rates in a large number of patients with this incision are comparable to that for the traditional longitudinal DAA hip incision in two different hospitals. Furthermore, presence of co-morbidities or BMI was not associated with increased deep infection or wound complication rates. A large randomized prospective study comparing the longitudinal incision with the limited oblique incision would be helpful in further investigation.

Safety Measures in Hip Arthroscopy and Their Efficacy in Minimizing Complications: A Systematic Review of the Evidence

Abstract ID: Poster 096

Asheesh Gupta, M.D. / Fairfax, VA
John M. Redmond, M.D. / Jacksonville, FL
Jon E. Hammarstedt, B.S. / Westmont, IL
Leslie E. Schwindel, M.D. / Chicago, IL
*Austin W. Chen, M.D. / Chicago, IL
Benjamin G. Domb, M.D. / Westmont, IL

BACKGROUND: While the number of hip arthroscopy procedures performed in the United States is increasing rapidly, they are not without risks and complications. Few studies have rigorously evaluated the current literature with regards to safety and complications during hip arthroscopy.

PURPOSE: The purpose of this systematic review is to evaluate the literature to determine complications of hip arthroscopy, with a focus on minimizing complications and risks.

MATERIALS AND METHODS: Two independent reviewers performed a search on PubMed for articles that contained at least one of the following terms: complications and hip arthroscopy, hip impingement, femoral acetabular impingement (FAI), complications, or femoroacetabular impingement and complications. The search was limited to articles published between 1999 and June 2013. We also performed a search on studies evaluating techniques on how to minimize complications.

RESULTS: 81 studies were identified (5,535 patients; 6,277 hips). Average age was 35.48 years with mean Body Mass Index (BMI) of 25.20 kg/m^2. There were 52% male participants and 48% female participants. The majority of our studies were Level IV evidence (63%). A total of 285 complications were reported for an overall rate of 4.5%. There were 26 major complications (.41%) and a 4.1% minor complication rate. The overall reoperation rate was 4.03%. A total of 94 hips underwent revision arthroscopy. With regards to open procedures, 150 patients (93%) underwent either a total hip arthroplasty or a hip resurfacing procedure. The conversion rate to total hip arthroplasty or a resurfacing procedure was 2.4%.

CONCLUSIONS: Overall, primary hip arthroscopy is a successful procedure with a low rate of major (.41%) and minor (4.1%) complications. We present a systematic review of the complications and how to minimize these with careful technique and planning.

The Cumulative Risk of Re-Dislocation After Revision THA Performed for Instability Increases Close to 35% at 15 Years

Abstract ID: Poster 097

Suenghwan Jo, M.D.
Jose Jimenez Almonte, M.S.
*Rafael J. Sierra, M.D.
Rochester, MN

INTRODUCTION: The purpose of this study is to (1) report the cumulative risk of re-dislocation and subsequent revision in a large series of revision THA performed for instability and (2) to identify the patient and surgical related variables that are associated with redislocation and re-revision THA.

METHODS: A retrospective analysis was conducted on 539 hips (528 patients) undergoing revision THA done for instability between 1995 and 2005. Patient demographics, etiology for instability, and surgical strategies aimed at treating the instability were identified from medical records. The cumulative risk of re-dislocation and revision was calculated using Kaplan-Meier method and risk factors were identified using Cox proportional-hazard regression models. Risk factors were compared for re-dislocated and undislocated groups and also for revised and non-revised groups.

RESULTS: The average follow-up after revision THA was 5.4 years (range, 1 day to 17.4 years), and 86 hips (15.9%) had at least one dislocation during the follow-up period. The cumulative risk of dislocation at 1, 5, 10, and 15 years was 6.8%, 15.4%, 23.7, and 34.5%, respectively. Re-revision THA was performed for all causes in 122 hips (22.6%). The cumulative risk of re-revision at 1, 5, 10, and 15 years was 5.1%, 17.9%, 33.2%, and 45.9%, respectively. 56 of these were done for subsequent episodes of instability and the risk of re-revision for instability was 2.0%, 9.6%, and 17.0% at 1, 5, and 10 years, respectively. In the multiple variable analyses, history of 2 or more revisions was a risk factor for re-dislocation (HR 1.936) and revision (HR 1.801); while the use of head size 36 or greater (HR 0.388, 0.376) and acetabular component revision (HR 0.454, 0.675) were identified as protective factors against subsequent dislocation and revision. The use of a constrained liner was protective against re-dislocation (HR 0.299), but was associated with subsequent revision.

CONCLUSIONS: The cumulative risk of dislocation after a revision of an unstable THA is close to 7% during the first year and rises constantly during the life of the arthroplasty to an incredibly high rate of almost 35% at 15 years. Use of a head size 36 or larger, cup revision, and constrained liners were protective strategies against re-dislocation; however, use of a constrained liner was associated with need for revision when dislocation occurred. When possible, surgical strategies that incorporate the above, with judicious use of constrained liners may reduce dislocation as well as revision rates.

Does Neuraxial Anesthesia Decrease the Rate of Postoperative Complications and Blood Transfusions? An Analysis of 29,452 Primary Total Hip Arthroplasty Cases

Abstract ID: Poster 098

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*Brian D. Haughom, M.D. / Chicago, IL
William W. Schairer, M.D. / New York, NY
Michael D. Hellman, M.D. / Chicago, IL
Benedict U. Nwachukwu, M.D. / New York, NY
Brett R. Levine, M.D. / Chicago, IL

INTRODUCTION: The impact of neuraxial anesthesia on postoperative complications and perioperative blood loss in THA is limited to small studies with variable results. Using a national database, we compared complications following THA using neuraxial and general anesthesia, and determined the independent risk factors for blood transfusions.

METHODS: The National Surgical Quality Improvement Database includes prospectively collected perioperative lab, comorbidity, and postoperative complications data. THAs from 2005-2012 were analyzed. A propensity score model incorporated preoperative and perioperative variables to assess the conditional probability of receiving neuraxial vs. general anesthesia. Univariate analysis was performed evaluating postoperative complications between neuraxial and general anesthesia. A multivariate analysis, utilizing the propensity score to balance the probability of receiving neuraxial anesthesia, determined independent risk factors for blood transfusion following THA.

RESULTS: 29,452 primary THA (11,420 neuraxial) were included in this study. Propensity score balancing showed no preoperative differences between groups ($p>0.05$). Neuraxial anesthesia cases demonstrated shorter operative time (88.2 vs. 101.4 minutes; $p<0.001$) and length of stay (3.3 vs. 3.5 days; $p=0.03$), lower rates of overall (4.1% vs. 4.8%; $p=0.006$) and medical complications (2.7 vs. 3.5%; $p<0.001$), deep infection (0.23% vs. 0.37%; $p=0.04$), pneumonia (0.23% vs. 0.37%; $p=0.04$), unplanned intubation (0.16% vs. 0.29%; $p=0.015$), ventilation over 48 hours (0.04% vs. 0.13%; $p=0.03$), stroke (0.08% vs. 0.20%; $p=0.013$), and death (0.12% vs. 0.24%; $p=0.025$). Multivariate analysis demonstrated decreased risk of postoperative transfusion (OR=0.79; CI:0.69-0.91) using neuraxial anesthesia. Independent risk factors for transfusion included female sex (OR=1.90; CI:1.66-2.18), operative time (OR=1.23 per 30 minutes; CI:1.18-1.29), and a history of hypertension (OR=1.33; CI:1.16-1.51).

CONCLUSIONS: We present the largest series to date evaluating neuraxial vs. general anesthesia in THA. Neuraxial anesthesia demonstrated fewer complications, and following multivariate regression, was a protective factor for blood transfusion. Independent risk factors for transfusion included female gender, prolonged operative time, and hypertension.

IV Tranexamic Acid is Associated with Significantly Decreased Transfusion Rates and No Increased Risk of Thromboembolic Disease in Patients Undergoing Periacetabular Osteotomy

Abstract ID: Poster 099

Andrew J. Bryan, M.D.
*Rafael J. Sierra, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Periacetabular osteotomy (PAO) is associated with significant blood loss and need for postoperative transfusion. Tranexamic acid has been shown to decrease blood loss and minimize transfusion rates in patients undergoing total joint arthroplasty with no increased risk of thromboembolic disease (TED). There is a paucity of data on its use in other hip procedures, including joint preservation procedures such as PAO. The purpose of this paper is to report the results of use of IV TXA in patients undergoing PAO and compare the results to those not receiving TXA and historical controls.

METHODS: Patients undergoing femoral procedures (except femoral chondroplasty) combined with PAO were excluded. 266 hips (242 patients) that underwent isolated PAO at one institution between 2003 and 2014 were retrospectively reviewed. 68 patients (75 hips) received intravenous tranexamic acid (TXA) 1 gram at the time of incision and 1 gram at the time of closure. TED was defined as DVT or PE occurring within 6 weeks of the procedure. Transfusion rates were compared between the two groups. The demographics and comorbid conditions between the two groups were similar including age (mean, 26.9), BMI (mean, 26.1), preoperative Hgb (13.6), and postoperative Hgb (mean, 9.6). Aspirin was the predominant prophylactic regimen in both groups. TED and transfusion rates were also compared to a group of 108 PAO previously reported from our institution.

RESULTS: There was no significant difference in TED rates between TXA 1.33% (1/75) and non-TXA groups .52% (1/191; p=0.49). There was also no difference in TED rates between the TXA group and historical control (1.33% vs. 1.83%; p=.79). The mean number of units transfused in the TXA and non-TXA group was 1.05 and 1.51, respectively (p=.0044). The TXA group also showed a significantly decreased rate in transfusion when compared to historical controls (2.01 vs. 1.05; p=.0001).

CONCLUSION: The use of IV TXA has led to a decreased rate of transfusion with no increased risk of TED in this contemporary cohort of patients undergoing PAO. As with patients undergoing total joint arthroplasty, IV TXA should be considered as a blood management tool in patients undergoing joint preservation surgery.

Combined Femoroacetabular Anteversion: Does Ethnicity, Body Size, or Gender Play a Role? A CT Scan Study.

Abstract ID: Poster 100

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*Brian E. Schwartz, M.D.
Stephen N. Schwartz, B.S.
Domenic P. Esposito, M.D.
Vincent M. Moretti, M.D.
Ritesh R. Shah, M.D.
Chicago, IL

INTRODUCTION: Femoral and acetabular version play an important role in component positioning in total hip arthroplasty, developmental childhood hip abnormalities, and femoroacetabular impingement. Limited data exists regarding the variability of native femoral and acetabular version based on patient demographics. The aim of this study was to evaluate whether acetabular, femoral, or combined femoroacetabular version varies based on patient demographics, specifically ethnicity, body size, and gender.

METHODS: Computed tomography (CT) studies that included the pelvis to the knee were retrospectively reviewed over a 10-year period for which IRB approval was obtained. Acetabular version was measured at the mid-level of the femoral head. The femoral version was calculated by superimposing a line through the center of the femoral neck and a line parallel to the posterior femoral condyles. Statistical analysis included Pearson's correlation coefficient (r), Student's t-test, and ANOVA with an alpha level of 0.05.

RESULTS: 87 patients (46 males, 41 females) were identified. 44 patients were African-American, 26 Caucasian, 9 Hispanic, 2 Asian, and 6 patients were listed as "other". The mean acetabular anteversion was 18.11° (SD 6.04, range 6.8-34.5°). The mean femoral anteversion was 12.0° (SD 8.68, range -7.8-33.5°). The mean combined anteversion was 30.1° (SD 10.03, range 11.4-50.8°). Acetabular ($p=0.58$), femoral ($p=0.345$), or combined anteversion ($p=0.873$) did not significantly vary based on patient ethnicity. Female patients were found to have a significantly greater acetabular anteversion (19.6° vs. 16.5°, $p=0.016$); however, femoral ($p=0.57$) and combined anteversion ($p=0.34$) were not significantly different from male patients. Patients shorter than 169 cm had a significantly greater acetabular (20.6 vs. 15.6, $p<0.01$) and combined anteversion (32.8 vs. 27.3, $p=0.01$) than patients taller than 169 cm. Acetabular anteversion demonstrated a moderate negative correlation with height ($r=-0.326$). No significant difference in acetabular ($p=0.12$), femoral ($p=0.94$), or combined anteversion ($p=0.32$) was found between patients ≤ 80 kg and > 80 kg.

DISCUSSION: This study demonstrates that the average combined anteversion is approximately 30°. Version did not significantly vary based on either ethnicity or weight. Females and patients shorter than 169 cm had statistically significant greater acetabular anteversion. Female gender and shorter stature impact acetabular anteversion and are important factors when determining acetabular component positioning during total hip arthroplasty

Total Hip Arthroplasty in Avascular Necrosis: Perioperative Outcomes and National Trends

Abstract ID: Poster 101

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*Brian E. Schwartz, M.D.
David E. Mossad, B.S.
Vincent M. Moretti, M.D.
Ritesh R. Shah, M.D.
Chicago, IL

INTRODUCTION: Total hip arthroplasty (THA) is a highly successful surgery for the management of both osteoarthritis (OA) and avascular necrosis (AVN) of the hip. While a majority of THA is performed for OA, a significant portion is performed in the setting of AVN for which limited national data exists. The purpose of this study was to assess patient demographics, perioperative outcomes, and recent national trends in THA performed in the setting of AVN.

METHODS: The National Hospital Discharge Survey database was searched using ICD-9 codes for patients admitted to U.S. hospitals from 2001-2010 for primary THA for either osteoarthritis (OA) or AVN. ICD-9 codes were used to identify patient demographics, in-hospital adverse events, and discharge disposition. Statistical analysis included linear regression with Pearson's correlation coefficient (r), Student's t-test, and chi-square analysis for proportions with a significance level of 0.05.

RESULTS: 18,186 patients who underwent a primary THA were identified, of which 1,650 patients (9.1%) had a diagnosis of AVN and 14,745 (81.1%) patients had a diagnosis of OA. After adjusting for fluctuations in annual hospital admissions, both the rates of THA for AVN ($r=0.65$) and THA for OA ($r=0.82$) demonstrated a positive correlation with time.

The AVN group was significantly younger (56.9 vs. 65.9 years, $p<0.01$), more likely to be male (51.9% vs. 43.0%, $p<0.01$), and more likely to be African American (11.2% vs. 5.4%, $p<0.01$) than the OA group. There was no significant difference in the rate of DVT (0.24% vs. 0.12%, $p=0.36$), PE (0.18% vs. 0.23%, $p=0.90$), blood transfusion (25.7% vs. 25.3%, $p=0.70$), postoperative wound infections (0.18% vs. 0.12%, $p=0.78$), or mortality (0.18% vs. 0.12%, $p=0.84$) between the AVN and OA groups, respectively. The AVN group had significantly more medical co-morbidities (5.16 vs. 4.77, $p<0.01$). The AVN group had a significantly longer average hospitalization (4.08 days vs. 3.77 days, $p<0.01$), were more likely to be discharged directly home (51.5% vs. 48.3%, $p=0.01$), and less likely to be discharged to a rehabilitation facility (22.8% vs. 28.6%, $p<0.01$).

DISCUSSION: This study demonstrates that in-hospital complications rates are similar between patients with AVN and OA undergoing a THA, with no significant difference in the rate of DVT, PE, wound infection, transfusion, and mortality. Patients undergoing THA for AVN were more likely to be younger, male, African American, and have more medical co-morbidities than those with OA.

The Effect of Liposomal Bupivacaine Injection During Total Hip Arthroplasty: A Controlled Cohort Study

Abstract ID: Poster 102

Benjamin G. Domb, M.D. / Westmont, IL
Asheesh Gupta, M.D. / Fairfax, VA
Jon E. Hammarstedt, B.S. / Westmont, IL
Kinzie Sharp, P.A. / Westmont, IL
John M. Redmond, M.D. / Jacksonville, FL
*William Cregar, B.S. / Richmond, VA

BACKGROUND: Postoperative analgesia in total hip arthroplasty (THA) involves multimodal analgesia. Postoperative opioid-related events can slow recovery and increase patients' length of stay. Decreasing opioid use while maintaining adequate pain control could reduce opioid-related events, increase patient time to first ambulation, and decrease length of stay. The study purpose was to compare liposomal bupivacaine to bupivacaine for postoperative analgesia.

METHODS: Between November 2012 and February 2013, 57 consecutive patients that underwent THA and hip resurfacing received either an intraoperative injection of liposomal bupivacaine or bupivacaine alone. All patients received a combination of medications prior to the procedure including celecoxib 400 mg by mouth, pregabalin 75 mg by mouth, and 1 gm of intravenous acetaminophen. The study group received 20 cc of liposomal bupivacaine, combined with 40 cc 0.25% bupivacaine with epinephrine and 20 cc of normal saline. The control group received 60 ml of 0.25% bupivacaine with epinephrine. Data collected included average visual analog pain scale (VAS), opioid consumption, time to first ambulation, hospital length of stay, and postoperative adverse drug events.

RESULTS: The study group included 27 consecutive patients who received liposomal bupivacaine and the control group included the previous 30 consecutive patients who received bupivacaine alone. Both groups had average VAS scores of 2.8 during the first 24 hours after surgery and 3.3 during the time frame of 24 to 48 hours after surgery. The study group average morphine equivalent use during the first 24 hours after surgery was 31.7 mg, and the control group 53.4 mg ($p < 0.05$). From 24 to 48 hours from surgery, the average morphine equivalent use in the study group was 46.4 mg and the control group 64.9 mg and was not statistically significant. The study group median length of stay was 1.9 days; the control group median length of stay was 2.5 days ($p = 0.051$). The study group had a total of 16 patients able to ambulate > 20 feet on the day of surgery, compared to the control group with four patients ($p < 0.05$). Four times as many patients were able to ambulate the day of surgery in the study group.

CONCLUSION: Administration of liposomal bupivacaine demonstrated decreased opioid consumption during the first 24 to 48 hours, while maintaining equivalent pain scores following THA. Length of stay was decreased from 2.5 to 1.9 days with the use of liposomal bupivacaine.

Non-Constrained Cemented Liners in Revision Total Hip Arthroplasty: 10-Year Outcomes

Abstract ID: Poster 103

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*Diren Arsoy, M.D.
Matthew P. Abdel, M.D.
Joseph R. Cass, M.D.
Robert T. Trousdale, M.D.
Rochester, MN

INTRODUCTION: Liner cementation at the time of acetabular component revision is common, but concerns remain for mechanical failure and instability with long-term follow-up. The aim of this study was to determine the long-term failure rate of previously cemented polyethylene liners at the time of revision total hip arthroplasty (THA).

METHODS: We retrospectively reviewed 428 revision THAs (408 patients) where cementation of a highly crosslinked polyethylene liner at the time of acetabular revision surgery was performed. Survivorship rates, radiographic outcomes, and the risk of instability were analyzed. The median age was 65 years. Median follow-up was 10 years.

RESULTS: In 328 cases, liners were cemented into a new cementless acetabular shell. In the remainder of cases, the liner was cemented into an existing well-fixed acetabular component. At 10 years, survivorship free of aseptic isolated liner revision was 99%, while survivorship free of aseptic acetabular shell revision was 91%. For unrevised liners, there was no evidence of loosening or progressive acetabular osteolysis at 10 years. The dislocation rate at 10 years was 15%.

CONCLUSIONS: Cementation of a highly crosslinked polyethylene liner into a cementless acetabular shell during revision THA provides durable fixation at 10 years. Instability after revision THA remains of concern, but is slightly less than other reported series. This is likely due to the ability to place the cemented liner in a safer position to mitigate the risk of dislocation.

SUMMARY: Cementation of a highly crosslinked polyethylene liner into a cementless acetabular shell is associated with a low (1%) failure rate at 10 years.

Dual Mobility Liners for Revision THA Decrease Early Dislocation

Abstract ID: Poster 104

Salvatore J. Frangiamore, M.D. / Cleveland, OH
*Nicholas Gajewski, B.S. / Cleveland, OH
Carlos A. Higuera, M.D. / Cleveland, OH
Wael K. Barsoum, M.D. / Cleveland, OH
Bryan D. Springer, M.D. / Charlotte, NC
Robert M. Molloy, M.D. / Cleveland, OH

INTRODUCTION: Hip dislocation and recurrent instability continue to be a major cause of failure in revision arthroplasty, as has been reported by some studies to be as high as 27%. Dual mobility acetabular components were designed to reduce dislocation rate while maintaining low friction. Little has been published on modular dual mobility (MDM) THA in the revision setting, specifically regarding early dislocation (i.e., within 3 months of revision surgery). The purpose of this study was to evaluate early dislocation rates and complications in patients who received MDM during THA.

METHODS: A retrospective chart review was performed at two high volume arthroplasty centers on 124 consecutive patients who underwent revision THA with an MDM dual mobility liner between 2011 and 2013. Data including age, gender, BMI, smoking status, number of revision surgeries, infection status, type of prosthesis used, and length of follow-up were collected for each patient. Additionally, any postoperative complications including dislocation, infection, and periprosthetic fracture were recorded. Data were analyzed using JMP 11 software.

RESULTS: Of the 124 revision surgeries investigated, 53% of the patients were male with an average age of 70 years (± 15 years) and average BMI of 30.7 (± 7.3). Nearly half (45.9%) of the patients required graft augmentation at the time of revision surgery. The average length of follow-up was 311 days (± 248 days). One or more complication was observed in 12 patients (9.7%). Of these, 2 were dislocations (1.6%). Both of these were intraprosthetic dislocations (dissociation of the poly head) where the inner head was used off-label to match the trunnion of retained femoral components. The remaining complications included 7 patients who had postoperative prosthetic joint infections (5.6%) and 3 periprosthetic fractures that required reoperation (3.5%).

CONCLUSION: Dislocation in the early postoperative period (3 months) remains a challenge in revision hip arthroplasty. Based on this study, dual mobility shows significant improvements in dislocation rates within a 3-month postoperative period when used appropriately. The “mix and match strategy” appears to increase the dislocation risk and should be discouraged or performed with caution.

Salvage of Monoblock Metal-on-Metal Acetabular Components Utilizing a Dual-Mobility Bearing

Abstract ID: Poster 105

Herman G. Botero, D.O. / Chicago, IL
Darren R. Plummer, M.S. / Chicago, IL
Keith R. Berend, M.D. / New Albany, OH
James W. Pritchett, M.D. / Seattle, WA
Adolph V. Lombardi, Jr., M.D. / New Albany, OH
*Craig J. Della Valle, M.D. / Chicago, IL

BACKGROUND: Large diameter, monoblock acetabular components have been used for both hip resurfacing arthroplasty (HRA) and metal-on-metal total hip arthroplasty (THA). If revision is secondary to an adverse local tissue reaction or a femoral-sided failure, one solution is to retain the shell use a dual-mobility bearing. The purpose of this report is to describe an early, multi-center experience with this technique.

METHODS: At a minimum of two years, we retrospectively reviewed the results of 25 revision total hip arthroplasties including 11 HRA and 14 failed metal-on-metal THA where a monoblock acetabular component was mated to a dual-mobility bearing; femoral head materials included 14 cobalt-chromium, 9 ceramic, and 2 ceramicized metal. Acetabular cup position was assessed along with serum metal ion levels in a subset of 12 patients. Functional outcomes, Harris Hip Score (HHS), and complications were monitored postoperatively. A student's t-test determined statistical significance.

RESULTS: At a mean follow-up of 29 months (range, 24-45 months), there was one failure, an intraprosthetic dislocation of the dual-mobility bearing, that required a second revision surgery in a patient with a cup abduction angle of 67°. The average cup abduction angle was 49° for the entire cohort (range 39°-67°) and anteversion was 19° (range 10°-39°). Twelve patients had both pre- and postoperative serum metal ions. The mean preoperative serum cobalt level decreased from 14.8 to 1.36 ppb ($p = 0.02$), and the mean serum chromium level decreased from 11.9 to 1.59 ppb ($p = 0.04$) postoperatively. The average HHS increased from 57 to 87 points ($p < 0.005$).

CONCLUSION: Retention of a well-fixed, monoblock metal-on-metal acetabular shell and mating it to a dual-mobility bearing in the setting of revision surgery for a failed hip resurfacing or metal-on-metal THA seems to be a reasonable, low morbidity option at short-term follow-up in appropriately positioned cups.

Non-Modular, Fluted, Tapered, Grit-Blasted Titanium-Alloy Revision Stems: Early North American Results

Abstract ID: Poster 106

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*Michael D. Hellman, M.D.
Richard A. Jacobson, M.D.
Bryan D. Haughom, M.D.
Thymur A. Chaudhry, B.S.
Nicholas M. Brown, M.D.
Brett R. Levine, M.D.
Chicago, IL

INTRODUCTION: Revision of femoral component failures can be technically demanding due to periprosthetic bone loss. Nonmodular, fluted, tapered, grit-blasted titanium-alloy stems have been a long-standing option to bridge bone defects in the proximal femur while achieving stability and fixation in the diaphysis. The purpose of this study is to review the early results of these stems in setting of revision total hip arthroplasty (r-THA) in the United States.

METHODS: A consecutive series of 46 patients (August 2008-January 2012) who underwent r-THA utilizing a non-modular, fluted, tapered, grit-blasted titanium-alloy femoral stem, with a minimum two-year follow-up, were reviewed. Pre- and postoperative data including co-morbidity scores, hip outcome measurements, complications, and radiographic measurements were collected. A student's t-test was used to compare results.

RESULTS: 33 patients were included, 18 females and 15 males, average age 59.7±11.6 (32-83). 12 patients were lost to follow-up and 1 patient died. Average Charlson comorbidity index was 2.32±1.52. Average preoperative Harris Hip Scores (HSS) were poor (36.9±20.21). 14 patients had Paprosky 3a femoral 16 periprosthetic joint infections, and 12 cases of aseptic loosening. At 2 years, 27.7% of patients required some type of re-operation (4 required an irrigation and debridement, 1 required an open reduction for dislocation, 3 required a femoral component revision,and 1 required an open reduction and internal fixation for fracture). 9.1% (3/33) of stems failed at 2 years for aseptic loosening. Average HHS at 2 years was fair (68.01±23.40) with an average improvement of 31.1 points ($p<0.0001$). Radiographs revealed no significant subsidence (> 1 cm), the average improvement in the cortical index was 0.41 mm ± 0.50, and bone regeneration was noted in all but one hip.

DISCUSSION AND CONCLUSION: Despite an extensive history of success abroad, this is the first report in North America documenting the results of this stem during complex revision hip arthroplasty. While the re-operation rate was high, patients demonstrated significant improvements in their HHS. Furthermore, radiographic analysis showed no significant subsidence and excellent spontaneous bone regeneration at short-term follow-up.

Increased Risk of Periprosthetic Femur Fractures Associated with a Unique Cementless Stem Design

Abstract ID: Poster 107

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*Chad D. Watts, M.D.
Matthew P. Abdel, M.D.
David G. Lewallen, M.D.
Daniel J. Berry, M.D.
Arlen D. Hanssen, M.D.
Rochester, MN

INTRODUCTION: Identifying and understanding risk factors for periprosthetic femur fractures are important to mitigating future risk. The goals of this study were to compare the incidence, survivorship, and predictive risk factors for periprosthetic femur fracture between a unique stem design which has a radical proximal taper angle and other contemporary cementless, proximally fixed tapered stems. We hypothesized that there would be an increased risk of periprosthetic femur fracture associated with this unique stem design.

METHODS: We performed a retrospective cohort study evaluating all cases in which a ProxiLock® femoral component was implanted during a primary THA at a single academic institution (PL group). This group was compared to a cohort of patients who underwent primary THA during the same time interval (1995–2008) using any other cementless, proximally coated tapered stem design (non-PL group). Periprosthetic fractures were identified within each group, and medical records and radiographs were reviewed for all fracture patients. Groups were similar in regards to age, sex, BMI, and preoperative diagnosis. Mean follow-up was 5.8 years for the PL group, and 5.5 years for the non-PL group.

RESULTS: During the study, 3,964 primary THAs were performed using six different cementless proximally fixed tapered stem designs. There were 736 stems in the PL group and 3,228 in the non-PL group. The Kaplan-Meier estimated survival free of postoperative fracture was significantly lower in the PL group at 30 days, 1 year, 5 years, and 10 years ($p<0.001$). The PL group had significantly increased risk of postoperative periprosthetic femur fracture (HR 5.6, $p<0.001$), fracture requiring reoperation (HR 8.4, $p<0.001$), and fracture requiring stem revision (HR 9.1, $p<0.001$).

CONCLUSIONS: Hips implanted with the ProxiLock® stem had a significantly increased risk of early and late postoperative periprosthetic femur fracture. Most fractures required reoperation or stem revision. The unique proximal geometry may contribute to increased fracture risk. These findings should be considered as future cementless stems are designed.

ALVAL Scores Do Not Correlate with Metal Ion Levels or Unreadable Synovial Fluid WBC Counts

Abstract ID: Poster 108

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*Darren R. Plummer, M.S. / Chicago, IL
Paul Yi, M.D. / San Francisco, CA
Joshua J. Jacobs, M.D. / Chicago, IL
Robert Urban, Ph.D. / Chicago, IL
Mario Moric, M.S. / Chicago, IL
Craig J. Della Valle, M.D. / Chicago, IL

INTRODUCTION: Failed metal on metal (MOM) bearings are being increasingly encountered with little information to guide evaluation for infection and ALVAL (aseptic lymphocytic-dominated vasculitis-associated lesions). Prior work has suggested that the synovial fluid WBC count may be inaccurate in patients with a failed MOM bearing. Further, it is oftentimes assumed that elevated metal ion levels correlate with the occurrence of ALVAL. Our purpose was to determine the utility of the erythrocyte sedimentation rate (ESR), C-Reactive Protein (CRP), synovial white blood cell count (WBC), differential (%PMN), and serum metal ion levels in diagnosing ALVAL.

METHODS: We identified 80 failed MOM THA requiring revision. Tissue samples were examined under light microscopy and graded on a scale of ALVAL severity (0-4 low, 5-8 moderate, 9-10 severe). 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.

RESULTS: ALVAL scores were graded as low in 30 (37.5%), moderate in 39 (49%), and severe in 8 (10%) with 3 being unreadable. No clear cutoff values for ESR, CRP, or synovial WBC count could be determined to reliably diagnose moderate or severe ALVAL. Further, no correlation was found between ALVAL grade and the readability of their synovial WBC count. Similarly, serum cobalt and chromium levels had no correlation with ALVAL score. The best test to diagnosis ALVAL was the synovial fluid monocyte percentage with an optimal cut-off value of 39% and AUC of 73% (fair testing performance).

CONCLUSION: The diagnosis of ALVAL remains challenging, with the majority of screening tests being unreliable. Although serum metal ion levels are typically elevated in failed MOM bearings, higher levels do not appear to correlate with ALVAL grade. Elevated synovial fluid monocytes may provide diagnostic utility for ALVAL suggesting a possible delayed-type hypersensitivity reaction.

Eliminating Blood Transfusion in Primary Total Hip Arthroplasty: An Achievable Goal?

Abstract ID: Poster 109

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*Joshua B. Holt, M.D.
Benjamin J. Miller, M.D.
John J. Callaghan, M.D.
Charles R. Clark, M.D.
Melissa D. Willenborg, M.D.
Nicolas O. Noiseux, M.D.
Iowa City, IA

INTRODUCTION: Surgical blood loss requiring transfusion in hip arthroplasty remains a major concern despite advances in blood conservation. We introduced a multimodal approach to perioperative blood management aimed at eliminating blood transfusions in primary total hip arthroplasty. The algorithm includes (1) preoperative hemoglobin optimization through a novel multi-disciplinary approach including non-invasive hemoglobin screening, (2) minimization of peri-operative blood loss through administration of tranexamic acid (TXA), and (3) utilization of strictly defined transfusion triggers. Our hypothesis was that adherence to this algorithm could eliminate blood transfusions after uncomplicated primary total hip arthroplasty.

METHODS: Our institutional registry of prospectively collected data on 547 consecutive patients undergoing primary total hip arthroplasty was reviewed after the initiation of a new multimodal perioperative blood management algorithm (May 2012). Transfusion rates were determined and compared to the immediately previous patient cohort (February 2009-April 2012, 916 cases). Detailed chart evaluation of adherence to the algorithm was then performed in all patients requiring allogeneic blood transfusion.

RESULTS: There was a significant reduction in the overall transfusion rate (23/547 [4.2%] vs. 217/916 [23.7%], $p<0.0001$) for all patients undergoing primary hip arthroplasty after introduction of our algorithm, when compared to the historic cohort. Four patients (0.8%) undergoing total hip arthroplasty required blood transfusion despite adherence to the protocol. Three of them, however, did not receive IV TXA due to relative contraindications. These patients would receive intra-articular TXA at our institution today. The fourth had an intraoperative fracture requiring prolonged surgery.

CONCLUSION: Adoption of a multimodal, multi-disciplinary blood management algorithm resulted in a significant reduction in allogeneic blood transfusions after primary total hip arthroplasty. The authors believe there is potential to eliminate blood transfusions in uncomplicated primary hip arthroplasty with full implementation of this algorithm.

Total Hip Arthroplasty Survival and Complications as a Function of Age

Abstract ID: Poster 110

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*Eric R. Wagner, M.D.
Cathy D. Schleck, B.S.
W. Scott Harmsen, M.S.
Daniel J. Berry, M.D.
Rochester, MN

PURPOSE: Age is associated with risk of complications after total hip arthroplasty (THA). However, studies have only examined age using thresholds. The purpose of this investigation was to estimate implant survival and risk of complications after THA parameterizing age as a continuous variable.

METHODS: 21,361 consecutive THAs, in 17,774 patients, from 1985-2012 were analyzed using prospectively collected data from a single institution. Patients were followed routinely until revision or death. Average age was 66 years (11-103). The 6,096 patients alive and unrevised at last contact were followed for a mean of 7.5 years. Association of age with outcomes was assessed using Cox regression with hazard ratios (HR) per 5 years of age and smoothing splines. Statistical significance was p-value <0.05.

RESULTS: Older age was associated with lower rates of revision surgery, revision for mechanical failure, and reoperation. Revision risk decreased linearly per year with increasing age between 40 and 85 years (HR 0.83 per 5 years, p<0.001) (Figure 1). In the 13,259 hips with a diagnosis of osteoarthritis, older age was also associated with a lower rate of implant failure (HR 0.81 per 5 years, p<0.001). Older age also was associated with a decreased risk of revision surgery for mechanical failure in all THAs (HR 0.79 per 5 years, p<0.001) and those patients with only osteoarthritis (HR 0.78 per 5 years, p<0.001) (Figure 1). In a multivariate model taking into account gender and BMI, age continued to be significantly associated with both the overall risk of revision surgery (HR 0.83, p<0.001) and revision for mechanical failure (HR 0.79 per 5 years, p<0.001). As seen with revision rates, older age also was associated with a lower risk of reoperation in all THAs (HR 0.84 per 5 years, p<0.001) and those with osteoarthritis (HR 0.83 per 5 years, p<0.001. Of note, risk of any infection (HR 0.98 per 5 years, p=0.29), deep infection (HR 1.01 per 5 years, p=0.70), or early dislocation (HR 1.0 per 5 years, p=0.78) was not similarly associated with age.

SUMMARY POINTS: There is a strong association between older age decreased rates of revision surgery and reoperation after THA. In particular, there is a striking correlation between increasing age and decreased rates of revision surgery for mechanical failure. This data provides information for younger patients considering THA on their increased risks when compared to older patients, and will provide information to quantify risk in policy-making.

Click here to view Figure

Intraoperative Radiograph in Total Hip Replacement Performed in the Lateral Decubitus Position: Help or Hindrance?

Abstract ID: Poster 111

Saran Tantavisut, M.D.
Nicolas O. Noiseux, M.D.
Melissa Willenborg, M.D.
Yubo Gao, Ph.D.
*John J. Callaghan, M.D.
Iowa City, IA

INTRODUCTION: An intraoperative AP hip radiograph during posterior approach total hip replacement in the lateral decubitus position has been performed at our institution for over two decades. The purpose of this study was to determine what benefits, if any, are obtained from these studies.

METHODS: We retrospectively reviewed 175 consecutive cases where an intraoperative AP radiograph was obtained after implanting the trial components during posterior approach (in the lateral decubitus position) total hip replacement. Patient characteristics including height and BMI were recorded. Measurements were performed on all intraoperative radiographs included the entire hip with variable amounts of the contralateral hip and pelvis. These measurements were compared to the same measurements obtained on the first postoperative low AP pelvis radiograph that included the tip of the femoral stem. Measurements included: cup medialization and inclination, leg length, and femoral offset.

RESULTS: Comparing intraoperative and postoperative radiographic measurements, there were significant differences in all measurement parameters. Body stature and leg positioning (abduction, adduction, and rotation) at the time of intraoperative radiographs contributed to these differences. BMI showed significant correlation with the difference in leg positioning (R 0.16, p 0.04). Height showed significant correlation with the difference in femoral stem alignment.

DISCUSSION: The surgeons have routinely obtained intraoperative hip radiograph after inserting trial components in THR to evaluate femoral component positioning, femoral canal fill, and occult fractures. The results of this study confirm observations that use of such radiographs are of little benefit in determining cup position, leg length, and femoral offset. Newer computer algorithms have been developed to more accurately determine these three variables. The surgeons are investigating these algorithms and will use the present data for comparison.

An Analysis of the Orthopedic In-Training Examination Journal References: Have They Changed 10 Years Later?

Abstract ID: Poster 112

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*Bryan D. Haughom, M.D.
Ishaq Ibrahim, B.S.
Paul H. Yi, M.D.
Michael D. Hellman, M.D.
David Levy, M.D.
Brett R. Levine, M.D.
Chicago, IL

INTRODUCTION: The Orthopaedic In-Training Examination (OITE) serves as a benchmark of resident knowledge. The level of evidence (LOE) of orthopedic literature at-large has improved over the past decade. The purpose of this study was to determine if the LOE of the recommended references on the OITE has changed over the past decade as well.

METHODS: Questions from the 2002 and 2012 OITE examinations were reviewed and the recommended references were compiled into a database; only references representing scientific articles were included. Questions and their corresponding suggested references were grouped according to their designated subspecialty domains. The LOE was determined for each journal reference. T-tests were utilized to compare the mean LOE between the 2012 and 2002 test administrations; subanalyses compared LOE between subspecialties' references in 2012 vs. 2010. Fisher's exact tests were used to compare the proportion of high (level I and II) and low-quality (level III-V) references.

RESULTS: The 2002 test was comprised of 346 journal references (64%) while the 2012 test included 464 journal references (77%). The most common journals cited in both test administrations included the Journal of Bone and Joint Surgery (JBJS) and the Clinical Orthopaedics and Related Research (CORR). Level IV and V evidence predominated both the 2002 (IV: 42.8%, V: 41.6%) and 2012 test administrations (IV: 28.2%, V: 48.9%). The overall average LOE showed no difference between test years (4.2 in 2002, vs. 4.1 in 2012; $p = 0.4$). However, there was a higher proportion of level I/II evidence in 2012 (9.9%) than in 2002 (4.6%, $p=0.0032$). When comparing each subspecialty domain between years, significant differences were observed only for the subspecialty of foot and ankle (4.6 in 2002 vs. 4.0 in 2012; $p = 0.02$).

CONCLUSIONS: Although the LOE of the orthopedic literature at-large has risen, the overall LOE of the recommended journal references on the OITE from 2002 to 2012 continues to be primarily comprised of level IV and V references. Consistent with the literature at large, however, we observed an increase in the proportion of level I/II evidence on the OITE between 2002 and 2012. Foot and Ankle was the sole subspecialty domain which demonstrated a net improvement in LOE between the test administrations.

The Effect of Simulation Training on Fluoroscopy Attempts Needed for Accurate Percutaneous K-Wire Placement: A Randomized Controlled Trial

Abstract ID: Poster 113

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*Rachel M. Frank, M.D.
Laith M. Al-Shihabi, M.D.
Brandon Erickson, M.D.
Robert W. Wysocki, M.D.
Brett R. Levine, M.D.
Chicago, IL

INTRODUCTION: The use of Kirschner wires (K-wires) remains one of the most common skills utilized by orthopedic surgeons. The purpose of this study was to determine the effect of simulation training on fluoroscopy use needed for accurate percutaneous K-wire placement.

METHODS: A randomized controlled trial of medical students and orthopedic surgery residents was conducted. All participants received an introduction lecture followed by demonstration of fluoroscopic-aided percutaneous K-wire placement into the distal radius of a Sawbones Encased Wrist Model. Participants were then randomized to receive either a fixed protocol of simulation training on the simulation model, or no training. A blinded examiner then evaluated each participant on placement of a percutaneous, bicortical K-wire into the distal radius of the model, perpendicular to the shaft of the radius (Day 1). All participants performed the same task on one week later (Day 8). Variables analyzed included number of fluoroscopy shots, safety with fluoroscopy, task completion time, and accuracy. Statistical analysis with T-tests and ANOVA was performed for analysis, with $P < 0.05$ denoting statistical significance.

RESULTS: Ten trainees (4 junior residents, 6 senior students) were randomized into two groups: training (T) or no training (NT), with 2 residents and 3 students per group. There were no significant differences between the groups in the number of fluoroscopy shots used on either day ($P>0.05$). Participants in the NT group captured their own hand in their fluoroscopic images (60% Day 1, 60% Day 8) more often than those in the T group (0% Day 1, 20% Day 8). Three (60%) participants NT group placed their pin “outside” the bone compared to 1 (20%) participant in the T group; no participants in either group were “outside” the bone on Day 8 (sagittal plane accuracy). There were no significant differences in pin deviation from the axis of the radius between the groups (coronal plane accuracy, $P>0.05$). There were no significant differences in task completion time between the groups on either day ($P>0.05$).

DISCUSSION AND CONCLUSION: Simulation training resulted in an overall improvement in K-wire placement accuracy both immediately after training and 1 week following training. Further, safer fluoroscopy practice patterns were seen in participants undergoing simulation training compared to those without training, as NT group captured their own hand in the images more often than the T group.

Optimizing Orthopedic Residency: A Comparison of Resident and Program Director Perspectives on Time Spent in Training

Abstract ID: Poster 114

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*Christopher L. Camp, M.D. / Rochester, MN
John R. Martin, M.D. / Rochester, MN
Matthew D. Karam, M.D. / Iowa City, IA
Daniel B. Ryssman, M.D. / Rochester, MN
Norman S. Turner, M.D. / Rochester, MN

INTRODUCTION: Although much attention has been paid to deliberate practice as a means of achieving expert levels of performance in other medical and surgical specialties, little has been published regarding its' role in training orthopedic residents to become expert surgeons. As an initial step in this process, we sought to determine how residents' current time spent in training is allocated and what the theoretical ideal distribution of their time should be in an attempt to maximize potential for residents to develop expertise in orthopedic surgery.

METHODS: An electronic survey was sent to all U.S. orthopedic surgery residents and program directors (PD) belonging to the Midwest Orthopedic Surgical Skills Consortium asking how they felt residents' time spent in training was distributed across 10 general domains and four roles in the operating room (OR). Participants subsequently created a time distribution construct that they felt represented the ideal resident training program. Responses were compared between residents and PDs, and between current schedules and ideal schedules. Applying the Bonferroni correction, p values ≤ 0.001 were considered significant.

RESULTS: The survey was completed by 11 PDs (11/11 =100%) and 231 residents (231/353; 65%) for a response rate of 66% (242/364). No significant differences were noted between PD and resident views on the current distribution of residents' time for any of the domains or OR roles; however, they did disagree on multiple components of an ideal program construct such as percent of time spent: in the OR (40% vs. 33%, $p<0.0001$), caring for inpatients (8% vs. 12%, $p<0.0001$), and attending formal lectures (5% v. 3.7%, $p=0.0005$). Residents desired more time spent: in the OR, deliberately practicing surgical skills outside of the OR, conducting research, and serving as primary surgeon ($p<0.001$). They desired less time spent: as a second assist in the OR, in clinic, caring for inpatients, making phone calls, and completing paperwork ($p<0.001$). With the exception of one (time spent completing paperwork; $p=0.0003$), PDs did not demonstrate differences in their views of the current structure of their residency programs to that of their theoretical ideal.

CONCLUSIONS: Residents and PDs agree with how residents' time is spent during orthopedic residency training; however, they disagree on the time construct of an ideal program. Residents desire more time spent in the OR, deliberately practicing surgical skills outside of the OR, and conducting research.

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Arutyunyan, Grigoriy	n
Ashraf, Ali	n
Asti, Lindsey	n
Avdic, Aldijana	n
Azar, Frederick M.	4 – Pfizer; 7 - Elsevier
Backes, Jeffrey R.	n
Baer, Geoffrey S.	n
Baker, Kevin	5 – Arthex, Inc., K2M, Stryker, Synthes, Zimmer
Balazs, George C.	n
Banglemier, Richard	n
Barber, Joshua	n
Barlow, Jonathan 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
Barrack, Toby	1, 3b, 5, 6 – Stryker; 5 – Biomet, Smith & Nephew, Wright Medical Technology, Inc.; 7 – The McGraw-Hill Companies, Inc., Wolters Kluwer Health – Lippincott Williams & Wilkins
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; 6 – KEF Healthcare
Bartley, Justin H.	n
Bashyal, Ravi K.	2 – Synthes
Bateman, Dexter	n
Bauer, Thomas W.	3b - Stryker
Bauman, Ryan D.	4 – Amgen Co.
Bawa, Harpreet	n
Beahrs, Taylor R.	n
Beal, Matthew D.	1, 3b, 5 – Medacta; 3b, 5 – Zimmer; 5 – MAKO Surgical, National Institutes of Health (NIAMS & NICHD), Stryker
Beam, Craig	n
Beaty, James H.	7 – Saunders/Mosby-Elsevier
Beckert, Mitchell W.	n
Bedard, Nicholas A.	n
Beebe, Allan C.	n
Belatti, Daniel A.	n
Belmont, Barry	n
Bennett, Erwin	n
Bennett, Lee	n
Bentley, Jared C.	n
Benzel, Edward C.	1 – DePuy, A Johnson & Johnson Company; 1, 3b, 4, 7 – AxioMed
Berbari, Elie F.	n
Berbaum, Kevin	n

Berend, Keith R.	1, 3b, 5 – Biomet; 5 – Kinamed, Pacira, Stryker
Berend, Michael E.	1, 3b, 5 – Biomet; 4 – Orthalign; 5 – Johnson & Johnson, Stryker (into our 501c3 research foundation)
Berger, Richard A.	1 – Zimmer; 3b - MicroPort
Bergmann, Karl A.	2 - Synthes
Bergum, Christopher	N
Bernstein, Derek T.	n
Berry, Daniel J.	1, 3b, 5 – DePuy, a Johnson & Johnson Company; 7 – Elsevier, Wolters Kluwer Health – Lippincott Williams & Wilkins
Bettin, Clayton C.	n
Bey, Michael J.	n
Bishop, Allen T.	n
Bishop, Julie Y.	n
Black, Brandee S.	n
Blaha, J. David	1, 3b – MicroPort Orthopaedics
Bollier, Matthew J.	2, 3b – Arthrex, Inc.
Bollinger, Alexander J.	n
Bonadurer, George F., III	n
Bond, Jeffrey R.	n
Bonnaig, Nicolas	n
Bono, Kenneth T.	n
Bordern, Robert	n
Borque, Kyle	n
Botero, Herman G.	n
Bradbury, Thomas L.	2 – Marathon, Pacira; 3b – Arthrex, Inc.
Bravo, Dalibel	n
Brelin, Alaina M.	n
Brennan, Kindyle L.	n
Brimmo, Olubusola	n
Briski, David	n
Brolin, Tyler J.	n
Brooks, Peter J.	3b – Smith & Nephew, Stryker
Brophy, Robert H.	2 – Smith & Nephew; 3b – ISTO Technologies; 4 – Ostesys
Brown, Nicholas M.	n
Bryan, Andrew J.	n
Buckwalter, Joseph A., IV	7 – Journal of Orthopaedic Research, Wolters Kluwer Health – Lippincott Williams & Wilkins
Buckwalter, Joseph A., V	n
Burgers, Travis A.	n
Busel, Gennadiy	n
Bush-Joseph, Charles A.	n
Butler, Paul D.	n
Buzas, David	n
Byron, Markus	n
Cabanela, Miguel E.	n
Cagle, Robert A.	n
Callaghan, John J.	1, 3b – DePuy, a Johnson & Johnson Company; 7 – Journal of Arthroplasty (Deputy Editor), Wolters Kluwer Health – Lippincott Williams & Wilkins

Camp, Christopher L.	n
Campion, Heather A.	n
Cannada, Lisa K.	2, 5 – Smith & Nephew; 3b, 5 – Zimmer; 5 – Synthes
Carlson, Jon B.	n
Carpenter, James E.	4- Pfizer, Stryker
Carpenter, Shannon R.	n
Carreon, Leah	3a, 5 – Norton Healthcare; 5 – AO Spine, OREF; 6 - Travel and accommodations for Study Planning Meetings from Orthopedic Research and Education Fund, Department of Defense and Association for Collaborative Spine Research. Travel and accommodations for required Continuing Education for Institutional Review Board Members, University of Louisville Institutional Review Board. Honoraria for participation in Review Panels of the National Institutes of Health, participation in Global Evidence Advisory Board Medtronic. Medtronic provided funds directly to database company. No funds were paid directly to Individual or Individual's Institution 01/2002 to 09/2009. Nuvasive provides funds directly to database company. No funds are paid directly to Individual or Individual's Institution
Cass, Joseph R.	n
Castile, Ryan M.	n
Castaneda, Joaquin A.	n
Cates, Robert A.	n
Chakkalakal, Dennis	n
Chalmers, Peter N.	n
Chamberlain, Aaron M.	n
Chambers, Bryan T.	3b – Smith & Nephew; 5 – DePuy, a Johnson & Johnson Company
Chandran, Aiswarya Pillai	n
Chang, Justin T.	n
Chaput, Christopher D.	3c – Facet-Link; 5 – Globus Medical, Medtronic, Nuvasive
Chaudhry, Thymur A.	n
Chen, Austin W.	
Chen, Lan	n
Chen, Tan	n
Chimento, George F.	3b, 5 – DePuy, a Johnson & Johnson Company
Chinthakunta, Suresh	3a – Globus Medical
Chmell, Samuel J.	n
Choate, Walter S.	n
Christy, Jonathan M.	n
Chuinard, Christopher R.	1, 3b, 5 – Tornier; 3b – Mitek
Cil, Akin	3b (shoulder replacement) – Stryker
Clark, Charles R.	2, 3b, 5 – DePuy, a Johnson & Johnson Company; 6 – Merck, Zimmer; 7 – Journal of Bone and Joint Surgery
Clohisy, John C.	5 – Pivot Medical, Smith & Nephew, Zimmer; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Cofield, Robert H.	1 – DJO, Smith & Nephew
Cohen, Joseph B.	n
Cohen, Mark S.	1, 3b – Integra; 3b – Acumed, LLC

Cole, Brian J.	1 – DJ Orthopaedics; 1, 3b, 5 – Arthrex, Inc.; 3b, 4 – Regentis; 3b, 5 – Zimmer; 4 – Carticept; 5 – Medipost, Musculoskeletal Transplant Foundation, National Institutes of Health; 6 – Athletico, Ossur, Smith & Nephew, Tornier; 7 – Elsevier, Lippincott, Saunders/Mosby-Elsevier, SLACK Incorporated
Cole, Peter A.	4 – BoneFoams Inc., LLC; 5 – Stryker, Synthes
Collins, Mark S.	n
Collins, Paul C.	n
Collis, Philip N.	n
Cook, Shane	n
Cooper, Jonathan M.	n
Cottrell, Benjamin J.	n
Cracchiolo, Allison M.	n
Crebs, Dylan	n
Cregar, William	n
Criado, Enrique	n
Crist, Brett D.	2, 5 – Medtronic; 3b – KCI; 4 – Amedica Corporation, Orthopaedic Implant Company; 5 – Sonoma Orthopedics, Synthes, Wound Care Technologies
Cross, William W., III	3b – Zimmer, Zyga Tech Inc.
Crowder, Douglas	n
Crowe, Matthew M.	n
Cui, Shari	n
Currier, Bradford L.	1 – DePuy, a Johnson & Johnson Company, Stryker; 1, 3b – Zimmer; 4 – Spinology Tenex; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Cvetanovich, Gregory L.	n
Dadsetan, Mahrokh	n
Dahm, Diane L.	1,4 – TENEX health (spouse)
Dailey, Steven K.	n
Daly, Thomas	n
Daniel, Jared W.	n
Davis, Dawn M. R.	n
Davis, Richard L, II	n
Deadwiler, Monica	n
Deans, Katherine J.	n
DeClaire, Jeffrey H.	2, 3b – Biomet; 5 - Pacira
Della Rocca, Gregory J.	2, 3b, 5 – Synthes; 3b – Bioventus, LifeNet, Pacira; 4 – Amedica, MergeNet, The Orthopaedic Implant Company
Della Valle, Craig J.	1, 3b, 5 – Biomet; 3b – DePuy, a Johnson & Johnson Company; 3b, 5 – Smith & Nephew; 4,5 – CD Diagnostics; 5 – Stryker; 7 – SLACK Incorporated
Dennison, David G.	2 – AO (instructor for AO hand fracture course); 5 – DePuy, a Johnson & Johnson Company
Dennison, Taylor D.	3a – Eisai Oncology
DeWald, Christopher J.	2 – Nuvasive, Integra; 3b – Integra, Kisco, Nuvasive; 4 – Alphatech, Medtronic
Dibbern, Kevin	n
Dickens, Jonathan F.	n

Dilisio, Matthew F.	n
DiNicola, Nicholas	n
Dirschl, Douglas R.	3b - Stryker
Dolan, Lori	n
Dolenc, Andrea J.	n
Domb, Benjamin G.	1 – DJ Orthopaedics, Orthomerica; 2, 3b, 5 – Arthrex, Inc.; 2, 5 – ATI; 3b – Pacira; 3b, 5 – MAKO Surgical; 4 – Stryker; 5 – Aventist Hinsdale Hospital, Breg, MedWest
Donohue, Michael A.	n
Dougherty, Paul J.	n
Duchman, Kyle R.	n
Dudda, Marcel	n
Dulaney-Cripe, Elizabeth	n
Duncan, Christopher M.	n
Duncan, Jonathan S.	n
Dunne, Kevin F.	n
Duplantier, Neil L.	n
Dusad, Anand	n
Ebersole, Gregg M.	n
Ebraheim, Nabil A.	n
Edelstein, Adam I.	n
Edwards, Alan D.	n
Eggenberger, Eileen	n
Elattar, Osama	n
Elbanna, Ashraf	n
El Bitar, Youssef	n
Elgafy, Hossein K.	n
Elguizaoui, Sameh	n
Elhassan, Bassem T.	n
Elias, John J.	5 – MedShape; 6 – Mitek, Synthes
Elkhecher, Rami	n
Emohare, Osa	n
Endres, Terrence J.	2 – AONA; 3b – Spectrum Health Hospitals, Grand Rapids
Engasser, William M.	n
England, Eric	n
Erens, Greg	4 – Johnson & Johnson; 6 – Stryker (institutional and research support); 7 – UpToDate (Wolters Kluwer Health)
Erickson, Brandon J.	n
Erickson, Jill	n
Eslam Pour, Aidin	n
Esposito, Domenic P.	n
Esquivel, Amanda O.	n
Etier, Brian E., Jr.	n
Falls, Thomas D.	n
Farias Kovac, Mario	n
Feldman, John F.	n
Femino, John E.	n
Fening, Stephen. D.	4, 5 – Apto Orthopaedics
Ferrel, Jason R.	6 – DePuy, a Johnson & Johnson Company, Stryker

Fey, Paul	n
Ficke, Brooks W.	n
Filipkowski, Danielle E.	n
Fillingham, Yale A.	n
Finch, Nathan A.	n
Finnie, Dawn	n
Fleischli, James E.	5 – Arthrex, Inc, DePuy, a Johnson & Johnson Company, Smith & Nephew, Zimmer
Fleissner, Paul R., Jr.	2, 3b, 5 – Exactech, Inc.
Fleming, Mark E.	n
Floccari, Lorena V.	n
Flynn, Jeffrey C.	n
Fogelson, Jeremy L.	3b – DePuy, a Johnson & Johnson Company
Folpe, Andrew L.	7 - Elsevier
Ford, Marcus C.	n
Fowler, T. Ty	2, 5 - Synthes
Fox, Justin P.	n
Frangiamore, Salvatore J.	n
Frank, Rachel M.	n
Frankle, Mark A.	1, 2, 3b, 5, 6 – DJO Surgical; 5 – Biomimetic Therapeutics
Fredericks, Douglas C.	3b – Olympus Biotech America; 5 – Biostructures Inc., Medtronic Sofamor Danek, Olympus Biotech America
Friedman, Michael	n
Frisch, Nicholas B.	n
Froimson, Mark I.	3b – Care Fusion, DePuy Synthes; 3b, 4 – Medical Compression Systems
Frush, Todd J.	n
Fuchs, Daniel J.	n
Gable, Dan	n
Gagnier, Joel J.	n
Gajewski, Nicholas	n
Galatz, Leesa M.	7 – Journal of Shoulder and Elbow Surgery
Gale, Andrea L.	n
Gao, Yubo	n
Garapati, Rajeev	2 – Stryker
Garvin, Kevin L.	3c – TRAK Surgical
Georgiadis, Gregory M.	n
Gholson, J. Joseph	n
Gilbert, Shawn R.	n
Gillette, Blake P.	n
Gioe, Terence J.	4 – Eli Lilly, Johnson & Johnson
Gitelis, Steven	1, 4 – Wright Medical Technology, Inc.; 3b - Stryker
Giveans, Marc R.	n
Gloystein, David	n
Godinsky, Ryan J.	n
Goetz, Devon D.	n
Goetz, Jessica E.	n
Goitz, Henry T.	n
Goldberg, Benjamin A.	1, 2, 3b – Aston Medical; 2, 3b – Acumed, LLC, Allen Medical,

	Medwest/Arthrex, Stryker; 4 – Biomimetic, MAKO
Golnick, Phil	n
Gombera, M. Mustafa	n
Gonzalez, Mark H.	1 – Biomet, Johnson & Johnson; 3b – Smith & Nephew; 4 – Ortho Sensing Technology
Goodwin, Ryan C.	3b – Stryker
Gossett, Leland E.	n
Gossett, Timothy D.	n
Gothard, M. David	n
Gottschalk, Lionel J.	n
Goulet, James A.	1 – Zimmer
Goyal, Nitin	n
Gradisar, Ian M.	n
Grant, Kevin D.	n
Graves, Christopher M.	n
Graziano, Gregory P.	3c – Medtronic Sofamor Danek
Greiner, Justin	n
Griffin, Joshua S.	n
Griffith, Sandra	n
Groll-Brown, Mary	n
Gross, Christopher E.	n
Gruev, Viktor	n
Guirguis, Albair	n
Gupta, Asheesh	n
Gurd, Alan R.	n
Gurd, David P.	n
Guseila, Loredana M.	n
Guthrie, S. Trent	n
Habermann, Elizabeth B.	n
Haider, Hani	2 – Government of Brazil (INMETRO); 2, 3b – AMTI, Inc.; 3b – Endolab (Germany), Remedy Informatics (UT); 3c, 4, 5 – Trak Surgical, Inc.; 4 – SI-BONE, Softjoint; 5 – Arthrex, Inc., Biomet, Department of Defense, Exponent, University of Tokyo
Haile, Nathan B.	n
Haleem, Ambar	n
Hallstrom, Brian R.	n
Hamilton, William G.	2, 3b, 5 – DePuy, a Johnson & Johnson Company; 5 – Biomet, Inova Health Care Services
Hamilton, William P.	n
Hammarstedt, Jon E.	n
Hammer, Matthew R.	n
Hamming, David E.	n
Hanssen, Arlen D.	1, 5 – Stryker; 7 – Elsevier
Haque, Omar	n
Harmsen, W. Scott	n
Harner, Christopher D.	6 – CONMED Linvatec, Smith & Nephew; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Harpole, Bethany G.	n
Harrast, John	n

Hartman, Curtis W.	2, 3b, 5 – Smith & Nephew; 3b, 4 – Trak Surgical, Inc.; 5 – Pfizer
Haughom, Bryan D.	n
Haynes, Jacob	n
Hazboun, Rajaie	n
Hebert, Casey T.	4 – Stryker
Heck, Robert K., Jr.	1 – Wright Medical Technology, Inc.; 7 – Mosby Elsevier
Heidenreich, Mark J.	n
Hellman, Michael D.	n
Helvie, Peter	n
Henzman, Cameron T.	n
Hettrich, Carolyn M.	3b – Pacira
Hevesi, Mario	n
Hewlett, Angela	n
Hidden, Krystin A.	n
Hiesterman, Timothy G.	n
Higgins, Laurence D.	n
Higuera, Carlos A.	5 – KCI, Stryker
Hildebrand, Gregory R.	n
Hill, Brian	n
Hillen, Travis	1 – Define Inc.; 3b – Biomedical Systems
Hlavacek, James D.	n
Ho, Bryant S.	n
Hoashi, Jane	n
Hoeffel, Daniel P.	1 – Zimmer; 2, 3b, 5 – DePuy, a Johnson & Johnson Company; 5 – OrthoCor Medical
Hoffmann, Martin F.	n
Holcombe, Sven A.	n
Holmes, James R.	n
Holt, Joshua B.	n
Horazdovsky, Ryan D.	n
Houdek, Matthew T.	n
Huang, Jiapeng	n
Huddleston, Paul M., II	6 – DePuy, a Johnson & Johnson Company; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Hudson, Ian	n
Hunter, Allison	n
Hussain, Haroon M.	n
Hussain, Mohammed S.	n
Hussain, Waqas M.	n
Iannotti, Joseph P.	1 – Integra; 1, 2, 3b – DePuy Synthes; 1, 3b – Tornier; 1, 2 – Zimmer; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Ibrahim, Ishaq	n
Iglesias, Rodrigo A.	n
Ilgenfritz, Ryan M.	n
Incavo, Stephen J.	1 – Biomet, Innomed, Smith & Nephew, Wright Medical Technology, Inc.; 1, 3b, 4 – Zimmer
Inkrott, Bradley P.	n
Irwin, Todd A.	3b – Smith & Nephew

Iyer, Hariharan V.	n
Israel, Heidi	n
Jaafar, Sami	n
Jackson, Nancy M.	n
Jackups, Ronald	n
Jacob, Adam K.	n
Jacob, Paul	n
Jacobs, Joshua J.	4 – Implant Protection; 5 – Medtronic Sofamor Danek, Nuvasive, Zimmer
Jacobsen, Kimberly A.	4, 6 – Zimmer
Jacobson, Richard A.	n
Jacobson, Steven R.	n
Jennings, Matthew T.	n
Jiang, Jimmy J.	n
Jimenez-Almonte, Jose H.	n
Jo, Suenghwan	n
Johannesmeyer, David	n
Johnson, Jeffrey E.	1, 4 – OrthoHelix Surgical Designs, Inc./Division of Tornier; 4 – Midwest Theapy, LLC; 6 – Arthrex, Inc.
Johnson, Jeremiah D.	n
Johnson, Nathan	n
Johnson, Shawn	n
Johnson, Staci R.	n
Johnston, Richard C.	n
Jones, Clifford B.	n
Jones, Deryk G.	2 – Mitek; 2, 3b – Genzyme; 3b – Musculoskeletal Transplant Foundation
Jones, Grant L.	6 – Musculoskeletal Transplant Foundation
Jones, Morgan H.	n
Jong, Nahbee	n
Jupiter, Daniel C.	n
Kadakia, Anish R.	2, 3b, 5 – Acumed, LLC; 3b – BME; 5 – Synthes; 7 – Lippincott Williams & Wilkins
Kahlenberg, Cynthia A.	n
Kakar, Sanjeev	1, 3b, 5 – Arthrex, Inc.; 3b – Skeletal Dynamics
Kakazu, Rafael	n
Kang, Vicky	n
Karam, Joseph	n
Karam, Matthew D.	n
Karau, Melissa	n
Karpinsky, Joseph	n
Kaufman, Kenton R.	5 – American Orthotic and Prosthetic Association
Keating, Patrick M.	n
Keegan, Molly A.	n
Keene, James S.	n
Keener, Emily	n
Keener, Jay D.	5 – National Institutes of Health
Keeney, James A.	3b – OrthoSensor; 5 – Stryker
Kelikian, Armen S.	2 – Stryker, Trimed; 7 – Wolters Kluwer Health – Lippincott

	Williams & Wilkins
Kellam, James F.	n
Keller, Robert A.	n
Kelly, Brandon J.	n
Kelly, Bryan T.	3c, 4 – A-3 Surgical
Kelly, Derek M.	2 – Medtronic; 7 – Elsevier Health
Kelly, Michael P.	n
Kenney, Brian D.	n
Kenter, Keith	2- Smith & Nephew; 3b – Schwartz Biomedical
Kergosien, Matthew C.	n
Kern, Andrew M.	n
Kesto, William	n
Khakhkhar, Rishi	n
Khoriaty, Justin D.	n
Khoury, Joseph G.	n
King, Brandon W.	n
King, Alexander H.	n
Klaus, Derek J.	n
Klein, Sandra E.	5 – Midwest Stone Institute
Kliethermes, Stephanie	n
Klika, Alison K.	n
Koberling, Jessica	n
Koehler, Daniel M.	n
Koets, Michael D.	n
Koh, Jason L.	3b – Aesculap/B.Braun, Arthrex, Inc.; 3b, 4 – Aperion
Kohen, Robert B.	3b – Arthrex, Inc.
Kok, Peter L.	n
Kokmeyer, Daniel	n
Kolmodin, Joel D.	n
Kolowich, Patricia A.	n
Konigsberg, Beau S.	n
Koroukian, Siran	1, 3a – American Renal Associates (spouse); 4, 6 – American Renal Associates
Koscielniak, Joseph B.	n
Kouetier, Denise	n
Krahe, Amy	n
Kremers, Walter K.	n
Krishnamurthy, Anil B.	n
Kruppa, Christiane G.	n
Krutzfield, Nancy	n
Krych, Aaron J.	3b – Arthrex, Inc.; 5 – Arthritis Foundation, Histogenics
Kuivila, Thomas E.	n
Kuklis, Matthew	n
Kurd, Mark F.	n
Kurdziel, Michael	n
Kurtz, William	n
Kwasny, Mary J.	n
LaBelle, Mark W.	n
Lacy, Kyle W.	n

Lafferty, Paul M.	n
Lake, Spencer P.	n
Larson, A. Noelle	n
Larson, Dirk	n
Larson, Evan P.	n
Latz, Kevin H.	n
Laughlin, Richard T.	2 – AO North America, Smith & Nephew, Synthes; 3b – Premier Health Partners Orthopaedic Institute, South Surgery Center, LLC , World Arthrosis Organization; 3c – Community Tissue Bank; 5 – Grants: AOFAS, Ohio Third Frontier, Orthopaedic Trauma Association, Wright State University Boonshoft School of Medicine
Lawless, Matthew W.	n
Lawton, Jeffrey N.	3b – Innomed; 5 – Biomet; 6 – AO North America
Lee, John J.	n
Lee, Simon	n
Leland, J. Martin, III	3b – Arthrocare; 3b, 5 – Stryker
Lemos, Stephen E.	5 – Arthrex, Inc., CONMED Linvatec, DePuy, a Johnson & Johnson Company, Smith & Nephew
Lenart, Brett A.	n
Lester, Jonathan D.	n
Levina, Yelena	n
Levine, Brett R.	3b – Baxter, CONMED Linvatec, Janssen Pharmaceuticals, Orthoview; 3b, 5 – Zimmer, 5 – Biomet
Levy, Bruce A.	1 – VOT Solutions; 1, 3b, 5 – Arthrex, Inc.; 5 – Biomet, Stryker
Levy, David	n
Lewallen, David G.	1 – MAKO/Stryker; 1, 2, 3b – Zimmer; 1, 3b – Pipeline Biomedical Holdings; 3c, 4 – Ketai Medical Devices
Lewis, Caitlin	n
Lewis, Steven P.	n
Li, G. Ying	n
Lichota, Derek K.	n
Lieberman, Isador H.	1 – Stryker; 1, 3b, 4 – MAZOR Surgical Technologies; 1, 4 – AxioMed, Merlot Orthopedix; 2 – DePuy, a Johnson & Johnson Company; 3b – Baxano, Globus Medical; 4 – Bioniks Laboratories, CrossTrees, Medical Compression Systems, Pearldiver; Zyga Inc.
Lilyquist, Michael B.	n
Lindner, Dror	n
Lissy, Micah E.	n
Liu, Jiayong	n
Liu, Steve S.	n
Lombardi, Adolph V., Jr.	1 – Innomed; 1, 2, 3b, 5 – Biomet; 3b, 5 – Pacira; 5 – Kinamed, Stryker
Lotzien, Sebastian	n
Lowe, Jason A.	2, 5, 6 – Synthes; 5 – Stryker
Luczak, S. Brandon	n
Lu, Min	n
Ludwig, Brian J.	n

Ludwig, Todd	n
Luk, Pamela C.	n
Luo, T. David	n
Luu, Hue H.	n
Ly, Amanda V.	n
Lyden, Elizabeth	n
Lynch, Jonathan R.	n
Mabry, Tad M.	n
Macalena, Jeffrey A.	2 – Arthrex, Inc., Smith & Nephew
Magnussen, Robert A.	n
Mahida, Justin B.	n
Mahoney, Craig R.	3b, 4 – Trak Surgical, Inc; 3b,5 – Smith & Nephew; 5 – Liventa Biosciences
Malandra, Allison E.	n
Malcolm, Tennison	n
Malkani, Arthur L.	1, 2, 3b, 5 – Stryker; 5 - Synthes
Mancini, Eric J.	n
Manning, Blaine T.	n
Manning, David W.	1 – Biomet; 2, 3b – Medacta; 3b – Biomet; 4 - Iconacy
Maradit Kremers, Hilal	n
Marcantonio, David	n
Marco, Rex A. W.	2 – DePuy, a Johnson & Johnson Company, Nuvasive; 3b – Aesculap/B. Braun
Markel, David C.	1, 2, 3b, 4, 5 – Stryker; 4 – Arbotetum Ventures, Novi Bone and Joint Center, The CORE Institute; 5 – OREF
Markert, Ronald J.	n
Markiewitz, Andrew D.	7 – American Board of Orthopaedic Surgery, Inc., CRC Press
Marra, Guido	1, 3b - Zimmer
Marsh, J. Lawrence	1 – Biomet; 4 – FxRedux; 7 – Oxford Press
Marshall, Nathan E.	n
Marston, Scott B.	n
Martell, John	1 – UCTech patent from University of Chicago; 3b – Biomet, StelKast, Inc.
Martin, Christopher T.	n
Martin, John R.	n
Mass, Daniel P.	n
Matava, Matthew J.	3b – ISTO Technologies, Schwartz Biomedical; 6 – Arthrex, Inc., Breg
Mather, Richard C., III	3b – KNG Health Consulting, Pivot Medical, Smith & Nephew, Stryker; 4 – for[MD]
Mathis, Kenneth B.	1 – Zimmer; 3b – OMNIlife Science
May, Jedediah H.	n
McAndrew, Christopher M.	2 – Synthes; 7 – Journal of Bone and Joint Surgery -American
McArthur, Benjamin A.	n
McCarthy, Mark A.	n
McClary, Kaylan N.	n
McCormick, Jeremy J.	2 – Synthes Integra; 5, 6 – Midwest Stone Institute, Wright Medical Technology; 6 – Arthrex, Inc.
McCunniff, Peter	n

McGinnis, Mark	n
McIntosh, Amy L.	3b – Synthes
McKinley, Todd O.	3b - Bioventus
McKinney, Amy	n
McLaughlin, John	n
McLendon, Paul B.	n
McMahon, Megan J.	n
McQueen, Peter D.	n
Mead, Matthew	n
Meadows, Molly C.	n
Medairos, Robert A.	n
Mednick, Rachel E.	n
Meehan, Erin M.	n
Mehle, Susan	n
Mehran, Nima	n
Mehta, Kaushal	n
Meister, Melissa	n
Mejia, Alfonso	3c, 4 – BloxR; 5 – Acumed, LLC, Arthrex, Inc., Smith & Nephew, Synthes
Melton, L. Joseph, III	n
Mendoza-Lattes, Sergio A.	2 – Globus Medical
Merrell, Gregory A.	3b - Stryker
Merrick, Michael T.	n
Mesfin, Addisu	n
Meyer, Mark S.	n
Mihalko, William M.	1, 2, 3b, 5 – Aesculap/B. Braun; 3b – Medtronic; 5 – Smith & Nephew, Stryker; 7 – Saunders/Mosby-Elsevier, Springer
Miller, Benjamin J.	n
Miller, Eric T.	3b, 3c - Synthes
Miller, Lindsay R.	n
Miller, Robert H., III	7 – Saunders/Mosby-Elsevier
Miller, Ryan E.	n
Miller, Timothy	n
Millis, Andrew A.	n
Mills, Karen M.	n
Minhas, Shobhit V.	n
Miniaci, Anthony	1 – ArthrosurfaceZimmer; 2, 3b – CONMED Linvatec, Smith & Nephew; 2, 3b, 4, 6 – ArthroSurface; 3b, 4 – Zimmer; 3b, 4, 6 – Stryker; 4 – DePuy, a Johnson & Johnson Company, Medtronic; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Minneci, Peter C.	n
Moed, Berton R.	1 - Biomet
Moen, Patrick	n
Moisan, Alice A.	n
Moldavsky, Mark	3a, 4 – Globus Medical
Molinari, Robert W.	n
Molinari, William J.	n
Molloy, Robert M.	2, 3b, 5 – Stryker; 5 - Zimmer
Momaya, Amit M.	n

Mooers, Brian	4 – Abbott, GE Healthcare, GlaxoSmithKline, Johnson & Johnson, Norvartis, Procter & Gamble
Moore, Michael	n
Moore, Timothy A.	n
Moorman, Andrew	n
Moran, Steven L.	1, 2, 3b – Integra; 4 – Axogen, Conventus
Morcuende, Jose A.	n
Moretti, Vincent M.	n
Morgan, Courtney E.	n
Moric, Mario	n
Mormino, Matthew A.	3b – Cardinal Health
Morrey, Bernard F.	1 – DJ Orthopaedics, SBI; 3a, 4 – Tenex Health; 3b – Zimmer; 7 – Wolters Kluwer Health- Lippincott Williams & Wilkins
Morrey, Mark E.	4 – Tenex Health
Morris, Andrew C.	n
Morris, Mark S.	n
Morris, Michael R.	n
Morris, William Z.	n
Morscher, Melanie A.	n
Morrison, Joseph D.	n
Mossad, David E.	n
Moutzouros, Vasilios	n
Mulligan, Ryan P.	n
Munz, John W.	n
Murayama, Takayuki	n
Murdoch, Nathan	n
Murphy, Joshua	n
Murray, Trevor G.	3b – Pacira Pharmaceuticals, Smith & Nephew, Zimmer
Muzumdar, Aditya	3a, 4 – Globus Medical
Naessens, James	n
Nair, Rueben	n
Nam, Denis	4 – OrthAlign Inc.; 5 – EOS Imaging
Namdari, Surena	1, 3b – Miami Device Solutions; 3b – Bulletproof Bone Designs, LLC; 5 – Integra, Zimmer; 7 – Saunders/Mosby-Elsevier
Naranje, Sameer	n
Nassr, Ahmad	5 – AO Spine, Synthes; 7 – Journal of Bone and Joint Surgery-American
Nekhline, Mikhail	n
Nelson, Bradley J.	5 – DePuy, a Johnson & Johnson Company, Histogenics, Omeros, Zimmer
Nessler, Joseph M.	n
Nessler, Joseph P.	1, 2, 3b, 4, 6 - Stryker
Newton, Michael	n
Nguyen, Mai P.	n
Nho, Shane J.	3b – Ossur; 3b, 5 – Stryker; 5 – Allosource, Arthrex, Inc., Athletico, DJ Orthopaedics, Linvatec, Miomed, Smith & Nephew
Nicholson, Nathan A.	n
Nies, Matthew S.	n
Nieto, Michael J.	n

Nikolaus, O. Brant	n
Noel, Curtis R.	2, 3b – Arthrex, Exactech, Inc.
Noiseux, Nicolas O.	3b – MicroPort, Smith & Nephew; 5 – DePuy, a Johnson & Johnson Company, Zimmer
Norambuena-Morales, German A.	n
Nossov, Sarah B.	n
Nuber, Gordon N.	4 – Johnson & Johnson, Stryker; 5 – Smith & Nephew
Nunley, Ryan M.	3b – Biocomposites, Cardinal Health, CardioMEMS, DePuy, a Johnson & Johnson Company, Integra Sciences, Medtronic; 3b, 5 – Smith & Nephew, Wright Medical Technology; 5 – Biomet, DePuy Synthes, Medical Compression Systems, Inc., Stryker
Nwachukwu, Benedict U.	n
Nystrom, Lukas M.	n
Obermeier, Michael	n
Obri, Tawfik	n
O'Byrne, Thomas	n
Ochenjele, George	n
Ochsner, John L., Jr.	n
Odgren, Paul R.	n
O'Driscoll, Shawn W.	1 – Aircast (DJ); 1, 2, 3b, 5 – Tornier; 1, 3c, 5 – Acumed, LLC
Ohrt, Gary	3a, 4 – Sawbones/Pacific Research Laboratories
Oji, David E.	n
Okafor, Richard	n
Okoroha, Kelechi R.	n
Olinger, Catherine	n
Oliphant, Bryant W.	2 – Synthes; 4 - PersonalRN
Olson, Doug	n
Olson, Joshua T.	n
O'Mara, Sean	n
Onyekwelu, Ikemefuna	n
O'Rourke, Colin	n
O'Shaughnessy, Maureen A.	n
Osmon, Douglas R.	n
Otero, Jesse E.	n
Otte, Jeffrey E.	n
Otto, Thomas J.	n
Pagnano, Mark W.	1 – DePuy, a Johnson & Johnson Company, MAKO, Stryker; 5 – Zimmer; 7 – Clinical Orthopaedics and Related Research
Pancio, Steven I.	n
Pang, Eric	n
Pappou, Ioannis P.	n
Paprosky, Wayne G.	1 – Stryker MAKO; 1, 3b – Zimmer; 3b – Medtronic, Stryker; 3b, 4 – Intellijoint; 4 - Ketai Medical Limited, MAKO; 6 – Cadence Health; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Parry, Joshua A.	n
Parvizi, Javad	3b – ConvaTec, Johnson & Johnson, Medtronic, TissueGene; 3b, 4 – Corentec; 3b, 5 – CeramTec, Smith & Nephew, Zimmer; 4 – Alphaeon, CD Diagnostics, Hip Innovation Technology, Joint

	Purification Systems, PRN; 5 – 3M, Cempra, DePuy, a Johnson & Johnson Company, National Institutes of Health (NIAMS & NICHD), OREF, StelKast, Stryker; 7 – DataTrace, Elsevier, Jaypee Publishing, SLACK Incorporated, Wolters Kluwer Health – Lippincott Williams & Wilkins
Patel, Pranay B.	n
Patel, Robin	1 – Up-to-Date; 3c – Thermo Fisher; 3c, 5 – Curetis; 5 – 3M, Astellas, BioFire, nanoMR, Pfizer, Pocared, Pradama, Tornier
Patel, Ronak M.	n
Pawlak, Stephanie	n
Pedersen, Douglas	n
Peters, Christopher L.	1, 2, 3b - Biomet
Peters, Nicholas J.	n
Petersen, Erica J.	n
Peterson, Michelle	n
Pfefferle, Kiel J.	6 – Pacira
Phillips, Caleb	n
Phisitkul, Phinit	3b – Arthrex, Inc., Smith & Nephew; 4 – First Ray, MTP Solutions
Phruetthiphat, Ong-art	n
Pichelmann, Mark A.	n
Pinkas, Daphne	n
Piponov, Hristo I.	n
Planalp, Michael P.	n
Plummer, Darren	n
Poehling-Monaghan, Kirsten L.	n
Politi, Joel R.	1, 2, 3b – DePuy, a Johnson & Johnson Company
Polly, David W., Jr.	n
Poludnianyk, Kim N.	n
Post, Joel M.	n
Potter, Benjamin K.	n
Prayson, Michael J.	2 – AO faculty; 2, 3b - Bioventus
Pritchett, James W.	1, 3b – Zimmer
Pugely, Andrew J.	n
Pulley, Benjamin R.	n
Puryear, Aki S.	2 – DePuy, a Johnson & Johnson Company; 2, 3b – Medicrea; 2, 3b, 3c – K2M
Radley, Joseph M.	n
Ralles, Steven	n
Ransom, Jeanine E.	n
Redmond, John M.	n
Reeve, Robert E.	n
Regnier, Terry D.	n
Reich, Michael S.	n
Ricci, William M.	1 – Wright Medical Technology; 1, 3b, 5 – Smith & Nephew; 3b – Biomet, Stryker; 7 – Journal of Bone & Joint Surgery-American, Wolters Kluwer Health – Lippincott Williams & Wilkins
Ridley, T. J.	n
Riehl, John T.	2, 3b – Arthrex, Inc.

Ries, Zachary G.	n
Rieser, Geoffery R.	n
Rife, Lauren	n
Rizkala, Amir R.	n
Rizzo, Marco	5 – SBI, TriMed
Robbins, Christopher	n
Roberson, James R.	5 - Stryker
Roberson, Troy A.	n
Roberts, Craig S.	7 – Elsevier
Robinson, Le Don	N
Robinson, Luke P.	4 – Johnson & Johnson
Robinson, Matthew	n
Romrell, Lynn J.	n
Rose, Peter S.	n
Rosenbaum, Samuel L.	n
Rosenthal, Brett D.	n
Ross, James R.	n
Ross, Joseph S.	5 – Johnson & Johnson, Medtronic; 7 – Journal of the American Medical Association
Rothermich, Marcus A.	n
Rue, John-Paul H.	n
Rungprai, Chamnanni	n
Russo, Scott S.	2 – Medtronic Sofamor Danek; 4 – Pfizer, Micromachines
Ruta, David J.	n
Ryssman, Daniel B.	n
Sabesan, Vani J.	5 – Exactech, Inc., Tornier
Sacksteder, Nicholas	n
Sadowski, Jason	5 - Medtronic
Safadi, Fayez	n
Sahai, Nikhil K.	n
Salata, Michael J.	3b – Linvatec, Smith & Nephew
Saleh, Anas	n
Saltzman, Bryan M.	7 – Nova Science Publishers
Saltzman, Matthew D.	1, 3b – Tornier; 3b – Medacta
Samuelsen, Brian T.	n
Samuelson, Eric M.	n
Sanchez-Sotelo, Joaquin	1, 5 – Stryker; 5 – Biomet, DePuy, Zimmer
Sarfani, Shumaila	n
Sassoon, Adam A.	n
Sauber, Timothy J.	n
Savin, David D.	n
Sawyer, Jeffrey R.	7 – Mosby, Wolters Kluwer Health – Lippincott Williams & Wilkins
Scallon, Greg	n
Schairer, William W.	n
Scher, Courtney E.	n
Schick, Cameron W.	n
Schildhauer, Thomas A.	2, 3b – Smith & Nephew, Zimmer
Schill, Michelle	n

Schipper, Oliver N.	n
Schleck, Cathy D.	n
Schlitz, Nicholas	n
Schneiderman, Brian A.	1 – DePuy, a Johnson & Johnson Company, Medtronic; 4 - Ouroboros
Schoch, Bradley S.	n
Schoch, Jennifer J.	n
Schraut, Nicholas B.	n
Schueler, Beth A.	n
Schwartz, Brian E.	3a – Baxter Pharmaceuticals
Schwartz, Daniel G.	2 – DJ Orthopaedics; 4 – Johnson & Johnson, Tornier
Schwartz, Stephen N.	n
Schwindel, Leslie E.	n
Scott, Alesha	n
Scott, Allison C.	n
Scott, Ethan	n
Sebastian, Arjun S.	n
Seligson, David	3b – Stryker; 7 - Springer
Semaan, Hassan	n
Sembrano, Jonathan N.	5 - Nuvasive
Sems, S. Andrew	1, 3b - Biomet
Shah, Apurva S.	n
Shah, Ashish	2 – Arthrex, Inc., Tornier
Shah, Neil S.	n
Shah, Ritesh R.	2 – Biomet, DePuy, a Johnson & Johnson Company; 3b – Smith & Nephew
Shah, Roshan P.	4 – Alnylam, GlaxoSmithKline, Intuitive Surgical, Merck, Pfizer
Shah, Sapan H.	n
Shakir, Irshad A.	n
Shannon, Steven F.	n
Sharma, Vinay	n
Sharp, Kinzie	2 – Cadence Pharmaceuticals
Shaughnessy, William J.	n
Shaw, Adam F.	n
Shemory, Scott T.	n
Sheppard, Evan	n
Shi, Lewis L.	n
Shih, Albert	n
Shin, Alexander Y.	1 – Trimed; 3b – LMT Orthopedics; 5 - Bacterin
Siebler, Justin C.	2 - Synthes
Siegel, Elana J.	n
Sierra, Rafael J.	1, 2, 3b, 5 – Biomet; 5 – DePuy, a Johnson & Johnson Company, Stryker, Zimmer
Sietsema, Debra L.	2, 3b – Eli Lilly
Silverstein, Michael P.	n
Silverton, Craig D.	1 - Biomet
Sim, Franklin H.	7 – Saunders/Mosby-Elsevier
Simon, Anne-Laure	n
Sinicrope, Brent J.	n

Siqueira, Marcelo	n
Skelley, Nathan W.	n
Smith, Casey L.	n
Smith, Christopher	n
Smith, Craig A.	n
Smith, Hugh M.	n
Smith, Kevin M.	n
Smith, Langan S.	n
Smith, Richard A.	n
Sokja, John M.	n
Sorce, Angelo J.	n
Sorkin, Anthony T.	2 – Synthes; 3b – Stryker; 4 – Johnson & Johnson
Sousa, Paul L.	n
Spence, David D.	n
Spencer-Gardner, Luke	n
Sperling, John W.	1 – Biomet, DJ Orthopaedics; 3b - Tornier
Spindler, Kurt P.	3b – Cytori-Scientific Advisory Board; 5 - National Institutes of Health (NIAMS & NICHD)
Sporer, Scott M.	3b – Smith & Nephew; 3b, 5 – Zimmer; 5 – Central Dupage Hospital; 7 – SLACK Incorporated
Springer, Bryan D.	2 – CeramTec, DePuy, a Johnson & Johnson Company; 3b – Convatec, Polaris, Stryker; 6 – Joint Purifications Systems
Squire, Matthew W.	3b - Biomet
Stake, Christine E.	6 – Salary support from American Hip Institute
Stannard, James P.	3b – Regeneration Technologies, Inc., Smith & Nephew; 3b, 5 – DePuy, a Johnson & Johnson Company, Synthes; 5 – Arthrex, Inc.; 7 - Thieme
Stans, Anthony A.	n
Statz, Joseph	n
Steensen, Robert N.	n
Stefl, Michael	n
Stephens, Byron F.	n
Stevens, Jeff W.	n
Stewart, Cory M.	n
Stewart, Robert J.	n
Stewart, Thomas M.	n
Stimac, Jeffrey	n
Stitgen, Andrea C.	n
Stover, Michael D.	n
Strnad, Greg	n
Strong, Clayton E.	n
Stuart, Michael J.	1, 3b – Arthrex, Inc.; 5 - Stryker
Stubbart, James R.	n
Stuhlman, Casey R.	n
Stulberg, S. David	1 – Biomet, Innomed; 1, 2, 3b – Aesculap/B.Braun; 2, 3b – Zimmer; 2, 3b, 4 – Stryker; 4 – Blue Belt Technologies, Johnson & Johnson; 7 – Peachtree Publishers
Styron, Joseph F.	n
Suleiman, Linda I.	n

Sundberg, Eric B.	n
Sundblad, Jeffrey J.	n
Suri, Misty	2, 3b – Arthrex, Inc., Breg
Sutaria, Shiv I.	n
Swann, R. Presley	n
Swiontkowski, Marc F.	3b – Eli Lilly; 7 – Saunders/Mosby-Elsevier, Wolters Kluwer Health - Lippincott Williams & Wilkins, Journal of Bone and Joint Surgery-American
Switaj, Paul J.	n
Sykes, Joshua B.	n
Szubski, Caleb R.	n
Tai, Bruce	n
Taiber, Andrew	n
Talpos, Gary B.	n
Tantavisut, Saran	n
Taunton, Michael J.	3b – DJ Orthopaedics; 5 - Stryker
Taylor, Benjamin C.	2 – Synthes; 3b – Biomet; 7 – Orthobullets.com
Tenfelde, Allison M.	n
Tennant, Joshua N.	n

Terry, Michael A.	1, 5, 6 – Smith & Nephew; 6 – Arthrex, Inc.; 7 – Saunders/Mosby-Elsevier
Teuscher, David	n
Teusink, Matthew J.	n
Thomas, Geb W.	n
Thompson, Nicolas	n
Thomsen, Kristine	n
Throckmorton, Thomas W.	2, 3b, 5 – Biomet; 3b – Zimmer; 4 – Gilead; 7 – Saunders/Mosby-Elsevier
Tolich, Deborah	n
Tompkins, Marc	n
Toohey, John S.	n
Toolan, Brian C.	4 - Pfizer
Tonnos, Frederick E.	n
Toor, Aneet S.	n
Torchia, Michael T.	n
Tortolani, P. Justin	1, 2, 3b, 5 – Globus Medical
Toy, Patrick C.	n
Trask, Darrin J.	n
Treder, Vickie M.	n
Trimba, Roman	n
Trinh, Thai Q.	n
Trippa, Carissa J.	n
Trousdale, Robert T.	1, 3b – DePuy, a Johnson & Johnson Company, MAKO, Wright Medical Technology
Tsai, Eugene Y.	n
Turner, Norman S.	n
Ubl, Daniel	n
Urban, Robert	3b – DePuy, a Johnson & Johnson Company, Exactech, Inc., Spinal Motion; 3b, 5 – Wright Medical Technology, Inc.; 5 - Zimmer
Uribe, Bastian	n
Urquhart, Andrew G.	n
Vaidya, Rahul	1 – Smith & Nephew; 1, 2, 5, 6 – Synthes; 2, 3b, 3c – Stryker
Vallier, Heather A.	n
Van Beek, Corinne	n
Van Demark, Robert E., III	n
Van Heest, Ann E.	n
van Holsbeeck, Marnix	4 – Bristol-Myers Squibb, Johnson & Johnson, Norvartis; 4, 5 – GE Healthcare; 5 – Fuji Healthcare, Siemens Healthcare; 7 – Saunders/Mosby-Elsevier
Van Patten, Ryan	n
Van Straaten, Meegan G.	n
van Wijnen, Andre	n
Vang, Sandy	n
Vasileff, William K.	n
Vasileiadis, Georgios I.	n
Vasta, Sebastiano	n

Vaughn, Derek	n
Vizza, Scott	n
Volgas, David A.	5 - Pfizer
von Roth, Philipp	n
Voor, Michael J.	1 – DePuy, a Johnson & Johnson Company; 3b, 4 – Vivorte, Inc.; 4 – Intellirod Spine, Inc.
Vrabec, Gregory A.	4 – Smith & Nephew, Teva Pharm, Zimmer; 5 - Synthes
Wagie, Amy E.	n
Wagner, Eric R.	n
Walczak, Brian E.	n
Walia, Piyush	n
Walsh, Christopher P.	n
Wang, Stewart C.	n
Ward, Christina M.	n
Warner, Jon J. P.	1, 3b, 6 (Royalty on Rotator Cuff Implant)) – Tornier; 4 – IMASCAP Company, Orthospace; 6 – Arthrex, Inc., Arthrocare, Breg, DJ Orthopaedics, Mitek, Smith & Nephew (Fellowship Support)
Warner, William C., Jr.	3c – Medtronic Sofamor Danek; 7 – Saunders/Mosby-Elsevier
Warth, Lucian C.	n
Watson, J. Tracy	1, 2, 3b – Smith & Nephew; 1, 2, 3b, 6 – Biomet; 2, 3c – Ellipse; 3b – Bioventus; 3c – accelalox, Acumed, LLC
Watts, Chad D.	n
Weatherford, Brian M.	n
Weber, Alexander E.	n
Weiner, Bradley K.	n
Weinlein, John C.	7 – Saunders/Mosby-Elsevier
Weinstein, Stuart L.	7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Weller, William J.	n
Welsh, John	n
Welton, Kristina L.	n
Wenger, Doris	n
Wentz, Brock T.	n
Wenzlick, Thomas S.	n
Wera, Glenn D.	n
Werthel, Jean David	n
Westerlind, Brian O.	n
Westermann, Robert W.	n
Weston, John T.	n
White, Tyler	n
Whiting, Daniel R.	n
Whiting, Jeffrey B.	n
Wiater, Brett P.	n
Wiater, J. Michael	2 – DePuy, a Johnson & Johnson Company; 2, 3b, 5 – Zimmer; 3b – Biomet; 4 – Eleven Blade Solutions, Inc.; 5 – Synthes, Tornier
Wiegmann, Aaron L.	n
Wilke, Benjamin K.	n
Wilkie, Paul	n

Willenborg, Melissa D.	n
Willey, Michael C.	n
Williams, Chad G.	n
Williams, Gerald R., Jr.	1 – IMDS; 1, 3b, 5 – DePuy, a Johnson & Johnson Company; 4 – CrossCurrent Business Analytics, Force Therapeutics, ForMD, In Vivo Therapeutics, OBERD; 5 – Synthasome, Tornier; 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Williams, Keith D.	n
Wiltfong, Roger E.	n
Winkler, Jennifer A.	n
Wissman, Robert	n
Wolf, Brian R.	3b – CONMED Linvatec; 5 – OREF; 6 – Arthrex, Inc.
Wolfe, Jared A.	n
Wood-Wentz, Christina M.	n
Wooten, Clint J.	n
Worden, Alicia F.	n
Wozniczka, Jennifer K.	n
Wright, John	n
Wright, Rick W.	5 – National Institutes of Health (NIAMS & NICHD); 7 – Wolters Kluwer Health – Lippincott Williams & Wilkins
Wrobel, James S.	n
Wyles, Cody C.	n
Wyrick, John D.	3b – Stryker
Wysocki, Robert W.	n
Yack, John	n
Yaffe, Mark A.	n
Yamaguchi, Ken	1 – Tornier, Zimmer
Yaszemski, Michael J.	3b – Medtronic
Yi, Paul H.	n
Yoon, Patrick	3b – Arthrex, Inc., Orthofix, Inc.
York, Timothy	n
Youdarian, Ari R.	n
Yson, Sharon C.	n
Yu, Johnathan	n
Yu, Stephen	n
Zamfirova, Ina	n
Zampogna, Biagio	n
Zappa, Nicole M.	n
Zavala, Jeff C.	n
Zerris, Vasilios	n
Zhang, Jingwei	n
Zinberg, Ephraim M.	n