

# SOA 32nd Annual Meeting

July 15-18, 2015

The Omni Grove Park Inn

Asheville, NC

## PODIUM ABSTRACTS

### Thursday, July 16

#### GENERAL SESSION 1: Total Joint Outcomes

##### **Incidence and Magnitude of Metal Ion Levels in Blood with Large Ceramic and Metal Femoral Heads: A Prospective Study with Five-Year Follow-Up**

Chitranjan S. Ranawat, MD; Peter B. White, BA; Morteza Meftah, MD; Sandra Fong, BA; Amar S. Ranawat, MD

**Introduction:** There is a recent recognition of the trunionosis and trunion failure. The incidence and magnitude of metal ion release at the head-neck junction with large ceramic and metal heads has not been studied in a prospective manner. **Materials and Methods:** Between March of 2006 and April 2010, 60 patients with non-cemented total hip arthroplasty (THA) on highly cross-linked polyethylene were included and followed prospectively for 5 years: of these 30 THA had large (32- or 36-mm) metal and 30 THA had large (32- or 36-mm) ceramic femoral heads. Serum level of Cobalt, Chromium and Nickel were measured in all patients. **Results:** Patients with metal heads had elevated Cobalt and Chromium levels. Cobalt level was elevated in 17 (56.7%) patients with a mean value of 2.0  $\mu\text{g/L}$  (range: <1.0  $\mu\text{g/L}$  to 10.8  $\mu\text{g/L}$ ). Chromium level was elevated in 5 patients (16.7%) with a mean of 0.3  $\mu\text{g/L}$  (range: <1.0  $\mu\text{g/L}$  to 2.2  $\mu\text{g/L}$ ). All patients with ceramic heads had Cobalt and Chromium levels below 1  $\mu\text{g/L}$ . Cobalt and Chromium levels were significantly higher with metal heads compared to ceramic heads ( $p < 0.01$ ). All ceramic THA were asymptomatic. Seven patients with metal femoral heads had mild hip symptoms of pain and discomfort; adverse local tissue reaction was confirmed by MRI. **Conclusions:** Incidence of Cobalt and Chromium levels is higher in large metal heads compared to large ceramic heads ( $p < 0.01$ ). The clinical significance of elevated levels and adverse tissue reaction remains to be established. Role of trunion size, metallurgy and engagement distance may play a role and needs to be further studied.

##### **Custom Cutting Guides Do Not Improve Total Knee Arthroplasty Clinical Outcomes at Two Years Follow-Up**

Ryan M. Nunley, MD; Denis Nam, MD, MSc; Andrew G. Park, MD; Jeffrey B. Stambough, MD; Staci R. Johnson, MEd; Robert L. Barrack, MD

**Introduction:** Custom cutting guides (CCGs) in total knee arthroplasty (TKA) use 3-dimensional imaging to fabricate cutting blocks specific to a patient's anatomy. To date, small cohorts and short follow-up have limited reports studying clinical and functional outcomes of CCGs versus standard instrumentation. The purpose of this study was to determine if CCGs improve clinical outcomes versus standard instrumentation following TKA. **Methods:** This prospective study included a consecutive series of patients undergoing TKA using the same cruciate-retaining, cemented system. All patients were offered the option of TKA with CCGs. Patients self-selected either CCG or standard instrumentation. The first 95 patients that selected CCGs were compared with the first 95 with standard instrumentation. The alignment goal for all was hip-knee-ankle (HKA) angle of 0° with components aligned perpendicular to the mechanical axis. UCLA, SF-12, and Oxford Knee scores were collected preoperatively. These scores,

along with the Forgotten Joint score and a satisfaction and function questionnaire, were collected at follow-up. Postoperative scout CTs were used to measure overall HKA. Complications within 6 months were reviewed. **Results:** 95 patients each in the standard and CCG cohorts were analyzed. There was no difference in age, BMI, tourniquet time, or percentage of HKA outliers between the cohorts. CCG patients had higher UCLA, SF-12 physical, and Oxford knee scores preoperatively. At follow-up, no differences were present for range of motion, UCLA, SF-12, Oxford Knee, or Forgotten Joint scores. No differences were present for improvement in these scores from preoperative values. Patient satisfaction and presence of residual symptoms were also similar. No differences in overall or knee-related complications were found. **Discussion and Conclusions:** At mean follow-up of > 2 years, CCGs fail to demonstrate advantages in clinical outcomes versus standard instrumentation in TKA. The clinical benefit of CCGs must be proven prior to continued implementation of this technology.

### ***SOA Resident Travel Grant Award Winner***

#### **Lumbar Plexus Catheters Versus Infiltration with Liposomal Bupivacaine in THA**

Peter M. Formby, MD; Kristine Lyons, MD; Hisani R. Edwards, RN; Andrew Mack, MD; Michael T. Newman, MD; Scott E. Grabill, MD; Michael L. Kent, MD

**Introduction:** Surgical infiltration has offered inferior perioperative pain management compared to lumbar plexus catheters in THA patients, possibly due to its limited duration of action. With its reported prolonged duration, we sought to compare outcomes in patients undergoing THA treated with liposomal bupivacaine (Exparel®) versus patients receiving a lumbar plexus catheter. **Material/Methods:** Retrospective review of THA patients receiving either lumbar plexus catheters or surgical infiltration with liposomal bupivacaine. All patients received a general anesthetic and were prescribed identical multimodal analgesic regimens. Outcomes measures included pain ratings within the PACU and the first two postoperative days (Numerical Rating Scale- NRS), opioid usage, and time until discharge as defined by physical therapy criteria. **Results:** 26 patients were within the liposomal bupivacaine infiltration group and 20 patients were within the lumbar plexus catheter group. Median PACU Pain scores (3.0 (0-6)) vs. 0 (0-2)) and PACU opioid use measured in morphine equivalents (12.08 (0-20.67) mg vs 0 (0-2.5)) were significantly greater in patients receiving infiltration. Median pain scores (3.5 (2.4-4.8) vs 1.3 (0.3-2.3)) and opioid use (10.5 mg (2.5-15) vs 1.25 mg (0-5)) throughout postoperative day zero were significantly greater in patients with infiltration. However, pain scores and opioid throughout postoperative days 1-2 were not significantly different. Median time to meet physical therapy discharge criteria was significantly longer in patients receiving lumbar plexus catheters (66 (47-70) hours) versus Exparel® infiltration (46 (42-50) hours). **Discussion and Conclusion:** Liposomal bupivacaine's purported long duration of action possibly can increase the efficacy of surgical infiltration. However, in this review, lumbar plexus catheters were superior to liposomal bupivacaine infiltration in THA throughout the duration of the infusion. Following discontinuation of the catheter and cessation of nerve blockade on postoperative day one, liposomal bupivacaine still did not provide a comparative benefit throughout the rest of patients' hospital course.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

#### **Complications of Total Hip Arthroplasty in Solid Organ Transplantation Recipients**

Thorsten M. Seyler, MD, PhD; Abiram Bala, BA; Colin T. Penrose, BS; Richard C. Mather III, MD; David E. Attarian, MD; Samuel S. Wellman, MD; Michael P. Bolognesi, MD

**Introduction:** Organ transplantation (OT) has overcome major technical limitations including surgical techniques for vascular anastomoses and managing the immune system. As a result of improvements in peri- and postoperative management of OT, both organ and patient survival continue to improve and more patients with solid OTs will continue to seek care for THA. While newer immunosuppressive therapies have led to improved survival, these therapies are not only associated with significant individual drug side effects, but also systemic side effects. The purpose of this study was to evaluate co-morbidities and complications after THA in patients who had various prior solid OTs. **Methods:** A PearDiver analysis of the entire Medicare database was performed and ICD-9 codes were used to identify the procedure, co-morbidities and post-operative complications of interest. There were a total of 3,180 patients who underwent THA after one or more various solid OTs (2,312 kidney transplants, 561 liver transplants, 196 lung transplants, 428 heart transplants, 149 pancreas transplants). A cohort of 771,498 patients who underwent elective primary THA without prior history of solid organ transplant served as a control. Incidence (IN), odds ratios (ORs) and their respective 95% confidence intervals (CIs) for 30-day, 90-day and overall complications were calculated. **Results:** There was a significant difference in 25 out of 29 comorbidities as defined in the Elixhauser co-morbidity measure between the transplant and control cohort. When analyzing postoperative complications, there was an overall increased risk in the transplant cohort for: acute renal failure (IN 76%, OR 13.), anemia (IN 39%, OR 1.188), arrhythmia (IN 22%, OR 1.165), arthrotomy/I&D (IN 2%, OR 1.605), blood transfusion (IN 48%, OR 1.587), bleeding (IN 11%, OR 2.546) DVT/PE (IN 11%, OR 2.058) heart failure (IN 29%, OR 1.995), MI (IN 5.9%, OR 1.463), prosthetic complications (IN 34%, OR 2.160), proximal DVT (IN 3.8%, OR 2.094), mortality (IN 0.6%, OR 1.874), periprosthetic infection (IN 4.3%, OR 1.713), pneumonia (IN 26%, OR 2.267), sepsis/SIRS (IN 16%, OR 3.726), wound complications (IN 2.6%, OR 2.277), wound infection (IN 16%, OR 1.993). **Conclusion:** The results of this study demonstrate that solid organ transplant recipients who undergo THA have more co-morbidities and represent an at-risk population with higher medical complexity. Transplant patients should be counselled on the inherent risks of postoperative complications after THA.

### *SOA Presidents' Resident Award Winner*

#### **Comparison of Post-Operative Complications following Metal-On-Metal Total Hip Arthroplasty with Other Hip Bearings in Medicare Population**

Lindsay T. Kleeman, MD; Thorsten M. Seyler, MD, PhD; Abiram Bala, BA; Colin T. Penrose, BS; Samuel S. Wellman, MD; Michael P. Bolognesi, MD

**Background:** There is increasing evidence that metal-on-metal hip bearings have high complication rates and early failure. The use of metal-on-metal (MOM) implants has dramatically decreased with most hip bearings used today being metal-on-polyethylene (MOP), ceramic-on-polyethylene (COP) or ceramic-on-ceramic (COC) implants. Using a Medicare database, we sought to determine if MOM implants are associated with higher complication and revision rates when compared to other hip bearings in a large subset of patients. **Methods:** Using a Medicare database, we retrospectively reviewed patients who underwent a primary unilateral total hip arthroplasty from 2005-2011. ICD-9 codes were used to categorize patients according to the type of hip bearing received including: metal-on-metal, metal-on-polyethylene, ceramic-on-polyethylene and ceramic-on-ceramic implants. We identified patient comorbidities as well as several post-operative complications following the index surgery. **Results:** Among patients who received a primary total hip arthroplasty, 81520 received a MOM implant, 162881 received a MOP implant, 33819 received a COP implant, and 9898 received a COC implant. Post-operative complication rates were higher for patients with a MOM and MOP implant, specifically including heart failure, arrhythmia, respiratory failure, DVT, stroke, pneumonia, renal failure, anemia requiring transfusion, and nonspecific hip pain. MOM implants carried similar post-operative complication rates compared to MOP, however complication rates were higher for MOM than for COP or COC bearings. The revision rate for MOM implants (5.3%) was only slightly higher than for COP (3.5%),

MOP (4.3%) and COC implants (4.9%). **Conclusions:** We conducted a comparison of post-operative complications associated with different hip bearings in the Medicare population. We found that metal-on-metal implants are associated with higher complication rates when compared to ceramic-on-polyethylene and ceramic-on-ceramic but had similar rates when compared to conventional metal-on-polyethylene. Revision rates for metal-on-metal implants are only slightly higher compared to other bearings.

### **Mild Arthritis and Elevated BMI Predict Poor Young TKA Patient Outcomes**

James A. Keeney, MD; Adam Sassoon, MD; Jacob Haynes, MD

**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, less prominent osteophytes, less frequent knee malalignment, and lower Kellgren-Lawrence score. BMI over 32 kg/m<sup>2</sup> was associated with lower UCLA activity, SF-12 physical function and SF-12 mental health subscores. Female patients had uniformly lower preoperative and postoperative scores, 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, SF-12 mental health, Knee Society function, and WOMAC subscores. Patients with at least 50% articular cartilage loss had trends toward higher SF-12 physical function, SF-12 mental health, and WOMAC pain subscores. **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.

### **Liposomal Membrane Bound Bupivacaine Versus Femoral Nerve Catheter for TKA**

Erick G. Torres, MD; Ashley B. Anderson, BS; Brandon Broome, MD; Stephen P. Geary, MD; Brian Burnikel, MD

**Introduction:** Inadequate postoperative pain management can interfere with participation and progression of physical rehabilitation, resulting in prolonged hospital stay, increased financial cost, and overall dissatisfaction with the procedure. At our institution, total knee arthroplasty (TKA) has been conventionally performed utilizing femoral nerve catheters (FNC) for postoperative pain control. The purpose of our study is to compare FNC with a liposomal membrane bound bupivacaine based on pain control, range of motion, ability to ambulate, and length of hospital stay. **Methods:** The study was a retrospective, longitudinal, repeated measures design that captured 23 individuals who underwent TKA on both knees at two distinct timepoints. The first was performed under FNC and the second under periarticular liposomal membrane bound bupivacaine. **Results:** There was a statistically significance difference in favor of liposomal membrane bound bupivacaine between the two groups for length of stay (2.3 days versus 2.8 days), total walking distance per attempt during hospitalization (136 feet versus 84 feet) and total range of motion at 3 weeks (116 degrees versus 107 degrees). **Discussion and Conclusion:** Our study findings show that patients treated with a liposomal membrane bound bupivacaine experienced comparable pain control with improved knee range of motion and a shorter length of hospital stay

compared to those receiving FNC. Additional clinical studies are necessary to better determine the efficacy and cost-effectiveness of these long-acting local anesthetic formulations such as liposomal membrane bound bupivacaine.

### **History of Extension-Gap First Balancing Technique in Total Knee Arthroplasty**

Chitranjan S. Ranawat, MD; Morteza Meftah, MD; Peter B. White, BA; Amar S. Ranawat, MD

Historically, gap-balancing was described as a technique for soft-tissue balancing, focusing on creating a rectangular flexion-gap followed by an equal rectangular extension-gap. However, in cases of severe deformities, flexion contracture or soft tissue elongation, this technique was found to lead to inadequately restore the (1) posterior offset, (2) joint line, (3) patellar tracking, and (4) complicate appropriate sizing of components. In 1989, Dr. Chitranjan Ranawat modified the gap-balancing technique to balance the extension-gap first, followed by the flexion-gap using the “parallel to the tibial cut technique”. This novel extension-gap first technique has been well-studied and shown to decrease the occurrences of femoral component malalignment, instability and accurately restore the joint line. This technique will be demonstrated by video.

### **RAPID FIRE SESSION 3A: Total Hip**

#### **Metal Ion Concentrations in Young, Active Patients following Total Hip Arthroplasty with the Use of Modern Bearing Couples**

Ryan M. Nunley, MD; Denis Nam, MD, MSc; James A. Keeney, MD; Staci R. Johnson, Med; John C. Clohisy, MD; Robert L. Barrack, MD

**Introduction:** Elevated whole blood metal ion levels remain a concern following total hip arthroplasty (THA), but the impact of ceramic or oxinium femoral heads on metal ion concentrations remains unknown. The purpose of this study was to compare whole blood metal ion levels in young, active patients undergoing primary THA with the use of a cobalt-alloy, ceramic, or oxinium femoral head and highly crosslinked polyethylene acetabular liner. **Methods:** We prospectively enrolled 37 young, active patients undergoing primary THA (10 cobalt-poly, 15 ceramic-poly, 12 oxinium-poly). All utilized a cementless femoral stem and titanium-alloy acetabular socket. Patients 6 were included. All had clinically well-functioning prostheses and radiographically well-fixed components. Whole blood metal ion analysis was performed preoperatively, and 1-year, 2-years, and 5-years postoperatively. **Results:** In the cobalt-alloy cohort, cobalt levels were 3.5 times higher at 2 years and 2.0 times higher at 5 years postoperatively versus preoperatively, but standard deviations were broad. At 2 years postoperatively, mean cobalt concentrations were 3.0 times higher in the cobalt-alloy cohort versus the ceramic cohort and 2.3 times higher in the cobalt-alloy cohort versus the oxinium cohort. Titanium levels were elevated at all postoperative time points versus preoperatively in all three cohorts, reaching significance at each postoperative interval in the cobalt-alloy and ceramic cohorts, and at the 1-year postoperative interval in the oxinium cohort. Titanium levels were elevated 3.3 to 4.4 times versus preoperatively in each cohort. **Discussion and Conclusion:** Use of a ceramic or oxinium femoral head decreased the degree of whole blood cobalt elevation versus a cobalt-alloy femoral head, but did not reach statistical significance. Titanium levels remained elevated in all three cohorts postoperatively. Patients with well-functioning primary THAs demonstrate elevated whole blood cobalt and titanium concentrations, but its clinical significance requires further investigation.

### **New Cells New Problems: Arthroplasty in Bone Marrow Transplant Patients**

Joseph Kavolus, MD, MSCR; Thorsten M. Seyler, MD, PhD; Abiram Bala, BA; Colin T. Penrose, BS; Michael P. Bolognesi, MD

**INTRODUCTION:** The number of bone marrow transplants is growing rapidly, as this patient population grows and survival improves the number of patients undergoing total joint replacement will increase. This study investigates the risks of complications in this group relative to a control group. **METHODS:** Utilizing data from a Medicare database (serviced by PearlDriver technologies) ICD-9 codes for hip arthroplasty, knee arthroplasty and hematopoietic stem-cell transplant were identified. Complication rates at 30-days, 90-days, and over the entire timeline of the database were compared in these groups to a control group. **RESULTS:** Of the hip replacement patients 1039 also underwent hematopoietic stem-cell transplant and of the knee replacement patients 712 also underwent hematopoietic stem-cell transplantation. Interestingly, when comparing patients who underwent THA before HSCT to those who underwent THA after HSCT having surgery before HSCT was associated with higher rates of infection and revision. Both intersection groups (HSCT +KA and HSCT + HA) demonstrated a significantly increased risk of sepsis (OR 2.8 and 2), periprosthetic joint infection (OR 2.3 and 1.8), pneumonia (OR 2.1 and 1.8), and fungal infection (OR 1.9 and 1.8). Knee arthroplasty patients were noted to be at increased risk of cellulitis (OR 1.6) and subsequent arthrotomy (OR 2.1). HSCT patients who underwent hip replacement were at a decreased risk of post-operative urinary tract infection (OR 0.6). **DISCUSSION AND CONCLUSION:** This investigation is the first of its kind looking at joint replacement in patients who underwent stem cell transplantation. The data suggests that due to immunocompromise patients suffer from an increased risk of a range of peri-operative infections. Orthopaedic surgeons should be even sensitive to the post-operative infectious complications in this patient population and aware of the risk for systemic illness. A multi-disciplinary approach to this patient population is recommended.

### **Frozen Sections in Revision THA and TKA following Deep Infection**

Grayson A. Moore, MD; \*Malone V. Hill III, BS; Yong-Fang Kuo, PhD; Kelly W. Stephenson, MD; Ronald W. Lindsey, MD

**INTRODUCTION.** The intraoperative decision to proceed with re-implantation total joint arthroplasty (rTJA) during the management of a periprosthetic infection can be challenging. A negative frozen section histopathology analysis is widely employed to determine a wound's suitability for rTJA; however, its utility in predicting infection eradication remains controversial. **METHODS.** All revision total hip and knee arthroplasty procedures performed at a single institution from 2002 to 2012 were reviewed retrospectively. Inclusion criteria were prior resection arthroplasty for infection, and the availability of both intraoperative frozen section and culture results. Exclusion criteria consisted of procedures with missing data, a negative history of deep infection, subtotal revision arthroplasty, and prisoner status. Favorable frozen sections (fewer than 10 PMN/HPF) were correlated with the subsequent intraoperative culture outcomes and the well-established confounding factors body mass index, number of previous surgeries, diabetes mellitus, and current smoking status. **RESULTS.** A total of 331 rTJA procedures were identified, 43 of which were eligible for analysis. Favorable frozen sections (fewer than 10 PMN/HPF) occurred in 13 rTJA procedures (30.2%) that subsequently had positive intraoperative cultures (negative predictive value equaled 69.8%). Among these 13 procedures, 12 had fewer than 4 PMN/HPF. Patient confounding factors did not correlate with these outcomes. **DISCUSSION AND CONCLUSION.** Favorable intraoperative frozen sections during rTJA do not guarantee negative intraoperative cultures. In these patients clinicians should consider staged rTJA and await a negative culture prior to revision arthroplasty.

## **Diabetic Control in Total Joint Arthroplasty**

Carlos J. Lavernia, MD; \*Jesus M. Villa, MD

**INTRODUCTION:** Low and high HbA1c values have been associated with increased mortality and cardiovascular complications in diabetic patients. Our objective was to study the effects of diabetic control in the outcomes after total joint arthroplasty (TJA). **METHODS:** 121 consecutive primary TJA (88 TKA, 33 THA) were performed in type 2 diabetic patients (mean age 71.8 years, 67% women). Patients were stratified into quartiles based on their preoperative mean HbA1c levels [lowest 25% (LQ25): 6% (range: 5.1-6.4%); interquartile range or middle 50% (IQ50): 6.9% (6.5-7.6%); highest 25% (HQ25): 8.7% (7.7-11.5%)]. Patient oriented outcomes (QWB-7, SF-36, and WOMAC), complications, length of stay (LOS), and hospital costs were compared between quartile groups. Age, sex, ethnicity, and severity of illness (Kellgren-Lawrence, Alhback) were identified as confounding factors, and used for statistical adjustment. ANOVA and independent t-test were used to compare outcomes. **RESULTS:** At 2.7 years (range: 2-5) there were no significant differences between quartiles. However, a trend of worse scores in the lowest 25% and highest 25% quartiles was identified for the QWB-7 (LQ25: 0.627; IQ50: 0.637; HQ25: 0.627), SF-36 physical role (LQ25: 71; IQ50: 78; HQ25: 77), SF-36 social functioning (LQ25: 72; IQ50: 78; HQ25: 76), SF-36 mental health component (LQ25: 55; IQ50: 57; HQ25: 55), WOMAC function (LQ25: 7; IQ50: 3; HQ25: 5) and WOMAC total scores (LQ25: 8; IQ50: 4; HQ25: 7). Hospital LOS and costs were higher in both the lowest 25% and the highest 25% quartiles. After controlling for all confounders, this inverted U-shaped pattern was still observed. There were no significant differences in complications between quartiles. All perceived outcomes improved significantly two years after surgery. **DISCUSSION AND CONCLUSION:** Diabetic Patients undergoing TJA with low or high pre-operative levels of HbA1c have inferior outcomes. There may be an optimal range for the HbA1c in arthroplasty patients.

## ***Harley & Betty Baxter Resident Award Winners***

### **The Influence of Psychiatric Disorders and Substance Abuse on Outcomes after Total Hip Arthroplasty**

Mitchell R. Klement, MD; Abiram Bala, BA; David E. Attarian, MD; Richard C. Mather III, MD; Samuel S. Wellman, MD; Michael P. Bolognesi, MD; Thorsten M. Seyler, MD, PhD

**Background:** Psychiatric disorders and substance abuse have been associated with increased health risks and poor long-term treatment outcomes in numerous medical disciplines. The effect on outcomes in total hip arthroplasty (THA) is incompletely understood. We hypothesize that patients with psychiatric disorders and substance abuse should have a higher complication rate profile. **Methods:** A search of the entire Medicare database from 2005 to 2011 was performed using International Classification of Disease version 9 (ICD-9) codes to identify the procedure, co-morbidities and post-operative complications of interest. There were a total of 86,976 patients who underwent THA with one or more psychiatric disorders and substance abuse including bipolar disease (4,626), depression (82,557), schizophrenia (3,766), and alcohol abuse (12,814). A cohort of 590,689 patients who underwent elective primary THA without prior psychiatric disorder or substance abuse served as a control. Medical co-morbidities and post-operative complications at 30-day, 90-day, and overall were compared between the two cohorts. **Results:** There was a statistically significant increase in 29 out of 29 medical co-morbidities as defined in the Elixhauser co-morbidity measure between the study and control cohorts including diabetes, renal failure, and peripheral vascular disease. In addition, there was a significant increase in 31 out of 33 recorded post-operative complication rates at 30-day, 90-day, and overall time points. Select complications included revision (6.81%), periprosthetic infection (4.28%), bleeding complications (5.32%), dislocation (2.35%), hip fracture (2.10%), deep venous thrombosis (7.55%), pulmonary embolism (3.62%), and death (0.55%). **Discussion and Conclusion:** The results of this study demonstrate that patients with psychiatric disorders

and substance abuse who undergo elective primary THA have more co-morbidities and represent an at-risk population with higher post-operative complication rates. These patients may require more extensive peri-operative evaluation and need to be counseled accordingly regarding the increased complication rate.

### **Impact of Lumbar Arthrodesis on Outcomes after Elective Total Hip Arthroplasty**

Thorsten M. Seyler, MD, PhD; Colin T. Penrose, BS; Abiram Bala, BA; David E. Attarian, MD; Samuel S. Wellman, MD; Richard C. Mather III, MD; Michael P. Bolognesi, MD

**Introduction:** Malpositioning of the acetabular cup has been associated with major complications including dislocation. Anteversion is determined by pelvic orientation; flexion of the pelvis increases anteversion, extension decreases anteversion. The degree of pelvic movement is determined by lumbar spine sagittal balance and it is well established that lumbar arthrodesis procedures influence sagittal balance and pelvic parameters. The purpose of this study is to determine the impact of prior lumbar arthrodesis and revision lumbar arthrodesis on complications after THA. **Methods:** A database review using the entire Medicare sample was performed using ICD-9 codes. The search identified 14,439 patients who underwent elective THA after prior lumbar arthrodesis and 1,157 patients who underwent elective THA after prior revision lumbar arthrodesis. A search for patients who underwent elective THA without prior history of lumbar or revision lumbar fusion yielded 749,403 patients who served as a control. Incidence (IN), odds ratios (ORs) and their respective 95% confidence intervals (CIs) for 30-day, 90-day and overall complications were calculated. **Results:** The following complications reached statistical significance for THA after primary lumbar arthrodesis: bleeding (IN 9.7%, OR 2.334), dislocation (IN 5.6%, OR 1.947), infection (IN 3.6%, OR 1.986), mechanical complication (IN 0.7%, OR 1.417), mechanical loosening (IN 2.3%, OR 1.736), other mechanical complication (IN 2.1%, OR 2.128), DVT/PE (IN 8.4%, OR 1.504), periprosthetic fracture (IN 1.6%, OR 1.449), and prosthetic-related complication (IN 30%, OR 1.846). Higher complications rates were observed for patients who had revision lumbar arthrodesis: bleeding (IN 12.4%, OR 3.063), dislocation (IN 9.7%, OR 3.544), infection (IN 5%, OR 3.321), mechanical complication (IN 6.9%, OR 14.938), mechanical loosening (IN 3.2%, OR 2.414), other mechanical complication (IN 3.5%, OR 3.564), DVT/PE (IN 10.7%, OR 1.959), periprosthetic fracture (IN 2.7%, OR 2.465), and prosthetic-related complication (IN 40%, OR 2.878). **Conclusion:** The results demonstrate that lumbar arthrodesis and revision lumbar arthrodesis negatively impact postoperative complication rates. The particularly increased rates of dislocation, infection, loosening, and prosthesis-related complication in this patient population should alert surgeon to undertake additional measures to decrease complication rates.

### **RAPID FIRE SESSION 3B: Sports Knee**

#### **Return to the Operating Room Following Cartilage Restoration Procedures**

Samuel Rosas, MS; \*Frank McCormick, MD; Benedict Nwachukwu, MD, MBA; Brandon Erickson, MD; Chau Nguyen, MD; Tsun yee Law, MD; Rachel M. Frank, MD

**Introduction:** There are several successful cartilage restoration options available to treat chondral defects of the knee including microfracture (MFX), autologous chondrocyte implantation (ACI), osteochondral autograft transplantation (OATS), and osteochondral allograft (OA) procedures. Purpose: To describe the rate of return to the operating room for knee procedures following cartilage restoration procedures at 90 days, 1 year, and 2 years. Hypothesis: The rate of return to the operating room for revision cartilage restoration procedures will be less than 10% during the first 2 years, and will not statistically vary between procedures. **Methods:** We performed a retrospective analysis of a prospectively collected commercially insurance company database. We performed a query based on Current Procedural



Terminology Codes (CPT) for microfracture MFX (29879), autologous chondrocyte implantation ACI (27412), OATS (29866, 29867) and Osteochondral allograft OA (27415, 27416). Medical records were evaluated for any return to the operating room within the follow-up period querying: diagnostic arthroscopy with biopsy (CPT-29870), lysis of adhesions (CPT-29884), synovectomy (29875, 29876), arthroscopy for infection or lavage (CPT 29871), arthroscopy for removal of loose bodies (29874), chondroplasty (29877), unicompartmental knee arthroplasty (27446) and total knee arthroplasty (27438, 27446, 27447). Descriptive statistical analysis and contingency table analysis were performed. **Results:** Within our private payer database from 2007 to 2011, we identified 44,170 MFX, 1825 OATS, 652 ACI, and 1068 osteochondral procedures within the study period. Return to the OR rates for each cartilage restoration procedure is listed in Table 1. We found no statistically significant difference existed between the four procedures (Table 1). **Conclusion:** In our large US private payer database, we found no significant difference in return to the OR rates existed at 90 days, one year, or two years amongst cartilage restoration procedures.

### **Gender Differences in Knee Flexion Angle during Running**

Christopher L. Sheu, MD; \*David Brown, BS; Aaron M. Gray, BS; Brian A. Smith, MD

**INTRODUCTION.** Females experience higher overall rates of athletic ACL injury than males. The specific mechanisms are unclear. Modeling of knee kinematics has shown that the more extended the knee joint, the greater the strain on the ACL. We hypothesized that female athletes would have a lesser degree of knee flexion than male athletes at initial ground contact while performing change-of-direction cutting maneuvers. **METHODS.** Twenty female and 20 male high school soccer athletes with at least 1 year of experience were recruited. Athletes were excluded if they had a history of any major lower limb injury or current knee pain causing a reduction in training and/or competition. Reflective markers were attached at the greater trochanter of the femur, lateral epicondyle of the knee, and lateral malleolus of the ankle to enable motion capture. Each athlete performed six change-of-direction maneuvers in random order in front of two cameras. Multiple regression analysis was used to determine differences between the sexes from the motion data captured. **RESULTS.** Statistically significant differences existed in knee flexion angles between males and females at 90- and 135-degree cutting angles. At 90 degrees, males and females showed average initial contact knee flexion angles of 39.0 plus/minus 6.8 and 29.3 plus/minus 6.2, respectively, a statistically significant difference. At 135 degrees, males and females showed average initial contact knee flexion angles of 36.8 plus/minus 7.9 and 29.7 plus/minus 7.8, a significant difference. At 90 degrees, males and females showed average maximum flexion angles of 56.4 plus/minus 6.9 and 49.7 plus/minus 7.0, a significant difference. At 135 degrees, males and females showed average maximum flexion angles of 60.7 plus/minus 8.1 and 51.6 plus/minus 9.4, a significant difference. **DISCUSSION AND CONCLUSION.** This project is innovative as wider side-cut maneuvers (90 degrees or higher) were studied, offering a model for alternative sports actions.

### **Emerging Off-the-Shelf Therapies for Focal Chondral Defects: a Systematic Review**

Samuel Rosas, MS; \*Frank McCormick, MD; Benedict Nwachukwu, MD, MBA; Josh Kotler, MS; Max L. Citrin, DO; Tsun yee Law, MD; Chau Nguyen, MD

**Introduction:** Recent strides in tissue manufacturing enable the ability to process and preserve biologic allografts or manufacture acellular scaffolding. These innovative single-stage “off-the-shelf” procedures potentiate a disruptive technology that enables a long shelf life, immediate availability for surgeons, decreased surgical and implant cost, single-stage surgical treatments, and increase commercial availability. Currently, there is little published literature and no comparative reviews on this new technology **Methods:** A literature review of studies reporting on the treatment of each of the four

emerging cartilage restoration technologies was conducted by searching the MEDLINE database using the PubMed interface. Search terms were “Chondrofix”, “Cartiform”, “Biocartilage Arthrex” and “MaioRegen”. **Results:** Our query returned a total of 86 publications, which were all retrieved. Seventy-four were excluded because they did not report outcomes of the procedures. Of the remaining twelve only ten were deemed relevant. **Conclusion:** There is little published literature on emerging techniques for cartilage restoration. Off the shelf cartilage solutions provide the benefit of a long shelf-life, immediate availability, and the prospect of improved options for early cartilage lesions, that could prolong, delay, or help mitigate the need for total joint replacement. Emerging cartilage solutions have demonstrated strong proof of concept, however their clinical efficacy is yet to be demonstrated.

### **Liposomal Bupivacaine for Pain Control for Anterior Cruciate Ligament Reconstruction: a Prospective, Double-Blinded, Randomized, Positive-Controlled Trial**

Ajay Premkumar, BS; \*Harris S. Slone, MD; Heather Samady, MD; Spero G. Karas, MD; John W. Xerogeanes, MD

**Background** Post-operative pain control can be challenging following ACL reconstruction, and severe post-operative pain has been shown to decrease range of motion, decrease activity, decrease patient satisfaction, and prolong rehabilitation times. Liposomal bupivacaine is a novel, multivesicular formulation of bupivacaine designed to allow slow diffusion of a single dose of local anesthetic over a 72 hour period. While early results are promising when compared to placebo in patients undergoing bunionectomy or hemorrhoidectomy, no studies have investigated the use of pain management regimens containing liposomal bupivacaine compared to traditional regimens in patients undergoing ACL reconstruction. **Methods** Thirty-two adult patients receiving a primary ACL reconstruction with a soft tissue quadriceps tendon autograft were prospectively enrolled between July 2014 and March 2015. Patients were randomized in a double-blinded fashion to receive either a 40 mL suspension of either 20 mL Exparel® (1 vial of bupivacaine liposome injectable suspension) and 20 mL 0.9% injectable saline or 40 mL of 0.25% bupivacaine HCl, administered into the graft harvest site and portal sites during surgery. Patients were given either a paper post-operative journal or a post-operative journal smartphone application to record data for one week following ACL reconstruction. Primary outcome measures included Numeric Rating Scale (NRS) pain scores and opioid analgesic requirements. Secondary outcome measures included time in the recovery room, pain location, time to first home opioid use, and time to first straight leg raise. **Results** There were no significant differences in post-operative pain, medication use, pain location, recovery time, or mobility between patients who received liposomal bupivacaine and those receiving 0.25% bupivacaine HCl. **Conclusions** Bupivacaine HCl had comparable outcomes at a 200-fold lower cost than liposomal bupivacaine. We do not support the widespread use of liposomal bupivacaine for pain control following ACL reconstruction.

### **RAPID FIRE SESSION 3C: Foot and Ankle**

#### **Predictors of Failure for Delayed Surgical Treatment of Closed Ankle Fracture-Dislocations**

Andrew P. Matson, MD; Robert D. Zura, MD

**INTRODUCTION** In our practice, ankle fracture-dislocations are treated according to protocol. Reductions are performed in the Emergency Department (ED). If the reductions are stable, the fractures are scheduled for clinic visits to set up delayed open reduction and internal fixation (ORIF). If reductions are deemed unstable –either in the ED or in clinic, urgent operative reduction and internal vs. external fixation is performed based on the status of the soft tissues. We seek to identify factors that are predictive of instability and unsuccessful delayed ORIF. **METHODS** Following IRB approval, a retrospective chart

review identified patients with closed, isolated, bi- and tri-malleolar ankle fracture-dislocations treated operatively between 2008-2012 at a single, Level 1 trauma center. All patients were managed initially with closed reduction and splinting in the Emergency Department, followed by operative treatment. Patient characteristics, as well as pre- and post-reduction radiographic injury characteristics were recorded. Closed reduction was considered to be successful when delayed ORIF was performed, and unsuccessful when urgent surgery was required. **RESULTS** After exclusion criteria were applied, there were 55 patients included in the statistical analysis. There were 20 successful closed reductions (36%) and 35 unsuccessful closed reductions (64%). Successful closed reduction was more common in patients without a posterior malleolus fracture (58%) than in patients with a posterior malleolus fracture (29%). When compared to patients with unsuccessful closed reductions, patients who underwent successful closed reduction had less fibular shortening (4.1mm vs 9.4 mm) and smaller posterior malleolus fracture fragment size (5.5mm vs 8mm) on average. Post-reduction radiographic characteristics were not associated with reduction success rate. **DISCUSSION and CONCLUSION** Larger posterior malleolus fracture size and greater fibular shortening are associated with higher rates of closed reduction failure in ankle fracture-dislocations. Consideration of these characteristics during initial evaluation and management may assist the surgeon in operative planning.

### **Does Syndesmosis Fixation Affect the Fibulotalar Relationship?**

Nicholas G. Vance, MD

**INTRODUCTION:** To determine if over tightening of syndesmotic screws will cause widening of the lateral clear space. **METHODS.** A 3D finite element model was constructed and analyzed using geometries from a CT scan of a lower leg. Starting 2 cm from the Tibial plafond, screw fixation was simulated at 5 mm increments up to a distance of 5 cm from the plafond. The fibula was compressed 2 mm towards the tibia at each interval, and the change in distance between to the lateral talus and distal fibula was measured. **RESULTS.** Medial deflection of the fibula resulted in widening of the lateral clear space, which was proportional to the amount of deflection. There was increasing effect as screws were placed closer to the plafond with 1.5 mm of widening at 2 cm (0.76 mm/mm) vs 0.7 mm at 5 cm (0.34 mm/mm). **DISCUSSION AND CONCLUSION.** There has been historical debate as to whether the syndesmosis can be over tightened during surgical fixation. This model demonstrates that over tightening of the syndesmosis with medial fibular displacement does cause widening of the lateral clear space. It also suggests that screws placed farther from the plafond do this to a lesser degree, which may be advantageous during surgical fixation.

### **Costs Associated with Geriatric Ankle Fractures: Operative Versus Nonoperative Management**

Rishin Kadakia, MD; Briggs M. Ahearn, MD; Jason T. Bariteau, MD

**INTRODUCTION:** Ankle fractures are the third most common orthopaedic injury seen in the geriatric patient. Studies have identified mortality benefits with operative management, but treatment must be considered on a case by case basis. Value based analysis requires an understanding of outcomes and costs of treatment. The purpose of this study was to analyze the inpatient and readmission costs associated with operative and non-operative management of geriatric ankle fractures. **METHODS:** Patients were identified using diagnosis codes for ankle fractures from all 2008 part A Medicare claims. Patients less than 65 years old and those who sustained an ankle fracture during the previous year were excluded. Operative patients were then identified by ICD-9 procedure codes. Other variables collected included age, comorbidities, and the incidence of hospital readmissions within 90 days. Inpatient costs were determined for inpatient stays and for hospital readmissions using Medicare reimbursement data. **RESULTS:** 19,648 patients with ankle fractures were identified. Of those, 15,193 (77.3%) underwent operative intervention.

The mean cost for initial fracture admission was \$5,097.2 for non-operative management compared to \$8,798.1 for operative management. The mean inpatient costs associated with readmission for non-operative intervention was \$5161.5 and \$5071.4 for operative treatment. The reimbursement for hospital readmissions for both groups combined for approximately 29.7 million dollars. The total cost of initial treatment plus readmission for both treatment groups combined was approximately 185 million dollars. **CONCLUSION:** The combined total expenditure estimate of 185 million dollars found in this study has likely increased given the steady growth of the geriatric population. Expenditures associated with hospital readmissions for both groups was approximately 30 million dollars – nearly a sixth of total costs. Future work must focus on determining which patients will benefit from operative intervention and optimizing care to decrease readmissions and their associated cost in this growing cohort of patients.

### **Open Calcaneus Fractures and Associated Injuries**

Jacob R. Worsham, MD; Mark Elliott, MD; Michael J. Harris, MD

**INTRODUCTION:** To describe the associated injuries, demographic distribution, and management of patients sustaining open calcaneus fractures. **METHODS:** A retrospective case series was performed of open calcaneal fractures at a single level-1 trauma center. Sixty-six patients with open calcaneus fractures were identified from an orthopaedic trauma registry. All patients were managed with surgical irrigation and debridement with or without internal fixation. **RESULTS** The most common mechanisms were motor vehicle crashes (56%) and falls greater than six feet (23%). Five patients (8%) had a posterior tibial artery transection. Fifty-five patients (78%) had a Gustillo type II or type III open medial injury. Eight patients (12%) had a femoral shaft fracture, fourteen patients (21%) had ipsilateral ankle fractures, sixteen patients (24%) had a metatarsal fracture, and eleven patients (17%) had associated midfoot fractures. In the associated midfoot fracture group 12 patients (18%) had a talus fracture and 5 patients (7%) had a cuboid fracture. Nine patients (14%) had an associated spine fracture with 66% being lumbar fractures. Fifteen patients (23%) had associated upper extremity fractures. Thirteen patients (20%) had significant associated pulmonary injury. Ten patients (15%) had an associated closed head injury and six patients (9%) had an abdominal injury. Fifteen patients (22%) were treated with percutaneous wire fixation and seven patients (10%) with open reduction internal fixation. Forty-four (66%) were treated non-operatively. Overall all seven patients (11%) with Gustillo type III open calcaneal fracture eventually underwent a below the knee amputation. **DISCUSSION and CONCLUSION:** Open calcaneus fractures are severe injuries with potential for significant morbidity to the patient, given the high rate of concomitant injuries. Type III open injuries have a significant risk of needing subsequent amputation. Management of these injuries should include intravenous antibiotics, tetanus prophylaxis and urgent debridement and irrigation.

### **United States National Trends in Foot and Ankle Arthrodesis**

Leonard T. Buller, MD; Matthew J. Best, BS; Alejandro D. Miranda, MD

**Introduction:** Foot and ankle arthrodesis reliably reduces pain and functional disability among patients with arthritis and deformity. Since its introduction 50 years ago, improvements in surgical technique have enhanced outcomes and reduced complications. However, little is known regarding U.S. national trends of foot and ankle arthrodesis. This study sought to use the most recently available Centers for Disease Control and Prevention data to investigate changes in the utilization of inpatient and ambulatory foot and ankle arthrodesis. **Methods:** Cases of foot and ankle arthrodesis were identified using the National Hospital Discharge Survey and National Survey of Ambulatory Surgery and the data were analyzed for trends in demographics, treatment and utilization. **Results:** Between 1994 and 2006, population-adjusted rates of foot and ankle arthrodeses increased by 146% (8.2/100,000 capita to 20.2/100,000 capita). The

population-adjusted rate of ankle arthrodeses performed in the outpatient setting increased 108% between 1994 and 2006. The largest overall increase was seen among tarsometatarsal fusions (1,304%). The greatest increases in the ambulatory and inpatient setting were seen among subtalar fusions (11,943%) and tarsometatarsal fusions (453%), respectively. The number of outpatient arthrodeses performed with arthroscopic assistance increased by 858%. The population-adjusted rate of outpatient and inpatient procedures increased by 415% and 17%, respectively. Sex-adjusted rates increased by 59% for males and 209% for females. Age-adjusted rates increased among patients over 35 years of age in both settings. The use of peripheral nerve blocks during ambulatory procedures increased from 3.3% to 10.1%. Private insurance was the largest compensator. **Discussion and conclusion:** In conclusion, the rate of foot and ankle arthrodesis increased dramatically between 1990 and 2007 based upon the most up-to-date publicly available data. Knowledge of these national practice patterns may aid policy-makers and surgeons in appropriately allocating healthcare resources to ensure quality patient care.

### **RAPID FIRE SESSION 3D: Trauma**

#### **Influence of the Method of Fracture Repair on Bone Healing**

E. Lex Hanna, MD; Evan L. Hanna, MD; Yongren Wu, PhD; Astor Robertson, MD; Robert E. Holmes, MD; William R. Barfield, PhD; Vincent D. Pellegrini Jr., MD

**INTRODUCTION** Fractures heal by two different pathways, endochondral (EO) or intramembranous ossification (IO), and clinically the pathway followed is determined by the nature of fracture stabilization. Without a clear understanding of the impact of such factors as smoking, radiation, or the local biology of the host, surgeons more often elect intramedullary nailing of diaphyseal fractures based on technical considerations rather than optimizing the biologic pathway of fracture repair most appropriate for the clinical scenario. Our objective is to characterize the differential features of fracture healing via the EO and IO pathways in the same animal by histologic, biomechanical, and radiographic means to assess the comparative rates and completeness of fracture healing. **METHODS** Sprague-Dawley (SD) rats (n=24) have been used to develop a bilateral femur fracture model for concurrent study of both healing pathways of bone in the same animal. One side is repaired with a novel, customized dynamically locked intramedullary device (healing via EO) while the other side is rigidly fixed with plate and screws (healing via IO). At indicated time points the animals were euthanized and their femora harvested for analysis by micro-CT, histology, and biomechanical testing. **RESULTS** The amount of callus formation in femurs repaired using IM nail was consistently greater than observed in those repaired using rigid plate fixation when evaluated with biplanar radiographs. The volume of calcified callus in the plated group at week 4 was  $22.12 \pm 7.49$  mm<sup>3</sup> compared with  $39.76 \pm 3.50$  mm<sup>3</sup> in the IM group. There is also a significantly greater increase in the callus volume of the IM nail group from week 1 ( $5.74 \pm 2.01$  mm<sup>3</sup>) to week 4 ( $39.76 \pm 3.50$  mm<sup>3</sup>) compared to callus volume of the plated group from week 1 ( $7.72 \pm 3.31$  mm<sup>3</sup>) to week 4 ( $22.12 \pm 7.49$  mm<sup>3</sup>). When subjected to biomechanical testing in a four-point bending apparatus, specimens fixed with IM nails exhibited greater early stiffness at 6 weeks ( $119 \pm 28$  N/mm IM nail vs.  $53 \pm 65$  N/mm plate) and greater load to failure at 6 ( $51 \pm 16$  N/mm IM nail vs.  $15 \pm 15$  N/mm plate) and 12 weeks ( $77 \pm 53$  N/mm IM nail vs.  $41 \pm 18$  N/mm plate). However, specimens fixed with plates exhibited greater stiffness ( $141 \pm 110$  N/mm IM nail vs.  $406 \pm 255$  N/mm plate) and load to failure ( $44 \pm 47$  N/mm IM nail vs.  $76 \pm 58$  N/mm plate) at final 6 month testing. Tissue histomorphometry at 2 weeks demonstrated a statistically significant increase in overall callus size, cartilage area, and fibrous tissue in fractures treated by IM nailing compared with increased bone area in fractures treated by rigid plate fixation.

**DISCUSSION and CONCLUSION** The biological and structural composition of healing fractures differs greatly dependent on the pathway of fracture healing as determined by the selected method of fracture fixation. Through enhanced understanding of the complex differences in these two healing

pathways, it may be possible to one day choose the best method of fracture fixation not simply based on the characteristics of the broken bone, but rather with the intent to optimize bony healing by selecting the method of fracture repair that is most appropriate for the biological environment and mitigating factors present in each individual patient.

### **Conventional Versus Cable Pin Fixation for Transverse Patellar Fractures**

Aaron D. Schrayner, MD; \*Andrew G. Patton, MD; Randal P. Morris, BSc; William L. Buford Jr., PhD; Ronald W. Lindsey, MD

**BACKGROUND.** Transverse patellar fractures require fixation that anatomically restores continuity of the knee extensor complex and resiliency to the loads of early postoperative knee mobilization. The objective of this study was to evaluate the biomechanical fixation strength of three patella osteosynthesis techniques. **METHODS.** Transverse osteotomies were created in 24 custom fourth-generation composite left patellae, randomized into three groups for osteosynthesis fixation: Group I--modified anterior tension wiring; Group II--cannulated lag screws with anterior tension wiring; Group III--cable pin fixation system. All patellae were loaded at a tensile rate of 15 mm/min until complete failure in simulated 60-degree knee flexion angle using a servo-hydraulic materials testing system. Analysis of failure load, stiffness, and medial/lateral gapping was conducted to determine differences between the three constructs. **RESULTS.** Mean load to failure for Group I (415.14 plus/minus 150.10 N) was statistically significantly less than the load for Group II (814.37 plus/minus 281.98 N) and Group III (1103.64 plus/minus 358.70 N). Mean stiffness values for Group II and Group III were 51.60 plus/minus 5.01 N/mm and 46.53 plus/minus 3.09 N/mm, respectively, and significantly higher than Group I (23.86 plus/minus 7.02 N/mm). Mean medial gapping in Group III (10.33 plus/minus 6.50 mm) was statistically higher than that in Group II (4.59 plus/minus 3.19 mm). **DISCUSSION AND CONCLUSION.** The more robust constructs, Group II and Group III, may allow more timely and aggressive postoperative mobilization. The biomechanical differences likely lie in greater compression gained across the fracture site.

### **Plates Proximal to Pin Sites and Long Bone Torsional Strength**

Fred L. Speck III, MD; Randal P. Morris, BSc; Ronald W. Lindsey, MD

**INTRODUCTION.** Complex tibia fractures are often provisionally stabilized with external fixation prior to definitive fracture fixation. Bicortical defects, such as those left after removal of a fixator pin, can decrease the torsional strength of long bone. Evaluating the effect of subsequent plate fixation in close proximity to a defect on the torsional strength of the tibia was the purpose of this study. **METHODS.** Eight groups of five fourth-generation left composite tibias were tested to failure in torsion. The experimental plated groups consisted of bicortical defects at 3 cm, 2 cm and 1 cm distal to the plate end, with one plated group without a defect. The control groups consisted of equivalent defects in the same distal longitudinal locations, without plates attached, as well as an unplated group without a defect. **RESULTS.** There were no statistically significant differences in torsional stiffness or failure torque between any of the groups. The mode of failure for all specimens with bicortical defects was a spiral fracture that bisected the axis of the defect. **DISCUSSION AND CONCLUSION.** Based on the results of this composite tibia study, varying the proximity of a bicortical defect to a plate does not affect the torsional stiffness or torsional failure strength of the bone.

### **Evaluation of Bioburden on the Development of Heterotopic Ossification in an Established Rat Model**

Gabriel Pavey, MD; \*Ammar T. Qureshi, PhD; Donald N. Hope, MD; Rebecca L. Pavlicek, PhD; Benjamin K. Potter, MD; Thomas A. Davis, PhD; Jonathan A. Forsberg, MD

**INTRODUCTION:** Heterotopic ossification (HO) forms in the majority of severe combat-related amputations, particularly when the amputation occurs within the zone of injury. Current means of prophylaxis for HO in the combat setting are logistically complicated. Additionally, these wounds are often heavily contaminated and require multiple debridements. Subsequent infection remains one of the common and significant complications following blast-related severe fracture and amputation with *Acinetobacter Baumannii* and Methicillin Resistant *Staphylococcus aureus* (MRSA) being the most common isolate from traumatized tissue of wounded servicemembers. Expanding on an established rat model for the development of post-traumatic HO, we sought to evaluate the influence of wound colonization on the formation of HO. **METHODS:** Using a blast-related HO model, we subjected 48 rats to blast overpressure, femur fracture, crush injury and subsequent immediate transfemoral amputation through the zone of injury. Wounds were inoculated beneath the myodesis with vehicle or  $1 \times 10^6$  CFUs of *A. baumannii* or MRSA. **RESULTS:** All animals formed HO. At 12 weeks, we observed more severe HO in rats infected with MRSA ( $68.9 \text{ mm}^3 \pm 8.6$ ) when compared to *A. baumannii* ( $20.9 \text{ mm}^3 \pm 3.7$ ;  $p < 0.001$ ) or vehicle ( $16.3 \text{ mm}^3 \pm 3.2$ ;  $p < 0.001$ ). Soft-tissue and marrow from rats inoculated with *A. baumannii* tested negative for *A. baumannii* infection but were positive for other strains of bacteria ( $1 \times 10^2 - 8.6 \times 10^6$  CFU), whereas tissue from MRSA-infected rats contained MRSA only ( $> 1 \times 10^5$  CFU). **DISCUSSION AND CONCLUSION:** Our findings suggest that persistent infection with MRSA is associated with more severe HO, which may be due to chronic soft-tissue inflammation. Interventions which mitigate wound contamination and inflammation (e.g., early debridement, systemic and local antibiotics) may also have a beneficial effect with regard to HO formation or severity.

### **Olecranon Fractures with Sagittal Splits Treated with Dual Fixation**

Michael P. Morwood, MD; David S. Ruch, MD; Fraser J. Leversedge, MD; Suhail Kamrudin Mithani, MD; Robin N. Kamal, MD; Marc J. Richard, MD

**INTRODUCTION:** To assess the results of olecranon fractures with an intra-articular sagittal plane fracture managed by orthogonal fixation constructs. **METHODS:** A retrospective chart review was performed and 14 proximal ulna fractures with intra-articular comminution resulting in separate medial and lateral fragments were identified. All fractures were classified according to the Schatzker, Mayo, and AO classification systems. Post-operative functional assessment, Disabilities of the Arm, Shoulder, and Hand score, time to union, and complications were recorded. **RESULTS:** Eleven patients were treated with both dorsal and lateral plates. Three patients were managed with a single dorsal plate and cerclage wires. All fractures healed. Mean length of follow-up was 15 months (4-72). Mean range of motion at final follow-up was a flexion-extension arc of 24-129 degrees with 89 and 79 degrees of pronation and supination, respectively. The most common complication was symptomatic hardware, leading to removal of hardware in 5/14 (36%) patients. Average post-operative DASH score was 7. 2 patients developed heterotopic ossification and 1 patient required a local pedicled flap for soft-tissue coverage. **DISCUSSION and CONCLUSION:** Identification of this subset of fractures is critical to successful management. A supplemental lateral plate or cerclage wires can successfully manage these difficult fractures and achieve good outcomes.

### **Limb Length and Alignment after Intramedullary Nailing of Intertrochanteric Fractures**

Christopher Warrell, MD; Richard J. Thomas, MD; Joshua Langford, MD; Kenneth Koval, MD; George J. Haidukewych, MD

**INTRODUCTION:** Intertrochanteric hip fractures are common, costly and associated with residual disability. Most intertrochanteric fractures are treated surgically, and recent decades have seen the cephalomedullary nail become the implant of choice for surgical stabilization. This study is the first to evaluate postoperative leg length and alignment using full standing leg-length films following fixation of intertrochanteric fractures using a cephalomedullary nail. **METHODS:** A retrospective review was performed on patients who had stabilization of an intertrochanteric fracture with a cephalomedullary nail. A standing leg-length radiograph was obtained between 3 months to 6 months. Fractures were classified using the Orthopaedic Trauma Association scheme and categorized into stable (31A1) versus unstable (31A2) fracture patterns. Leg-length films were used to measure limb length, mechanical axis deviation, femoral offset, and femoral neck-shaft angle. The contralateral lower extremity was used as a control. Data was recorded and included patient demographics, fracture pattern, implant characteristics and implant position. **RESULTS:** 149 consecutive patients with an intertrochanteric hip fracture were treated with a cephalomedullary nail. Sixty-six patients had postoperative leg-length films, which were taken at a mean of 151 days. There were 25 stable and 41 unstable intertrochanteric fractures. Compared to stable fractures, the unstable fractures had significantly greater mechanical axis deviation (13.3mm vs. 8.2mm), mechanical axis deviation angle (3.9° vs. 2.0°), and change in femoral offset (-4.3mm vs. +0.6mm). There was no significant difference in the changes seen in postoperative limb-length (-0.72cm vs. -0.58cm) or neck-shaft angle (-2.0° vs. -0.8°). **CONCLUSION:** We found no significant difference in leg length after intramedullary fixation of stable versus unstable fracture patterns. However, significant differences were found in proximal femoral geometry and lower limb frontal plane alignment. Such alterations may be important to consider for counseling purposes, and when planning for future arthroplasty.

## **GENERAL SESSION 4: Sports Medicine 1**

### **MRI Findings Versus Intra-Operative Pathology in Hip Arthroscopy**

Julie A. Neumann, MD; \*Kathleen D. Reay, MD; Monet A. France, MD; Thomas Hash II, MD; Steven A. Olson, MD

**INTRODUCTION:** This study was conducted to determine the accuracy of MRI when compared to intra-operative labral and chondral pathology in the presence of hip dysplasia. **METHODS:** Seventeen patients (19 hips) with hip dysplasia were retrospectively reviewed after having undergone an MRI followed by a combined hip arthroscopy and periacetabular osteotomy (PAO). A fellowship trained musculoskeletal radiologist blindly reviewed the 19 MRIs to specifically evaluate labral pathology, chondral pathology on the articular surfaces of the acetabulum and femoral head, and the ligamentum teres. These findings were directly compared to the findings in the operative note. **RESULTS:** The cohort consisted of 14 females and three males. Eight of the 19 surgeries were on right hips and 11 were on left hips. The average age at the time of surgery was 29.49 years (range, 17-42 years). MRI findings correctly correlated to labral pathology in 18/19 (94.7%) of hips in this study. In 1/19 (5.3%) hip the MRI demonstrated a labral tear when intra-operatively the labrum was found to be intact. Discrepancy was found between MRI and intra-operative findings in 8/19 (42.1%) of hips in this study for chondral lesions on the acetabulum or femoral head. MRI demonstrated acetabular cartilage delamination in 4/19 (21.1%) of the hips when intra-operatively the acetabular cartilage was noted to be intact, partial thickness cartilaginous lesions were found in 3/19 (15.8%) of hips when intra-operatively the femoral head cartilage was noted to be intact, no chondral defects were found in the acetabulum in 1/19 (5.3%) of hips when there was no delamination along the acetabulum. In 1/19 (5.3%) hip the MRI demonstrated questionable acetabular chondral loss, but intra-operatively grade III/IV changes were noted in the acetabulum. There was a discrepancy between MRI and intra-operative findings in 7/19 (36.8%) of hips with regard to the ligamentum teres. **DISCUSSION AND CONCLUSION:** This study suggests that MRI is accurate in the



diagnosis of labral pathology but caution should be undertaken when using MRI to diagnose cartilaginous or ligamentum teres pathology.

### **Return to Operating Room Following Meniscus Allograft Transplantation: 90 Day, 1 Year, and 2 Year Analysis**

Tsun yee Law, MD; \*Samuel Rosas, MS; Rachel M. Frank, MD; Chau Nguyen, MD; Brandon Erickson, MD; Benedict Nwachukwu, MD, MBA; Frank McCormick, MD

**Introduction:** The purpose of this study is to utilize a large private payer database to determine more accurately the rate of return to the operating room (OR) within the first two years following MAT.

**Methods:** A retrospective review of a large private payer database within the PearlDiver Supercomputer application (Warsaw, IN) was conducted between the years 2007 through 2011 utilizing CPT code 29868 (MAT) and ICD-9 codes 836.0 (tear of medial cartilage or meniscus of knee) or 836.1 (tear of lateral cartilage or meniscus of knee). Within 90 days, 1 year, and 2 years of surgery, this search was cross-referenced with CPT codes 29877, 29881, 29882, 29883, 29868, 27446, 27447 and 27570 (chondroplasty, arthroscopy with meniscectomy including meniscal shaving, arthroscopy with meniscus repair medial or lateral, arthroscopy with meniscus repair medial and lateral, revision MAT, unicompartmental knee arthroplasty, total knee arthroplasty, and manipulation under anesthesia respectively). Statistical analysis, descriptive analysis, and contingency table analysis was performed. **Results:** A total of 556,521 patients were found to have meniscal pathology as determined by ICD-9, with 291 (0.05%) undergoing MAT (134 females, 157 males) during the 5-year time period. The majority of MATs were performed in the 15 – 19 year old age group (21.6%), followed by the 20 – 24 year old age group (18.2%). The incidence of the analyzed post-operative return to OR rate was 0% at 90 days postoperatively (Table 1), while the rate of revision MAT was 4.5% at 1 year and 2-years following surgery. The rate of chondroplasty was 4.1% at 1-year and 5.5% at 2-years, while the rate of arthroscopic meniscectomy was 5.5% and 7.9%, respectively.

**Conclusion:** In a large private payer database encompassing over 550,000 patients, the 90-day return to OR rate is 0%, while the 1 and 2-year return to OR rates were 14.1% and 17.9%, respectively.

### ***SOA Resident Travel Grant Award Winner***

#### **Nationwide Return to The Operating Room following Meniscal Repair Surgery**

Samuel Rosas, MS; Frank McCormick, MD; Benedict Nwachukwu, MD, MBA; Chau Nguyen, MD; Tsun yee Law, MD; Rachel M. Frank, MD; Brandon Erickson, MD

**Introduction:** Meniscal repair surgery is currently a viable, safe and common treatment option for patients who suffer meniscal tears. However, the rate of return to the Operating room following this procedure has not been investigated in a large national patient population sample. The purpose of this study is to describe the rate of return to the operating room following meniscal repair surgery at the 90 day, 1 year, 2 year and 4 year interval. **Methods:** A large, commercially available private-payer insurance company database was queried through the use of the Pearldiver Supercomputer (Warsaw, IN) for arthroscopic meniscal repair. This was followed by the determination of return to the operating room for arthroscopic debridement, arthroscopic meniscectomy, second meniscal repair of the medial and lateral compartment and second meniscal repair of the medial or lateral compartment. Subgroup analysis was performed by gender and age. Statistical analysis was mainly descriptive and return to the operating room was described as incidence at each time interval. **Results:** There were a total of 18,895 meniscal repair surgeries 11,486 in males and 7,409 performed on females. There were a total of 3,954 revision procedures. The cumulative return to the OR after 90 days of the index procedure was 6.3% and 15.6%, 19.6%, 20.9% at 1, 2 and 4 years post-operatively respectively. Fifteen to 19 year olds was the group that underwent the majority of meniscal repair procedures 5,597, followed by 20 to 24 year olds 2,414.

**Conclusions** Meniscal repair surgery often requires revision procedures and in our large study population we found a incidence of return to the operating room of 6.38%, 15.61%, 19.6%, 20.95% at 90 days, 1, 2 and 4 years post-operatively respectively.

### **Height, Weight, and Age Predict Quadriceps Tendon Length and Thickness**

Dane Todd, MD; John W. Xerogeanes, MD; Alexander Ghasem, MD

**Introduction:** Quadriceps tendon autografts have been used with success in adults and are becoming a popular graft option in pediatric patients due to size, decreased donor site morbidity, ease of harvest, and favorable biomechanical characteristics. However, little is known about the length and thickness of the quadriceps tendon in pediatric patients. **Methods:** Height, weight, age, and gender of 151 children between 4 and 16 years old were recorded. Ultrasound measurements of the length and thickness of bilateral quadriceps tendons were performed by a single technician and recorded for statistical analysis. **Results:** Average quadriceps tendon length and thickness were 6.87 plus or minus 1.49cm and 0.37 plus or minus 0.12cm respectively. Tendon length averaged 3.89cm at 4 years and 7.98cm at 16 years of age while thickness averaged 0.24cm at 4 years and 0.40cm at 16 years of age. There was no significant difference in tendon length or thickness between males and females ( $p=0.97$ ). Tendon length and thickness increased significantly with age, weight, and height. **Conclusions:** The quadriceps tendon length and thickness follows a predictable pattern of growth based on height, weight, and age. Thus, quadriceps tendon autograft size can be predicted using easily identifiable patient variables and confirmed using ultrasound.

### **Total Knee Arthroplasty within Six Months after Knee Arthroscopy is Associated with Increased Postoperative Complications**

James A. Browne, MD; Brian C. Werner, MD; Jourdan M. Cancienne, MD

**INTRODUCTION:** Some surgeons may attempt to improve symptoms from knee osteoarthritis and delay total knee arthroplasty (TKA) by offering knee arthroscopy. The impact of knee arthroscopy on the results of subsequent TKA remains unknown with conflicting reports in the literature. The purpose of the present study was to examine the association of knee arthroscopy prior to TKA at selected time intervals with selected postoperative complications after TKA. **METHODS:** A national insurance database was queried for patients who underwent TKA following ipsilateral knee arthroscopy. Three cohorts were created: TKA within 6 months following ipsilateral knee arthroscopy ( $n = 681$ ), TKA between 6 months and 1 year after knee arthroscopy ( $n = 1,301$ ), and TKA between 1 and 2 years after knee arthroscopy ( $n = 1,069$ ). An age-matched control group of TKA without prior knee arthroscopy was created for comparison purposes ( $n = 37,235$ ). The rates of postoperative infection, stiffness, and venous thromboembolism (VTE) were compared between the arthroscopy cohorts and control TKA using Pearson  $\chi^2$  analysis. **RESULTS:** The incidence of infection (OR 2.0, 95% C.I. 1.3 - 3.2,  $p = 0.004$ ), stiffness (OR 2.0, 95% C.I. 1.4 - 3.0,  $p = 0.001$ ), and VTE (OR 1.6, 95% C.I. 1.0 - 2.4,  $p = 0.047$ ) within 90 days following TKA were higher in patients who underwent TKA within 6 months after ipsilateral knee arthroscopy compared to age-matched control TKA. There were no significant differences in the incidence of postoperative complications when knee arthroscopy was performed more than 6 months prior to TKA when compared to controls who had not undergone arthroscopy. **DISCUSSION AND CONCLUSION:** TKA performed within six months following ipsilateral knee arthroscopy appears to be associated with increased rates of postoperative infection, stiffness, and VTE. This association is time-dependent, as TKA performed more than six months following ipsilateral knee arthroscopy had similar rates of complications compared to age-matched controls who had not undergone arthroscopy.

## **MRI Classification for UCL Injuries of the Elbow**

LCDR Patrick W. Joyner, MD, MS; \*Justin Cowart, MD; Jeremy Bruce, MD; Ryan W. Hess, MD; Aaron Mates, MD; James R. Andrews, MD

**Background:** Currently there is no widely accepted classification system for ulnar collateral ligament (UCL) injuries. We present a MRI based classification for UCL injuries. **Materials & Methods:** A total of 240 elbow MRI's from athletes that had undergone UCL reconstruction were reviewed. The UCL injuries were classified as follows; Type I were low-grade partial tears, Type II were high grade partial tears, Type III were complete tears in one location (ulna sided, humeral sided or midsubstance) and Type IV were tears in more than one location. The tears were further sub-classified by location of injury as follows; U-ulna, H-humerus, M-midsubstance. Secondary parameters investigated included; the presence of a T-sign on MRI, and the presence of a vacuum sign on stress radiograph. **Results:** The MRI classification found 22/240 (9.1%) were Type I, 139/240 (58%) were Type II, 66/240 (27.5%) were Type III, and 13/240 (5.4%) were Type IV. Injury location was noted on the ulna 90/240 (37.5%) of the time, the humerus 107/240 (44.6%) of the time and midsubstance pathology was present in 30/240 (12.5%). T sign on the ulna was noted in 94/240 (39%) of the cases. The vacuum sign was found in 39/240 (16%) of the cases of which 1/39 (2.6%) was a Type I UCL injury and 38/39 (97.4%) were a Type II, III, or IV. **Conclusion:** We present a MRI based classification system that helps to separate low from high grade partial UCL injuries as well as complete tears. The vacuum sign being present almost exclusively in Type II injuries or worse, confirms this radiographic finding as a marker of severity. As a result, we feel this classification will not only help with communication, but may also help to direct care.

## **Trends in ACL Reconstruction in the Adolescent Population in the United States**

Samuel Rosas, MS; Frank McCormick, MD; Rachel M. Frank, MD; Brandon Erickson, MD; Benedict Nwachukwu, MD, MBA; Bernard R. Bach Jr., MD; Chau Nguyen, MD

The national incidence of trends in pediatric and adolescent anterior cruciate ligament reconstruction have not been recently described in a large nationwide sample of patients. The purpose of this study was to determine the current demographic distribution of anterior cruciate ligament (ACL) reconstruction within the United States adolescent population. **Methods:** We performed a retrospective analysis of a Health Insurance Portability and Accountability Act compliant, private payer database between the years of 2007-2011 using the Pearldiver Supercomputer (Warsaw, IN). A search was performed for the Current Procedural Code (CPT) 29888 (reconstruction of the anterior cruciate ligament of the knee with the use of a tendinous graft). The incidence, growth, and demographic factors associated with ACL reconstruction were assessed among all patients between 10 and 19 years of age. **Results:** From 2007 through 2011, 63,234 patients (25,808 male, 37,441 females) underwent ACL reconstruction within the database. A total of 3,028 (4.8%) patients were between the ages of 10 to 14. The mean incidence over the 5-year period of this age group was 0.0016, with a mean annual growth rate of  $5.3 \pm 8.7\%$  (Figure 1). A total of 15,498 (24.5%) were between the ages of 15 and 19, with a mean incidence over the 5-year time period of 0.0075, and a mean annual growth rate of  $2.8 \pm 4.9\%$ . The 10-14 group had a statistically higher annual growth rate compared to the 15-19 group. Patients between the ages of 10 to 14 had a higher mean annual growth percentage (5.62%) compared to the 15-19 group (2.89%).

**Friday, July 17**

**GENERAL SESSION 5: Trauma**

## **Intraoperative Topical Antibiotics for Infection Prophylaxis in Pelvic and Acetabular Surgery**

Matthew T. Owen, MD; Jason Lowe, MD; Emily Keener, DO

**INTRODUCTION:** Application of topical antibiotics (TA) has been shown to reduce surgical site infection (SSI) in spine surgery. The purpose of this study was to determine if TA (vancomycin and tobramycin) reduces the incidence of SSI in open pelvic and acetabulum surgery. The authors hypothesize that TA will reduce incidence of infection without increasing incidence of renal failure. **METHODS:** Retrospective case control of patients at a level I trauma center undergoing operative fixation of the pelvis and acetabulum from March 2012 to November 2013 was conducted. Group 1 had no topical antibiotics (10 months), and Group 2 (10 months) had TA applied to surgical site at time of closure. Statistical significance was determined using Fisher's exact test and Student's t-test with  $P < 0.05$ . Univariate logistic regression determined effect of each covariate on the risk of infection with odds ratio  $P < 0.05$ .

**RESULTS:** 153 patients were included. Group 1 (n=75) and Group 2 (n=78) were statistically similar for sex, age, ethnicity, and body mass index (BMI). The odds of infection for the non-vancomycin group were 3.52 times that for Group 2 ( $p = 0.037$ ). Blood transfusions and intra-operative blood loss were also significant predictors of infection ( $p=0.029$  and  $<0.001$ , respectively). There were no adverse clinical outcomes from administration of topical antibiotics. **CONCLUSIONS:** Topical antibiotics reduced the incidence of SSI following open pelvic and acetabulum fixation without increasing risk of renal failure. Increasing blood transfusions and intra-operative blood loss were associated with increased risk of infection.

## **The Effect of Computer-Assisted Surgery Training in the Placement of Iliosacral Screws**

Elizabeth W. Hubbard, MD; \*Erika L. Templeton, MD; William C. Eward, MD, DVM; Markku T. Nousiainen, MS, MD; Robert D. Zura, MD

**INTRODUCTION:** Percutaneous placement of iliosacral screws for posterior pelvic ring injuries is the standard treatment to achieve rigid stabilization. However, this is a complex procedure and hardware malposition can result in significant neurovascular complications. Historically, technical mastery of this technique has required intra-operative learning on patients using fluoroscopic guidance. This study attempts to determine if computer navigation assisted simulation training can be used as a tool to help surgical novices learn this complex technique. **METHODS:** A prospective randomized controlled study was conducted using surgical trainees with no prior experience at percutaneous iliosacral screw placement for pelvic ring injuries. After a training session, participants underwent a pre-test which involved using fluoroscopy to place guidewires for S1 and S2 iliosacral screws. Participants were then randomized to surgical training that involved either fluoroscopic or computer navigation assisted guidance, followed by a post-test using the assistive modality by which each participant had been trained. Participants returned 4 weeks later to perform retention and transfer tests. Outcomes involved frequency and grade of perforation of guidewires for S1 and S2 iliosacral screws. **RESULTS:** No significant improvement was seen in the overall frequency or grade of guidewire perforation for S1 and S2 iliosacral screws was seen, regardless of whether fluoroscopy or computer navigation training was used. Participants who trained using computer navigation were able to perform the procedure faster, with fewer attempts and less overall exposure to radiation. **DISCUSSION AND CONCLUSION:** The results suggest that computer navigation is a safe and efficient training modality. However, further studies are needed to show if it can be used to improve a trainee's ability to accurately position the hardware.

## ***Harley & Betty Baxter Resident Travel Grant Award Winner***

### **Epidemiology and Outcome Predictors for Patients Admitted with Acetabular Fractures**

Leonard T. Buller, MD; Matthew J. Best, BS; Stephen M. Quinnan, MD

**Introduction:** Acetabular fractures are major injuries frequently associated with life-altering sequelae and a significant resulting cost to society. The incidence of acetabular fractures and in-hospital complication rates in the United States are poorly defined. Studies evaluating predictors of outcome for isolated acetabular fractures are weakly generalizable due to small sample sizes or inclusion of all types of pelvic fractures. This study sought to analyze trends of acetabular fractures and associated complications in the United States using the largest and most recent national dataset available. **Methods:** The National Hospital Discharge Survey was queried to identify all patients admitted to U.S. hospitals with acetabular fractures between 1990 and 2007. Multivariable logistic regression was used to identify independent predictors of mortality, adverse events, requirement of blood transfusion, and non-routine discharge to another inpatient facility. **Results:** A cohort representative of 403,927 patients was identified Between 1990 and 2007, the population-adjusted incidence of acetabular fractures increased from 7.8 to 11.3/100,000 capita. Mortality declined from 5.9% to 1.5% paralleling an increase in the proportion of patients treated with open reduction and internal fixation (12.6% to 27.8%), which was the variable associated with the lowest odds of mortality. Surgical intervention was associated with lower odds of non-routine discharge to inpatient facilities but higher odds of adverse events and requirement for blood transfusion. The average in-hospital length of stay decreased from 17.0 days to 8.5 days. **Discussion and conclusion:** This is the largest and most comprehensive epidemiologic analysis of acetabular fractures in the United States. Knowledge of prognostic factors associated with poor outcomes may improve results.

### **Continual Near Infrared Spectroscopy Monitoring in Acute Compartment Syndrome**

Michael S. Shuler, MD; Mellisa Roskosky, MSPH; William M. Reisman, MD; Charles (Chip) L. Ogburn, MD; Tracy L. Kinsey, MSPH; Brett A. Freedman, MD

**INTRODUCTION** Acute compartment syndrome (ACS) is a prevalent and morbid complication of severe extremity injury in the combat and civilian setting. The leg is most commonly involved (>50%). The purpose of this manuscript was to summarize the experience with and lessons learned regarding the ideal management of acute compartment syndrome in the combat setting, and to specifically recount the work to date evaluating the potential of Near-Infrared Spectroscopy (NIRS) to serve as a technological solution for known deficiencies with the clinical diagnosis of ACS. **METHODS** In this prospective observational trial subjects were enrolled within 12 hours of severe leg injury or severe trauma not involving the leg. Patients with severe leg injuries were observed for up to 48 hours or until they developed ACS. Synchronous data from the injured and non-injured like compartment were compared graphically and statistically. **RESULTS** Seventy-five subjects were enrolled in the severe leg injury cohort and an additional 23 patients were enrolled in the critical control cohort. NIRS data was obtained for at least 2 hours on all patients, with a median of 40 and 45 hours on monitor for the 2 cohorts, respectively. At least one compartment of the leg could be monitored in all patients for some portion of the study period. An illustrative case, demonstrates the hyperemic response, which persisted over the duration of the study period. **DISCUSSION AND CONCLUSION** The reliable and accurate diagnosis of ACS is a critical unmet need in combat casualty care. The ideal solution will leverage technology in the form of physiological monitoring to make or support the diagnosis of ACS. Our preliminary analysis demonstrates that current NIRS oximetry devices can be used to monitor the regional oxygenation of the muscle compartments of the leg in most, but not all situations. Further development and clinical validation is warranted.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

## **Biomechanical Analysis of Percutaneous Fixation of Vertical Femoral Neck Fractures**

Ryan Schnetzer, MD; \*W. Zachary Stone, MD; Adam Bruggeman, MD; MaryBeth Horodyski, EdD, ATC, LAT, FNATA; Richard G. Vlasak, MD; Cong Chen, MS

**Introduction:** The Pauwels III fracture pattern is the most vertical fracture pattern, and tends to happen more frequently in high energy traumatic injuries sustained in younger patients. Recent papers have attempted to describe the best fixation method for these difficult fracture patterns. Traditionally, percutaneous screws are placed parallel to the angle of the femoral neck, which may orient them obliquely to the fracture, if the fracture is at an angle other than 90 degrees to the neck. In general, it is widely accepted that optimal fracture fixation is achieved when a screw can be oriented perpendicular to the fracture line. However, it is not currently known whether placement of screws in a Pauwels III fracture that is perpendicular to the fracture instead of parallel to the femoral neck will result in superior stabilization. Therefore, the purpose of this study was to determine whether screws placed perpendicular to the fracture have improved biomechanical attributes compared to screws oriented parallel to the neck. Our hypothesis was that the fixation perpendicular to the fracture would demonstrate a significantly stronger construct with respect to stiffness and load to failure **Methods:** Synthetic composite bone was chosen as a model for testing the mechanical properties of the screw constructs. A vertical shear fracture was created with a saw at an angle of 70 degrees to the femoral neck, qualifying the fractures as Pauwels III fractures. The order of testing the specimens was randomized. Two groups were tested with screws placed either parallel to the femoral neck or perpendicular to the fracture line. The fracture was reduced and screws placed in one of the two ways described above. Prepared specimens were subjected to biomechanical loading using a servohydraulic material testing machine (MTS Systems, Eden Prairie, MN). Load was applied under displacement control at a rate of 1 mm/s, until failure of the construct. Failure was defined as a drop in load greater than 30% of the peak load. From the load-displacement data, peak load, stiffness, yield load, displacement at peak load and displacement at yield load were determined. **Results:** The stiffness, displacement at max load, yield load, and displacement at yield load between Group 1 (parallel fixation) and Group 2 (perpendicular fixation) showed no significant differences. There was a significant difference in max load with Group 2 at 3967.05 N versus Group 1 at 3034.49 N ( $p=0.011$ ). **Discussion and Conclusion:** Vertical femoral neck fractures show a high rate of complications, most notably non-union, mal-union and avascular necrosis of the femoral head. This is likely secondary to increased loads on fixation constructs secondary to increased shear forces in these fractures. There are multiple fixation techniques for these fractures and recent studies have shown decreased complications with increased fixation strength. This study compared traditional parallel screws versus perpendicular screws constructs for fixation of these fractures. Screws placed perpendicular to fracture line showed increased max load to failure as compared to screws placed parallel to the femoral neck for fixation of Pauwels III femoral neck fractures.

### ***SOA/OREF Resident Award Winner***

## **Risk Factors for Infection after Operative Fixation of Tibial Plateau Fractures**

Amit Momaya, MD; Jimmy Hlavacek, MD; Brian Etier, MD; David Johannesmeyer, MD; Lasun Oladeji, BS; Emily Keener, DO; Jason Lowe, MD

**Introduction:** Tibial 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. **Methods:** A retrospective review was undertaken to identify all patients with tibial plateau fractures over a 10 year period (2003 – 2012) who underwent open reduction internal fixation. A total of 531 patients were identified who met the inclusion criteria. Several patient and clinical characteristics were recorded, and those variables with a significant association with postoperative infection were further analyzed using a multivariate analysis. **Results:** Ninety-four (17.7%) of the 531

patients developed an infection. Of these 94 patients, 58 (61.7%) sustained a deep infection, while 36 (38.3%) developed 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 (44.8%) of the deep 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. **Discussion and Conclusion:** The rate of deep infection remains high after operative fixation of tibial plateau fractures. Patients with risk factors for infection should be counseled on the possibility of reoperation, and surgeons should consider MRSA prophylaxis in those patients who are at higher risk.

### **Diagnosis of Occult Ankle Fractures with Ipsilateral Tibial Shaft Fractures**

Christopher Holden, MD; \*W. Zachary Stone, MD; Richard G. Vlasak, MD; Terrie Vasilopoulos, PHD; Jessica L. Diaz, BS

**INTRODUCTION:** The diagnosis of tibial shaft fractures that extend into the ankle changes operative management. The purpose of this study was to identify: clinical, injury specific, and radiographic variables that influence whether a tibial shaft fracture will have an ipsilateral extension into the plafond. **METHODS:** Retrospective case-control study. Academic Level I trauma center. One hundred and forty-seven adult patients were selected that were treated surgically for tibial shaft fractures and received a pre-operative CT scan. Preoperative radiographs of tibial shaft fractures were reviewed and the fractures categorized. Patient demographics, comorbidities, and injury specific data (ex: high vs. low energy) were collected. CT imaging was then used to identify fracture extension into the plafond. Variables were identified that were associated with fracture extension into the plafond, visible on CT scan, but not on plain radiographs (occult plafond fractures). **RESULTS:** 29.3% of the patients were found to have a fracture extension into the plafond that was not identified on plain films and was only identified on preoperative CT imaging. The demographic or injury specific data that showed an increased association with occult plafond fracture included: tobacco use (OR, 2.6), spiral fracture pattern (OR, 3.96), and malleolar fracture (OR, 4.53). High vs low energy mechanism and open vs closed fracture, did not show an association. CT imaging changed the operative management in 79.1% of patients. **DISCUSSION AND CONCLUSIONS:** Tibial shaft fracture pattern is the greatest predictor of fracture extension into the plafond. Clinical and injury specific variables, with the exception of smoking history, do not appear to influence fracture extension.

### **Computer-Assisted Orthopaedic Surgery (CAOS) in the Treatment Of Intertrochanteric Fractures**

Carlos J. Lavernia, MD; \*Jesus M. Villa MD

**Introduction:** Navigated Intertrochanteric (IT) fracture pinning resulted in a significant decrease in radiation exposure as compared to a control group in this simulated randomized controlled trial. **Methods:** 25 hip models with soft tissue were used. Pin placement was randomized to a navigated system (n=13) versus a standard fluoroscopic technique (n=12). Total procedure time was collected, and radiation exposure was measured as the total number of seconds of radiation. Digital radiographs were performed on all models after the procedure, and were used to measure pin placement accuracy using the tip-apex distance (TAD); blinded re-test were performed in all cases to assess reproducibility. Mann-Whitney test and Spearman correlation were used for statistical analysis. **Results:** Average time to pin placement was 6.4+/-0.7(SE) minutes with the navigated technique and 6.1+/-0.8 minutes in the models in which the standard technique was used (no significant difference). Radiographic measurements for both AP and lateral view were highly correlated (0.95 and 0.79, respectively; statistically significant difference). The mean TAD for the navigated group was 2.1+/-0.2 cm and 2.3+/-0.2 cm for the standard group (no

significant difference). The percentage of pin placements with a TAD of more than 2.5 cm was 29% in both groups. Radiation exposure was measured and found significantly different; in the navigated procedures it averaged 6.14+/-0.67 seconds while in the conventional group it was 11.43+/-1.7 seconds. **Discussion And Conclusion:** Our data clearly demonstrated that the use of CAOS to pin an IT fracture does not add significant extra time to pin placement. Both techniques were comparable in terms of accuracy. We found that radiation exposure when using the navigation system was reduced by almost 50%.

## **Two Generations of Intramedullary Nails for Diaphyseal Lower Extremity Fractures**

Garland K. Gudger Jr., MD; Thomas M. Schaller, MD; Timothy P. McHenry, MD; Stephanie L. Tanner, MS

**Introduction:** Intramedullary nail (IMN) fixation of diaphyseal femur and tibia fractures is the gold standard of treatment. New elements have been added to IMN designs including multiple locking hole options to increase the versatility of the nail for treatment of more complex fractures. However, these new elements greatly increase the cost of the implant. The goal of this study was to compare two generations of IMN to see if the increased cost is justified by differences in healing rates or complications in diaphyseal lower extremity fractures. **Methods:** We retrospectively reviewed 102 consecutive closed diaphyseal femur and tibia fractures (AO/OTA classification 32 and 42) from 2008 through 2013 treated with one of two generations of IMN by one manufacturer (Group A with traditional uniplanar locking bolts and Group B with multiplanar with fixed angle locking options. Primary outcomes were fracture healing and implant associated complications. **Results:** There were 50 IMN in Group A and 52 in Group B. There were no significant differences between the number of tibias and femurs between groups. Time to healing was not significant between groups (3.8 months and 36 months respectively). There were four patients delayed unions in Group A and seven in Group B. Two nonunions were observed in Group A and five in Group B. There were no broken nails. A broken/backed out screw was observed in 5 cases in Group A and in four cases in Group B. All cause reoperations occurred in 10 patients in the Group A and 9 patients in Group B. **Discussion and Conclusions:** Based on our data, the use of newer generation IMNs may not be warranted for the treatment of closed diaphyseal lower extremity fractures. Limiting the use of the more expensive devices to complex or meta-diaphyseal fractures may provide cost savings.

## **Acute Compartment Syndrome of the Leg following Trivial Trauma**

L. Jared Hudspeth, MD; \*Andrew G. Carlone, MS; Daniel K. Grahl, MD; Jeffery A. Fried, MD; Lawrence X. Webb, MD; John C. P. Floyd, MD; Don C. Beringer, MD

**INTRODUCTION:** Acute compartment syndrome is well recognized to occur after long bone fractures and other major traumatic events. However, seemingly trivial trauma may also initiate a cascade of events that subsequently leads to increased intracompartmental pressures. Fewer than 35 cases of acute, lower leg, compartment syndrome following events perceived to be of negligible risk for such a diagnosis have been reported. We present a series of eight patients who presented with lower leg compartment syndromes following trivial trauma as well as an extensive literature review of previously published reports. **METHODS:** Patient charts were reviewed retrospectively for details surrounding the inciting events, operative reports, hospital course, and complications. An extensive literature review was conducted and included reports of acute compartment syndrome of the lower leg. Reports of compartment syndrome of chronic nature, induced by exercise, and caused by major trauma were excluded. **RESULTS:** Eight patients, four male and four female, presented with pain out of proportion to their injuries and excessive pain on passive movement of the lower extremity. Five patients had increased pressures in all four compartments requiring four-compartment fasciotomy. Average time to decompression was 66.75hrs.



During fasciotomy, all patients were found to have torn muscle fibers, seven patients had hematomas requiring evacuation, and two patients had evidence of myonecrosis. One patient with myonecrosis subsequently developed ischemic necrosis of the wound involving the skin and subcutaneous tissues, which required a secondary operation. **DISCUSSION and CONCLUSION:** Orthopaedic surgeons often rely solely on clinical suspicion to diagnosis compartment syndrome. Early recognition and surgical intervention is imperative to avoid catastrophic complications, however cases after trivial trauma are often overlooked on initial examination. This case series serves as a tool to sharpen the clinical acumen of orthopaedic surgeons to have high index of suspicion for compartment syndrome, not only after high-energy injuries, but, also, after seemingly minor traumatic events.

### **Rate of Contralateral Hip Fractures following DHS vs IMN Fixation**

Jonathan D. Hughes, MD; Kindyle L. Brennan, PhD, PT; Justin Bartley, MD; Yolanda Munoz Maldonado, PhD; William Robinson, BA; Michael L. Brennan, MD; Christopher D. Chaput, MD

Rate of Contralateral Hip Fracture Following Dynamic Hip Screw vs Intramedullary Nail for the Treatment of Peritrochanteric Hip Fractures **Background:** Previous studies have indicated an increased risk of subsequent contralateral hip fracture after initial injury. A recent study demonstrated an increased risk of a subsequent contralateral hip fracture after fixation of femoral neck fracture with CRPP compared to total hip arthroplasty. To our knowledge, there are no previous studies that specifically compare the rate of subsequent contralateral hip fractures between surgical fixation methods for intertrochanteric and peritrochanteric hip fractures. **Methods:** A retrospective, comparative study was performed within a single healthcare system at which electronic medical records and digital radiographs were reviewed for all patients who underwent treatment for intertrochanteric and peritrochanteric hip fractures with either a hip screw and side plate or intramedullary nail. Of these patients, 1102 met our inclusion criteria. For the primary outcome of subsequent contralateral hip fracture, a logistical regression analysis with propensity scores was applied. **Results:** Four hundred and two patients were treated with a hip screw and side plate (HSSP) and 700 were managed with an intramedullary nail (CMN). Of these patients, 147 sustained a contralateral hip fracture. Fixation technique was not associated with a significant difference in the rate of contralateral fracture. The percentage of contralateral hip fractures in both HSSP and CMN groups was 13.3%. Among the patients with a contralateral fracture, the median time to contralateral fracture following HSSP was 2.7 years and for CMN was 2.0 years. Age and bisphosphonate use were found to be significant predictors of contralateral fracture. **Conclusion:** There is no difference in the rate of subsequent contralateral hip fracture when comparing hip screw and side plate with an intramedullary nail. Additionally, the time to second surgery between the two treatment modalities was not found to be statistically significant. Younger age and bisphosphonate use increased the odds of having a contralateral fracture, regardless of the surgical intervention.

### **RAPID FIRE SESSION 7A: Mixed Topics/General Orthopaedics**

#### **Increased Patient Satisfaction with Mobile Compression Pumps for VTE Prophylaxis**

Ryan M. Nunley, MD; Denis Nam, MD, MSc; James A. Keeney, MD; John C. Clohisy, MD; Staci R. Johnson, MD; Douglas J. McDonald, MD; Robert L. Barrack, MD

**Introduction:** Thromboembolic events (VTE) are a common complication following total joint arthroplasty. Several prophylaxes are effective, but introduce complications and cost. AAOS's recommendations include mechanical compression devices (MCDs). American College of Chest Physicians has a grade 1C recommendation for MCDs, but they must be portable, battery-powered, and record compliance. The purpose of this study was to prospectively compare MCDs to warfarin for

postoperative VTE prevention and evaluate patient satisfaction with VTE prophylaxis. **Methods:** Adults undergoing elective primary or revision knee or hip arthroplasty were prospectively enrolled. Patients were ineligible if they had prior surgery within three months, pre-operative deep vein thrombosis, history of pulmonary embolism, were on chronic anticoagulation therapy, or required prolonged immobilization postoperatively. Patients were stratified to standard or high risk anticoagulation therapy per clinical protocol. Standard risk patients wore MCDs 10 days and took aspirin six weeks postoperatively. High risk patients received warfarin adjusted for target INR 4 weeks and compression stockings 6 weeks postoperatively. Patients were followed 6 months and monitored for bleeding complications, symptomatic VTEs, and satisfaction with VTE prophylaxis. **Results:** 1,888 standard risk and 834 high risk participants were included. VTE rate at 4-6 weeks was 0.6% for standard and 0.4% for high risk. No differences were found by procedure. High risk participants had drainage  $\geq 4$  days postoperatively more frequently than standard risk patients (21% vs 14%). Major bleeding events were more frequent in high risk participants (2.0%) than standard risk (0.3%). High risk participants had more wound problems (1.3% vs 0.2%). Standard risk participants were more satisfied at 2 weeks and 4-6 weeks than high risk. **Discussion and Conclusion:** MCDs were equivalent to warfarin for VTE prevention, with reduced major bleeding events, wound complications, and days of drainage, and increased patient satisfaction.

### **Humeral Torsion Adaptation in Little League Pitchers Compared to Adolescents**

Charles A. Thigpen, PhD, PT, ATC; Michael J. Kissenberth, MD; Amanda Arnold, PT, DPT, OCS, SCS; Lane B. Bailey, PT, DPT, CSCS; Richard J. Hawkins, MD; Ellen Shanley, PhD, PT, OCS

**Background/Objective:** The extreme forces of repetitive throwing are thought to result in stresses to the epiphyseal plates that slow the natural adaptation of humeral torsion (HT) in the dominant compared to non-dominant arm. While alterations in HT and range of motion (ROM) are associated with arm injury in adolescent and adult pitchers there are no studies that have examined the rate and timing of these bony changes occur. Therefore, the purpose of this study was to compare dominant (D) and non-dominant (ND) HT of youth pitchers over 1 year with adolescent pitchers. **Methods:** Fifty-three youth (n=25; age=  $9.5 \pm 1.0$  yrs) and adolescent (n=28; age=  $14.3 \pm 1.2$  yrs) pitchers height, weight, and bilateral HT was assessed prior to the spring season and again at least one year later. HT was measured using a digital inclinometer (DI) via previously validated indirect ultrasonography (US) technique for pitchers who reported participating in all training, practices, and games without limitation. Independent t-tests were used to compare age and time to follow up between youth and adolescent pitchers. Separate mixed model ANOVAs (group by time) were used to compare HT, height, and weight measures for each arm (D and ND), with a Tukey's HSD for planned post hoc comparisons ( $\alpha=0.05$ ). **Results:** Youth pitchers displayed a significant increase in D HT ( $14.3 \pm 12.1^\circ$ ) and ND HT ( $10.1 \pm 11.2^\circ$ ) while the adolescent pitchers did not display a clinically meaningful change in D HT ( $2.9 \pm 11.3^\circ$ ) or ND HT ( $4.3 \pm 11.9^\circ$ ). Youth players grew significantly taller ( $6.9 \pm 2.5$  cm vs.  $4.5 \pm 4.5$  cm) compared to the adolescents but there was no difference in their weight gain ( $5.5 \pm 6.5$  kg vs.  $6.1 \pm 7.2$  kg) or average time between assessments ( $15 \pm 5.2$ ). **Conclusions:** This is the first study to document the adaptations in humeral torsion due to throwing in the context of skeletal maturation. Youth pitchers displayed greater adaptations in humeral torsion concurrent with an accelerated growth velocity suggesting humeral torsion adaptations are associated with skeletal maturity. Clinical relevance: Youth pitchers as young as age 8 displayed significant side-to-side differences in humeral torsion that dramatically changed over 12-15 months while adolescents humeral torsion began to stabilize.

### **Fibular Plate Conceals Malreduction of Posterior Malleolar Fixation**

Jason J. Griffin, MD; \*Nicholas G. Vance, MD; Vinod K. Panchbhavi, MD

**INTRODUCTION.** We hypothesized that a lateral fibular plate would obscure the fracture plane and therefore affect fluoroscopic assessment of reduction of the posterior malleolus on a lateral view.

**METHODS.** A Haraguchi type 1 posterior malleolus fracture was produced in a cadaver ankle by using an osteotome. The lateral edge of the plafond was measured and the fracture line was made to represent 25% of the AP dimensions on both direct visualization and fluoroscopy. A 1/3 tubular lateral fibular plate was applied. The ankle was imaged on a standard C-arm in a true lateral view with the fracture reduced, and then the fracture was displaced vertically by 2 mm and 5 mm. The images were incorporated in a survey twice to allow assessment of response reproducibility and sent out to 932 AOFAS surgeons. Response options were reduced, displaced, or unable to assess reduction. **RESULTS.** One hundred forty-eight responses were received. Most respondents felt unable to accurately assess reduction of the posterior malleolus in the lateral view with fibular hardware in place when the fracture was reduced or 2 mm displaced. The respondents who felt they were able to assess reduction were less accurate than random guessing in assessing reduction with both image sets. However, once the fracture was widely displaced, most respondents felt able to assess reduction and were near-perfect in their assessment with both image sets. **DISCUSSION AND CONCLUSION.** This study shows that clinicians feel that they are unable to accurately assess fine reduction of the posterior malleolus with fibular hardware in place. When clinicians do attempt to assess reduction in this scenario, they are not accurate. The problem may be magnified by the easy and accurate assessment of wide displacement, which may lead to false confidence.

### **Variability in The Interpretation of NSAID Utilization in Orthopaedic Surgery: a Systematic Review of the Literature**

Alejandro Marquez-Lara, MD; Ian Hutchinson, MD; Thomas L. Smith, PhD; Anna N. Miller, MD

**Introduction:** Orthopaedic surgeons often avoid non-steroidal anti-inflammatory drugs (NSAIDs) due to their reported negative effect on bone healing. The purpose of this review is to critically analyze the published literature that evaluates the impact of NSAIDs on bone healing as well as to highlight the variability in the interpretation of these reports. **Methods:** A MEDLINE search was conducted utilizing free text and MeSH terms to identify all articles relating to bone and fracture healing, and the utilization of NSAIDs following orthopaedic procedures. All human studies, including review articles were identified for further analysis. Non-English manuscripts, in-vitro and animal studies, and studies not specifically associated with bone healing were excluded. A total of 16 clinical articles and 22 literature reviews were selected for analysis. **Results:** There was significant variability in the type of injury, mean age, NSAID selectivity, dose and route of administration among the clinical studies. 50% of the studies concluded that NSAID utilization was associated with an increased risk of non-unions. However, the studies with the highest level of evidence (RCT and meta-analysis) all concluded that NSAIDs were not associated with delayed healing or worsened outcomes when used at low doses and for less than 14 days. Review articles also demonstrated significant variability in the cited clinical studies and overall conclusions and recommendations. Review articles with less than 2 cited clinical articles more often concluded to avoid NSAID utilization during bone healing, while those who cited more than 3 studies more often concluded that not enough evidence was available to make any recommendations or that NSAIDs were ok to use. **Conclusion:** Despite great variability in the understanding of how NSAIDs affect bone healing, low-dose and short-term administration does not appear to have a significant detrimental effect. However, currently there is no definitive evidence to recommend for or against their use following Orthopaedic procedures.

### **Tennessee's Narcotic Restrictions Have Reduced Preoperative Narcotic Usage in Arthroplasty Patients**

Andrew A. Shinar, MD

**Introduction** The state of Tennessee instituted new restrictions on prescribing narcotics in early 2013, including a controlled substance database. While the AAOS strongly recommends NSAIDs and tramadol, it is inconclusive on recommending opioids as a treatment for knee osteoarthritis. Further, preoperative narcotic use has correlated with increased postoperative pain with arthroplasty. We sought to determine whether the new restrictions have reduced preoperative narcotic use or increased the use of tramadol or NSAIDs in Tennessee patients. **Methods** We compared preoperative listed medications and demographics for all surgical patients of a single arthroplasty surgeon for the last 2 months of 2011, 2012, 2013, and 2014. We grouped the post-restriction patients (2013 and 2014) as the study group and compared them to the pre-restriction patients (2011 and 2012) as the control group. We excluded 18 study and 20 control patients who resided in other states, leaving 137 in the study group, and 118 in the control group. The surgeon prescribed none of the preoperative narcotics. **Results** Preoperative opioid use decreased 38% between 2011-2012 and 2013-2014, from 34% of patients to 21%, which was highly statistically significant. Each year saw a decrease: 37% to 31% to 23% to 19%. No significant increase occurred in preoperative tramadol or NSAID usage (5.8% vs. 4.2% and 42% vs 46%). The groups did not significantly differ in percent with anti-depressants (25% vs. 30%) or gender (55% vs. 52% female). Both groups had the same average age (61), ASA score (2.6), and BMI (31). Evaluating primary arthroplasties only, narcotic usage dropped 33%, from 29.2% to 19.5%. Anxiety medications among all patients similarly dropped 38%, from 18% to 11%, but these 2 results did not reach statistical significance. **Conclusion** Restrictions on prescribing opioids in Tennessee have correlated with a substantial decrease in preoperative narcotic usage in our practice.

### **Diagnosing the Undiagnosed: Osteoporosis in Patients Undergoing Lumbar Fusion**

Peter M. Formby, MD; Scott C. Wagner, MD; Daniel G. Kang, MD; Melvin D. Helgeson, MD

**BACKGROUND:** We utilized a recent technique utilizing Hounsfield Units (HU) to estimate bone mineral density (BMD) of the lumbar spine and hypothesized that this technique would reveal a high percentage of undiagnosed osteoporotic patients undergoing TLIF. **METHODS:** Review of patients over age 50 undergoing TLIF. We determined the mean HU of L4 on axial computed tomography. Average HU values for patients with diagnosed lumbar osteoporosis (DEXA BMD less than 0.75 g/cm<sup>2</sup>) were compared to osteopenic patients with normal BMD (between 0.75 to 0.9 g/cm<sup>2</sup> and greater than 0.9 g/cm<sup>2</sup>, respectively). The percentage of patients with HU values consistent with osteoporosis, but without any formal evaluation, was also calculated. **RESULTS:** Over ten years, 143 patients over age 50 underwent TLIF, and 127 had available perioperative lumbar CT scans. Males and females comprised 60.6% and 39.4% of the population, respectively. Average age was 61.5 years (range: 50.0 to 83.5 years). Twenty nine patients had both DEXA and CT data available for analysis. There was a significant association with decreased HU in patients with lumbar BMD less than 0.75 g/cm<sup>2</sup> (105.6HU +/- 6.75HU, 95% CI) in comparison to patients with osteopenia (146.0HU +/- 4.1HU) and with normal BMD (164.8 +/- 22.3HU). Ten males (13.0%) and 15 females (38.3%) had L4 HU values consistent with osteoporosis. Fifty-three percent of females and 100% of males with osteoporotic HU values had never been formally evaluated for the disease. **CONCLUSIONS:** HU can provide accurate assessment of bone mineral density of the lumbar spine. We found that more than half of all females, and all males, over age 50 undergoing TLIF with osteoporosis of the lumbar spine were undiagnosed at the time of surgery. The clinical significance of this finding requires further study, but it is clear that increased vigilance on the part of the surgeon is required.

### **RAPID FIRE SESSION 7B: Total Knee**

## **Weight Gain in a Young, Healthy Cohort after Total Knee Arthroplasty**

Peter M. Formby, MD; Richard Purcell, MD; Ronald P. Goodlett, MD; Andrew Mack, MD; Michael T. Newman, MD

**Introduction:** Total knee arthroplasty (TKA) is one of the most successful procedures in orthopaedics which can restore pain-free mobility for the majority of patients. There is little in the literature regarding weight loss following total knee arthroplasty, particularly in a young otherwise healthy cohort. **Methods:** A retrospective review over a ten year period (2004-2014) of 116 consecutive patients less than or equal to 50 years at the time of primary TKA. We reviewed preoperative weight and BMI as well as 3 month, 6 month, 1 year, 2 year, and 3 year postoperative weight and BMI through our electronic medical records. In addition, we performed a subgroup analysis of 54 patients with a preoperative BMI greater than or equal to 30 to determine their postoperative weight trends. We excluded any patient who underwent bariatric surgery during this period. **Results:** Patients gained weight following TKA, with significant gains at 1 year (+3.37 lbs), 2 years (+4.56 lbs), and 3 years (+8.95 lbs) following their index TKA. For patients with BMI greater than or equal to 30 preoperatively, we found significant weight gains at 2 years (+4.9 lbs) and 3 years (+11.12 lbs). **Discussion and Conclusion:** Despite a theoretical restoration of function and mobility following TKA, we found that patients generally maintain their pre-operative weight until the first postoperative year and then continue to gain weight up to three years postoperatively. This could have negative effects on the function and longevity of the implant.

## **Peri-Articular Injection Versus Combined Femoral/Sciatic Blocks in Total Knee Arthroplasty**

Andrew A. Shinar, MD

**INTRODUCTION** Peri-articular injection has equaled femoral nerve blocks in early pain following total knee arthroplasty, while reducing falls and nerve palsies. We studied whether this technique in our hands yielded equivalent pain relief to our prior combined femoral and sciatic nerve blocks, had a learning curve, was influenced by prior narcotic use, and/or yielded earlier discharge and increased early ambulation. **METHODS** We studied the electronic medical record of 80 consecutive total knee replacement patients, excluding 2 patients. The first half was treated with indwelling femoral nerve catheters (24 hours), and single shot sciatic blocks. The second half was injected about the knee with a ropivacaine, epinephrine, and ketorolac solution instead. We used knee immobilizers to prevent falls in the nerve block group, as well as foley catheters for the first 12 to 24 hours. **RESULTS** Peri-articular injection yielded significantly superior pain scores at the 24 hour point (5.7 vs. 7.0) and in terms of worst score recorded in the first 24 hours (7.3 vs. 8.3). Ambulation distance was significantly higher in study group in the first 24 hours (81 vs. 22 ft.), and in the second 24 hours (163 vs. 105 ft.). Length of stay significantly dropped in the study group (2.7 vs. 3.3 days). No learning curve regarding any outcome was found. The groups did not differ significantly in discharge disposition or early complications, nor in ASA score (2.83 v. 2.80), age, BMI, gender, or total operative time. The nerve block group had a higher percentage taking regular narcotics pre-operatively, but this factor had no effect on any outcome parameter. **DISCUSSION AND CONCLUSION** Relative to combined femoral and sciatic nerve blocks, peri-articular injections were superior in reducing pain at 24 hours, reducing length of stay, and in increasing early ambulation. Pre-operative narcotics had no effect, and no learning curve was present.

## **Bariatric Surgery Prior to Total Knee Arthroplasty is Associated with Fewer Postoperative Complications**

James A. Browne, MD; Brian C. Werner, MD; Gregory M. Kurkis, BS; Frank W. Gwathmey, MD

**INTRODUCTION:** Morbid obesity has been identified as an independent risk factor for complications following total knee arthroplasty (TKA). Bariatric surgery has been suggested as a way for some patients to lose weight before surgery although the impact of this intervention on postoperative outcomes is unknown. **METHODS:** This study used a national database to compare 90 day postoperative complication rates between three groups of patients who underwent total knee arthroplasty (TKA): (1) non-obese patients (n = 66,523), (2) morbidly obese patients who did not have bariatric surgery (n = 11,294) and (3) morbidly obese patients who underwent bariatric surgery prior to TKA (n = 219). **RESULTS:** Morbidly obese patients who underwent bariatric surgery prior to TKA had reduced rates of major (OR 0.45, p = 0.001) and minor (OR 0.61, p = 0.01) complications compared to morbidly obese patients who did not have bariatric surgery. However, these patients continued to experience higher rates of complications compared to non-obese patients. **DISCUSSION AND CONCLUSION:** Bariatric surgery prior to TKA appears to be associated with less risk of postoperative complications, although not to the same level as non-obese patients.

### **Allogenic Transfusion in Primary Hip and Knee Arthroplasty Tranexamic Acid**

Scott M. Sandilands, DO; \*Jesus M. Villa, MD; Carlos J. Lavernia, MD; Michele D'Apuzzo, MD

**INTRODUCTION:** Allogenic blood transfusion has been shown to be detrimental to the outcome of arthroplasty. A recent and promising management option is the use of tranexamic acid (TXA). The aims of this study were (1) to determine the preoperative hemoglobin level that is associated with an increased risk for allogenic transfusion and (2) to quantify the amount of change in hemoglobin postoperatively of patients undergoing primary total joint arthroplasty (TJA) and receiving TXA. **METHODS:** A total of 318 consecutive admissions for primary arthroplasty of the hip and knee were studied utilizing a joint registry. Data collection was supplemented through chart review. Inclusion criteria included unilateral procedures who received TXA. The average age of patients in the study was 71 years  $\pm$  8.9 SD, 70% were females, average BMI was 30.9 kg/m<sup>2</sup>  $\pm$  5.8 SD and 71.4% were total knee arthroplasties. Statistical analysis included Chi-square and binary logistic regression. A p<0.05 was considered significant. **RESULTS:** The average preoperative hemoglobin was 13.2 g/dl  $\pm$  1.3 SD, average postoperative hemoglobin was 10.4 g/dl  $\pm$  1.2 SD with an average hemoglobin change after surgery of 2.8  $\pm$  1.2 g/dl SD. Only 7 patients required transfusion postoperatively (2.9%). Patients with preoperative hemoglobin less than 11.5 g/dl had a significantly higher prevalence of postoperative transfusions (14% vs. 0.5%). In our regression model only preoperative hemoglobin less than 11.5 g/dl was a significant risk factor for transfusion (OR: 29; 95% CI: 3.2-259). **DISCUSSION AND CONCLUSION:** We found that a value of 11.5 g/dl for preoperative hemoglobin level should probably trigger an intervention with a hematopoietic agent preoperatively to decrease the risk of allogenic blood transfusion in primary total joint arthroplasty. This threshold gives orthopedic surgeons a better handle on when to intervene pre TJA. Further studies needed to be completed in a larger group of patients to confirm the findings of this study.

### **Day of Week Does Not Influence LOS in Primary Joint Replacements**

Paul K. Edwards, MD; \*C. Lowry Barnes, MD; Kevin M. Cullinan, MHA; D. Gordon Newbern, MD

**INTRODUCTION:** Recent work has suggested increased length of stay (LOS) for primary joint replacements based upon the day of week of surgery. Our hypothesis was that LOS and disposition to home were unaffected by day of week in our highly managed joint replacement program. **METHODS:** A retrospective review was performed on 2,302 primary joint replacements performed between Jan 1, 2012 and Sept 30, 2014. We recorded day of week of surgery, LOS, and whether discharged to home. All patients participated in our Joint Academy program which includes, Pre-op Teaching, Hospitalist Coverage, APN In-Hospital Care, and oversight by Joint Coordinator. **RESULTS:** Monday 1.45 Day

LOS 96% Discharged home Tuesday 1.59 Day LOS 94% Discharged home Wednesday 1.69 Day LOS 90% Discharged home Thursday 1.58 Day LOS 93% Discharged home Friday 1.81 Day LOS 91% Discharged home In this highly managed program, there was no significant difference in LOS or percent discharged to home related to the day of week of surgery. **DISCUSSION AND CONCLUSION:** As the volume of joint replacement increases and alternative payment models are implemented, programs that allow short LOS and discharge to home regardless of day of week surgery will become more important.

## **RAPID FIRE SESSION 7C: Hand**

### **Effects of Traction During Nerve Transection on Neuropathic Pain**

Brooks Ficke, MD; Brent A. Ponce, MD; James R. Bowman, MD, PhD; Jonathan C. Yu, BS; Dustin K. Baker, BS; Richard D. Meyer, MD

**INTRODUCTION** Painful neuromas complicate 25% or more of amputations, and no method of prevention is universally successful. Traction during nerve transection is a commonly taught method of neuroma prevention. However, traction is an injurious stimulus to nerves, and its effect on neuroma formation has not been formally studied. After sciatic nerve transection, rats express neuropathic pain through autotomy, or self-cannibalization, of the denervated limb. This study compared neuropathic pain after sciatic nerve transection with and without traction. **METHODS** Twelve adult male Sprague-Dawley rats were divided into two treatment groups. One underwent sciatic transection without traction, and the other had sciatic nerve transection with application of 500 g traction. During 28 days of observation, levels of autotomy were graded bi-weekly using modified Wall scores. Rats reaching a maximum allowed score (6) were euthanized to prevent undue distress. **RESULTS** Eighty-three percent (10/12) of rats demonstrated autotomy during the observation period. Both rats without autotomy were in the traction group. Fifty-eight percent (7/12) rats reached the maximum allowed Modified Wall Score: 2 in the traction group and 5 in the no traction group. Statistically significant differences were found in the average autotomy score at 1, 7, 14, 21, and 28 days post-operatively, all favoring the traction group. **DISCUSSION and CONCLUSION** Traction during nerve transection seems to offer a protective effect against neuropathic pain in a rat model. Possible mechanisms include withdrawal of the neuroma to a less sensitive area and a protective effect of oblique nerve transection. Further study, including histologic investigations of the resultant neuroma and the use of multiple different clinical signs of neuropathic pain, may elucidate the mechanisms behind this phenomenon. The findings potentially suggest that traction during nerve transection may be protective against post-operative neuropathic pain but require additional investigation.

### **An App Provides Reliable Finger Measurement Faster than a Goniometer**

Jeremy C. Smalley, MD; Eric W. Angermeier, MD; William R. Barfield, PhD; Kyle P. Kokko, MD, PhD

**INTRODUCTION:** In orthopaedic hand clinics, measurement of finger joint motion is commonly performed using mechanical goniometers, producing results that are accurate and precise but time-consuming. Recent studies have validated the use of a smartphone clinometer for measuring motion of the shoulder and knee. We investigated a custom iOS application for finger measurement designed to provide equivalent precision and superior efficiency compared to a mechanical goniometer with paper recording. **METHODS:** Examinations of finger range of motion were conducted by two orthopaedic hand surgeons and five residents using the custom iOS application (app) and an off-the-shelf mechanical goniometer. Plastic anatomic models of the hand, glued in flexion for standardization, were examined. The examiners followed a printed protocol and familiarized themselves with the devices before starting. Each hand examination measured the flexion angles of the thumb MP and IP joints and the finger MCP, PIP, and

DIP. The angle was immediately recorded when captured in the app. Goniometric measurements were recorded on paper in a pre-printed grid. Examiners measured each hand twice with each device, for a total of 8 exams and 112 data points per examiner and 784 measurements overall. Each hand examination was timed. **RESULTS:** The app and the goniometer both demonstrated high reliability for repeated and comparative measurements as tested by ICC. The Cronbach's alpha score for the goniometer was 0.929 and for the app, 0.938. Pearson correlation coefficient between device measurements was 0.845. The app provided more rapid and statistically significant data acquisition with mean times of 2:13 for the app and 2:52 for the goniometer. **DISCUSSION:** The app is a similarly reliable measurement instrument to the goniometer and allows significantly faster capture of the range of motion of finger joints than a mechanical goniometer.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

### **Ultrasound vs Fluoroscopy Evaluation of Screw Prominence following Volar Distal Radius ORIF** Fraser J. Leversedge, MD; Ilvy H. Cotterell, MD; Megan Crosmer, MD; Marc J. Richard, MD; Brian T. Nickel, MD; Eric W. Angermeier, MD; David S. Ruch, MD

**Introduction:** Dorsal screw prominence after volar plating of distal radius plating can result in extensor tendon irritation. Despite the use of intra-operative fluoroscopy, including various views that have been described to increase the accuracy in detection, dorsal screw penetration may still be unrecognized, due to the morphology of the distal radius, and the limitations of two-dimensional imaging. Furthermore, these views may be difficult to obtain in a patient post-operatively due to limitations in motion. Ultrasound may be a helpful adjunct in detecting screw prominence intra-operatively and in an outpatient setting.

**Methods:** A standardized model for volar plating of the distal radius was used in 46 fresh-frozen human upper limb cadaveric specimens. Three distal radius screws were placed using a volar fixed angle distal radius plate. The screw lengths were pre-determined for each hole, such that a screw length of +4, +2, 0, -2, or -4 was assigned via a randomization chart. Violation of the dorsal cortex was then evaluated fluoroscopically, and using an 18MHz musculoskeletal ultrasound transducer by two different fellowship trained hand surgeons, without attempted palpation of the dorsal radius. Dorsal wrist dissection was then performed to evaluate screw prominence by direct measurement. Statistical analysis was performed to assess the accuracy of ultrasound and fluoroscopic evaluation of potential dorsal screw prominence

**Results:** Ultrasound and fluoroscopy were both equally accurate, and there was no statistically significant difference in sensitivity and specificity between the two methods in identifying the presence of a dorsally prominent screw or in identifying the correct location of the prominent screw. Ultrasound was slightly superior in estimating the correct length of screw prominence. Combining both methods did slightly improve sensitivity and specificity over the individual methods alone. **Discussion and Conclusions:** Ultrasound evaluation is an accurate and reliable tool in detecting dorsal screw prominence in the distal radius, particularly when compared to fluoroscopy, and may be a cost-effective adjunct in evaluating screw prominence during and after volar plate fixation in a clinical setting. As unrecognized variables may exist in the traumatic condition, clinical study is warranted.

### **Locking Versus Lag-Locking Fixation for Distal Radius Fractures: Biomechanical Study** Amit Momaya, MD; Tyler Marshall, MD; Nilesh Chaudhari, MD; Thomas R. Hunt III, MD, DSc

**INTRODUCTION:** To determine biomechanical differences between a fixed angle locking volar plate and a fixed angle lag-locking volar plate in the fixation of distal radius fractures with AO C3 fracture patterns. **METHODS:** Eighteen cadaveric upper extremities (9 matched pairs) with an average age of 54



years were tested. All specimens had no evidence of prior injury or instability. A four part AO C3 fracture pattern was created in each specimen. The fractures were then reduced under direct visualization and fixed with either the fixed angle locking volar plate or the fixed angle lag-locking volar plate. Motion tracking analysis was then performed while the specimens underwent cyclic loading. Changes in displacement and rotation were recorded in addition to the load to failure and mode of failure.

**RESULTS:** The fixed angle lag-locking construct demonstrated less displacement and rotation when compared to the fixed angle locking volar plate. The average reduction in aggregate fragment displacement and rotation of fracture fragments was 5 mm and 3 degrees respectively in the fixed angle lag-locking group. The average loads to failure for the fixed angle locking volar plate and the fixed angle lag-locking volar plate were 1109 N and 1334 N respectively. The lag-locking group showed no trend in method of failure while the locking plate group failed most often by articular fixation failure (5/9 specimens). **DISCUSSION and CONCLUSION:** The fixed angle lag-locking volar plate demonstrates a kinematic advantage in the fixation of distal radius AO C3 fracture patterns when compared to fixation by the fixed angle locking volar plate.

### **Ultrasound-Guided De Quervain's Injection: Accuracy and Anatomic Considerations**

Fraser J. Leversedge, MD; Ilvy H. Cotterell, MD; Brian T. Nickel, MD; Megan S. Crosmer, MD; Marc J. Richard, MD; Eric W. Angermeier, MD

**Introduction:** Studies evaluating corticosteroid injection into the first extensor compartment (1EC) for de Quervain's stenosing tenosynovitis have demonstrated improved clinical outcomes, although inaccurate injection may cause subcutaneous atrophy and skin depigmentation. Confirmation of pertinent anatomy and accurate needle placement for injection may improve outcomes and limit complications. We evaluated: (1) the accuracy of ultrasound assessment of the pertinent anatomy of the 1EC, and (2) the accuracy of ultrasound-guided injection of the 1EC, with priority for the EPB sub-compartment.

**Methods:** The senior author performed anatomic assessment and ultrasound-guided 1EC injection in 50 fresh-frozen upper limb amputation specimens. Ultrasound evaluation evaluated for the presence or absence of an EPB sub-compartment within the 1EC. Initial needle placement was done without ultrasound guidance; its final position was evaluated with ultrasound. Then, 1cc of India ink was injected into the EPB compartment under ultrasound guidance. Open evaluation confirmed pertinent anatomy and injection location, including complications. **Results:** A sub-compartment of the 1EC was identified in 27/50 (54%) of the wrists; 18/27 complete and 9/27 incomplete, for which ultrasound was 94% accurate. Accurate clinical needle placement into the 1EC occurred in 26/50, but only 2/27 (7%) were correctly located within the EPB sub-compartment. Ultrasound-guided injection of the 1EC was 100% accurate (50/50) and was 96% accurate (26/27) for EPB injection when 2 compartments were present. Minimal extravasation was identified in 6/50, or 12%. **Discussion and Conclusions:** Ultrasound-guided de Quervain's injection improves injection accuracy through the visualization of compartmental anatomy and needle placement. Consistent and reliable injection methods associated with ultrasound-guidance may improve clinical outcomes and minimize complications compared to non-imaging injection methods.

### **Dorsal Tangential View: a Useful Tool for Intraoperative Screw Assessment**

Devin S. Ganesh, MD; Brian Zirgibel, MD; Ben Service, MD; Kenneth Koval, MD

**Introduction:** The dorsal tangential view (DTV) provides unique perspective to the topography of the dorsal cortex of the distal radius. Although studies have reported the utility of this view as an adjunct to traditional fluoroscopy, no studies have evaluated its value in detecting dorsal screw penetration compared to CT scan. This study was performed to assess the DTV utility in detecting intraoperative dorsal screw penetration in distal radius fractures treated with volar plating, compared to CT scan.

**Methods:** We prospectively examined 30 consecutive distal radius fractures in 25 patients treated with volar locked plating. Intraoperative AP, lateral, 20 degree tilted lateral and dorsal tangential views were obtained via fluoroscopy in all wrists. A CT scan was taken post operatively to identify prominent screws. Metaphyseal dorsal screw penetration was recorded as > 1mm of penetration. Statistical analyses were performed to assess the utility of the DTV in identifying dorsal screw penetration, compared to CT scan. **Results:** A total of one hundred and seventy-five metaphyseal screws were assessed. Eight patients out of twenty five (32.0%) had prominent screws evident on the DTV but not seen on standard fluoroscopic analysis. CT scan identified five additional screws with > 1mm dorsal penetration not identified by the DTV. All except one screw were in the second dorsal wrist compartment. The DTV was 66.7% sensitive with a negative predictive value of 97.0%. **Discussion and Conclusion:** The DTV is an economic alternative to CT scan to ensure proper screw depth reducing the risk of extensor tendon irritation and possible tendon rupture in most wrist compartments. We advocate the routine use of this view to help prevent prominent dorsal screws with volar locked plating of the distal radius and suggest caution when using this view to verify acceptable placement of screws in proximity to the second dorsal compartment.

## **RAPID FIRE SESSION 7D: Shoulder/Elbow Reconstruction**

### **Allogeneic Blood Transfusion Predicts Infectious Complications in Total Shoulder Arthroplasty**

Abiram Bala, BA; Colin T. Penrose, BS; Thorsten M. Seyler, MD, PhD; Richard C. Mather III, MD; Samuel S. Wellman, MD; Michael P. Bolognesi, MD; Grant E. Garrigues, MD

**INTRODUCTION:** Allogeneic blood transfusion is postulated to cause increased infection-related complications through transfusion-related immunomodulation. Evidence is currently mixed on whether this increases infection-related complications in hip and knee arthroplasty. Although transfusion rates in total shoulder arthroplasty (TSA) are not as high as those in total hip and knee arthroplasty, rates in the literature vary between 7-43%. The purpose of this study was to evaluate if allogeneic blood transfusion predicts early (90-day) infection-related post-operative complications when compared to autologous blood transfusion in TSA. **METHODS:** We retrospectively queried 116,537 total and reverse shoulder arthroplasties in the Medicare database containing 100% of inpatient and outpatient administrative records from 2005 to 2011 using PearlDiver technologies. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes were used to identify the procedure, comorbidities based on the Elixhauser measure, and post-operative complications of interest. Rates (R), odds ratios (OR), and 95% confidence intervals (CI) were calculated. **RESULTS:** 9390 patients received allogeneic transfusion and 1286 patients received autologous transfusion. Allogeneic transfusion receiving patients were older and had higher prevalence of comorbidities, suggesting a “sicker” cohort. Analysis of infection-related complications revealed statistically significant higher rates of pneumonia (OR 4.21, CI 2.66 – 6.68), urinary tract infection with and without catheter inclusion (OR 1.64 and 1.59, CI 1.34 – 2.01 and 1.30 – 1.95 respectively), and cellulitis/seroma (OR 2.07, CI 1.18 – 3.65). These patients also had statistically significant higher rates of non-infectious complications such as acute MI, heart failure, DVT/PE, stroke, and acute renal failure. There was no difference in early prosthetic-related mechanical complications or TSA revision/repair. **DISCUSSION AND CONCLUSION:** Patients who receive allogeneic blood transfusion appear to have higher infectious and medical related complications, but not mechanical complications or revisions. Surgeons should be aware that these patients might be at risk for early infectious-related complications.

### **Revision with Reverse Total Shoulder Arthroplasty following Periprosthetic Shoulder Infection**

Daniel J. Hackett, MD; Lynn A. Crosby, MD; William Melton, MD

**INTRODUCTION** Consensus is lacking in regards to optimum treatment of periprosthetic shoulder infections. The ideal treatment modality would eradicate infection and provide a functional, pain-free shoulder after revision. Recent reports of functional results of revision shoulder arthroplasty have been mixed. We report on our results of revision total shoulder arthroplasty (tsa) after periprosthetic infection using reverse tsa. **METHODS** In this multi-institutional study, we retrospectively analyzed the outcome of nineteen patients with periprosthetic infection. All patients underwent a two-stage revision with the use of an antibiotic spacer in the first stage, followed by revision with a reverse tsa. Clinical outcome was assessed by recurrence of infection, complications, range of motion, and scoring utilizing ASES and Constant scores. Individuals who underwent revision within 120 days (early) were then compared to those who underwent revision after 120 days (late). **RESULTS** Mean follow-up for all patients was 22.4 months. All nineteen patients had successful eradication of infection. At last follow-up, mean forward flexion and abduction were 110.8 and 75 degrees, respectively. Mean ASES and Constant scores were 73.3 and 60.1, respectively. Complications included a fractured screw resulting in an unstable glenoid component in one patient and lesser tuberosity impingement in one patient. Individuals who underwent early revision had a median forward flexion of 142.5 degrees compared to 105 degrees in those who underwent late revision. Individuals who underwent early revision had a median ASES score of 80.5 compared to 73 in those who underwent late revision. **DISCUSSION and CONCLUSION** Two-stage revision is a dependable method for eradication of infection. Post-operative functional results significantly improved compared to pre-operative results with reverse tsa. Furthermore, functional results improve the sooner the revision can be safely performed so as to prevent fibrosis of the deltoid and remaining posterior rotator cuff musculature.

### **Outcomes of Reverse Total Shoulder Arthroplasty in Patients 65 and Younger**

Christopher Matthews, MD; \* Kevin W. Farmer, MD; Joseph J. King, MD; Thomas W. Wright, MD; Aimee Struk, MEd, MBA, ACT

**INTRODUCTION:** There is limited data on the outcomes of reverse total shoulder arthroplasty (RTSA) in a younger patient population. This study presents clinical outcomes of a consecutive series of RTSA patients age 65 years and younger with matched controls. **METHODS:** Fifty patients (mean age, 60 years) were retrospectively identified from a prospective research database at a mean follow-up of 3.2 years (range, 24-96 months). 15 had a revision arthroplasty and 35 patients underwent primary RTSA. Patients were consecutively matched by gender and diagnosis to controls 70 years and older (mean age, 76). Preoperative and postoperative standardized range-of-motion testing was performed and functional outcomes included Shoulder Pain and Disability Index 130 (SPADI-130), Simple Shoulder Test (SST), American Shoulder and Elbow Surgeons (ASES), and Constant scores. Univariate analysis was performed. **RESULTS:** Both RTSA  $\leq 65$  and control patients had significant improvements in all functional scores at 2-years. The SST improved from 2.5 to 7.2 for RTSA  $\leq 65$  and from 3.7 to 9.2 for controls. Active forward elevation improved from 69.1° to 116.3° for RTSA  $\leq 65$  and from 73.4° to 114.5° for controls. The change in all outcome scores and ROM was not statistically different for RTSA  $\leq 65$  and controls. For primary RTSA  $\leq 65$ , preoperative and 2-year SPADI-130 and SST scores were worse compared to controls. The change in functional scores was not significantly different. ROM was similar to the control group. Revision RTSA  $\leq 65$  had similar ROM and functional outcomes compared with controls. Both RTSA  $\leq 65$  and the control group each had a reoperation rate of 6%. **CONCLUSION:** Primary and revision RTSA in patients 65 years and younger has a similar change in functional scores and improves ROM compared to control patients 70 years and older. RTSA can resolve pain and improve shoulder function in younger patients when evaluated at 2-year follow up.

## **Combined In-Wound Exparel and IV Decadron in Shoulder Arthroplasty**

Howard D. Routman, DO; Andrew D. Boltuch; Molly A. Moor; Logan R. Israel

**Introduction:** The multiple medical consequences of the use of narcotic pain medication after elective shoulder arthroplasty are well documented. The purpose of this study was to evaluate length of stay, narcotic use, and VAS pain scores of patients undergoing elective shoulder arthroplasty before and after a change in medication utilized in a perioperative multimodal pain program. **Methods:** A retrospective analysis of two 90-day windows of surgery in a single fellowship trained shoulder surgeon's practice was the basis of this study. Thirty-three consecutive arthroplasty cases from 2013 and 34 consecutive arthroplasty cases from 2014 were evaluated. After exclusion criteria, 55 total patients remained. Perioperative multimodal pain management was identical between the two groups with the exception of the addition of 8-10 mg of intravenous Dexamethasone (Decadron) and intraoperative injection of liposomal Marcaine (Exparel) in the 2014 group. Patients on pre-operative narcotics were analyzed together and separately from those who were not on pre-operative narcotics. Postoperative length of stay, narcotic requirement converted to morphine equivalents, and VAS pain scores during hospitalization were measured. **Results:** The addition of the Decadron and Exparel to the protocol resulted in less pain postop day 0 and 1, significantly lower doses of opioids each day individually and for the entire hospitalization, and the length of hospitalization was reduced by a full day. When the patients who were on pre-operative narcotics (29% of the group) were evaluated separately, the required median dose of morphine equivalents was reduced by 68% on postoperative day 1 and 63% for all postoperative days cumulatively in the Decadron/Exparel group. The length of stay was also decreased from 2 days to 1 and VAS pain on postoperative day 1 was also decreased from 7 to 3.5. **Conclusion:** The addition of intravenous Decadron combined with the intraoperative use of Exparel in the elective shoulder arthroplasty decreased length of stay, VAS pain and narcotic requirements. These findings were similar for patients using preoperative narcotics as well as those not using preoperative narcotics.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

## **Perioperative Transfusion Predicts Early Periprosthetic Infection in Total Elbow Arthroplasty**

Abiram Bala, BA; Colin T. Penrose, BS; Thorsten M. Seyler, MD, PhD; Richard C. Mather III, MD; Samuel S. Wellman, MD; Michael P. Bolognesi, MD; Grant E. Garrigues, MD

**INTRODUCTION:** 90-day prosthetic-related complications remain an important metric in hip and knee arthroplasty in the Medicare population though these guidelines have not been established for total elbow arthroplasty (TEA). TEA is an important treatment modality for complex fractures, rheumatoid arthritis, osteoarthritis, and chronic instability. The purpose of this study was to determine if perioperative blood transfusion predicts early post-operative complications in Medicare patients who underwent TEA. **METHODS:** We retrospectively queried 8,337 TEAs in a Medicare database containing 100% of inpatient and outpatient administrative records from 2005 to 2011 using PearlDiver technologies. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes were used to identify the procedure, patient demographics, Elixhauser comorbidities, and post-operative complications. Rates (R), odds ratios (OR), and 95% confidence intervals (CI) were calculated. 90-day complications returning an OR >1.75 were considered substantial. **RESULTS:** The query returned 776 patients with perioperative blood transfusion and 7,561 without. Patients who received perioperative blood transfusion had higher prevalence of comorbidities and were older, suggesting a "sicker" cohort. Bivariate analysis revealed these patients had higher 90-day rates of periprosthetic infection (OR 2.46, CI 1.85 – 3.28) and cellulitis/seroma (OR 1.85, CI 1.37 – 2.50). These patients also had statistically significant higher rates of medical complications including acute MI,

heart failure, respiratory failure, pneumonia, sepsis/sirs, acute renal failure, and uti with and without catheter inclusion. There was no difference in mechanical-related complications such as a broken prosthetic joint/periprosthetic fracture or osteolysis/polyethylene wear. **DISCUSSION AND CONCLUSION:** TEA is important treatment for severe elbow pathology. Perioperative blood transfusion in TEA may serve as a simple metric to identify “sicker” patients. Surgeons should be aware that these patients may have higher rates of certain early complications and should pre-emptively counsel patients during admission and at discharge.

## **GENERAL SESSION 8: Pediatrics**

### **Continued Delay in Diagnosis of Slipped Capital Femoral Epiphysis**

Robert Runner, MD; Alexander M. Broom, BA; Lindsay M. Andras, MD; Kody Barrett, BA; Rachel Y. Goldstein, MD, MPH; Nicholas D. Fletcher, MD; David L. Skaggs, MD, MMM

**INTRODUCTION:** More than a decade ago, both Skaggs and Kocher et.al. reported significant delays in the diagnosis of slipped capital femoral epiphysis (SCFE). The purpose of this study was to identify if the time to diagnosis has improved. **METHODS:** A retrospective review of patients admitted with a SCFE at three large pediatric hospitals from January 2003 - December 2012. **RESULTS:** 478 patients with average age 12 years (range 5-18 years) met inclusion criteria. Average BMI was 28.7 (range 14.1-44.9). Over the entire study period, the average time from symptom onset to diagnosis was 16 weeks (range 0-169), and did not differ significantly between clinical sites. There was no statistically significant difference between the delay when separated into 2 year intervals: 2003-2004=11.4 weeks; 2005-2006=16.4 weeks; 2007-2008=18.4 weeks; 2009-2010=13.9 weeks; 2011-2012=19.8 weeks. 357 (74%) of the patients initially presented to a primary care clinic (PCC) or the emergency room (ER). Of those 357, 158 had documentation of date of initial evaluation at the PCC or ER and the average delay from PCC/ER initial evaluation to diagnosis of 5.2 weeks. Severity of the Southwick angle and grade of slip correlated with time from symptom onset to diagnosis. 15% had bilateral slips at time of presentation. There was no significant correlation between insurance status and delay in diagnosis. 56 patients developed a second SCFE with an average of 10 weeks between onset of symptoms and second SCFE diagnosis was significantly less than the overall mean delay for the initial SCFE presentation. 87% presented for their second SCFE while it was still a mild slip. **DISCUSSION AND CONCLUSION:** No improvement in the delay in diagnosis of SCFE was observed over the time period studied, and this delay was similar at all 3 geographically distinct locations across the U.S. Slip severity increased with increased time to diagnosis, thus a delay in diagnosis may worsen outcomes. There was a significant decrease in the time to diagnosis in patients with a second SCFE which suggests that patient and physician education of at risk children and parents may play a role in improving the management of this condition.

### **Spanning External Fixation for Open Joint Injuries in Pediatric Burns**

Daniel Torres, MD; Kelly D. Carmichael, MD; Matthew Comley, BS

**INTRODUCTION:** We report a case series on spanning external fixation (SEF) for treatment of open joint burn injuries in a pediatric population. **METHODS:** We reviewed the case logs of all orthopedic surgeons from 2000 to 2010 at a burn hospital to identify pediatric patients with open joints secondary to burn injuries. **RESULTS:** Nine patients who sustained open joint injuries after a burn and treated with an SEF were identified. Characteristics of the burns included: 5 elbow, 4 knee; 7 flame, 2 electrical; average total body surface area affected 49.4% (range 25%-79%); substantial third-degree burn in all patients. Average age at the time of the burn was 8.6 yr (range 2 mo-17.9 yr). Average time from the burn to SEF placement was 7.1 wk (range 3-10.5 wk). Before SEF placement, an average of 3.8 skin grafting

procedures (range 1-7) were performed to treat the open joint injuries. SEFs remained in place for an average of 6.4 wk (range 3-9 wk). After SEF application, substantially fewer skin grafting procedures (average 0.8, range 0-3) were performed. There were 2 complications (22%) considered to be directly associated with the SEF procedure due to failure of fixation. **DISCUSSION AND CONCLUSION:** In our small, retrospective case series on placement of an SEF for an open joint burn injury in children, the number of skin grafting operations was almost 5 times greater before fixation than after. We recommend early SEF to help assist with soft tissue healing and decrease the number of skin grafting procedures in this population.

### **Tranexamic Acid and Its Efficacy in Pediatric Hip Reconstruction Surgery**

Ibidumo Igah, MBBS, MRCS; Claudia Maizen; Ebraheim Izadi

**Introduction:** Evidence that tranexamic acid reduces blood transfusion in surgical patients has been available for over a decade. Its effect on thromboembolic events and mortality remains uncertain. Only a few studies have involved major paediatric orthopaedic procedure. **Objective:** Reduce blood transfusion in major paediatric hip reconstruction, reduce morbidity, reduce patient hospital stay, determine need for larger designed paediatric trial. **Method:** Retrospective study of all patients who had hip reconstruction surgery done within a two year period by a single surgeon. **Results:** There were 37 patients in this study and age range was 2 – 15 years with average age of 8 years. 14 patients had tranexamic acid and tranexamic acid was used in more complex hip reconstruction surgery with 50% of these patients requiring intra-operative blood transfusion. 13 patients had no tranexamic acid but had less complex procedure and 31% required intra-operative transfusion. There was significant difference in decrease in haemoglobin level 24 hours post-operative in patients who had no transfusion with use of tranexamic acid against those who had no tranexamic acid (2.0mg/dl versus 3.3mg/dl;  $p < 0.05$ ) but no significant difference between patients who had intra-operative blood transfusion with or without use of tranexamic acid. **Conclusion:** This study suggests tranexamic acid efficacy in paediatric hip reconstruction surgery in reducing blood loss without significant morbidity or side effects. In future, a larger designed study would be required to confirm findings.

### **Perioperative Risk Factors after Intramedullary Nailing of Pediatric Femur Fractures**

Amit Momaya, MD; Dustin K. Baker, BS; Shawn R. Gilbert, MD; Brent A. Ponce, MD

**INTRODUCTION:** Over the past few decades, operative fixation of pediatric femur fractures with intramedullary implants has grown in **popularity. However, risk factors for short-term adverse events and readmission have not been well studied.** **METHODS:** Pediatric patients who underwent intramedullary nailing of a femur fracture between 2012 and 2013 were identified from the American College of Surgeons National Surgical Quality Improvement Program database. Risk factors for any adverse event (AAE) and readmission after intramedullary nailing were evaluated using univariate and multivariate analysis. **RESULTS:** A total of 522 pediatric patients who underwent intramedullary nailing of the femur were identified. The mean age was 10.2 +/- 3.8 years. A total of 18 (3.4%) patients had AAE, while 20 (3.8%) patients were readmitted and 13 (2.5%) underwent a reoperation. After a multivariate analysis, independent risk factors for AAE were cardiac comorbidities (odds ratio [OR], 12.7), open fractures (OR, 10.2), and prolonged operative time (OR, 17.5). Independent risk factors for readmission were central nervous system disorders (OR, 4.5) and seizure disorders (OR, 4.9). **DISCUSSION and CONCLUSION:** Multivariate analysis suggests that cardiac comorbidities, open fractures, and prolonged operative time increase the risk for AAE. Furthermore, central nervous system disorders and seizure disorders may increase the risk for readmission. Surgeons should be aware of these

risk factors and counsel the families of pediatric patients who undergo intramedullary nailing of femur fractures.

### **Comparison of Fatigue Characteristics of Fully and Partially Threaded Cannulated Screws Used for Stabilization of Slipped Capital Femoral Epiphysis**

Stephen Stacey, MD, ME; John DesJardins, PhD; William R. Barfield, PhD; Luke W. Pietrykowski, BS; James F. Mooney III, MD

**BACKGROUND** Cannulated screw systems are widely used for the treatment of slipped capital femoral epiphysis (SCFE), however, the optimal choice and number of implants has not been clearly defined in the literature. Prior studies have shown that two screws are biomechanically superior to a single screw in load-to-failure testing, but the fatigue performance of different screw designs has not been previously investigated. The primary research goal of this study was to compare the bending fatigue characteristics of fully threaded and partially threaded cannulated screws. **METHODS** Partially threaded and fully threaded 7.3 mm cannulated screws were subjected to cyclic loading on a custom materials testing fixture. The screws were tested in 3 point bending, with a force between 20-780 N applied at 10 Hz. The number of cycles to failure was recorded for each screw, as well as force and displacement data. **RESULTS** Partially threaded screws had a statistically significant higher mean number of cycles to failure than fully threaded screws. The partially threaded screws failed at an average of 32,305, and the fully threaded screws failed at an average of 20,942 cycles. **CONCLUSIONS** Partially threaded screws demonstrated higher number of cycles to failure when subjected to cyclic loading, suggesting they may be more resistant to fatigue failure than fully threaded screws under similar clinical loading conditions.

## **Saturday, July 18**

### **GENERAL SESSION 9: Sports Medicine 2**

#### **Left-Handed Pitchers ROM and Torsion Adapt Differently than Right-Handed Pitcher**

Ellen Shanley, PhD, PT, OCS; Charles A. Thigpen, PhD, PT, ATC; Richard J. Hawkins, MD; Douglas J. Wyland, MD; Michael J. Kissenberth, MD; John M. Tokish, MD

**Background/Objective:** The left-handed pitcher remains a premium in major league baseball (MLB)—as it is well accepted that “lefties” have several advantages against the right handed hitter. As such, lefties make up 30% of MLB pitching staffs, more than 3x the make up of the normal population. While much has been written about the adaptations in the throwing athlete, no study has evaluated these adaptations with respect to hand dominance. The purpose of this study was to examine the side-to-side differences in mature pitchers establishing handedness norms based on our belief that right and left-handed pitchers are different. **Methods:** Data was collected on 257 right and 72 left-handed pitchers (age range=16-32; mean 20.5 yo) prior to the 2010-2014 seasons. Bilateral shoulder ROM and HT was measured using validated techniques in pitchers who were currently asymptomatic. Side-to-side differences were calculated, (non-dominant – dominant) and groups were established based on handedness for analysis. A one-way ANOVA was used to assess the difference between right and left handed pitchers ( $\alpha=0.05$ ). **Results:** Side-to-side comparison of HT and ROM revealed that left-handed pitchers presented with less side-to-side differences than right handed pitchers for humeral torsion, internal rotation(IR), total arc of motion(TARC), and horizontal adduction(HA) ( $p>0.05$ ). As a group, right-handed pitchers demonstrated 4.5-10.1° more asymmetry than left-handed pitchers for all measures. **Conclusion:** Our results show that left-handed pitchers adapt differently to throwing than their right-handed counterparts. Adaptive changes

are known to play a role in injury risk, therefore, we believe that skeletally mature lefties may need to be evaluated separately from righties to determine specific risks, and unique adaptations affecting performance and injury rates in lefties. This is the first study elucidating the need to consider hand dominance in the skeletally mature pitcher. Future studies should examine right-handed vs. left-handed profiles based across all age groups.

### **Biceps Tenodesis Superior to Tenotomy in Young Large Cuff Repairs**

Keith T. Lonergan, MD; \*Christina S. Gutta, BS; Michael J. Kissenberth, MD; Stefan J. Tolan, MD; Richard J. Hawkins, MD; Charles A. Thigpen, PhD, PT, ATC

**Background** Biceps pathology is commonly observed in surgical management of patients with rotator cuff tears (RCTs). However, the optimal treatment of biceps pathology is unclear as few studies have compared tenotomy versus tenodesis in the setting of RCTs. Therefore, the purpose of this study is to compare the outcomes of biceps tenodesis versus tenotomy in the setting of RCTs in order to determine if and when an advantage exists for one technique over the other. **Materials and Methods** We retrospectively reviewed 134 patients (age=59.3±8.6, males=88) following rotator cuff repair with concomitant biceps procedure and a minimum 2-year follow up. Validated outcomes scores, including the American Society of Shoulder and Elbow Surgeons (ASES) score was completed before and after surgery. Patients were stratified by age, RCT size and biceps procedure (tenotomy or tenodesis). Separate mixed model ANOVAs (time by group) were performed to compare ASES scores between biceps procedure groups within each RCT size and age group. **Results** There were 91 tenodeses and 43 tenotomies. There were no differences in baseline ASES scores or demographics between the groups ( $P>0.05$ ). Overall patients displayed improvements in ASES scores ( $43\pm13$ ) post-operatively but there were no differences between biceps modalities within each RCT size group. However, Patients < 55 years old with RCTs > 4cm and biceps tenodesis ( $n=18$ ) demonstrated nearly twice the improvement ( $52\pm3$ ) in post-operative ASES scores compared to those with a biceps tenotomy ( $28\pm14$ ). This difference was not observed in patients > 55 years old or with rotator cuff tears less than 4cm. **Conclusion** This is the first study to demonstrate the superiority of tenodesis over tenotomy in setting of RCTs. Specifically, in younger patients with larger tears, tenodesis had nearly double the improvement in ASES score compared to tenotomy. Our results suggest biceps tenodesis should be considered over tenotomy with concurrent greater than 4cm rotator cuff repairs in patients < 55 years old.

### **Massive Rotator Cuff Tears Repaired with Interposition Porcine Xenograft**

Julie A. Neumann, MD; Miltiadis H. Zgonis, MD; Kathleen D. Reay, MD; Stephanie W. Mayer, MD; Blake R. Boggess, DO, FAAFP; Alison P. Toth, MD

**INTRODUCTION:** Surgical management of massive rotator cuff tears in shoulders without glenohumeral arthritis is a complex issue including a failure rate of 20-90% with primary repair. This manuscript addresses using interposition porcine xenograft as an alternative to traditional ways to treat massive rotator cuff tears. **METHODS:** 37 patients were prospectively observed for an average of 33 months (23-48 months) following repair of massive rotator cuff tears using porcine acellular dermal matrix allograft through a mini-open approach. Range of motion was recorded pre-operatively and post-operatively. Supraspinatus and infraspinatus strength was assessed manually using the 10-point scale defined by Kendall et al. (0=no muscle contraction, 10=normal power) pre and post-operatively. Quantitative strength in the supraspinatus and infraspinatus was measured post-operatively and compared to the contralateral side using a dynamometer. Pain score using the visual analog scale (0-10, 0 = no pain), Modified American Shoulder and Elbow Score (MASSES) and Short-Form 12 (SF-12) were collected for subjective and functional outcome measures. The integrity of the repair was assessed using static and



dynamic ultrasound at the most recent follow-up. **RESULTS:** Active range of motion improved from 133.2° to 157.9° in forward flexion, 51.56° to 64.25° in external rotation, and 49.8° to 74.0° in internal rotation. Manual strength testing of the supraspinatus and infraspinatus increased from 7.3 to 8.9 and 7.4 to 9.4, respectively. Quantitative strength in the supraspinatus and infraspinatus in forward flexion was an average of 88.1N in the non-operative shoulder and 68.6N in the operative shoulder and 59.3N and 50.6N, respectively, in external rotation. Mean VAS pain level decreased from 4.5 to 1.1. Average post-operative MASES was 89.23. Ultrasound evaluation of the repairs showed 89.1% were fully intact, 8.1% had partial tears, and one repair was not intact. **DISCUSSION AND CONCLUSION:** Patients have statically significant improvement in pain, range of motion and strength following repair of massive rotator cuff tears using interposition porcine acellular dermal matrix graft. The repair was completely intact in 89% of patients, a vast improvement compared with results reported for primary repairs of massive rotator cuff tears. Tissue grafts such as the porcine acellular graft used in our study hold great promise in the treatment of massive, retracted rotator cuff tears.

### **Differences in Pitchers' UCL Morphology and Elbow Gapping Following Reconstruction**

Michael J. Kissenberth, MD; Charles A. Thigpen, PhD, PT, ATC; Lane B. Bailey, PT, DPT, CSCS; Douglas J. Wyland, MD; Thomas J. Noonan, MD; Ellen Shanley, PhD, PT, OCS

**Introduction:** Ulnar collateral ligament reconstruction(UCLR) of the elbow has received much attention given the rise in incidence among all pitchers. Recent studies have demonstrated stress ultrasonography is a critical tool in the evaluation of the UCL. . No study, has dynamically evaluated the UCL in uninjured professional pitchers under stress, nor has any study evaluated the ability of UCL reconstruction (UCLR) to restore normal kinematics. The purpose of this study was to compare ulnohumeral gapping and UCL thickness in both uninjured professional pitchers and those who had undergone UCLR during a moving valgus stress test. We hypothesized that the UCL will be thicker and the ulnohumeral joint will display adaptive gapping in D arms compared to ND arms. Furthermore we hypothesized that UCLR would restore gapping and UCL morphology.. **Methods:** Ultrasonography was used to assess the UCL of 70 asymptomatic professional baseball pitchers during spring training (history of UCLR, n=6). A 5-MHz linear-array transducer was used to capture images of the dominant (D) and non-dominant (ND) throwing elbows at the maximal cocking position under two loaded conditions within the moving valgus stress test arc:(1) gravity stress and (2)-10 lbs of valgus force using a dynamometer. Ulnohumeral gapping and UCL thickness was measured on sagittal images using the OsiriXTM platform. All measures displayed reliability with intraclass correlation coefficients (ICC) ranging from ICC(2,1)=0.94 -0.98 with Standard error of measure (SEM) of 0.14-0.26 mm for intra-rater and ICC(2,k)= 0.82-0.87; SEM=0.38-0.65mm for inter-rater reliability. Separate mixed model ANOVAs(side X UCL) were used to compare pitchers' D and ND arm variables between those with UCLR to those who never had a UCL injury.( $\alpha=0.05$ ) **Results:** The D arms of uninjured pitchers demonstrated increased gapping compared to ND arm ( $5.4 \pm 1.2$  vs  $4.7 \pm .86$   $p=0.001$ ) Players with a UCLR demonstrated decreased gapping compared to both the ND and uninjured D arms of professional pitchers. ( $2.6 \pm 2.9$  vs  $4.2 \pm 1.2$ ;  $P=0.002$ ), Furthermore, the UCLR elbows demonstrated greater D arm ligament thickness when compared to D arms in pitchers without UCL injury history( $17 \pm .07$  vs  $11 \pm .08$ ;  $P=0.03$ ).. **Conclusions:** This is the first study to our knowledge evaluating stress ultrasonography of the UCL during the moving valgus stress test in professional pitchers. Our data demonstrates that the UCLR results in a thicker, stiffer construct with less medial elbow gapping than even the normal condition. Using ultrasound to evaluate the UCL it was shown to be reliable, more efficient and provides a clinically feasible method to assess UCL thickness, loaded joint gapping, and stiffness post-UCLR. Future studies may consider this approach to evaluate surgical techniques and graft types for UCL reconstruction.

## **Biceps Tenodesis Superior to Tenotomy in Massive Irreparable Cuff Tears**

Michael J. Kissenberth, MD; \*S. Dane Swinehart, BS; Stefan J. Tolan, MD; John M. Tokish, MD; Keith T. Lonergan, MD; Charles A. Thigpen, PhD, PT, ATC

**Background/Objective:** Patients with massive irreparable rotator cuff tears with a diseased biceps tendon have been shown to significantly benefit from debridement of the cuff tear and treatment of the biceps with either tenotomy or tenodesis. No study, however, has addressed the rate of conversion of this patient population to reverse shoulder arthroplasty (rTSA), nor has any study differentiated between biceps tenotomy vs. tenodesis regarding this conversion. The purpose of this study was to examine the rate of failure of debridement of a massive rotator cuff tear and biceps treatment defined by subsequent reverse total shoulder (rTSA) and compare this conversion rate stratified by biceps tenotomy vs. tenodesis.

**Methods:** Sixty-one patients with massive (> 2 tendons or > 5 cm), irreparable rotator cuff tears treated with debridement and biceps tenotomy or tenodesis (17 tenodesis, age=62 yo and 47 tenotomies, age=61 yo) were retrospectively reviewed with a minimum of 3 year follow up (3.5±1.2 yrs). Gender, BMI, size of tear, activity level/occupation, and reoperation date were recorded. All surgeries were performed by fellowship trained, board certified surgeons between 2008-2010. Fifty-four percent of surgeries were revisions. Failure was defined as progression to rTSA as determined by continued pain and dysfunction deemed unacceptable by the patient and confirmed by the attending surgeon. All subsequent surgeries were rTSA in this study. All patients had medical records within the EMR for other care as an indirect confirmation of no loss to follow up for failures. Separate one-way ANOVAs were used to compare age, BMI, and time to rTSA and Chi Square analyses were used to compare the activity level, and gender between rTSA groups and biceps groups ( $\alpha=0.05$ ). **Results:** Thirty-seven percent of all patients who underwent debridement and a biceps procedure went on to have a rTSA within 3 years (1.8±1.5 yrs). Patients who received a biceps tenotomy (n=20, 46%) were significantly more likely to go to a rTSA compared to those with a biceps tenodesis (n=3, 18%;  $\chi^2=4.1$ ). There were no differences in age, BMI, gender, or activity level between groups. There was a trend for patients to go onto a rTSA after biceps tenotomy (1.6±1.5 yrs) sooner than biceps tenodesis (2.1±1.6 yrs). **Conclusions:** Thirty-seven percent of patients with irreparable, massive rotator cuff tears in our study went on to rTSA within 3 years. Furthermore, patients who received a debridement and biceps tenodesis were 4x less likely to receive rTSA. Clinical relevance: Biceps tenodesis appears to be superior to biceps tenotomy for patients with massive, irreparable rotator cuff tears and biceps pathology.

## **Perioperative Transfusion Predicts Early Prosthetic-Related Complications in Total Shoulder Arthroplasty**

Abiram Bala, BA; Colin T. Penrose, BS; Thorsten M. Seyler, MD, PhD; Timmothy R. Randell, MD; Richard C. Mather III, MD; Michael P. Bolognesi, MD; Grant E. Garrigues, MD

**INTRODUCTION:** 90-day prosthetic related complications are an important metric in hip and knee arthroplasty in the Medicare population, yet these guidelines have not been established for total shoulder arthroplasty (TSA). TSAs are rising in the Medicare population however the transfusion rate has remained constant. The purpose of this study was to determine if perioperative blood transfusion predicts early post-operative complications in Medicare patients who underwent TSA. **METHODS:** We retrospectively queried 116,537 total and reverse shoulder arthroplasties in a Medicare database containing 100% of inpatient and outpatient administrative records from 2005 to 2011 using PearlDiver technologies. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes were used to identify the procedure, patient demographics, Elixhauser comorbidities, and post-operative complications. Rates (R), odds ratios (OR), and 95% confidence intervals (CI) were calculated. 90-day complications returning an OR >1.75 were considered substantial. **RESULTS:** 10,559 patients received perioperative blood transfusion and 105,978 did not.

Patients who received perioperative blood transfusion had higher prevalence of comorbidities and were older, suggesting a “sicker” cohort. Bivariate analysis revealed these patients had higher 90-day rates of prosthetic related complications including: periprosthetic infections (OR 2.48, CI 2.02 – 3.04), cellulitis/seroma (OR 2.10, CI 1.81 – 2.44), prosthetic dislocation (OR 1.75, CI 1.48 – 2.06), and broken prosthetic joint/periprosthetic-fracture (OR 2.04, CI 1.61 – 2.59). There was no difference in early TSA revision/repair rates. The same patients had statistically significant higher rates of medical complications including acute MI, respiratory failure, stroke, PNA, sepsis/sirs, acute renal failure, and UTL.

**DISCUSSION AND CONCLUSION:** TSA remains an important treatment modality for numerous indications. Perioperative blood transfusion may serve as a useful metric to identify sicker patients. Surgeons should be aware that these patients may have higher rates of early complications and should preemptively counsel patients during admission and at discharge.

### **Oral Contraceptive Use Predicts Fewer ACL Reconstructions in Young Females**

Aaron M. Gray, BS; Zbigniew Gugala, MD, PhD; Jacques Baillargeon, PhD

**INTRODUCTION.** We hypothesized that reducing swings in serum estrogen through use of oral contraceptives (OCs) would reduce the incidence of ACL injury. Previous reports on the question lack the number of subjects necessary to derive meaningful conclusions and have used subject recall years after injury rather than prescription data to determine OC use. **METHODS.** We conducted a retrospective case-control study using Clinformatics Data Mart to determine the odds of whether females aged 15 to 39 years who underwent ACL reconstruction were more likely to be users or nonusers of OCs. All cases of ACL reconstruction were matched 1:3 to non-injured controls by geographic region, date of procedure, and age. **RESULTS.** A total of 12,819 cases of ACL reconstruction were identified that met our inclusion/exclusion criteria. Overall, there was no association between ACL reconstruction and OC use. Stratification by 5-year age groups yielded a pattern of increasing adjusted odds ratios, however, suggesting that an age effect may have biased our data. For ages 15 to 19 years (46% of all cases), case subjects were 22% more likely not to be using OCs compared with control subjects. In the group aged 20 to 24 years, cases again were more likely to be OC nonusers compared with users. **DISCUSSION AND CONCLUSION.** A retrospective, large database study showed that females aged 15-24 years who used oral contraceptives had lower odds of undergoing cruciate ligament reconstruction than those who did not use them. We estimate that 1 in 5 ACL injuries requiring reconstruction could be prevented through the use of OCs alone.

### **Association of Torsion, ROM, and Little Leaguer’s Shoulder and Elbow**

Ellen Shanley, PhD, PT, OCS; Charles A. Thigpen, PhD, PT, ATC; Amanda Arnold, PT, DPT, OCS, SCS; Richard J. Hawkins, MD; John M. Tokish, MD; Michael J. Kissenberth, MD

**Background/Objective:** Young throwers(8-16) make up more than 90% of baseball players and epiphyseal injuries (little leaguer’s elbow/ shoulder) are among the most common injuries in these pitchers. The extreme forces of repetitive throwing hypothesized to result in stresses to the epiphyseal plates that eventually cause adaptation in dominant humeral torsion (HT). When these stresses exceed the ability of the bone to remodel an injury to epiphyseal plates is observed presenting as Little League Shoulder (LLS) or Elbow (LLE). While alterations in HT and range of motion (ROM) are associated with arm injury in adult pitchers no study has established these factors for pitchers diagnosed with LLS and LLE. The purpose of this study was to compare dominant (D) HT and ROM of youth pitchers LLS and LLE with age-matched controls. **Methods:** Ninety-two youth/adolescent baseball players (47 cases and 47 matched controls; average age-13.8 and 13.7yo, respectively) were enrolled in the study. Bilateral shoulder ROM and HT was assessed using a digital inclinometer (DI) and indirect ultrasonography(US).

These measures were assessed in supine for external rotation(ER), internal rotation(IR), horizontal adduction(HA) ROM with the scapula stabilized at 90° of abduction. All healthy controls were measured at the beginning of the spring season prior to participation in official team activities. All cases(LLS-n=23 and LLE-n=26; 2 both) presented for PT treatment following radiologic confirmation of diagnosis by tertiary orthopedic practice. ROM and HT were assessed for cases after resolution of pain prior to return to sport. Separate one-way ANOVAs were used to compare HT and ROM measures (dominant arm, and side-to-side deficits) between groups, with a Tukey's HSD for planned post hoc comparisons( $\alpha=0.05$ ). **Results:** Youth pitchers with LLS and LLE displayed less D ER, HA, and total arc of rotation but equivalent D IR when compared to controls. Youth pitchers with LLS also displayed greater D HT (less retrotorsion) when compared to cases(9.9) and a similar trend between LLS and those with LLE(7.8). There were no significant differences observed for D IR or side-to-side ROM.( $P>0.05$ ) **Conclusions:** Youth pitchers with epiphyseal injuries display clinically meaningful alterations in D arm ROM when compared to age-matched controls. Those pitchers with LLS displayed less D humeral retrotorsion than pitchers with LLE or age matched pitchers without an injury history. **Clinical relevance:** Players with epiphyseal injuries present with alterations in D arm ER and HA ROM but not IR when compared to age matched controls. Additionally, alterations in humeral retrotorsion appear different between LLS and LLE and warrant further investigation.

### **Minimalist Running: an Orthopaedic Point of View**

Julie A. Neumann, MD; LCDR Jonathan M. Roth, MD; Matthew A. Tao, MD; William E. Garrett, MD

**INTRODUCTION:** Up to 70% of habitually shod runners sustain injuries annually. Minimalist running and its beneficial effects on injury rates, running performance, and soft tissue recovery are controversial. This study is a literature review of clinical data to provide information about the pros and cons of minimalist running as it pertains to orthopaedics. **METHODS:** Three independent orthopaedic surgeons conducted a literature search was conducted through PubMed which included publications from both orthopaedic and nonorthopaedic journals from 1987 to 2014 was conducted to review minimalist running. **RESULTS:** Minimalist running results in decreased ground reaction force (GFR), decreased contact time with the ground, decreased peak forces, a 3-fold decrease in average loading rate, absent impact transient, decreased leg stiffness, decreased ankle stiffness, improved energy storage and recovery in the Achilles tendon, decreased compartment pressures in chronic exertional compartment syndrome, decreased patellofemoral joint stresses and improved energy efficiency when compared to shod running. Critics believe that lack of cushion and support associated with barefoot has led to Achilles tendinitis, metatarsal stress fractures, and plantar fascia injuries due to increased plantar flexion and resultant stress across the foot. **DISCUSSION AND CONCLUSION:** There is no clear consensus for or against minimalist running. Additional studies on this minimalist running are needed such as an industry standard for minimalist running shoes as well as a consensus on an effective, safe transitioning program from shod to minimalist running.

### ***SOA/OREF Resident Award Winner***

### **Comparative Effectiveness of Viscosupplement and Corticosteroid Injections for Knee Osteoarthritis**

Jonathon R. Staples, MD; James A. Keeney, MD

**Background:** In spite of wide utilization of viscosupplement (VSI) and corticosteroid injections (CSI) in the treatment of knee osteoarthritis (OA), direct clinical and cost effectiveness comparisons have not been detailed. **Methods:** After obtaining IRB approval, we retrospectively evaluated 155 consecutive patients (200 knees) who received CSI or VSI to treat knee OA. Patients' osteoarthritis was verified and staged

(Mild/Moderate/Severe) by weightbearing radiographs evaluating percentage joint space narrowing, osteophyte formation and joint congruency. We then assessed the type (corticosteroid, visco supplement, or both), number, and frequency of intra-articular knee injections the patients received over 4 years period and whether arthroplasty surgery had been accomplished within 7 years of initial injection. Injection success was defined by symptom resolution or recurrent injection at accepted intervals with documented pain relief (CSI- 3 months, VSI- 6 months). Injection failure was defined by inadequate pain relief, additional injection(s) before accepted time intervals, or arthroplasty surgery within 2 years of the first injection. Cost effectiveness was calculated using average reimbursement for major joint arthrocentesis (\$110/injection), facility contracted direct material cost for CSI (\$6.45/ injection), VSI (\$240-405/ series) injections, and proportional patient response based on injection type (CSI vs VSI) and radiographic disease severity. **Results:** More patients were successfully treated with CSI than VSI (70.2% vs 57.0%), most notably among patients with moderate OA (82.1% vs 45.5%). The annual cost per patient of successful CSI was less than successful VSI (\$202 vs \$1073), with the least cost-effective care delivered to patients with mild OA receiving VS injections (\$1963) and most cost-effective care for patients with mild radiographic arthritis receiving a corticosteroid injection (\$86). Twenty-four patients (12%) underwent a TKA, including 16 patients (23.9%) with severe OA, 6 patients (9.2%) with moderate OA, and 2 patients (4.2%) with mild OA. **Conclusion:** CSI are more cost effective than VSI in the management of knee OA and should be used as a first line injection approach for most patients.

### ***Harley & Betty Baxter Resident Award Winners***

#### **Is Ketorolac the Next Intra-Articular Knee Injection for Osteoarthritis?**

Jaime L. Bellamy, DO, MS; Siraj A. Sayeed, MD; Brandon J. Goff, DO

**INTRODUCTION:** Knee osteoarthritis (OA) is a disabling disease affecting 9 million adults in the United States. In 2004, it cost >\$200 billion to treat osteoarthritis and a large sum of that was the cost of medicines. Corticosteroid is the gold standard for knee injection therapy, but it has varying amounts and durations of pain relief. Additionally, it can cost up to \$12 per injection. Ketorolac injection alone has not been studied in knee OA and the cost per injection is \$2. The aim of this study was to compare ketorolac to corticosteroid, as far as the amount and duration of pain relief, as well as, comparing validated patient outcome measurements. **METHODS:** Thirty-five patients were randomized to ketorolac or corticosteroid intra-articular knee injection in a double-blind, prospective study. Follow-up was 24 weeks. OA was evaluated on baseline and final follow-up radiographs using Kellgren-Lawrence (KL) grading. Injections were performed under ultrasound guidance. Visual analog scale (VAS), Western Ontario and McMaster University Osteoarthritis Index (WOMAC), Knee Society (KS), Short Form 36 (SF-36), Tegner Lysholm (TL) and University of California Los Angeles (UCLA) scores were compared. Age, gender, body mass index (BMI) and radiographic grade were correlated to VAS. Two-way, repeated measures ANOVA and Spearman-Rank Correlation were used for statistical analysis. **RESULTS:** Mean VAS for ketorolac and corticosteroid decreased significantly from baseline at two weeks, 6.3 to 4.6 and 5.2 to 3.6, respectively, and remained for 24 weeks. Mean WOMAC score for ketorolac and corticosteroid increased from baseline at 2 weeks, 49 to 53 and 53 to 68, respectively. There was no significant difference in KS, SF-36, TL, and UCLA scores among ketorolac or corticosteroid throughout the 24 weeks. There was no correlation between VAS and age, gender, BMI or KL grade within treatments. **DISCUSSION AND CONCLUSION:** Pain relief was similar between ketorolac and corticosteroid injection for knee OA. The WOMAC score was increased for both treatments at two weeks, with no difference in other outcome measures. Ketorolac intra-articular knee injection is safe and effective and is low cost compared to corticosteroid for OA.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

## **Visualization of Experimental Bone Defects by CT at Reduced Doses**

Jamie J. Alexander, MD; Zbigniew Gugala, MD, PhD; Ronald W. Lindsey, MD; John A. Hipp, PhD; Jay Sawyer Croley, MD

**INTRODUCTION.** In orthopedics, only in scoliosis imaging have clinical efforts been made to reduce CT radiation doses because of the need for multiple imaging. We examined whether decreasing the radiation dose in a porcine model would decrease quantitative and qualitative abilities to analyze defects. **METHODS.** Paired fresh-frozen porcine hindlegs--five with bicortical femur defects created with drill bits 1.59, 1.98, 2.38, 2.78, 3.18, and 3.57mm in diameter and five unaltered--were scanned after thawing to simulate routine CT of both legs to approximate the amount of scatter and absorption that occur in clinical situations. The control scan was the standard radiation dose; the subsequent scans had the dose decreased to 60%, 40%, 20%, and 10% of that dose. The scans were assessed (NIH DICOM PROGRAM; ImageJ) by three chief radiology residents blinded to the doses. CT interpretation included the number of defects, location and diameter of each defect, and whether the defects were easily seen. **RESULTS.** The defects were identified by the residents with 95.9%, 100%, and 77.0% accuracy. The actual average numbers of defects identified by the radiologists were between 6.2 and 6.4 with an intraclass coefficient of 0.81 estimated by linear mixed modeling. The precision of reading was calculated as the difference between the observed and actual size of the defect. From the multivariate linear mixed model, there was no significant association between dose and precision adjusted for the power, actual defect size, and defect location. **DISCUSSION AND CONCLUSION.** The ability to reliably and precisely detect bone defects as small as a hole 1.59mm in diameter is feasible with CT radiation doses reduced to 10% of the standard clinical dose. The results indicate the possibility of routinely applying CT imaging with significantly decreased radiation dose for skeletal imaging, thereby lowering the risks associated with ionizing radiation exposure.

## **RAPID FIRE SESSION 10A: Mixed Topics/General Orthopaedics**

### **Risk Factors for Disease Progression after Surgical Treatment of Extremity Metastatic Bone Disease**

Mitchell R. Klement, MD; \*Elizabeth J. Scott, BA; Brian E. Brigman, MD, PhD; William C. Eward, MD, DVM

**Background:** Radiotherapy is effective in achieving pain relief in 70-80% of patients with metastatic bone disease. However, large lesions, impending fractures, and completed fractures traditionally require surgical stabilization in conjunction with radiotherapy. While there is literature describing the behavior of metastatic lesions after radiotherapy, little exists on evaluation of disease progression after surgical intervention. **Methods:** Retrospective chart review included all patients greater than 18 years of age who underwent surgical treatment for metastatic bone disease between 2006 and 2012 with at least 9 month radiographic follow up. Patients with metastasis to the spine and pelvis were excluded. Factors evaluated included patient and lesion characteristics such as age, gender, location, size, tumor histology, quality, and Mirel's score. Surgical treatment details evaluated included procedure performed, timing of surgery, and adjuvant treatments administered. Postoperative radiographs were assessed for disease progression based on criteria described by Harada et al. on final follow up. **Results:** Overall, 28.9% (11/38) of patients experienced radiographic disease progression as defined by increasing size and bony destruction. Male gender, tumor histology, and type of surgical implant used were associated with a statistically significant increase in disease progression at final follow up. There was no difference in patient age, lesion size, character, or location in those whose disease progressed versus those who did not. Initial Mirel's score,

adjuvant chemotherapy, time from disease to metastasis, and time from metastasis to orthopedic intervention were not associated with disease progression. **Discussion and Conclusion:** Certain patients are likely to progress despite multimodal therapy for their at-risk skeletal lesions. Male gender and tumor histology have been associated with significant increase in progression of metastatic disease after surgical treatment in our study. For patients with high risk disease, resection and endoprosthetic reconstruction should be considered as an alternative to prophylactic fixation and radiation.

### **Novel Intraoperative Laser Ablation System for Treatment of Residual Sarcoma**

Alexander L. Lazarides, BSc; Melodi J. Whitley, BS, BA; David B. Strasfeld; Diana M. Cardona; Jorge M. Ferrer; Suzanne Bartholf Dewitt, DVM; Brian E. Brigman, MD, PhD; David G. Kirsch, MD, PhD; William C. Eward, MD, DVM

**Introduction:** Treatment of soft tissue sarcoma (STS) involves tumor excision with a wide margin. However, a critical unmet need in surgical oncology is the ability to detect and remove microscopic residual disease. Previously, we described a novel hand-held imaging device prototype that uses proprietary fluorescent probe (LUM015) to identify microscopic residual cancer during surgery. We have recently developed a pulsed Nd:YAG laser ablation system that works in conjunction with our imaging system to selectively remove cancer cells based on their activation of the fluorescent probe. In this study, we aimed to demonstrate that laser ablation, when paired with an intraoperative imaging system, can selectively ablate tumor tissue with high precision and improved outcomes. **Methods:** Tumors were generated in 30 tumor-bearing mice in a Braf c/+; P53 flox/flox model, which were injected intravenously with 3.0 mg/kg LUM015 and sacrificed 6 hours after injection. Mice were randomized to one of three cohorts: positive margins with laser ablation; positive margins without laser ablation; and negative margins. Tumor beds were examined for the presence of fluorescence above our threshold (indicating tumor). Regions with fluorescence above the threshold were subjected to ablation with our pulsed laser. Mice were then followed for recurrence. Additional studies were conducted characterizing the ablation cleft of the laser in tumor tissue on a histopathological level. **Results:** All tissue identified with fluorescence above the tumor-containing threshold was confirmed to be tumor on histopathology. Ablation of cancer cells via direct vaporization was visualized in the form of ablation clefts correlating with known passes of the laser. Ablation clefts demonstrated precise and predictable depth and width with minimal underlying thermal necrosis. Mice with residual sarcoma subjected to laser ablation demonstrated significantly improved recurrence free survival as compared to untreated mice with residual disease. **Conclusion:** In this study we demonstrate a system that combines a laser ablation module with our fluorescence-imaging device to selectively ablate cancer cells. This system generates ablation clefts with precise depth control and minimal underlying tissue damage while improving recurrence free survival.

### **Does Obesity Affect Soft-Tissue Sarcoma Outcomes**

John R. Harris, MD; Corey O. Montgomery, MD, MS; Sean M. Morell, MD; Margaret Wilson; Richard Nicholas, MD; Larry Suva, PhD

**INTRODUCTION** Obesity is widely recognized as not only an important medical issue but also a complicating influence in the management of a variety of complex medical problems. However, little information is available regarding the impact of obesity on patient outcomes in rare malignancies such as the group of cancers classified as soft tissue sarcomas (STS). Our hypothesis is that obesity would be associated with higher complication rate and negatively affect survival outcomes (stage, recurrence and death) in relation to STS. **METHODS** A retrospective chart review of treated STS was performed of patients undergoing surgical resection of extremity STS between January 2004-September 2013. 118

patients were identified after hand and forearm cases were excluded based upon the easy visibility of the hand/forearm being unlikely to impact time to identification of the tumor. Specific patient and tumor characteristics were recorded that included tumor size at diagnosis, site, grade, stage, primary or recurrence, complications and survival outcomes. For the analysis patients were stratified according to a BMI greater than 30 kg/m<sup>2</sup> classified as obese (43 patients) and patients with a BMI < 30 kg/m<sup>2</sup> as non-obese (75 patients). **RESULTS** Analysis revealed patients with a BMI  $\geq$ 30 had significantly larger sarcomas and a more advanced tumor stage at diagnosis. Furthermore, 25% of both non-obese and obese patients required surgical intervention for complications. In addition, a significantly decreased overall survival was observed for patients with a high grade sarcoma in the obese group at the 2-year survival interval. **DISCUSSION and CONCLUSION** In sum, the findings presented here suggest that obesity not only negatively affects STS management with increased post-surgical complications but is also significantly associated with decreased overall survival. We conclude that BMI should be considered in the evaluation and treatment plan of patients with STS.

### **Optimal Treatment of Malignant Long Bone Fracture**

Robert E. Holmes, MD; E. Lex Hanna, MD; Yongren Wu, PhD; William R. Barfield, PhD; Joseph Stains, PhD; Vincent D. Pellegrini Jr., MD

**Introduction** External beam irradiation is the cornerstone of treatment for metastatic bone disease. Intramedullary nails allow fracture motion and cause healing via cartilage callus, while plate and screw fixation is rigid and results in direct bone healing. We set out to determine if there is an optimal method of surgical repair of pathologic fractures in the setting of an irradiated fracture. **Methods** 18 Sprague-Dawley rats underwent bilateral diaphyseal femoral fractures. Left femurs were operatively fixed using a rigid construct. Right femurs were fixed using an intramedullary nail. Half of the animals were irradiated with 80cgy on postop day 3. The fracture site was excised, analyzed and sent for comparison of RNA expression. The amount of callus was compared for control and irradiated rats. **Results** In irradiated animals, 6 of 9 displayed no callus formation, while the rest displayed minimal callus formation. Controls displayed moderate to abundant callus formation in all 9 animals. **Results** of RNA analysis are currently pending. **Discussion and Conclusion** Pathologic femoral fractures are often treated with intramedullary nailing. Preliminary data in a bilateral femur fracture model suggest that primary bone healing as achieved by rigid plate fixation, is less affected by radiation treatment than secondary bone healing which results in cartilage callus formation.

### **Tranexamic Acid Reduces Allogeneic Transfusion, Hematocrit Decrease Compared to OrthoPAT**

Thomas M. O'Gorman; Andrew A. Shinar, MD

**INTRODUCTION** Recently, perioperative tranexamic acid (TA) has become a preferred method of reducing allogeneic transfusions in hip and knee arthroplasty. Prior methods have included blood recycling systems, such as the OrthoPat system, which have the disadvantages of increased cost, possible patient reactions, and extra nursing care. The goal of this study was to retrospectively determine which method was more effective at reducing allogeneic transfusions and stabilizing individual hematocrit levels. **METHODS** We studied 400 consecutive patients of the senior author who underwent total hip, total knee, or unicondylar replacement. The first 200 patients received either OrthoPat or no extra treatment intraoperatively, depending on transfusion risk. The second 200 patients received either 2000 mg intravenously of TA or OrthoPat intraoperatively, depending on contra-indications to TA. **RESULTS** The protocol for the first 200 (mainly OrthoPat) yielded 30 transfusions (with a hematocrit drop of 24%), while the second (mainly TA) protocol yielded only 16 (with a hematocrit drop of 22%), a nearly statistically significant result. Of these 16 transfusions, 10 occurred in those 40 who received OrthoPat, in



whom TA was deemed contra-indicated. Within the groups, TA significantly reduced allogeneic blood transfusion postoperatively as compared to OrthoPAT (.04 vs. .25 units/patient). OrthoPAT was not shown to significantly decrease the number of postoperative allogeneic blood transfusions as compared to no treatment (.186 vs. .076 units/patient). TA significantly lowered the percent change in hemoglobin levels as compared to OrthoPAT (21.52% vs. 25.77%) However, OrthoPAT did not significantly reduce the percent change in hemoglobin levels as compared to no perioperative treatment (23.91% vs. 24.36%). **CONCLUSION** Tranexamic acid significantly reduced the average number of units of allogeneic blood transfused postoperatively and significantly mitigated the change in hematocrit levels from pre-operation to discharge. OrthoPAT, a more expensive alternative, did not demonstrate significance compared to no treatment in either of these categories.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

### **Outcomes among Illicit Substance Misusers Undergoing Hip or Knee Arthroplasty**

Leonard T. Buller, MD; Matthew J. Best, BS; Alison K. Klika, MS; Wael K. Barsoum, MD

**Introduction:** Illicit drug misuse is associated with poor health consequences in multiple patient populations, but its influence on outcomes following primary total hip (THA) or knee (TKA) arthroplasty is poorly understood. This study sought to evaluate the association between illicit drug misuse and perioperative complications in patients undergoing primary THA or TKA. **Methods:** The National Hospital Discharge Survey was used to identify a cohort representative of 8,379,490 patients who underwent primary THA or TKA from 1990-2007. Patients were split into two groups: 1) those with a diagnosis of illicit drug misuse (cannabis, opioids, cocaine, amphetamines, sedatives, inhalants or mixed combinations) and 2) those with no diagnosis of misuse. Demographic data were collected and the groups were analyzed for differences in length of hospital stay, discharge status complications and mortality. **Results:** A total of 13,163 illicit drug misusers underwent THA or TKA over the study period. Compared with non-drug misusers, drug misusers had longer hospital stays and were nearly eight times more likely to leave against medical advice. Those who misused illicit drugs demonstrated an increased risk for complications including postoperative infection, anemia, convulsions, osteomyelitis, and blood transfusions while also having five times the mortality rate. **Discussion and conclusion:** This study demonstrates that patients who misuse illicit drugs are at significantly increased risk of having poor outcomes following primary THA or TKA compared to those who do not misuse illicit drugs.

### **RAPID FIRE SESSION 10B: Total Joint Arthroplasty**

#### **Use of Intravenous Perioperative Tranexamic Acid in Total Joint Arthroplasty: the Military Experience**

Peter M. Formby, MD; Adam Pickett, MD; Gregory S. Van Blarcum, MD; Andrew Mack, MD; Michael T. Newman, MD

**Objective:** Tranexamic acid (TXA), an antifibrinolytic drug, has recently received widespread interest in the total joint arthroplasty literature and has shown to reduce the need and amount of allogeneic blood transfusion when used either intravenously or topically. Tranexamic acid has yet to be studied in the military adult reconstruction population. The purpose of our study was to investigate the effect of intravenous TXA in a cohort of patients undergoing hip and knee arthroplasty at a single military institution and compare postoperative hemoglobin level, transfusion rates, and venous thrombotic complications. **Methods:** We conducted a retrospective review of medical records at a single military

institution from Feb 2012 to Apr 2014. During this time period, all three adult reconstruction surgeons at our institution implemented the use of 1 gram TXA acid administered intravenously prior to incision and another 1 gram TXA acid at the time of closure. The patients were divided into 2 groups, those who had received TXA and those who did not. We compared intraoperative blood loss, preoperative and postoperative hemoglobin levels, transfusion rates, and postoperative thrombotic complications in these patients. **Results:** During the time period studied, there were 222 patients that underwent either total knee arthroplasty (151) or total hip arthroplasty (71) and met inclusion criteria. We found 99 of the patients had received perioperative intravenous TXA and 123 did not. There was no significant difference in the mean hemoglobin levels, intraoperative blood loss, and postoperative thrombotic complications when comparing the 2 groups. However, TXA did significantly reduce transfusion rates and the amount of blood products used as compared to the group of patients that did not receive TXA. **Discussion and Conclusion:** Our analysis adds to the literature supporting the use of intra-operative TXA to significantly reduce the rate of transfusions as well as the amount of blood products used in the adult reconstruction population. The use of IV TXA for hip and knee arthroplasty is safe and effective in our cohort of patients at a military institution. Further studies may be warranted to see the effect of TXA use in other fields of orthopaedic surgery.

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### **Influence of Alcohol Misuse on Total Hip and Knee Arthroplasty**

Leonard T. Buller, MD; Matthew J. Best, BS; Alison K. Klika, MS; Wael K. Barsoum, MD

**Introduction:** Alcohol misuse is associated with postoperative complications in multiple patient populations, but its influence on outcomes following primary total hip (THA) or knee (TKA) arthroplasty is poorly understood. **Methods:** The National Hospital Discharge Survey was used to identify a cohort representative of 8,372,232 patients (without cirrhosis) who underwent THA or TKA between 1990 and 2007. Patients were split into two groups: 1) those who misused alcohol and 2) those who did not. Demographic data were collected and the groups were analyzed for differences in comorbidities, perioperative complications, and discharge status. **Results:** A total of 50,861 patients with a diagnosis of alcohol misuse (i.e., alcohol dependence or alcohol abuse) underwent THA or TKA between 1990 and 2007. Compared to patients with no diagnosis of alcohol misuse, alcohol misusers were nine times more likely to leave against medical advice and had longer hospital stays ( $5.2 \pm 3.2$  days compared to  $5.1 \pm 4.2$  days). Alcohol misuse was independently associated with higher odds of in hospital complications (OR: 1.334, range: 1.307-1.361), surgery related complications (OR: 1.293 range: 1.218-1.373) and general medical complications (OR: 1.300, range: 1.273-1.327). **Discussion and conclusion:** This study demonstrates that patients who misuse alcohol, even in the absence of cirrhosis, are at significantly increased risk of multiple perioperative complications compared to patients who do not misuse alcohol, when undergoing primary THA or TKA.

### **Complex Total Joint Arthroplasty: Length of Stay and Discharge Disposition?**

Eric M. Greber, MD; Paul K. Edwards, MD; Kevin M. Cullinan, MHA; D. Gordon Newbern, MD; C. Lowry Barnes, MD

**INTRODUCTION:** Total hip and knee arthroplasty is increasing while there is continued pressure to decrease cost of each episode. Alternative payment models such as episode-of-care and bundled payments attempt to decrease entire episode cost. The purpose of this study was to determine if certain complex patients that fall under the DRG 469/70 are associated with longer length of stay and higher rate of

discharge disposition to location other than home. **METHODS:** We performed a retrospective review of the last 2349 cases at our institution. All patients that were included in DRG code 469/70 during the study period were included. 80 patients with complex CPT codes including 27125 (hemiarthroplasty of hip), 27236 (open treatment of femoral neck fracture), 27132 (conversion of hemiarthroplasty or previous hip surgery to total hip arthroplasty), 20680 (removal of deep implant), and 27445 (fracture of distal femur requiring distal femoral replacement) were identified. Length of stay and discharge disposition were then compared between these complex “primary” joint replacements and the control group of primary joint replacements. **RESULTS:** Length of stay was 3.03 days for “complex” patient group and 1.56 for rest of patients. 37.5% of “complex” cohort were discharged to location other than home compared to only 6.2% of the control group. **DISCUSSION:** As we approach the future of alternative payment models, it is important that joint replacement surgeons understand which patients will likely become cost outliers in the DRG 469/70 for the hospital. We found that patients with “complex” associated CPT codes had significantly higher LOS and rate of discharge to somewhere other than home. These complex episodes cost more than their counterparts. As payment schemes change, we must develop a better understanding of the intricacies of these alternative models.

### **Perioperative Management of the Thrombocytopenic Patient in Total Joint Arthroplasty**

Devin S. Ganesh, MD; Andrew Hanna, BS; Ashley R. Humphries, BA; George J. Haidukewych, MD

**Introduction:** Post operative anticoagulation in patients undergoing total joint arthroplasty can become complicated by thrombocytopenia. Bleeding risks versus the risk of thromboembolic phenomenon determine a practitioner’s threshold for holding anticoagulation at certain platelet levels. Due to the rare nature of this disease, little research has looked into the perioperative management of chronically thrombocytopenic patients in total joint arthroplasty outside of heparin induced thrombocytopenia (HIT). We sought to retrospectively examine the management and outcomes of these patients to determine the risk of hematoma formation should anticoagulation be given versus thromboembolic phenomenon should it be withheld. **Methods:** Nine-hundred thirty-six total knee and total hip arthroplasties performed from January, 2009 to June, 2014 were retrospectively reviewed examining preoperative platelet levels. Those with less than one-hundred thousand platelets were determined to be significantly thrombocytopenic by the authors and were included in the study. The patient’s records were examined for means of anticoagulation, reoperation due to hematoma formation, need for transfusion, and diagnosis of deep venous thrombosis (DVT) or pulmonary embolism (PE). **Results:** Eleven patients were found with preoperative platelet levels less than one-hundred thousand. **Six** of the eleven (54.5%) required perioperative transfusion of platelets while 27.2% required packed red blood cell transfusion. Three patients received only mechanical DVT prophylaxis while eight received pharmacophylaxis in the form of either enoxaparin, warfarin, or fondaparinux. No patient underwent reoperation for hematoma or developed thromboembolic disease. **Discussion and conclusion:** An increase in frequency of significant bleeding leading to reoperation or excessive transfusion in patient’s with thrombocytopenic patients was not elucidated in this case series. Using once a day dosing of enoxaparin or restarting patients home dose of warfarin without excessive bridging therapy appears safe in thrombocytopenic patients. Larger case series and further research is required to fully explore perioperative management.

### **Primary THA in the Super Obese: Dramatically Higher Postoperative Complication Rates Even When Compared to Revision Surgery**

James A. Browne, MD; \*Matthew D. Higgins, MD; Joshua T. Carothers, MD; Brian C. Werner, MD

**INTRODUCTION:** Recent studies have reported higher postoperative complication rates in obese and morbidly obese patients undergoing total hip arthroplasty (THA). Less data is available regarding super

obese (BMI greater than 50 kg/m<sup>2</sup>) patients. This study aims to 1) quantify the risks of primary THA in this patient population, and 2) put these risks in context by comparing them to revision THA surgery, typically assumed to be higher risk than primary surgery. **METHODS:** Utilizing a large national database (PearlDiver), 90 day complication rates after THA in super obese patients (n = 1,694) were compared to non-obese, obese, and morbidly obese patients undergoing primary THA as well as all patients in the database undergoing revision THA. **RESULTS:** Super obese patients had significantly higher rates of local and systemic complications compared to all other BMI groups (p value less than 0.001) including higher rates of venous thromboembolism (5.1%), infection (11.7%), and medical complications (26.6%). Compared to non-obese patients, the super obese had an odds ratio (OR) of 18.1 (95% CI 15.6 – 21.1) for local complications and 8.8 (95% CI 8.0 – 9.8) for systemic complications. Substantially higher rates of local and systemic complications were noted even compared to those patients undergoing revision THA (OR of 3.5 [95% CI 2.9 – 4.1] and 5.7 [95% CI 5.1 – 6.4], respectively). **DISCUSSION AND CONCLUSION:** Super obese patients have dramatically higher rates of postoperative complications at 90 days, even compared to patients undergoing revision THA. To our knowledge, this is the largest study to date looking at super obese patients undergoing THA and includes substantially higher numbers of patients than previous studies. The risks of primary THA in this population are dramatically higher than even those seen with revision THA surgery.

### **Resident Education and Physician Extenders in TJA: Costs and Outcomes**

Carlos J. Lavernia, MD; \* Jesus M. Villa, MD

**INTRODUCTION:** Physician Assistants (PA-C) are assuming an increasingly important and growing scope of practice. We hypothesized that in an arthroplasty service, the use of a PA-C instead of orthopaedic residents would not be detrimental to hospital length of stay (LOS), costs, or patient perceived outcomes (PPOs). **METHODS:** Within one year, 200 consecutive patients underwent total hip/knee replacements by a single surgeon in a single institution. Residents took care of patients (n=89) in the first half of the year while the PA-C did it (n=111) on the second one. Patients were retrospectively studied. **RESULTS:** Compared with the PA-C group, residents had longer LOS (by 1.9 days; p<0.001) and higher hospital costs (over \$1,500 higher per case; p<0.05). Postoperatively, PPOs were not significantly different. **DISCUSSION AND CONCLUSION:** Increasing the utilization of PA-Cs in orthopedic surgical practices may mitigate the growing costs of arthroplasty surgery and relieve working hour resident shortages without adversely affecting hospital resources or patient outcomes.

### **RAPID FIRE SESSION 10C: Spine**

#### **Sagittal Balance and Lordosis Correction in Lateral Interbody Fusion**

Daniel J. Blizzard, MD; Michael A. Gallizzi, MD, MS; Charles Sheets, PT; Megan E. Eure, MS; Christopher R. Brown, MD

**INTRODUCTION** Sagittal balance restoration has repeatedly been shown to be an important determinant of outcomes in corrective surgery for degenerative scoliosis. Lateral interbody fusion (LIF) is a less-invasive technique which permits the placement of a high lordosis interbody cage without the inherent risks associated with traditional anterior or transforaminal interbody techniques. Multiple studies have shown improvement or correction in lumbar lordosis in patients following LIF, but only one small study has yet to quantify sagittal balance in this population. The purpose of this study is to evaluate the ability of LIF to restore sagittal balance in degenerative lumbar scoliosis. **METHODS** Thirty-five patients who underwent LIF for degenerative thoracolumbar scoliosis from July 2013 to March 2014 were included in this retrospective study. Outcome measures included sagittal balance, lumbar lordosis, Cobb

Angle, and segmental lordosis. Measures were evaluated pre-operative, immediately post-operatively, and at their last clinical follow-up. Repeated measures ANOVAs were used to assess the differences between pre-operative, first post-operative, and a follow-up visit. **RESULTS** The average sagittal balance correction was not significantly different: 1.06cm from 5.79cm to 4.74cm forward. The average Cobb angle correction was 14.1 degrees from 21.6 to 5.5 degrees. The average change in global lumbar lordosis was found to be significantly different: 6.3 degrees from 28.9 to 35.2 degrees. **DISCUSSION and CONCLUSION** LIF is a minimally-invasive and reduced-morbidity technique that permits the placement of a large, lordotic interbody cage. This study demonstrates that LIF reliably restores lordosis, but does not significantly improve sagittal balance. Despite this, patients had reliable improvement in pain and functionality suggesting that sagittal balance correction may not be as critical in scoliosis correction as previous studies have indicated.

### **Computer-Assisted Navigation Versus Fluoroscopy in Anterior Transpedicular Screw Targeting**

Andrew G. Patton, MD; Randal P. Morris, BSc; Yong-Fang Kuo, PhD; Ronald W. Lindsey, MD

**INTRODUCTION.** Computer-assisted navigation (CAN) has demonstrated enhanced posterior pedicle screw placement at all spine levels; however, its efficacy in anterior transpedicular screw (ATPS) placement has not been determined. The objective of this study was to compare the accuracy of CAN systems to fluoroscopy in targeting ATPS. **METHODS.** The anterior vertebrae of nine fresh frozen cadaver cervical spines were exposed, with preservation of the lateral and posterior neck soft tissue envelope. After the specimens were foam mounted in plastic containers, nine practicing spine surgeons were recruited to place 2mm titanium anterior transpedicular Kirschner wires into the C3-T1 pedicles bilaterally using fluoroscopy or CAN guidance. Specimens were then imaged by computed tomography (CT) and analyzed with CT imaging software to overlay 3.0mm or 3.5mm virtual screws on the K-wires, depending on pedicle dimensions. Targeting accuracy in all planes was then compared between the two techniques using an accuracy grading scale. Only virtual screw positions in which the virtual screw was entirely contained within the pedicle cortex) were considered acceptable. **RESULTS.** Fifty-four pedicles were instrumented using each imaging technique. The percentage of acceptable screw placements for fluoroscopy and CAN were 42.6% and 66.7%, a statistically significant difference. Catastrophic screw placement was 33.3% for fluoroscopy and 16.7% for CAN, also a statistically significant difference. Overall accuracy rates significantly correlated with increasing width but did not correlate with placement order or height. A trend was seen with accuracy and descending spinal level but did not reach statistical significance. **DISCUSSION AND CONCLUSION.** Despite the higher accuracy of the CAN system, catastrophic virtual ATPS placement and the risk for spinal cord or vertebral artery injury were still high. Although surgeon experience may improve ATPS targeting, more accurate navigation modalities are warranted before this technique can be recommended for widespread clinical implementation.

### **Persistent Axial Neck Pain after Cervical Disc Arthroplasty: a Radiographic Analysis**

Scott C. Wagner, MD; Daniel G. Kang, MD; Gregory S. Van Blarcum, MD; Peter M. Formby, MD; Ronald A. Lehman Jr., MD

**INTRODUCTION:** There is very little literature examining radiographic parameters for placement of CDA, nor is there substantial evidence evaluating the relationship between persistent postoperative neck pain and radiographic outcomes. Therefore, we set out to perform a single center evaluation of the radiographic outcomes, including associated complications, of CDA. **METHODS:** We performed a retrospective review of all patients from a single military tertiary medical center from August 2008 to August 2012 undergoing CDA. Preoperative, immediate post-operative and final follow up films were evaluated. The clinical outcomes and complications associated with the procedure were also examined.

**RESULTS:** A total of 312 patients were included in the review, with an average radiographic follow-up of 14 months and a 15.1% rate of persistent axial neck pain. For patients with persistent neck pain, the rates of heterotopic ossification (HO) formation and osteolysis were 27.7% and 14.9%, respectively, while the rates were significantly lower for patients without neck pain (12.8% and 6.2%, respectively). There was a significant association between severity of HO and the presence of neck pain. There were no differences in pre-operative facet arthrosis, pre- or post-operative disc height, segmental range of motion or placement of the device relative to the posterior edge of the vertebral body. However, patients with implants more centered between the uncovertebral joints were more likely to experience posterior neck pain. **DISCUSSION AND CONCLUSIONS:** We found that posterior, axial neck pain is relatively frequent after CDA, and patients with persistent neck pain were significantly more likely to have developed heterotopic ossification or implant-related osteolysis. The severity of the HO was also significantly associated with neck pain. We also found that patients with implants that were placed off-centered were less likely to also complain of neck pain, though the reasons for this finding remain unclear.

### **Outcomes after Operative Management of Combat-Related Low Lumbar Burst Fractures**

Peter M. Formby, MD; Scott C. Wagner, MD; Daniel G. Kang, MD; Melvin D. Helgeson, MD

**INTRODUCTION:** Combat-related lumbar burst fractures have been documented at an increased incidence during the Iraq and Afghanistan conflicts. We set out to report the intermediate outcomes of service members with operatively managed low lumbar fractures. **METHODS:** Retrospective analysis of patients undergoing spine surgery designated as engaged in Operations Enduring and/or Iraqi Freedom between 01JUL2003 and 01JUL2013. Medical records and radiographs were reviewed for all patients treated with combat-related lumbar burst fractures (L3-L5). We included all patients who underwent operative fixation in theatre or at our institution. **RESULTS:** Twenty-four patients with an average age of  $28.1 \pm 67.2$  sustained low lumbar (L3-L5) burst fractures. The average injury severity score was 22.6. Six patients sustained gunshot wound(s), fifteen sustained blast injuries from an improvised explosive device, in addition to one crush and one MVA injury. The average number of thoracolumbar levels injured was  $2.9 \pm 1.4$ . Nine patients had evidence of neurologic injury, three of which were complete. The average number of levels fused was  $4.3 \pm 2.1$  with fixation extending to the pelvis in four patients (17%). Ten acute postoperative complications occurred; seven required reoperation. One patient required late reoperation for nonunion. Average clinical follow-up was  $3.3 \pm 2.2$  years. At latest follow-up, all were retired from military service or were undergoing separation, ten (43%) experienced persistent bowel/bladder dysfunction, fifteen (65%) had persistent neurological symptoms, seventeen (74%) had documented persistent low back pain, and nineteen (83%) had chronic pain. **DISCUSSION and CONCLUSION:** Low lumbar burst fractures are rare injuries with an increased incidence in current combat casualties. Few studies have examined the intermediate outcomes after operative management of these injury patterns. We found a high rate of acute postoperative complications (43%), low back pain, and a high reoperation rate (30%), suggestive that surgical management of low lumbar burst fractures is fraught with complications.

### **C5 Nerve Palsy in Posterior Cervical Spinal Surgery: Does Width of Laminectomy Matter?**

Mitchell R. Klement, MD; Lindsay T. Kleeman, MD; Daniel J. Blizzard, MD; Michael A. Gallizzi, MD, MS; Megan E. Eure, MS; Christopher R. Brown, MD

**Introduction:** A common complication of cervical laminectomy and fusion with instrumentation (CLFI) is development of post-operative C5 nerve palsy. A proposed etiology is excess nerve tension from posterior drift of the spinal cord after decompression. A larger laminectomy width at C5 measured on

MRI has been associated as a risk factor in a recent study. The purpose of this study is to evaluate laminectomy width as a risk factor when measured on CT and to assess correlation to palsy severity. **Methods:** Retrospective chart review included all patients with cervical spondylotic myelopathy (CSM) who underwent CLFI between 2007 and 2014 by a single surgeon. Patients who underwent CLFI for trauma, infection, or tumor or had previous or circumferential cervical surgery were excluded. Patients with a new C5 palsy all received a postoperative MRI. An additional CT scan was ordered to assess hardware. All control patients received CT scan at 6 months postoperatively to evaluate fusion. Patient comorbidities such as obesity, smoking history, and diabetes were recorded in addition to pre- and postoperative deltoid and biceps motor strength. Pre- and post-operative radiographic measurements included C2-7 Cobb angle. Blinded width of laminectomy measurements were made postoperatively on CT scan. **Results:** Seventeen patients with C5 nerve palsy and 12 matched controls were identified. There were no baseline differences in age, sex, BMI, diabetes, smoking history, number of laminectomy levels, or sagittal alignment. There was no significant increase in laminectomy trough in width in patients with postoperative C5 palsy. There was no correlation of laminectomy trough width and palsy severity. **Discussion and Conclusion:** Laminectomy width at any level was not associated with an increased risk of postoperative C5 nerve palsy when measured on CT imaging, a modality more reliable for bony measurements. Reduction in laminectomy width may not reduce rate of postoperative nerve palsy.

### **Interbody Cage Height affects Subsidence after Transforaminal Lumbar Interbody Fusion**

Peter M. Formby, MD; Scott C. Wagner, MD; Daniel G. Kang, MD; Melvin D. Helgeson, MD

**INTRODUCTION:** A larger interbody cage footprint placed at the apophyseal ring is postulated to minimize implant subsidence after insertion. However, to our knowledge, no clinical or radiographic studies have analyzed interbody cage characteristics and risk factors for subsidence after TLIF.

**METHODS:** Retrospective review over a ten year period. We included all patients over age 50 following TLIF with immediate post-operative and follow-up computed tomography (CT) scans available. Medical records were reviewed for patient demographic information and surgical data, including number of levels fused, implant material/length/height, and the use of bone morphogenetic protein (BMP). **RESULTS:** We identified 128 patients with complete CT imaging and average follow up was 27.2 months. Fifty-five (43.0%) had evidence of implant subsidence at most recent follow up, with average erosion into the superior endplate of the inferior vertebral body of 5.5 millimeters. The remaining 73 patients had no implant subsidence, with no demographic differences between groups. The most commonly used interbody cage material was polyetheretherketone. The number of levels treated ranged from 1 to 4, with the subsidence group having a higher average number of levels fused (2 vs 1.7). BMP was used in 67.3% and 65.8% of patients in the subsidence and no-subsidence groups, respectively. Implant length averaged 21.4mm and 22.3mm in each group. Implant height was significantly higher in the subsidence group (12.6mm) when compared to the no-subsidence group (11.2mm). **CONCLUSIONS:** Our study found higher number of fusion levels and increased interbody cage height (1.4 mm difference between groups) were significantly associated with the occurrence of interbody cage subsidence after TLIF, with an average cage subsidence of more than half a centimeter. Our data suggest a larger interbody cage may ultimately lead to violation of the endplate over time, and the risk of interspace collapse must be considered during intraoperative implant height/size selection.

### **RAPID FIRE SESSION 10D: Hip**

#### **Total Hip Arthroplasty in Patients with Parkinson's Disease: Worth the Risks?**

Travis J. Dekker, MD; \* Colin T. Penrose, BS; Timmothy R. Randell, MD; Thorsten M. Seyler, MD, PhD; Abiram Bala, BA; David E. Attarian, MD; Michael P. Bolognesi, MD

**INTRODUCTION:** Parkinson's disease (PD) is a degenerative neurologic disease with musculoskeletal manifestations that can lead to post-operative complications in total joint arthroplasty. This study compares postoperative complications in patients with and without Parkinson's that undergo total hip arthroplasty (THA). **METHODS:** We conducted a retrospective review of a Medicare database from 2005 – 2011 using PearlDiver technologies. All patients who underwent primary THA were identified using both the corresponding ICD-9 procedure code (81.51) and CPT code (27130). The ICD-9 diagnosis codes for primary PD identified the cohort of patients who carried this diagnosis prior to the date of their THA. The reference group was defined as patients who did not carry a diagnosis of PD prior to their THA. Using relevant ICD-9 and CPT codes, we then identified the rates of various post-operative complications. **RESULTS:** Patients with PD who underwent THA demonstrated higher rates of prosthetic joint dislocation (5.56% vs 3.00% control), periprosthetic fracture (2.95% vs 1.68% control), and periprosthetic infection (3.72% vs. 2.56% control). Furthermore, these patient's had higher rates of post-operative medical complications to include heart failure (27.24% vs 16.65% control), pneumonia (25% vs 12.72% control), sepsis (12.21% vs. 6.06% control), urinary tract infection associated with catheter (47.23% vs. 28.44% control), and stroke (9.53% vs. 5.28% control). **DISCUSSION and CONCLUSION:** Parkinson's disease (PD) is a progressive neurodegenerative disease with musculoskeletal manifestations. The loss of dopaminergic neurons in the substantia nigra leads to cognitive decline, depression and impairment of the autonomic nervous system leading to tremors and gait instability. As a result, patients with PD are at higher risk for falls. This study demonstrates patients with PD have statistically significant higher rates of periprosthetic fracture and dislocations. Furthermore, these patients are at higher risk for periprosthetic infections and carry higher rates of medical complications following primary elective THA.

### **Severe Hardware Impingement Seen Via Hip Arthroscopy following Prior In-Situ Pinning of an Unstable SCFE Lesion**

Ross M. Dunbar, MD; Misty Suri, MD; Deryk G. Jones, MD; Stephen D. Heinrich, MD

**INTRODUCTION:** Unstable SCFE lesions can be devastating injuries, and they have great potential to cause long term complications. AVN, chondrolysis, hardware-related complications, and functional restrictions are well described. We present a case of severe hardware impingement discovered during hip arthroscopy and report our result after hardware removal.

**METHODS:** We report a case of a 13 year-old female who presented to us 1.5 years after she underwent in situ pinning of an acute-on-chronic slipped capital femoral epiphysis. She had developed debilitating hip pain, gait abnormality, and severe range-of-motion limitations of her involved hip. Imaging studies revealed profound degenerative changes, AVN of her femoral head, global labral degeneration, and evidence of FAI. We proceeded with hip arthroscopy, as other surgical options such as fusion and arthroplasty posed too great a morbidity risk in such a young patient.

**RESULTS:** Intraoperative hip arthroscopy revealed the expected findings of extensive chondrolysis and labral degeneration. An unexpected finding, however, was that her prior hardware was seen causing a severe mechanical block to hip motion as it encountered the acetabulum during hip flexion and rotation. Furthermore, it was directly visualized to be impinging on the labrum and further contributing to its damage and degeneration. The hardware was removed arthroscopically, and the patient had immediate, vast improvement in her range of motion about the involved hip.

**DISCUSSION:** Though there are limitations of hip arthroscopy in the setting of advanced degenerative disease, it is a low morbidity procedure which can address several underlying pathologic processes. As our case illustrates, this is especially true in pediatric patients who cannot entertain more permanent surgical options with higher morbidity. This case directly illustrates problems which can be encountered



by the hardware placed in cases of in-situ SCFE pinning, and it suggests arthroscopy as a therapeutic alternative for concomitant treatment of posttraumatic FAI and symptomatic hardware.

### **Total Hip Arthroplasty in Osteoporotic Patients: Medicare Data Review**

Timothy R. Randell, MD; Colin T. Penrose, BS; Abiram Bala, BA; Antonia F. Chen, MD, MBA; Samuel S. Wellman, MD; Michael P. Bolognesi, MD

**Introduction:** Osteoporosis is a progressive bone disease characterized by decreased bone mass and bone mineral density. These changes in the bone leads to an increased risk of fracture. This study compares Total Hip Arthroplasty (THA) complications in patients with the diagnoses of osteoporosis to those without the diagnoses. **Methods:** We conducted a retrospective review of a Medicare database from 2005 – 2011 using PearlDiver technologies. All patients who underwent primary THA were identified using both the corresponding ICD-9 procedure code (81.51) and CPT code (27130). The ICD-9 diagnosis codes for osteoporosis identified the cohort of patients who carried this diagnosis prior to the date of their THA. The reference group was defined as patients who did not carry a diagnosis of osteoporosis prior to their THA. Using relevant ICD-9 and CPT codes, we then identified the rates of various post-operative complications. **Results:** Osteoporotic patients were noted to have increased rates of periprosthetic fracture (1.91% vs 1.01%), prosthetic joint dislocation (3.76% vs 2.90%), and revision surgery (5.18% vs 4.48%). When looking at the 90 day post-operative complications, osteoporotic patients showed an increased risk of DVT (3.5% vs 2.71%), PE (1.4% vs 0.96%), and stroke (1.2% vs 0.88%). Osteoporotic patients were noted to have a decreased rate of osteolysis/poly wear (0.32 vs 0.35). **Discussion/Conclusion:** Osteoporosis is a progressive bone disease that can lead to poor bone quality and increased risk of fracture. The data demonstrates an increased rate of periprosthetic fracture, prosthetic joint dislocation, and revision surgery. Furthermore there is an increased rate for 90 day post-operative DVT, PE, and stroke. Osteoporotic patients do appear to have a greater resistance to osteolysis and poly wear.

### **Intergluteal Stripe Is Associated with Outcome after Endoscopic Abductor Repair**

Clint R. Beicker, MD; \*John M. Tokish, MD; Jason W. Folk, MD; Ellen Shanley, PhD, PT, OCS

**Objectives:** Tears of the gluteus medius tendon have become recognized as a source of disability and pain and have often been referred to as the "rotator cuff of the hip". Like the rotator cuff, the gluteal muscles can undergo fatty atrophic changes, but no study has evaluated the morphology of these changes, or more importantly, the effect this may have on outcome in patients undergoing endoscopic repair. The purpose of this study is to correlate patients' outcome after endoscopic gluteus medius repair with preoperative MRI findings. **Methods:** Forty-three patients (42 female, 1 male) with average age 59.3 years (range 43-88yrs) underwent endoscopic gluteus medius repair over a period of one year. Patients were included in the study if they had a documented preoperative MRI of bilateral hips, at least 2 year follow-up, and were available to be contacted for outcomes. Twenty-two patients met inclusion criteria. Outcome measures included IHOT-12 and modified Harris Hip scores. A single board certified fellowship trained orthopaedic surgeon who was blinded to outcomes evaluated the MRIs and noted that the operative side in patients demonstrated a characteristic widening of the intergluteal fatty area (referred to as Folk's stripe) as the medius and minimus atrophied after being torn. Folk's stripe was measured for both the operative and nonoperative side and analyzed to determine if qualities of this stripe were predictive of outcomes after endoscopic repair. Statistical analysis was performed using a paired t-test and associations were determined using bivariate correlation analysis. **Results:** The size of the intergluteal fat stripe differed significantly between operative and nonoperative sides of patients undergoing unilateral endoscopic gluteus medius repair. The area of the fat stripe on the operative side averaged 2.4cm<sup>2</sup> greater than the nonoperative side. The width of the fat stripe on the operative side

averaged 1.0cm greater than the nonoperative side. The width of the fat stripe on the operative side was significantly negatively correlated with outcome as determined by IHOT-12 scores ( $r=-0.59$ ). Modified Harris Hip scores at 2 year follow-up were not correlated with gluteal morphology. **Conclusion:** After a degenerative tear of the gluteus medius tendon from its insertion, the muscle undergoes a characteristic degenerative process. In particular, the space between the gluteus medius and minimus muscles develops increased fat signal seen on MRI as a characteristic fat stripe (Folk's stripe). This stripe is significantly wider and has significantly larger area than the nonoperative side and has a significant negative correlation with 2-year outcome as determined by IHOT-12. As the size of Folk's stripe increases, poorer outcomes were associated at 2 years.

### **Prospective Evaluation of Bone Density following Hip Arthroplasty Surgery in a Cohort of Young, Active Patients**

Ryan M. Nunley, MD; Denis Nam, MD, MSc; Staci R. Johnson, MD; John C. Clohisy, MD; Robert L. Barrack, MD

**Introduction:** Total hip arthroplasty (THA) and surface replacement arthroplasty (SRA) have been routinely performed in younger, more active patients who desire return to high impact activities. Data is limited evaluating modern cementless femoral THA and SRA and the long term results on femoral bone density in these patients. The purpose of this study was to determine the extent to which stress shielding occurs after modern cementless femoral THA and SRA, and whether patients can safely return to high impact activities. **Methods:** We prospectively enrolled 96 young, active patients (103 hips; 45 THA, 58 SRA) with pre-morbid UCLA scores  $\geq 6$ . UCLA and Harris Hip Scores (HSS) were collected and DEXA scans performed at 6 weeks, 6 months, 1, 2, and 5 years postoperatively. Bone density was analyzed for 7 traditional Gruen zones for all and 6 femoral neck zones for SRAs. Ratios were calculated for change in bone density from baseline. **Results:** Bone density was higher in SRAs than THAs at all intervals in Gruen zones 1, 2, 6, and 7, with greatest increase in zone L1 on the tension side between 6 months and 1 year. In THAs, bone density never returned to baseline during the 5 year period in Gruen zones 1, 2, 6, and 7, with greatest loss in zone 7. There were no differences in UCLA or HHS preoperatively or postoperatively. **Discussion and Conclusion:** Modern cementless THA shows decreased bone density in proximal femur Gruen zones 1, 2, and 7 over time. SRA shows increased bone density at all intervals and in most Gruen zones in a cohort of young, active patients. While it appears safe for young, active patients to return to high impact activities following hip arthroplasty, future developments in cementless femoral THA stems should aim to achieve less stress shielding of the proximal femur.

## **GENERAL SESSION 12: Hand and Upper Extremity**

### ***Harley & Betty Baxter Resident Award Winner***

#### **The Incidence of Propionibacterium Acnes in Open Shoulder Surgery: a Controlled Diagnostic Study**

Mitchell R. Klement, MD; William R. Mook, MD; Cynthia L. Green, PhD; Kevin C. Hazen, PhD; Grant E. Garrigues, MD

**Background:** Propionibacterium acnes has arisen as the most common microorganism identified using culture techniques at the time of revision shoulder arthroplasty. However, there is limited evidence to suggest how frequently false-positive cultures occur. The purpose of this prospective controlled was to evaluate culture growth from specimens obtained during open shoulder surgery. **Methods:** Patients undergoing an open deltopectoral approach to the shoulder were prospectively enrolled. Patients with a history of prior shoulder surgery, or any concern for active or previous shoulder infection were excluded

from prospective analysis. Three pericapsular soft tissue samples were taken from the shoulder for bacterial culture and incubated for 14 days. A sterile sponge was also analyzed in parallel with the tissue cultures. In addition, similar cultures were obtained from patients who had undergone previous surgery and included for retrospective analysis. **Results:** Overall, 20.5% (24/117) of surgeries yielded at least one culture positive for bacterial growth and 13.0% (7/54) of sterile control specimens had positive culture growth. *P. acnes* represented 83.0% (39/47) of all positive cultures at a median of 14 days of incubation. Among the subjects without previous surgery, 14.9% (13/82) had at least one positive *P. acnes* culture. Male gender and two or more preoperative corticosteroid injections (CSIs) were associated with a statistically significant higher likelihood of eventual bacterial growth in all patients and those with no previous surgery, respectively. **Discussion and Conclusions:** The clinical significance of positive *P. acnes* cultures at the time of open shoulder surgery remains uncertain. Male gender and preoperative corticosteroid injections were associated with a higher likelihood of bacterial culture growth and are risk factors that merit further investigation. The previously reported incidences of positive *P. acnes* culture results at the time of primary and revision shoulder arthroplasty may be overestimated due to substantial underlying bacterial culture contamination.

### ***SOA/OREF Resident Award Winner***

#### **Economic Impact of Preforming Elective Saturday Hand Surgery**

Jonathan Katz, MD; Dil Patel, MD; Ann Peterson, APRN-BC; Eric W. Angermeier, MD; Kyle P. Kokko, MD, PhD

**INTRODUCTION** The purpose of our study was to evaluate patient preferences and factors for elective Saturday hand surgery and to analyze economic and societal costs regarding missed days of work for elective hand surgery. We hypothesized that if given the option, the majority of patients would choose to undergo elective hand surgery on Saturdays. **METHODS** We retrospectively analyzed data on a 125 outpatient hand surgery patients seen at our institution beginning October 1, 2013, planning to undergo outpatient hand surgery. An anonymous quality improvement survey was distributed which included age, gender, zip code, education level, occupation, income level, and interest in Saturday hand surgery. We used SPSS software using Chi-square analysis to examine the data. **RESULTS** Forty-five males and eighty females answered the questionnaire. Seventy-eight (62.4%) of patients responded they would want to participate in elective Saturday hand surgery. Of those who reported income (n=66), the average daily salary of these patients was estimated to be \$223.44. If these patients had been given the opportunity to have Saturday hand surgery, a total of \$14,749.31 in lost income or paid leave would have been saved. We did not identify any significant factors (age, gender, education, job type, income, and distance from medical center) that correlated to patient's decision to undergo elective Saturday hand surgery. **DISCUSSION and CONCLUSION** Over half (62.4%) of our respondents would request Saturday elective hand surgery. Patients with higher earning potential were not more likely to elect for Saturday hand surgery. If 62.4% of operative hand surgery patients at our institution were to elect for Saturday surgery, we estimated a savings of over \$100,000 in lost wages or paid leave annually. If extrapolated to a national scale, the savings potential for patients is very meaningful.

### ***SOA Resident Travel Grant Award Winner***

#### **MRI Utilization for Rotator Cuff Tears by PCPs and Orthopaedists**

Jeremy C. Smalley, MD; \*Dane Daley, MD; R. Bryan Butler, MD; Richard J. Friedman, MD; Adam Griffith, BS; Russell Chapin, MD

**INTRODUCTION:** Magnetic resonance imaging (MRI) of the shoulder is commonly ordered for assessment of rotator cuff pathology but arguably the diagnosis of most shoulder pathologies can be made

by history, physical exam, and plain radiographs. Conservative treatment for 3 months is the initial treatment for most cases of rotator cuff pathology, and an MRI is not necessary indicated beforehand. Our hypothesis was that patients with shoulder MRIs ordered by non-specialists, such as primary care physicians, have a lower rate of preceding conservative therapy, appropriate x-ray workup, surgical tears on MRI, and subsequent surgery than patients with shoulder MRIs ordered by orthopaedic specialists.

**METHODS:** IRB approval for retrospective study and waiver of consent was obtained. A database search was performed on our institution's radiology archival system for shoulder MRI studies performed during 2013, and the relevant charts reviewed. Key inclusion criteria were age >40 and the availability of clinical records before and after MRI. Charts and MRI reports were categorized by ordering physician specialty and analyzed for clinical course and the presence and severity of rotator cuff tears. **RESULTS:** There were 204 patients who met criteria, 115 in the "Orthopaedic" group and 89 in the "PCP" group. The "Orthopaedic" group's patients received conservative care and imaging prior to MRI more frequently than the "PCP" group (61% vs 21% physical therapy, 39% vs 18% injections, 67% vs 34% xrays). Rates of partial tears and surgical tears on MRIs were similar between groups, with over 60% of patients having only partial tears. Patients in the "Orthopaedic" group more frequently had surgery. **DISCUSSION AND CONCLUSION:** In a patient population with comparable rotator cuff tear prevalence, orthopaedic specialists, more frequently than PCPs, provide conservative therapy prior to MRI for rotator cuff workup. Shoulder MRI may be utilized too early or too often in both groups.

### **Surgical Treatment Outcomes for Atraumatic Osteonecrosis of the Humeral Head**

Justin Kennon, MD; Jeffrey Smith, MD; David J. Janeira, BS; Lynn A. Crosby, MD

**INTRODUCTION** Humeral head osteonecrosis treatment varies among surgeons, generally guided by disease stage and symptomatology. Literature reports successful treatment outcomes with humeral head core decompression for stage I and II disease in steroid-induced osteonecrosis, but less data reported for sickle cell etiology. Surface replacement, hemiarthroplasty, and total shoulder arthroplasty (TSA) are common for advanced collapse with mixed results dependent upon etiology. In this prospective series, we evaluate radiographic progression and functional outcome following surgical intervention for humeral head atraumatic avascular necrosis (HAAVN). We evaluate core decompression efficacy in a highly prevalent sickle cell population and report outcomes of advanced disease requiring arthroplasty.

**METHODS** Between 2009 and 2014, 25 shoulders (20 patients) were treated surgically for HAAVN at a single institution by the principal investigator. Post-traumatic AVN patients were excluded. Stage I and II disease was treated with core decompression and postoperative ultrasound bone stimulator. Stage III was treated with surface replacement or hemiarthroplasty, while stage IV/V shoulders were treated with TSA. Post-operative radiographs and clinical scores were monitored on all patients. **RESULTS** 25 HAAVN shoulders were included – 13 sickle cell and 12 chronic steroid patients. 11 shoulders (stage I/II disease) underwent core decompression. 6 shoulders (86%) progressed to stage III after core decompression; all 6 being sickle cell patients. 16 shoulders had surface replacement or hemiarthroplasty (9 resurfacing, 3 hemiarthroplasty, 3 TSA, 1 reverse TSA). Constant, ASES, SST-12, and UCLA scores were significantly higher at 1 and 2-year follow-up. 13 patients (81%) had satisfactory to excellent results. 3 patients required revision surgery. **CONCLUSION** Our results suggest core decompression for early AVN in sickle cell patients does not alter the progression of osteonecrosis and progression to humeral head collapse, necessitating further surgical treatment. Resurfacing, hemiarthroplasty, and TSA are viable options for improving clinical outcomes with stage III, IV, or V disease.

### **Pre-Coutoured Olecranon Plate in Treatment of Comminuted Fractures - a Cadaveric Model**

David A. Hamilton Jr., MD, MBA; Danielle Reilly, MD; Felix Wipf, MS; Srinath Kamineni, MD

**INTRODUCTION:** Comminuted olecranon fractures pose unique management complexities resulting in variable clinical results. A standard tension band construct used for simple fracture patterns often fails in comminuted fractures as this construct relies on intact cortex on the compression side of the fracture. The purpose of this study is to investigate whether a pre-contoured locking plate construct is sufficiently robust to withstand physiologic stress in comminuted olecranon fractures. **METHODS:** Five samples of fourth generation composite sawbones and five samples of fresh frozen human cadaveric left ulnae were utilized for this study. The cadaveric specimens underwent dual-energy x-ray absorptiometry (DEXA) scanning to quantify the bone quality. The composite and cadaveric bones were prepared by creating a comminuted olecranon fracture and fixed with a pre-contoured olecranon plate with locking screws. Construct stiffness and failure load were measured by subjecting specimens to cantilever bending moments until failure. Fracture site motion was measured with differential variable resistance transducer (DVRTs) spanning the fracture. Statistical analysis was performed with two-tailed Mann-Whitney-U test with Monte Carlo Exact test. **RESULTS:** There was a significant difference in fixation stiffness and strength between the composite saw bones and human cadaver bones. Failure modes differed in cadaveric and composite specimens. No correlation was found between the DEXA results and stiffness. All cadaveric specimens withstood the physiologic load anticipated postoperatively. **DISCUSSION and CONCLUSION:** Anatomically pre-contoured olecranon plate and screw constructs are sufficiently robust to prevent excess fracture-site motion and maintain fracture fixation when subjected to physiological forces. Further clinical studies are needed to obtain clinically relevant validation of this conclusion.

## POSTER PRESENTATION ABSTRACTS

### **Risk Factors for Perioperative Blood Transfusion in Total Shoulder Arthroplasty**

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**INTRODUCTION:** The frequency of Total Shoulder Arthroplasty (TSA) is rising in the Medicare population, though the rate of perioperative transfusion has remained relatively constant. While risk factors for perioperative blood transfusion in TSA have been characterized, these have been in small cohorts of patients and often at single institutions. The purpose of this study was to examine the risk factors for perioperative blood transfusion in 116,537 TSAs performed in Medicare patients.

**METHODS:** We retrospectively queried 116,537 total and reverse shoulder arthroplasties in a Medicare database containing 100% of inpatient and outpatient administrative records from 2005 to 2011 using PearlDiver technologies. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes were used to identify the procedure, patient demographics, and Elixhauser comorbidities. Prevalence (PR), odds ratios (OR), and 95% confidence intervals (CI) were calculated. Comorbidities and demographic characteristics with an OR >1.75 were considered major predictors. **RESULTS:** The rate of perioperative transfusion was 9.1%. The following comorbidities returned as major predictors of perioperative blood transfusion: congestive heart failure (OR 2.10, CI 2.00 – 2.22), renal failure (OR 2.30, CI 2.18 – 2.44), history of lymphoma (OR 2.06, CI 1.79 – 2.40), history of metastatic cancer (OR 1.78, CI 1.53 – 2.07), fluid and electrolyte disorders (OR 2.00, CI 1.92 – 2.09), coagulation deficiency (OR 1.92, CI 1.79 – 2.07), weight loss (OR 1.90, CI 1.77 – 2.04), blood loss anemia (OR 2.46, CI 2.26 – 2.68), and deficiency anemia (OR 2.50, CI 2.41 – 2.61). The following demographic characteristics were also predictors of perioperative blood transfusion: female gender (OR 1.89, CI 1.81 – 1.98) and age > 85 (OR 2.46, CI 2.31 – 2.62). **DISCUSSION AND CONCLUSION:** Certain patient characteristics predict perioperative blood transfusion in TSA. Surgeons should be aware that these patients might require perioperative transfusion.

## **Factors for Perioperative Transfusion in Total Elbow Arthroplasty**

Abiram Bala, BA; \*Thorsten M. Seyler, MD, PhD; Colin T. Penrose, BS; Richard C. Mather III, MD; Samuel S. Wellman, MD; Michael P. Bolognesi, MD; Grant E. Garrigues, MD

**INTRODUCTION:** Total Elbow Arthroplasty (TEA) is an important treatment modality for complex fractures, rheumatoid arthritis, osteoarthritis, and chronic instability. While the rates and risk factors for blood transfusion in TEA have been characterized, these have been in small cohorts at single institutions. The purpose of this study was to identify risk factors for perioperative blood transfusion in 8,337 TEAs performed in Medicare patients. **METHODS:** We retrospectively queried 8,337 TEAs in a Medicare database containing 100% of inpatient and outpatient administrative records from 2005 to 2011 using PearlDiver technologies. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes were used to identify the procedure, patient demographics, and comorbidities based on the Elixhauser measure. Prevalence (PR), odds ratios (OR), and 95% confidence intervals (CI) were calculated. Comorbidities and demographic characteristics with an OR >1.75 were considered major predictors. **RESULTS:** The rate of perioperative transfusion was 9.3%. The following comorbidities returned as major predictors of perioperative blood transfusion: congestive heart failure (OR 2.34, CI 1.99 – 2.84), diabetes with chronic complications (OR 1.82, CI 1.43 – 2.32), paralysis (OR 2.07, CI 3.11), renal failure (OR 2.60, CI 2.12 – 3.19), HIV/AIDS (OR 1.8, CI 1.15 – 2.83), history of metastatic cancer (OR 2.15, CI 1.39 – 3.34), history of solid tumor without metastasis (OR 1.76, CI 1.42 – 2.20), coagulation deficiency (OR 2.31, CI 1.77 – 3.01), weight loss (OR 1.98, CI 1.55 – 2.54), fluid and electrolyte disorders (OR 2.09, CI 1.79 – 2.44), and deficiency anemia (OR 2.54, CI 2.19 – 2.95). Age 85 and greater predicted perioperative blood transfusion (OR 2.92, CI 2.44 – 3.50). Gender did not predict perioperative blood transfusion. **DISCUSSION AND CONCLUSION:** The above patient characteristics predict perioperative blood transfusion in TEA. Surgeons should be aware that these patients might require blood transfusion.

## **Pediatric Traumatic Amputations: A Multicenter 5-Year Review**

Allen Borne, MD; Austin Porter III, MPH; Corey O. Montgomery, MD, MS

**INTRODUCTION:** Pediatric traumatic amputations are potentially devastating injuries capable of causing permanent physical and psychological sequelae. Pediatric amputations have also been shown to be costly to both patients and the healthcare system. Few nationally representative studies characterizing trends of pediatric amputations exist in the literature. A significant number of traumatic amputations in children continue to occur despite evidence based prevention strategies. The objective of this study is to review the recent trends in pediatric traumatic amputations using a national databank. **Methods:** A review of all pediatric amputee patients was performed using the National Trauma Data Bank from 2007- 2011. Data including demographics, location of amputation, and mechanism of injury were collected and analyzed. **Results:** A total of 2,238 patients with amputation injuries were identified. The majority of amputations occurred in the youngest (0-5 year) and oldest (15-7 year) age groups with a 3:1 male to female ratio. Fingers (54%) and toes (20%) were the most common locations with above and below knee amputations (14.8%) following. A caught between mechanism (16.3%) was most common overall followed by machinery, lawn mowers, MVC, GSW, and off-road vehicles. Trends regarding age and amputation locations specific to each mechanism were identified. MVC was the most common mechanism of all adolescent amputations. Lawn mower amputations occurred mostly 0-5 year olds (56.6%) causing more severe amputations. Accidental GSW amputations occurred in young adolescents involving toes while intentional GSW injuries occurred in older adolescents involving BKA/AKA. **Conclusion:** This study is the second largest review of pediatric traumatic amputations using the most recent, nationally representative data. Recent trends show MVC and GSW are causing an increasing proportion of amputations. Lawn mowers continue to have significant impact on the youngest aged

children despite American Academy of Pediatrics recommendations. Prevention strategies should be evaluated and target appropriate age/mechanisms related trends.

### **Radiographic Assessments of Shoulder Radiographs for Radiographic Findings Correlating with Rotator Cuff Tears**

Seth Broster, BS; Srinath Kamineni, MD; Jeremy Burnham, MD; Paul Spicer, MD

**INTRODUCTION** Rotator cuff tear diagnosis can be conducted with X-ray rather than MRI to reduce cost while maintaining accuracy. Furthermore, this study provides a diagnosis tool to areas of the world without MRI resources. **METHODS** Health records of patients who had received both a shoulder AP X-ray and MRI within 90 days were collected (n = 121). 47% of these patients had a rotator cuff tear as determined by MRI. Reviewing physicians were presented with each patient's radiograph and answered five Yes/No questions regarding the presence of the following findings: (1) acromion change in shape (2) subacromial sclerosis or cysts (3) greater tuberosity change in shape (4) greater tuberosity sclerosis or cysts (5) change in acromial to humeral head distance. This data was compared to the presence of a tear as determined by MRI, the typical "gold standard" measure. **RESULTS** Preliminary data was gathered using orthopedic surgeons and radiologists. Using a cutpoint of 4/5 radiographic findings, the pilot data yielded an intraclass correlation (ICC) of 0.275 with a 95% confidence interval of (0.162, 0.393). The study is estimated to require a total of 21 reviewers to achieve statistical significance. Current data suggest that a cutpoint of 4/5 radiographic findings is 86% specific & 32% sensitive and a cutpoint of 5/5 findings is 93% specific and 21% sensitive. **CONCLUSION** Preliminary data suggest that for a subset of patients (estimated 32% of patients) X-ray can diagnose a Rotator Cuff tear with similar specificity to MRI (estimated 86%). This study highlights the need to continue collecting data in order to determine robust statistics. Amount of reviewers has doubled since initial statistics were run.

### **Predictors of Non-Routine Discharge following Spinal Fusion for Disc Disorders**

Leonard T. Buller, MD; Matthew J. Best, BS; Johnathan Falakassa, MD; David A. Vecchione, MD

**Introduction:** Intervertebral disc disorders are common causes of back pain that affect mobility and quality of life and are increasing in prevalence. Although outcomes following spinal fusion for intervertebral disc disorders have been studied, factors influencing discharge disposition and health care resource utilization have not been determined. This study sought to clarify perioperative risk factors for non-routine discharge and prolonged hospital stay in patients undergoing fusion for intervertebral disc disorders. **Methods:** The National Hospital Discharge Survey was queried to identify all patients discharged from U.S. hospitals following spinal fusion for intervertebral disc disorders between 1990 and 2007. A cohort representative of 1,943,707 patients was identified and separated into those who were discharged home and those who were discharged to rehabilitation facilities. Multivariable logistic regression analysis was used to identify independent predictors of non-routine discharge to another inpatient facility and prolonged hospital stay. **Results:** The strongest risk factors for non-routine discharge were age > 65 years, congestive heart failure, atrial fibrillation, any general in-hospital complication, diabetes mellitus, osteoporosis, hypertension and any surgery-related complication. Patients younger than 50 years and males had the lowest rate of non-routine discharge. The strongest risk factors for prolonged hospital stay were any surgery-related complication, congestive heart failure, any general in-hospital complication, atrial fibrillation, age > 65 years, osteoporosis and diabetes mellitus. Patients 36-50 years of age had the lowest risk of increased length of hospital stay. **Discussion and conclusion:** Knowledge of these risk factors may aid in better resource allocation and improved strategies for managing patients with intervertebral disc disorders in order to decrease healthcare costs.

## **Serious Complications of Shoulder Hardware Migration: A Systematic Review of the Literature**

Devin Collins, BA; Charles Mehlman, DO, MPH

**INTRODUCTION:** Pin migration from the shoulder has been well documented. It is estimated that more than six percent of fractures are about the shoulder, yet continued use of hardware fixation about the shoulder leading to serious life threatening migrations is still prevalent. The first incident of pin migration from the shoulder was a documented case report by Mazet in 1943. Many important vascular structures, organs and joints throughout the body are adversely affected by these hardware migrations. Many of the cases identified have led to serious-life threatening complications. A case report and literature review by Lyons and Rockwood in 1990 first addressed this topic. With a focus on patient associated outcomes as a measurement of medical success and reimbursements, it is imperative excellent patient outcomes are achieved on a consistent basis. The purpose of the present study was to determine the incidence of hardware migration about the shoulder leading to serious-life threatening complications from 1990 to present day, performing statistical analysis where appropriate. **METHODS:** An extensive search of the PUBMED and MEDLINE databases was performed with date restrictions of 1990 through 2014 to identify cases of hardware migration from the shoulder. Secondary outcome data extraction from serious-life threatening cases included the age of patients at time of migration diagnosis, time from surgical fixation to migration diagnosis, initial anatomic fixation and anatomical area shoulder hardware migrated. Biographies of included studies were reviewed to identify additional studies. Reviewers independently assessed the validity of each study and extracted data. **RESULTS:** Seventy-four studies were included from 1990 to 2014. One hundred eighty-two cases of migration from the shoulder were identified. Fifty-seven of these cases were identified as serious-life threatening. The average age at time of migration diagnosis was 52 and 70% of cases involved patients over the age of 40. The average time to detection of migration was twenty-four months. The majority of serious-life threatening cases occurred within two years and more than 50% occurred within four months. The sternoclavicular joint fixation had the fastest time to migration across all anatomical fixation groups and 100% of identified cases of sternoclavicular joint fixation resulted in serious-life threatening migrations. Cases of serious-life threatening migration were less likely to occur from fixation of the clavicle compared to all other fixation sites. Two deaths occurred from migrations about the shoulder since 1990; both migrations were from the proximal humerus and migrated to the heart. **CONCLUSIONS:** Although there have been advances in fixation of the shoulder complex and migrations have been well documented for over 70 years, there continues to be cases of serious-life threatening migrations from the shoulder involving pins, wires, screws and nails. This study further validates the importance of follow up for fractures about the shoulder and a need to design future research studies aimed at finding cost effective approaches to limiting shoulder hardware migrations with the intent of achieving excellent clinical and patient outcomes.

### **Extraskelatal Osteosarcoma of the Hand**

Ross M. Dunbar, MD; Mark Meyer, MD; Scott F. M. Duncan, MD, MPH, MBA; Gonzalo Sumarriva, BS; John Reith, MD

**INTRODUCTION:** Extraskelatal osteosarcoma (ESOS) is a malignant mesenchymal neoplasm that occurs without any attachment to bone or periosteum and produces osteoid, chondroid, or both. This tumor is exceedingly rare and only two other cases of ESOS of the hand have been documented. **METHODS:** A 46 year old African-American gentleman with no history of malignancy presented to clinic with a two year history of a right long finger mass. The patient was taken for excisional biopsy and the specimen was sent for pathology. Our in-house pathology team performed their analysis and sought consultation from 2 additional tertiary musculoskeletal pathology centers. **RESULTS:** All pathological consultants were in agreement that the specimen represented an extraskelatal osteosarcoma, and the



patient was referred to our musculoskeletal oncology team for further care. He ultimately underwent partial ray resection and was referred to medical oncology for consideration of chemotherapy and/or radiation therapy. **DISCUSSION:** ESOS is exceedingly rare and occurs as 1% of soft tissue sarcomas and 4% of osteosarcomas. There have been fewer than 400 estimated cases in the literature of ESOS. Extraskelatal osteosarcoma occurs predominantly in the lower extremity, in particular the thigh, and to our knowledge only 2 previous cases occurring in the hand have been reported. In contrast to skeletal osteosarcoma, which typically occurs in patients in the first two decades of life, ESOS occurs primarily in the fifth and sixth decades of life with a mean age of 47.5 to 61 years. Yet another unique consideration regarding this patient's tumor was its telangiectatic features. It is reported that almost all reported ESOS have shown conventional histology, rather than other histologic subtypes of high-grade osteosarcoma. The effectiveness of chemotherapy or radiation regarding this unique tumor has yet to be determined.

### **Inconsistent Responses Limit the Value of Multiple TKA Outcome Inventories**

James A. Keeney, MD; Denis Nam, MD, MSc; Ryan M. Nunley, MD

**Introduction:** Concerns that the use of single validated outcome instruments may not accurately represent total knee arthroplasty (TKA) performance has led some investigators to recommend the use a combination of inventories to provide greater detail. However, the consistency of patient responses when answering multiple inventories has not been defined. **Methods:** This was a retrospective review of 269 patient responses to four postoperative TKA inventories that included 24 parallel questions related to 11 low demand activity categories. Patient responses were assessed for concordance, partial concordance, and discordance. The influence of patient age, gender, and race on response consistency was also assessed. **Results:** Patients provided concordant answers for 72% of all questions (range 58.8- 86.3% for individual categories), partially concordant responses for 18% of questions (range 6.3%-29% for individual categories), and discordant responses for 10% of questions (range 2.6 – 14.5% for individual categories). Thirty percent of patients gave discordant responses for at least 2 of 11 question categories, unaffected by categorical age. Discordant answers were more commonly obtained from minority and female patients. **Conclusions:** While the use of single inventories may not perfectly define TKA performance, the use of multiple instruments to assess TKA outcomes introduces confounding effects that limit their benefit.

### **Sagittal Component Malposition Occurs during Obese Patient Total Knee Arthroplasty**

James A. Keeney, MD; Adam Sassoon, MD; Jacob Haynes, MD

**Introduction:** Technical factors have been associated with longer operative time and higher postoperative complication rates following total knee arthroplasty (TKA) performed for morbidly obese patients. While obesity has been associated with a higher risk for coronal plane tibiofemoral malalignment, the influence of obesity and individual component position on postoperative outcome scores has not been reported. **Methods:** We retrospectively assessed 110 TKAs performed for patients with morbid obesity (55 TKAs) or moderate obesity (55 TKAs) compared with 110 TKAs performed for non-obese patients. Postoperative weight bearing radiographs were assessed for coronal plane tibiofemoral, femoral component, and tibial component alignment. Lateral radiographs were assessed for tibial slope, femoral notching, and femoral component overhang. Postoperative functional performance was assessed using Knee Society, WOMAC, and SF-12 instruments obtained within 4 years of TKA. Revision rates were assessed up to 7 years after TKA. **Results:** Moderately (BMI 35) and morbidly obese (BMI 40) TKA patients were more likely than non-obese TKA patients to have femoral component malalignment (22% vs 10%), malalignment of both components (9% vs 1%), or femoral component overhang (29% vs 9%). Mean tibiofemoral angle was lower for morbidly obese than non-obese patients (2.8 vs 4.4 degrees), but

differences in tibial slope and femoral notching were not significant. Revision surgery rates within 7 years of surgery were not significantly different. While objective differences in component alignment were noted, no short term differences in any functional outcome instrument could be determined based on obesity class, coronal plane component malalignment, or the presence of sagittal plane femoral component malposition. **Conclusions:** Sagittal plane femoral component malposition occurs more commonly following TKA among obese than nonobese patients. Early postoperative functional scores do not appear to be adversely affected. Longer follow-up will be necessary to determine if sagittal component malposition increases risk for TKA failure in obese patients.

### **Risk Factors for Implant Failure in Surgical Treatment of Metastatic Bone Disease in the Extremities**

Mitchell R. Klement, MD; Elizabeth J. Scott, BA; Brian E. Brigman, MD, PhD; William C. Eward, MD, DVM

**Background:** Surgical stabilization is a mainstay of treatment for symptomatic bone metastases when a pathologic fracture is impending or already has occurred. While Mirel's criteria can suggest when surgical prophylaxis is indicated, it does not account for important variables such as disease duration, organ of origin, cancer histology, or adjuvant treatments. Furthermore, there is little consensus on type of surgical implant and risk factors for implant failure. The purpose of this study is to assess risk factors for failure of surgical stabilization in the treatment of metastatic bone disease. **Methods:** Retrospective chart review included all patients greater than 18 years of age who underwent surgical treatment for metastatic bone disease between 2006 and 2012 with at least 9 month radiographic follow up. Patients with metastasis to the spine and pelvis were excluded. Potential risk factors considered included patient and lesion characteristics such as age, gender, location, size, tumor histology, quality, and Mirel's score. Surgical treatment details included procedure performed, timing of surgery, and adjuvant treatments administered. **Results:** Overall, 41% (16/39) of patients experienced failure of surgical implants as defined by hardware breakage, migration, or need for reoperation. Increased time to metastatic diagnosis and decreased time to orthopedic intervention were associated with a statistically significant increase in implant failure rate. Tumor histology trended towards, but did not achieve, significance. There was no difference in patient age, gender, lesion size, character, or location in those whose implants failed versus those who did not. Initial Mirel's score, procedure type, and addition of radiation or chemotherapy either pre- or post-operatively were not associated with implant failure. **Discussion and Conclusion:** As decreased time delay from diagnosis to intervention is a risk factor for implant failure, some lesions may benefit from delayed versus urgent surgical interventions potentially due to more aggressive metastatic biology.

### **Multiple Lower Extremity Arthroplasties: Quality of Life**

Carlos J. Lavernia, MD; \* Jesus M. Villa, MD

**INTRODUCTION:** Scarce and outdated literature exists on QoL in patients with both knees and hips replaced. In this very unusual cohort of patients who had primary knee/hip multiple joint replacements (MJRs) we describe: (1) how much QoL improvement they obtain after each procedure, (2) how high and when their best QoL state is reached, and (3) how their QoL compares with the normal age-matched population. **METHODS:** Eleven patients (44 joints) had their QoL determined making use of the QWB-7. Preoperative QWB-7 obtained before the first replacement served as baseline. Mean QWB-7 obtained over time was recorded and compared with the one of the corresponding normal age-matched population. Mean follow-up: 12 years (range, 7-19 years). **RESULTS:** Compared to the baseline, QWB-7 scores significantly improved postoperatively at the latest follow-up (mean difference: 0.100, 95% confidence-interval [CI]: 0.034-0.167). After the fourth joint had been replaced, the best mean QWB-7 (0.638, CI:

0.554-0.721) was attained at an average of 5 years (range, 8 months-13 years). The best mean QWB-7 obtained over time compared favorably with the one of the normal age-matched population (0.661 vs. 0.616, respectively). Patient's mean QWB-7 fluctuated over time and it was at an inferior level compared to normal subjects (0.616) by the latest follow-up (0.577, CI: 0.488-0.667). **DISCUSSION AND CONCLUSION:** Our data suggests that patients who underwent MJRs attain significant improvement in QoL, with the majority of patients, achieving a higher QoL when compared with preoperative levels. Postoperative improvement varied over time but, for most patients, it was clear and sustained.

### **Psychosocial and Functional Outcomes in TKA and Resource Consumption**

Carlos J. Lavernia, MD; \* Jesus M. Villa, MD; Larry Brooks, PhD

**INTRODUCTION:** Costs and charges in TKA have received a lot of attention in the literature. How they relate to patient demographics, psychosocial measures, and functional measures pre and postoperatively is not clear. Our objective was to analyze the relationship between patient demographics, financial data, and psychosocial and functional measures for unilateral TKA patients. **METHODS:** We retrospectively studied 131 consecutive unilateral TKA patients (mean age 71.8 years; 72.5% women). We extracted financial information from the hospital's cost accounting software that included charges, direct costs, and indirect costs. Each patient was administered the QWB-7, SF-36, and WOMAC. Functional measures included the Hospital for Special Surgery scale (HSS) and the Knee Society Function Score (KSFS). Data was collected pre-operatively and at 3, 6, 12, and 24 month follow-up. Pearson-product moment correlations were used to evaluate the relationship between variables. T-tests were used to assess the effects of gender and ethnicity. **RESULTS:** A significant inverse relationship was found between cost and functional data at all-time points. This finding was strongest at three month follow-up. At three months, the HSS and KSFS were significantly correlated with: charges (HSS,  $r = -0.41$ ; KSFS,  $r = -0.46$ ), direct costs (HSS,  $r = -0.47$ ; KSFS,  $r = -0.46$ ), and indirect costs (HSS,  $r = -0.36$ ; KSFS,  $r = -0.44$ ). The QWB-7 score at the 2-year follow-up was significantly inversely correlated with: charges ( $r = -0.42$ ), direct costs ( $r = -0.40$ ), and indirect costs ( $r = -0.39$ ). **DISCUSSION AND CONCLUSION:** Worse outcomes are significantly associated with higher resource consumption.

### **Functional Ability and Gait Speed in Total Hip/Knee Replacement Patients**

Carlos M. Naranjo, MD; Carlos J. Lavernia, MD; Jesus M. Villa, MD

**Introduction:** The Timed-Up-and-Go test (TUG) is a physical composite measure of functional mobility. Patient-oriented-outcomes (POOs) are widely accepted questionnaires used to assess outcomes. The purposes of this study were: 1- to determine the preoperative TUG of patients scheduled for primary total hip/knee replacement; 2- to assess the correlations between the TUG and POOs and clinical hip/knee scores. **Methods:** Preoperatively, we prospectively evaluated the TUG of 75 primary hip ( $n=15$ ) and knee ( $n=60$ ) replacement patients. All patients had primary osteoarthritis as preoperative diagnosis. We compared the mean TUG of those patients who were scheduled for a hip with the one of those scheduled for a knee. Preoperative demographics, comorbidities, BMI, pain intensity/frequency as measured by a visual analogue scale, QWB-7, SF-36, WOMAC, hip Harris, Hip Postel D'Aubigne, HSS knee, and the Knee Society Knee/Function scores were evaluated. T-tests and Chi-Square were used to assess for differences between hip and knee replacement patients and MANCOVA was ultimately used to compare the TUG between them. Spearman's rho was used to ascertain the correlations between the TUG and POOs and hip/knee scores. Alpha was set at 0.01. **Results:** After adjusting for ethnicity, there was no statistically significant difference between the mean TUG of hip and knee replacement patients (22.80 sec vs. 25.72 sec, respectively). The TUG had a significant fair to moderate association with pain Intensity (0.414) and pain Frequency (0.520) in TKR patients. There were no significant correlations between the

TUG and the remaining patient oriented outcomes or clinical hip/knee scores. Discussion and Conclusion: There is no significant difference in terms of functional mobility between patients scheduled for hip or knee replacement. Clearly, the TUG had a fair to moderate correlation to self-reported pain as measured by a visual analogue scale. However, and with the exception of pain, our data demonstrates that perception may play an important role in patients' responses on validated outcome tools. We suggest implementing actual physical performance measures if we want to determine the "real" outcomes in total hip/knee replacement surgery.

### **Training Tomorrow's Medical Leaders**

Julie A. Neumann, MD; Kathryn Stabile, MD; Ann H. Taylor, RN; Dean C. Taylor, MD

**INTRODUCTION:** Formal leadership education is underrepresented in current medical training. However, physicians are expected to assume leadership roles and are regarded as leaders by their patients, colleagues, and communities. Lack of leadership instruction in medicine is a well-recognized phenomenon; to date there are few medical centers that have instituted formal leadership training in their curriculum. **METHODS:** Our institution has recognized this problem and as a result founded the John A. Feagin, Jr., MD Leadership Program in 2009. Fellows, residents, and medical student are eligible to apply for this yearlong leadership development program. Each year approximately 18 scholars are selected as members of a class. These scholars participate in seminars, workshops, conferences, and mentorship opportunities dynamically learning principles and skills of leadership throughout many disciplines including medicine, military, research, athletics, and business. **RESULTS:** Upon completion of the program, scholars are well equipped to assume leadership positions in their respective medical professions and communities. More information on the Feagin Leadership Program as well as the accomplishments of previous Feagin Leadership Program graduates is available on the website: [www.feaginleadership.org](http://www.feaginleadership.org). **DISCUSSION AND CONCLUSION:** Our institution has developed a novel, successful program to train fellows, residents, and medical students to assume leadership positions in their respective medical professions and communities. We would like to share information about this program with physician leaders across the country.

### **Custom Cutting Guides Do Not Improve Patient Satisfaction or Function following Total Knee Arthroplasty**

Ryan M. Nunley, MD; Denis Nam, MD, MSc; Keith R. Berend, MD; Adolph V. Lombardi Jr., MD; Robert L. Barrack, MD

**Introduction:** While total knee arthroplasty (TKA) is a commonly performed and highly successful procedure, recent studies have reported up to 15-30% of patients remain "unsatisfied" after TKA. A recent modification of surgical technique has been introduction of custom cutting guides (CCGs), in which 3-dimensional imaging is used to manufacture cutting blocks specific to a patient's anatomy. The purpose of this study was to evaluate the impact of CCGs versus standard instrumentation on patient satisfaction and residual symptoms after TKA targeting neutral, mechanical alignment. **Methods:** An independent, blinded survey center was used to evaluate patient satisfaction following TKA using CCGs versus standard instrumentation. Investigators queried their total joint registries and compiled a list of patients meeting inclusion criteria who had undergone primary TKA 1-4 years before the commencement of the study and had minimum one year clinical follow-up. All TKAs targeted a neutral mechanical axis using the same cemented, fixed-bearing, posterior cruciate-retaining component with patella resurfacing. **Results:** 341 Standard TKAs and 107 CCG TKAs were included. 74% in the CCG cohort and 78% in the Standard cohort reported their knee felt "normal". Only 65% in the CCG cohort and 66% in the Standard cohort reported participation in their most preferred activity in the last 30 days. Multivariate regression

analyses showed no benefits in patient satisfaction or residual symptoms with use of CCGs versus standard instrumentation. **Discussion and Conclusion:** While satisfaction following mechanically aligned TKA remains high, a large percentage of patients report residual symptoms postoperatively. This study questions the benefit of CCGs from the patient's perspective, as they did not result in improved patient satisfaction or reduction of postoperative symptoms. In the absence of proven patient-perceived outcomes or radiological advantages, we question continued implementation of CCGs. CCGs are of no proven value for improving patient satisfaction versus standard instrumentation in TKA.

### **Assessing NIRS Ability to Detect the Clinical Consequence of Delayed ECS**

Michael S. Shuler, MD; Mellisa Roskosky, MSPH; Brett A. Freedman, MD; Tracy L. Kinsey, MSPH; Steven Budsberg, DVM; Megan E. Hansen, BS, MS; Elizabeth Uhl, BS

**INTRODUCTION** Extremity compartment syndrome (ECS) can result in devastating consequences if missed or if treatment is delayed. Near infrared spectroscopy (NIRS) has been shown to provide continual, real time, non-invasive measurement of regional perfusion in an infusion model of ECS. The purpose of the study was to evaluate the correlation between NIRS and histological muscle damage in a prolonged trauma/infusion model of ECS. **METHODS** NIRS sensors placed on each leg of 6 landrace swine with 1cm of cranialateral compartment musculature proximal and cranial/caudal to the sensor. 18-gauge needles were centered under the sensors for direct measurement of compartmental pressure. Continual time-synchronized measurements of systemic blood pressure were collected. Trauma was induced by systematically dropping a weight onto the test limb. Albumin infusion then elevated tibial intra-compartmental pressures (TICP) above mean arterial pressure maintaining tibial compartment perfusion pressure (TIPP) below 0mmHg for 8 hours. Three pigs were then euthanized and underwent cranial tibial muscle biopsies. The other 3 pigs underwent fasciotomies with data collected for an additional 2 hours before biopsy. **RESULTS** Significant negative correlations of TICP and NIRS, positive correlations of TIPP and NIRS were observed. NIRS values decreased relative to the control limb from compartment pressure induced ischemia for the 8 hour duration and then rebounded to a hyperemic state following reduction of TICP. Muscle degeneration, necrosis and edema were significantly greater in post-fasciotomy pigs. Upon fasciotomy, NIRS values rebounded within 15 minutes despite the presence of extended ischemia and necrosis. **DISCUSSION AND CONCLUSION** This model provides evidence that prolonged depression in NIRS values correlates to muscle damage in the delayed/missed ECS state. Extended ischemia cannot be performed in humans, but is a serious clinical condition that occurs, this study demonstrates NIRS values are consistently diagnostic of ECS even in the setting of extended ischemia with subsequent muscle necrosis.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

### **Evaluation of NIRS, Serum Biomarker and Muscle Damage in a Porcine Balloon Compression Model of ECS**

Michael S. Shuler, MD; Mellisa Roskosky, MSPH; Brett A. Freedman, MD; Elizabeth Uhl, BS; Megan E. Hansen, BS, MS; Steven Budsberg, DVM

**INTRODUCTION** Extremity compartment syndrome (ECS) can result in devastating consequences if missed or treatment is delayed. Near Infrared Spectroscopy (NIRS) has been shown to provide continual, real time, non-invasive measurement of regional perfusion in an infusion model of ECS. Our objective was to assess/correlate NIRS, tibial intra-compartmental pressure (TICP), tibial intra-compartmental perfusion pressure (TIPP), serum-markers of inflammation and muscle injury in a balloon compression

model of ECS. **METHODS** NIRS sensors were placed on each leg of 6 landrace swine with 1cm of craniolateral compartment musculature proximal, and cranial/caudal to the sensor. 18-gauge needles were centered under the sensors and used for direct measurement of compartmental pressure. A balloon catheter was placed between the tibia and the cranial tibialis muscle in the test limb and inflated to 30mmHg over MAP for 6 hours. Continual time-synchronized measurements of systemic blood pressure were collected during equilibration and every hour during inflation. Measurements were obtained at 5, 10, 15, 30, 45, and 60 minutes after deflation, then hourly for 7 hours. Pigs were euthanized and muscle biopsies were collected. Serum was collected at each time-point for measurement of creatine-kinase (CK), myoglobin, TNF- $\alpha$ , IL-1 $\beta$ , and IL-6. **RESULTS** The test limb TIPP significantly decreased from baseline during balloon inflation and at 15 minutes post deflation and thereafter. Test limb TICP significantly increased compared to baseline during balloon inflation and at 1 to 6 hours following deflation. NIRS measurements were significantly lower at balloon inflation and thereafter. Myoglobin and CK concentrations significantly increased at deflation and 2hours post-deflation, respectively, and remained high. There was a significant correlation of muscle degeneration, edema and hemorrhage with NIRS. **DISCUSSION AND CONCLUSION** NIRS of the compartment provided a reliable, sensitive measure correlating to both an increase and decrease in TICP and TIPP. CK and myoglobin significantly increased following balloon removal.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation. (Refer to Accreditation Information).*

## **Ethnicity and Postoperative Outcomes in Total Knee Arthroplasty Patients**

Jesus M. Villa, MD; Carlos J. Lavernia, MD

**INTRODUCTION:** In total joint arthroplasty, some studies suggest that ethnic minorities receive lower-quality health care and have difficulties getting access to it. The purpose of this study was to evaluate the influence of ethnicity on pain, well-being, and function before and after primary total knee arthroplasty (TKA) and to determine whether ethnicity affects baseline and postoperative scores. **METHODS:** We retrospectively reviewed a consecutive series of 1,762 primary TKAs performed by a single surgeon. Only cases with preoperative diagnosis of primary osteoarthritis were included. In bilateral cases, one knee was excluded. Data on ethnicity and with a minimum follow-up of 2 years was available for 1,164 cases which were finally analyzed. Hispanics (n=930) and Not-Hispanics (n=234) were compared on demographics, comorbidities, preoperative and postoperative pain intensity/frequency as measured by a visual analogue scale (VAS, 0-10), QWB-7, SF-36, WOMAC, HSS Knee score, Knee Society (KS) Knee/Function Scores, and range of motion. T-tests, Chi-Square, and MANCOVA (to adjust for confounders) were used. Mean follow-up was 5.5 years (range, 2-18). Alpha was set at 0.05. **RESULTS:** When compared to Not-Hispanics, Hispanics were significantly older (68 vs. 71 years, respectively), had fewer patients of black race (24% vs. 3%), and had more females (55% vs. 76%). After adjusting for these factors and preoperatively, Hispanics underwent surgery with significantly more pain intensity (7.1 vs. 8.2) and frequency (7.3 vs 8.1); worse QWB-7 total (0.549 vs. 0.532), SF-36 physical component summary (28.5 vs. 25.7), WOMAC total (lower better, 48 vs. 53), WOMAC function (35 vs 39), HSS knee score (61 vs. 59), knee active flexion (109.1° vs 105.9°), and KS range of motion (109.4° vs. 106.9°). Postoperatively, the statistically significant differences between the groups disappeared for pain intensity and frequency, QWB-7, and SF-36 physical component summary. Further, Hispanics had better WOMAC function (9.8 vs. 5) and WOMAC total (12.7 vs. 6.2). **DISCUSSION AND CONCLUSION:** When compared to Not-Hispanics, Hispanics undergo TKA with more pain, worse quality of life, and worse function. However, after surgery, most differences disappear. Access to care should be improved for Hispanics as they seem to benefit considerably from TKA and should probably have the procedure earlier.

## Questionnaires and Patient Oriented Outcomes in Primary TKA Perception or Reality

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**INTRODUCTION:** Patient-oriented-outcomes (POOs) are widely accepted questionnaires used to assess outcomes. Actual Physical-performance tests remain the gold standard to assess the real outcome of musculoskeletal procedures. We aimed to examine the correlations between POOs and physical-performance tests in patients undergoing primary total knee arthroplasty (TKA). **METHODS:** 61 patients undergoing primary TKA were studied. Patient-oriented-outcomes [Pain-VAS, QWB-7, SF-36, WOMAC], knee scores [Hospital for Special Surgery (HSS), Knee Society Knee/Function], and physical-performance measures [Timed Up and Go (TUG), Knee Extensor Force (KEF) both limbs] were collected two weeks preoperatively. Pearson-Product Moment correlations assessed associations between POOs and physical-performance measures. We classified patients based on their ability or not to squat 90° into either: (1) able (SQ90, n=20) and (2) unable (USQ90, n=41). Independent-t-tests were used to assess for differences between groups. Alpha was set at 0.05. **RESULTS:** Overall, there was a low to poor association between POOs and performance based measures (range: -.01 to -.44). The TUG had a significantly fair to moderate association with the QWB ( $r = -.49$ ); SF-36 Physical Function Score ( $r = -.48$ ) and KSFS ( $r = -.62$ ). The SQ90 group had significantly better Pain intensity scores (6.95 vs. 8.13); QWB-7 (0.56 vs. 0.53); SF-36 Mental-Component-Summary (64 vs. 59); HSS (66 vs. 59), TUG (15.05 seconds vs. 20.89); and KEF on the involved (28.7 kg. vs. 20.25) and uninvolved side (35.06 kg. vs. 23.05) than the USQ90 group, respectively. **DISCUSSION AND CONCLUSION:** Our data clearly demonstrates that perception may play an important role in patients' response on validated outcome tools. Physical based measures correlate poorly with the answers in these questionnaires. We may need to implement actual performance tests if we want to evaluate the "real" outcome in TKA surgery.

## Complex Combat-Related Lumbosacral Dissociations

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**INTRODUCTION:** A relative increase in the incidence of complex lumbosacral dissociation (LSD) injuries has been noted throughout the Global War on Terror. LSD injuries are an anatomic separation of the spinal column from the pelvis, and represent a manifestation of severe, high energy trauma. We assessed the outcomes of combat-related LSD injuries after surgery. **METHODS:** We performed a retrospective analysis of a surgical database at three military institutions. Patients undergoing spine surgery designated as injured in combat between July 2003 and July 2013 were queried. Department of Defense and Veterans Affairs inpatient and outpatient medical records, in addition to radiographs, were reviewed and patients operatively treated for combat-related lumbar burst fractures were included. **RESULTS:** Twenty patients met inclusion criteria and were treated as follows: posterior spinal fusion (12), sacroiliac screw fixation (7), and combined anterior-posterior fusion (1). The mean age was 28.2 years old. The most common mechanism of injury was mounted improvised explosive device (IED, 50%). On average, 2.2 spinal regions were injured per patient. Neurologic dysfunction was present in four patients. Median time to surgery from injury was 12 days (range: 0-111 days), with a 20% wound infection rate. Median follow up was 45.5 months (range: 23.2-105.3 months), and one-third of all patients were medically retired due to their injuries. At most recent follow up, 45% complained of chronic low back pain and 35% had persistent neurologic deficits; however, 30% were actively engaged in strenuous physical activities, including swimming and distance running. **CONCLUSION:** This is the largest series of operatively managed lumbosacral dissociation patients currently reported. Our series suggests that combat-related lumbosacral dissociation injuries frequently result in persistent, long-term

neurologic dysfunction, disability and chronic pain. However, two-thirds of patients were able to remain on active duty after their injuries, and two patients were able to complete marathon training.

### **Validation of the Lumbosacral Injury Classification System (LSICS)**

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**INTRODUCTION:** There is currently no universally accepted classification or scoring system for lumbosacral dissociation (LSD) injuries. A new classification system called the lumbosacral injury classification system (LSICS) has been proposed based on three injury characteristics: injury morphology, neurologic status and posterior ligamentous complex (PLC) integrity. This new classification system for LSD injuries has not yet been validated in a systematic and scientific manner. Therefore, we set out to begin pre-clinical validation of the LSICS, and to assess for intra- and inter-observer reliability.

**METHODS:** Four orthopedic surgeons performed separate reviews of nineteen LSD injury case examples, including injury mechanism, description of neurologic examination, and pertinent imaging studies. A composite LSICS injury severity score was calculated for each case. The reviews were performed in two rounds one week apart. Statistical analysis was performed to determine intra- and inter-observer reliability for the LSICS. **RESULTS:** After two rounds of scoring, we found inter-observer reliability values of 0.81, 0.93 and 0.5 for fracture morphology, neurologic status and posterior ligamentous integrity, respectively. Inter-observer reliability for the overall calculated severity score was 0.86. Intra-observer reliability values were 0.76, 0.94 and 0.65 for all variables, respectively. Intra-observer reliability for the overall severity score was 0.87. **DISCUSSION AND CONCLUSIONS:** Our results suggest that LSICS is a reliable classification scheme for lumbosacral dissociation injuries, with high reproducibility within and between physicians. We believe that with further analysis and previously described clinical modifiers, LSICS is predictive of injury severity and provides guidance for management of these complex injuries. However, further validation using prospective clinical analysis must be performed.

### **Complications following Total Knee Arthroplasty in Patients with Osteoporosis**

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**INTRODUCTION:** Total knee arthroplasty (TKA) is commonly performed in the geriatric population. Osteoporosis is a common medical condition in this same demographic. Resultant decreased bone mineral density places patients at increased risk of fractures from low energy falls and may be associated with higher risk of periprosthetic fracture after TKA. Changes in the bone microarchitecture may also have an impact on implant fixation and subsequent revision. The purpose of this study is compare perioperative complications in Medicare patients undergoing primary total knee arthroplasty with or without osteoporosis. **METHODS:** The Medicare Standard Analytical Files were analyzed from 2005 to 2011. All patients undergoing primary TKA were identified using both the corresponding ICD-9 and CPT procedure codes. The ICD-9 code for osteoporosis was used to identify a cohort of patients within the Medicare files who carried a diagnosis of osteoporosis prior to TKA. The osteoporosis cohort was then compared the reference group without the diagnosis. Perioperative complications, periprosthetic fracture, and revision rates were compared between groups. **RESULTS:** Osteoporosis patients undergoing TKA had a higher rate of periprosthetic fracture (0.61% vs 0.36%). However, the overall revision rate for osteoporosis patients was lower than the reference group (2.66% vs 2.94%) and a decreased rate of osteolysis/polywear within the study period (0.20% vs 0.24%). Within the immediate 90 day post-operative period, osteoporosis patients had a higher rate of DVT (3.83% vs 3.08%), PE (1.69% vs 1.33%),



stroke (0.82% vs 0.73%) and death (0.15% vs 0.06%), but a slightly lower rate of early postoperative periprosthetic infection (0.86% vs 0.93%). **CONCLUSION:** Medicare patients undergoing primary TKA with a pre-existing diagnosis of osteoporosis have a higher rate of subsequent periprosthetic fracture, but a decreased rate of all-cause revision surgery in this study. In the immediate post-operative period, osteoporosis patients appear to have an increased risk of thromboembolic complications.

### **Effect of External Beam Irradiation on the Pathway of Bone Fracture Healing**

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**INTRODUCTION:** Though external beam irradiation has become a widely accepted method of treating cancerous metastatic lesions that compromise the structural integrity of the skeleton, its inhibitory effects on the two bone healing pathways remains poorly understood. The objective of this study is to investigate the differential effects of radiation on the two pathways of bone healing and propose an optimal method of surgical fracture repair for managing malignant fractures that require external beam irradiation for local tumor control. **METHODS:** Sprague-Dawley (SD) rats (n=24; male) were used to develop a bilateral iatrogenic femur fracture model for concurrent study of both healing pathways of bone in the same animal. One side was repaired with a novel, customized dynamically locked intramedullary nail (healing via endochondral ossification) while the other side was rigidly fixed with plate and screws (healing via intramembranous ossification). On postoperative day 3, the rats in the radiation group (n=12) underwent radiation treatment using PANTAX x-ray unit (250 kVp, 13 mA, 8 Gy). The morphology and microstructure of ossification at the fracture site was quantitatively assessed at weeks 1, 2 and 4.

**RESULTS:** A thin layer of calcified callus gradually formed from week 1 to week 4 around the fracture site in femurs repaired by plate fixation. In the plated femurs, there was no significant difference in the bone volume fraction of the control group versus radiation group at any of the studied time points. By contrast, in femurs repaired by intramedullary (IM) nail fixation a thicker layer of calcified callus formed around the fracture site. In the IM nail cohort, a significant difference in the bone volume fraction was observed between control and radiation groups at week 4, representing an approximately 40% decrease in bone volume fraction in the radiation group. **DISCUSSION and CONCLUSION:** Our results suggest a differential effect of radiation on the two pathways of bone healing; an insignificant effect on primary bone healing, or intramembranous ossification, as promoted by plate fixation, compared with a significant inhibition of endochondral ossification, or secondary bone healing, as occurs with IM nail fixation. A potential explanation for this may be radiation-mediated inhibition of neovascularization and mineralization of cartilage callus during its transition to bone in the endochondral ossification pathway. Thus, internal fixation of malignant metastatic fractures with compression plating, rather than intramedullary devices, may be a more appropriate and durable option for fracture repair of pathologic fractures that require external beam irradiation for local tumor control.