

## 2014 Scientific Program Abstracts — Tuesday

*(An asterisk (\*) by an author's name indicates the presenter.)*

**Tuesday, December 16, 2014**

**General Session 1: Trauma - Pelvis/Lower Extremity/Polytrauma (*Palomino Ballrooms 8-10*)**  
**Civilian Moderator:** CAPT (Ret) Michael J. Bosse, MD  
**Military Moderator:** COL Romney C. Andersen, MD

0845-0850

### **Risk Factors For Amputation In Combat Tibia Injuries, An Outcome Following Combat Tibia Injuries Study (OCTIS)**

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 LT Scott C. Wagner, MD  
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 Col Wade T. Gordon, MD

**Objectives:** The objective of this investigation was to describe the risk factors for successful limb salvage and amputation in fractures of the tibia resulting from recent conflicts in Afghanistan and Iraq. To date there have been limited studies which assess the outcomes of these specific injuries and there are no data on the risk factors that predict success of limb salvage or amputation in combat tibia injuries. Design: Observational, Retrospective review. Setting: This study was performed in a tertiary care, military hospital setting.

**Patients/Methods:** 197 patients were identified utilizing a surgical database and included in this series. Patients meeting inclusion criteria for the study were studied. Demographic, radiographic, and clinical data was compiled and analyzed. Main Outcome Measurements: Incidence of fracture non-union, osteomyelitis or acute infection, heterotopic ossification (HO), failure of limb salvage, associate injuries, condition of the soft tissue, associated neurovascular injuries, as well as successful prosthesis fitting and ambulation were all

measured.

**Results:** From the time periods of Oct 2001 to July 2013, 195 patients met inclusion criteria. All patients were male. Modes of definitive fixation included intramedullary nailing, circular external fixation and open reduction internal fixation with plate/screw constructs. Delayed amputation occurred in about 20% of patients. There was no correlation between mode of fixation and delayed amputation. Amputation was performed most often for a complaint of chronic pain, and most often in patients with a greater number of associated fractures.

**Conclusions:** To our knowledge, this is the largest and most comprehensive series in the literature to specifically describe demographics and outcomes following war trauma to the tibia. The demographic data obtained give insight into the epidemiology of injury patterns and some characteristics of the normal clinical course in these patients. The mode of fixation, rate of malunions, nonunions and infections were not significant causes for late amputation. Late amputation occurred in patients with chronic pain. Successful limb salvage occurred in patients who had fewer associated fractures. This limb salvage and amputation data reveal the potential for rehabilitation in the multiply injured, wounded combatant.

#### **Notes:**

0850-0855

## Functional Results Of Transfemoral Versus Through-Knee Amputation In Combat Injured Patients

LT Dustin Schuett, DO  
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CDR David Dromsky, MD

**Introduction:** The aim of this study was to assess the gait parameters of through-knee compared to above-knee amputation in combat injured U.S. Servicemembers.

**Methods:** Combat wounded service members with unilateral through-knee amputations who had Gait data collected after at least three months ambulating without assistive devices at Naval Medical Center San Diego between May 2008 and July 2013 were matched to combat injured above-knee amputees with similar height, weight, BMI and contralateral amputation levels. Previously collected gait temporal-spatial parameters as well as mechanical work parameters in ambulation for the two groups were analyzed.

**Results:** Four combat wounded service members with unilateral through-knee amputations were identified, all had contralateral below-knee amputations. These patients were matched to four long above-knee amputees (femoral length from ASIS 31-45cm) with similar height, body-mass index (BMI), and contralateral amputation level (all below-knee). There were no significant differences between through-knee and above-knee amputees with regards to walking velocity, step width, step length, cadence, stride length, single limb support time, total stance time, force parameters or mechanical work of ambulation measure in Joules per kilogram per meter. During the data collection period, two through-knee amputees at our institution not included in the study population had elective conversion to above-knee amputation at their request due to difficulty ambulating with asymmetrical knee centers.

**Discussion and Conclusions:** Gait parameters were similar in this group of combat wounded matched through-knee and above-knee amputees. Through-knee amputees with intact contralateral knees have asymmetrical knee centers which can cause significant difficulty with walking and may drive them to pursue elective conversion to above-knee amputation.

**Notes:**

0855-0900

## Female Combat Amputees Have Higher Rates Of PTSD Disability

MAJ Jessica C. Rivera, MD  
CPT Chad A. Krueger, MD  
LTC Anthony E. Johnson, MD

**Introduction:** Injuries sustained by US service members deployed in recent combat operations have been well characterized in recent literature as have the disabilities associated with combat injury. Differences in injury and disability profiles in special populations including the female service member, however, have not been extensively studied. The civilian trauma literature indicates that female patients react differently than men who sustain trauma including differences in survival and mental health outcomes. In order to determine if the reaction to combat injury is different between a specific war wounded population, service members with amputations, we examined the disability profiles of male and female amputees.

**Methods:** All US combatants who sustained a major extremity amputation between October 2001 and December 2011 were examined for demographic and injury information from the Department of Defense Trauma Registry and for disability system outcomes in the service specific Physical Evaluation Boards. Male and female amputees' disability outcomes were compared. Frequencies of disability were compared using fishers exact test and the disability ratings assigned to individual conditions and total disability were compared using student's t test.

**Results:** Among 992 amputees with physical evaluation board results, 21 were female. There was no difference in the average age (age 27 for females, age 25 for males) or military rank (enlisted grade 5) at the time of injury between male and female amputees. The average ISS for female amputees was 18.8 and for males 20.7. While the most common military occupation of male amputees was infantry service, the most common occupation for the female amputee was military police. All but one female amputee was injured in battle conditions; and as with the majority of male amputees, all battle injured female amputees were injured in an explosion. The overall disability ratings between females and males were not different (82% for females, 75% for males). The rates of orthopaedic related disabilities and the assigned disability ratings were not different between female and male

amputees. Female amputees had higher rates disability from Post-Traumatic Stress Disorder (38% versus 17%). Disability from PTSD tended to also be higher in females though no significantly so. The frequencies and ratings of other non-orthopaedic disabilities were not different between male and female amputees.

**Discussion:** Outside of variable occupational descriptions, both male and female amputees were exposed to explosions resulting in their injuries. Disabilities from orthopaedic causes including the amputations were not different between the sexes. However, consistent with many civilian trauma and veterans' population studies, female amputees have higher rates of disability from PTSD.

**Notes:**

0900-0905

### Late Amputation May Not Reduce Complications In Severely Injured Salvaged Limbs

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 CPT David J. Tennent, MD  
 Capt Andrew J. Sheean, MD  
 MAJ Jessica C. Rivera, MD  
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 Joseph C. Wenke, PhD

**Introduction:** We hypothesize that late amputation (LA) does not significantly reduce complication rates or burden of mental health disorders among patients who sustained significant combat-related extremity trauma and underwent attempted limb-salvage and an eventual LA.

**Methods:** All U.S. Servicemembers who sustained a late major extremity amputation from September 2001 through July 2011 were analyzed. Treatment conditions, pre/post-operative complications and mental health conditions, reason(s) for desiring amputation and disability outcomes were recorded.

**Results:** 129 late amputees were identified with 44 having detailed injury, demographic, outcome and amputation data available at our institution. A mean time of 576 days between injury and amputation was found and most LAs were at the transtibial level(33, 75%). There were an average of 2 documented reasons for undergoing a LA per amputee with pain (30, 29%) and lack of satisfaction with functional level (26, 25%) being the most common reasons. An average of 3.2 (range 1 to 10) complications were reported by the late amputees prior to undergoing their amputation and an average of 1.8 (range 0 to 5) after LA. The most common complications prior to and after LA were soft tissue infection (24(17%) and 9(22%), respectively). While there were significantly more complications prior undergoing LA as a whole than after undergoing LA ( $p=0.0132$ ) there were no significant differences found between the rates at which specific complications (ie soft tissue infection, PTOA, CRPS, non/malunion, osteomyelitis, etc) occurred before and after LA ( $p>0.05$ ). No associations were found between the rates pre or post-amputation complications and the amputee's tobacco usage, fasciotomy being closed prior to amputation, skin or soft tissue coverage used on the extremity, vascular injury to the extremity or need to be hospitalized. The most frequent reasons noted for needing a revision of the LA were soft tissue infection (4, 36%) and osteomyelitis (3, 27%). There were no significant differences in the total number of pre and post-amputation mental health diagnoses ( $p>0.05$ ) but the rates of depression and PTSD increased after undergoing late amputation.

**Discussion:** Patients with a severe, combat related lower extremity injury that is undergoing limb salvage may not have a reduction in their overall complication rate, a resolution of specific complications or an improvement of their mental health after undergoing a LA.

**Notes:**

0905-0910

## Turn-Up Plasty For Salvage Of Transtibial Amputations: A Case Series

CPT Elizabeth M. Polfer, MD

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**Introduction:** Combat-related open tibia fractures can result in large open complex wounds with gross contamination, large zones of injury, and associated bone and soft tissue loss necessitating the discussion between limb salvage and amputation. When limb salvage is not successful and amputation becomes a necessity, surgeons are tasked with providing a stable, durable, residual limb while maintaining length and level.

**Methods:** We present the operative technique for a turn-up plasty stabilized with modern compression plating following blast injury to salvage functional transtibial amputations after sustaining IIIB tibia fractures.

**Results:** The average residual length of the proximal tibia was 7cm prior to surgery and 14cm after surgery, and patients were followed for an average of 26 months. All patients achieved union at the osteosynthesis docking site, healed their soft tissue envelopes, and were ambulating in a prosthesis as a transtibial amputee. One patient subsequently went on to a transfemoral amputation for recurrent osteomyelitis and the remaining two are now running in their prosthesis.

**Discussion and Conclusion:** Blast injuries produce devastating traumatic amputations and limb-threatening extremity trauma. When limb salvage efforts fail or primary amputation would result in an extremely short transtibial amputation or revision to a more proximal level, a turn-up plasty for length and level salvage is sound option to provide robust, sensate soft tissue coverage with additional osseous length.

**Notes:**

0920-0925

## Cephalo-Medullary Nail Fixation Of Intertrochanteric Fractures: Are Two Proximal Screws Better Than One?

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Roy W. Sanders, MD

**Introduction:** The number of intertrochanteric hip fractures in the United States and other countries has risen over the past decade and is expected to continue to rise. A myriad of implants have been designed to treat these fractures, however the most common modern implants are sliding hip screws (SHS) and cephalo-medullary devices (CMD). While many CMDs are available, there are few direct clinical comparisons between them. To the authors' best knowledge, no study exists comparing the long-term radiographic outcomes of patients with intertrochanteric hip fractures treated with a single lag screw versus two integrated compression screws.

**Methods:** 1004 OTA 31-A, 31-B2.1 fractures (1002 patients) treated with either a single screw cephalo-medullary nail or a two integrated screw cephalo-medullary nail between 2/1/2005 and 6/30/2013 were identified at our institution and reviewed retrospectively. Patients younger than 50 years, follow-up (f/u) less than 3 months, a tip-apex distance greater than 25 mm, inaccurate lag screw placement, pathologic fractures and revisions were excluded. Fracture stability was based on the Evans classification. X-ray review included: fracture pattern (stable vs. unstable), post-operative (post-op) fracture reduction, differences in the neck shaft angle (NSA, i.e. varus collapse), and femoral neck shortening (FNS) at 3, 6, and 12 months post-op. Measurements of implant size, NSA and FNS were normalized using known lag screw dimensions that were digitally corrected for magnification. Rotational discrepancies between x-rays were controlled using a ratio of known to measured dimensions. NSA and FNS were compared at each time interval for all fractures, to measure changes occurring with each device. The Mann-Whitney U test was used for statistical analysis.

**Results:** 372 patients died and 219 were lost to f/u, leaving 413 patients (413 fractures) with more than 3 months of follow up. Mean age was 76 years (51–103 years) and 67% were female. Of 413 fractures, 130 were treated with a single screw

device (79 stable, 51 unstable), and 283 with a two integrated screw device (155 stable, 128 unstable). At 6 months of follow up, there were 64 fractures treated with the single screw device (33 stable, 31 unstable) and 107 with the two integrated screw device (51 stable, 56 unstable). At 12 months of follow up there were 54 fractures treated with the single screw device (32 stable, 22 unstable) and 54 with the two integrated screw device (23 stable, 31 unstable). The single screw device resulted in 2.5 times greater varus collapse (4.30 deg vs. 1.83 deg) and over 2 times greater femoral neck shortening (4.91 mm vs. 2.36 mm) over one year than the two integrated screw device ( $p<0.001$ ), regardless of fracture stability.

**Conclusion:** A cephalo-medullary nail with two integrated proximal screws appears to maintain initial fracture reduction and subsequent position over time (FNS), with less varus collapse (NSA) than a cephalo-medullary nail with a single proximal screw. This was true for both stable and unstable fractures. These data indicate that the two integrated screw device resulted in fewer intertrochanteric mal-unions, which may be clinically important when considering long-term functional outcomes in patients with these fractures.

**Notes:**

0925-0930

## Comparison Of Anterior Versus Posterior Exposure Of The Femoral Head And Acetabulum

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**Purpose:** To (a) quantify the surface area of femoral head exposed using a Direct Anterior approach, and to (b) compare the qualitative ability of a surgeon to see or palpate important anatomic landmarks using the Direct Anterior and Surgical Dislocation hip approaches

**Methods:** Ten thawed, fresh frozen hip and lower extremity cadavers were randomized to either the supine or the lateral decubitus position. Each specimen had two approaches performed. The supine cadavers had a direct anterior approach first while the lateral decubitus cadavers had the surgical dislocation approach first. Calibrated photographs and discrete data were collected for the first approach at this point. The cadavers were then moved to the other position and then the second approach was performed. Continuous data collection was obtained by taking a calibrated digital photograph from the surgeon's best view. Discrete data points consisted of the following anatomic landmarks: the margin of the acetabulum anteriorly, superiorly, and inferiorly, the anterior inferior iliac spine, the greater and lesser trochanters, the vastus ridge, and the femoral head fovea. These were classified as visualized, palpated but not visualized, or not visualized. The direct anterior approach was carried down to the anterior joint capsule where an H-shaped capsulotomy was performed. Homan retractors were then placed superior and inferior to the femoral neck, on the vastus ridge laterally, and below the indirect head of the rectus femoris into the notch between the anterior superior and inferior iliac spines. Discrete and continuous data were collected at this time. The exposed femoral head was then scored with an osteotome to mark the visualized femoral head prior to dislocation. Anterior dislocation was then performed using lateral traction and external rotation with the hip in an extended position. Data was collected at this time for the anterior dislocation. For the lateral decubitus position cadavers the Kocher-Langenbeck approach was performed first followed by a trochanteric osteotomy. The osteotomy was made from just anterior to the posterior one third margin of the gluteus medius insertion on the greater trochanter extending distally to the lateral femur just distal to the vastus ridge. Lastly, a surgical dislocation through a Z shaped anterior hip capsulotomy was performed. A sharp homan retractor was then placed anteriorly between the anterior inferior and anterior superior iliac spines. A blunt homan was placed inferior to the transverse acetabular ligament. Data was collected for the surgical dislocation at this time. We analyzed each photograph using ImageJ software to calculate the two dimensional surface area of bony exposure.

**Results:** The anterior approach exposed 26.49% (+/- 13.64%) of the total femoral head area. The ability to see and touch surgical landmarks was similar between the direct anterior and surgical dislocation approaches. The direct anterior approach allowed palpable exposure from the inferior acetabulum to the anterior inferior iliac spine in all ten

specimens and visual exposure of the anterior inferior iliac spine in six of ten specimens. Anterior dislocation increased this visual exposure to seven of ten specimens. Surgical dislocation allowed palpable exposure from the anterior inferior acetabulum to the anterior inferior iliac spine in all ten specimens and visual exposure of the anterior inferior iliac spine in eight of ten specimens. Performing a surgical dislocation also enabled the surgeon to visualize the inferior acetabulum and the femoral head fovea in every specimen. The direct anterior approach also allowed palpation of the inferior margin of the acetabulum in all ten specimens along with visualization in seven out of ten cadavers without dislocation and eight of ten with dislocation.

**Conclusion:** On average, the direct anterior approach provided visualization of over one fourth of the femoral head. This approach also showed no significant difference in the number of palpable landmarks evaluated in this study when compared to the surgical dislocation. There was also no significant difference in the number of visualized landmarks when anterior dislocation was compared to surgical dislocation.

**Notes:**

0930-0935

## War Related Femoral Neck Fractures: Incidence And Outcomes

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Col Wade T. Gordon, MD

**Introduction:** Femoral neck fractures in young adults are considered an orthopedic urgency, as delayed treatment may increase rates of femoral head avascular necrosis, fracture non-union, and malunion. To our knowledge, there have been no studies in the literature looking at the incidence or outcomes of these injuries in the combat setting. The purpose of this study is to determine incidence of war related

femoral neck fractures, and determine the rates of nonunion, delayed union and avascular necrosis associated with these injuries.

**Methods:** We performed a retrospective review and identified 21 patients who sustained combat related femoral neck fractures from October 2001 to the present. We collected demographic data, time to fixation, time to union, incidence of avascular necrosis, as well as complications and final recreational activity status.

**Results:** There were 21 males (100%), and 20 met inclusion criteria. The average length of radiographic follow up was 21.4 months. The average patient age was 25.2 (21-36) years. Displaced fractures were seen in 71.4% of patients. Most injuries were due to the explosion of an improvised explosive device (71.4%). Eight (38.1%) patients sustained an ipsilateral above-knee amputation and five (23.8%) had bilateral lower extremity amputations. Initial reduction and fixation within 24 hours of injury was performed in 57.1% of patients. Almost all patients (90.5%) had internal fixation with percutaneous screws, dynamic hip screw or a cephalomedullary device, two underwent a salvage procedure. The average time to union was 5.5 months. There was one nonunion and one delayed union. Three of the patients (16.7%) had avascular necrosis of the femoral head; two of these patients were initially reduced and provisionally fixed within 24 hours. Of the patients available for follow up, 17/20 patients functioned as a community ambulatory or greater at last follow up.

**Discussion:** Our data demonstrates a high rate of displaced femoral neck fractures, consistent with the high-energy injury mechanisms sustained by our patients. Even with frequently delayed fixation the incidence of avascular necrosis was 16.7%, which is comparable to previous reported rates in the younger age population. Urgent reduction and fixation continues to be of utmost importance to decrease the risk of femoral head avascular necrosis following a femoral neck fracture.

**Notes:**

0935-0940

## Retrograde Intramedullary Fixation Of Fractures Through Amputations

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**Objectives:** The objective of this investigation was to describe the technique of retrograde intramedullary fixation of fractures through open, traumatic combat-related amputations.  
**Design:** Retrospective case series. **Setting:** This study was performed in a tertiary care, military hospital setting.

**Patients/Participants:** Ten patients were identified utilizing a surgical database and included in this series. **Intervention:** Each patient underwent retrograde intramedullary fixation of a long bone fracture through an ipsilateral traumatic amputation. **Main Outcome Measurements:** Incidence of fracture nonunion, osteomyelitis or acute infection, heterotopic ossification (HO), as well as successful prosthesis fitting and ambulation.

**Results:** Ten patients met inclusion criteria. All were male, and all were injured via improvised explosive device. Average time to fixation after injury and amputation closure was 13.7 days and 14.2 days, respectively. Follow up averaged 20.2 months. The radiographic union rate was 100%, and time to osseous union averaged 7.5 months. One patient had an amputation site infection requiring revision, but none of the nails were removed for infectious reasons. HO occurred in seven patients, and two patients required revision for symptomatic HO. All patients were successfully fitted with prostheses and able to ambulate.

**Conclusions:** To our knowledge, this is the only series in the literature to specifically describe retrograde intramedullary fixation of long bone fractures through the zone of traumatic amputation sites. The infectious risk is relatively low, while the union rate (100%) and successful prosthesis fitting are high. For patients with similar injuries, retrograde intramedullary fixation through the zone of amputation is a viable treatment option.

### Notes:

0940-0945

## Volumetric Muscle Loss Contributes To Permanent Disability Following Extremity Trauma

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**Introduction:** Extremity injuries comprise the majority of battlefield injuries and contribute the most to long-term disability of service members. The purpose of these studies is to better define the contribution of muscle deficits and volumetric muscle loss (VML) to long-term disability in order to highlight a persistent gap in treatments available to limb salvage patients.

**Methods:** Medically retired service members who sustained a combat related Type III open tibia fracture were reviewed for results of their medical evaluation leading to discharge from military service. To gain insight into the impact of VML on a general population of service members (including those with non-orthopaedic injuries), a cohort consisting of patients medically retired due to a variety of injuries was also examined. Frequency and severity of muscle related conditions resulting in VML as determined by the US Army Physical Evaluation Board was compiled and projected life time disability costs calculated.

**Results:** Muscle conditions accounted for 65% of the disability of patients in the Tibia cohort despite “successful” limb salvage as determined by bone healing, VML persisted as the primary source of disability in this cohort. Among service members retired for non-orthopaedic injuries, 92% of the muscle conditions were identified as VML. The financial impact of muscle conditions in both populations was significant.

**Discussion:** Volumetric muscle loss is a condition that contributes significantly to long term disability. The development of therapies addressing VML has the potential to fill a significant void in orthopaedic care.

### Notes:

**Tuesday, December 16, 2014**

**General Session 2: Trauma and Military Medicine  
(Palomino Ballrooms 8-10)**

**Civilian Moderator:** James P. Stannard, MD  
**Military Moderators:** MAJ Jean-Claude D'Allyrand, MD  
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1045-1050

**US Military Experience From 2001 To 2010  
With Extremity Fasciotomy In War Surgery**

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James K. Aden III, PhD  
Anne L. McKeague, PhD  
COL Todd E. Rasmussen, MD  
David G. Baer, PhD  
COL Lorne H. Blackbourne, MD

**Introduction:** Extremity compartment syndrome after trauma is common, disabling, and—if managed sub-optimally—lethal problem in war, and its treatment by surgical fasciotomy continues to be useful although controversial. Prior reports looked at shorter periods of data from a trauma registry. The purpose of the present study is to associate survival and fasciotomy for 10 years in a large trauma system in order to indicate trends.

**Methods:** We retrospectively surveyed military trauma registry data of casualties that had fasciotomy from 2001 to 2010. We associated survival and fasciotomy. Casualties had extremity injury (13853) or fasciotomy (3313).

**Results:** Of 17,166 casualties in the total study, 19% (3313) had fasciotomy and 2.8% (481) had compartment syndrome. Annual fasciotomy rates started at 0% and rose to end at 26%. The linear regression line of the annual fasciotomy rate started at 8% and ended at 26% (Rate =  $1.9706 \times \text{Year} - 3935.4$ ;  $R^2 = 0.5913$ ), indicating a threefold increase. The proportion of casualties by ISS ranges indicated that most casualties were less severely injured. Those least injured (ISS range of 1 to 9) constituted 68% (11670/17166) of casualties. When ISS values for each casualty were analyzed by linear regression by month and year of injury, ISS increased a small amount over time ( $\text{ISS} = 0.3896 \times \text{Year} - 772.9$ ,  $R^2 = 0.0087$ , 17,166 casualties,  $p < 0.0001$ ; Fig. 4). Fasciotomy rates rose by the given ISS ranges, 1 to 9 (10%), 10 to 15 (33%), 16 to 24 (44%), and

>24 (42%,  $p < 0.001$ ). For all 17,166 casualties, the survival rate initially was high (100%) but decreased steadily until its nadir (96.4%) in 2005, when it increased to make a V-shaped trend with the reversal occurring promptly after fielding two interventions within the trauma system specifically for casualties at risk for fasciotomy—tourniquet use and a fasciotomy education program.

**Conclusions:** Over a decade of war, the survival rate of extremity-injured casualties was associated with two trauma system interventions—tourniquet usage and a fasciotomy education program. In summary, the present survey of war casualties with injuries that risked extremity compartment syndrome showed an association of improved casualty survival rates after implementation of two focused healthcare initiatives that aimed at improved casualty survival. The finding of the present study indicates the following recommendations: 1. Analysis of trauma casualty data evidenced an association between improved casualty survival rates after implementation of healthcare initiatives; the current example may be useful as a model for future improvements. 2. Medical healthcare instruction for surgeons was associated with improved survival, and similar research analyses may be useful to evidence other attempted improvements in healthcare.

**Notes:**

1050-1055

**Prediction Of Tibial Nonunions At Three Months After Intramedullary Nailing**

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Jason W. Nascone, MD  
LtCol Christopher T. Lebrun, MD  
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Christina L. Boulton, MD  
Renan C. Castillo, PhD

**Purpose:** Interest exists in predicting which tibia fractures are likely to result in nonunion and require additional surgery. Multiple parameters might predict likelihood for nonunion,

including patient and fracture characteristics, time until weight bearing is allowed, and the radiographic healing of the tibia or fibula. We hypothesized that a prediction tool could be created based on information available at 3 months that would be useful in predicting tibial nonunion.

**Methods:** A retrospective review of all tibia shaft fractures treated at a single Level 1 trauma facility between 2006 and 2012 yielded 59 nonunions. Patients were excluded if they were treated with anything other than an IM nail, if there was a planned surgical intervention to prevent nonunion after the index procedure, or if the fracture pattern had a critical defect of >3cm. 21 patients met the inclusion criteria and were compared to a randomly selected control group of 76 patients treated with an intramedullary nail that went on to radiographic union without the need for further intervention. Patient data was collected for each to include: fracture grade, American Society of Anesthesiologists Score (ASA), body mass index (BMI), smoking status and time until weight bearing was allowed. An image set was created of these 97 cases utilizing their 3 month interval follow-up radiographs. The image set was presented in random order and viewed using standard clinical software to clinicians who were blinded to the final outcome. Four fellowship trained orthopaedic traumatologists were asked to review the radiographs. The previously described RUST (radiographic union score of the tibia) score for each of the four cortices of the tibia were recorded as it was for the fibula. In the cases of a segmental fracture, the reviewer was asked to grade the fracture with the least amount of radiographic healing.

**Results:** As shown in Table 1, the tibia RUST score at 3 months was a powerful predictor of tibia nonunion. Patients with a score of 8 or above had a 0% (0/44) nonunion rate. Although application of the RUST score to the fibula at 3 months was predictive of nonunion in bivariate analysis ( $p=0.002$ ), this effect was not observed when used in combination with tibia RUST. For patients with tibia RUST scores below 8, a separate predictive model was developed. Predictors of nonunion in this model included: open fracture [Odds ratio: 11.7, 95% CI:1.2-118,  $p=0.04$ ] and tibia RUST score [Odds ratio: 0.3 per RUST point, 95% CI: 0.14 to 0.67,  $p=0.003$ ]. This model was highly predictive of tibial nonunion, accounting for >60% of variance in these outcomes. Table 1. Tibia RUST score at 3 months and history of open fracture vs. chance of nonunion Tibia RUST Score Fracture Type 8-12 7-7.9 6-6.9 4-5.9 Closed 0% (0/26) 0% (0/8) 0% (0/3) 33%(2/6) Open 0% (0/18) 18% (2/11) 50% (4/8) 76% (13/17).

**Conclusion:** The RUST score applied to tibia healing at 3 months appears to be a powerful predictor of need for tibial nonunion surgery. We have developed a simple, clinically practical model that predicts need for tibial nonunion surgery based on data available at the 3 month timepoint.

#### Notes:

1055-1100

### Infection And Non-Union In Tibial Plateau And Shaft Fractures: A Matched Cohort Comparison

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Murat Erdogan, MD  
H. Claude Sagi, MD

**Introduction:** Compartment syndrome of the lower leg is a well-recognized complication of fractures involving the tibia. Compartment syndrome in an open tibia fracture is a reported complication and is directly associated with the degree of soft tissue injury. While it may be considered a marker for more severe injury, it is not well understood if the presence of a compartment syndrome and treatment with decompressive fasciotomies influences the risk of developing late infection or the time to fracture union. The purpose of this analysis is to document the rate of infection, non-union, and delayed union in operatively treated tibial fractures with and without compartment syndrome requiring a four-compartment fasciotomy.

**Methods:** Groups 1 (tibial plateau) and 3 (tibial shaft) (case) were comprised of skeletally mature patients presenting with acute compartment syndrome requiring fasciotomy. Groups 2 and 4 (control) were comprised of a 1:3 matched cohort of patients with operatively treated tibial plateau and shaft fractures without compartment syndrome or fasciotomy and internally controlled for age, injury pattern, and method of fixation. Patients were excluded from the study if a vascular injury was present, or if they had incomplete medical records and insufficient follow up to determine time at union. A two-

incision technique to release all four compartments was used as the fasciotomy procedure for all patients in Groups 1 and 3. Tibial plateau fractures were treated with plate fixation and tibial shaft fractures were treated with an intramedullary device. Data recorded included age, gender, smoking status, OTA fracture classification, Gustilo-Anderson classification, time between fasciotomy and definitive fracture fixation, definitive management of fasciotomy wounds, time to union, presence of delayed union and non-union, incidence of infection, and secondary operations.

**Results:** Group 1 consisted of 14 patients: 12 males, 7 smokers (50%), and 4 open fractures (29%). Group 2 consisted of 42 patients: 29 males, 11 smokers (26%), and 12 open fractures (29%). Group 3 consisted of 13 patients: 10 males, 5 smokers (38%), and 8 open fractures (62%). Group 4 consisted of 39 patients: 25 males, 8 smokers (21%), and 24 open fractures (62%). Group 1 averaged 29.2 weeks to union (range: 10-68 weeks), four (29%) presented with delayed union, three (21%) presented with non-union, and two (14%) developed late infection. Group 2 averaged 15.9 weeks to union (range: 12-52 weeks), four (9.5%) presented with delayed union, one (2.4%) presented with non-union, and four (9.5%) developed late infection. Group 3 averaged 33.9 weeks to union (range: 15-59 weeks), three (23%) presented with delayed union, five (38%) with non-union, and three (23%) developed late infection. Group 4 averaged 20.9 weeks to union (range: 10-71 weeks), ten (26%) presented with delayed union, four (10%) with non-union, and two (5%) developed late infection.

**Discussion/Conclusion:** The presence of acute compartment syndrome and the need for fasciotomy in patients with either tibial shaft or plateau fractures is associated with a significant increase in the rate of non-union and an increased time to union but with no statistically significant increase in infection rates.

**Notes:**

1100-1105

## Smokeless Tobacco And Healing In Combat Tibia Fractures, An Outcome Following Combat Tibia Injuries Study (OCTIS)

LT Benjamin Chi, MD

\*LT Matthew G. Hanley, MD

CPT Daniel G. Kang, MD

CPT Michael A. Donohue, MD

Lt Col Wade T. Gordon, MD

**Objectives:** The literature suggests that smoking tobacco prevents fracture healing. This study describes the correlation between smokeless tobacco and tibia fracture healing in injuries acquired in the war trauma setting. These results are compared against smoking tobacco to determine if there is a correlation between these demographic data sets and outcomes following complex combat tibial injury.

**Design:** Observational, Retrospective review. Setting: This study was performed in a tertiary care, military hospital setting.

**Patients/Methods:** 195 patients were identified utilizing a surgical database and included in this series. Patients meeting inclusion criteria for the study were studied. Data on smoking and smokeless tobacco use was extracted from the medical record. Further demographic, radiographic, and clinical data was compiled and analyzed. Main Outcome Measurements: Mode of fixation, nonunions, malunions, failure of limb salvage, associated injuries, condition of the soft tissue, associated neurovascular injuries, flap failures and flap types were measured.

**Results:** From the time periods of Oct 2001 to July 2013, 195 patients met inclusion criteria. All patients were male. Modes of definitive fixation included intramedullary nailing, circular external fixation and open reduction internal fixation with plate/screw constructs. Most injuries were open tibia fractures. Of the total cohort, about 25% of the patients smoked, about 10% patients used some form of smokeless tobacco. Delayed amputation occurred in about 20% of patients. A (non)significant proportion of patients using smokeless tobacco encountered complications in treatment related to non-healing fractures or soft tissues.

**Conclusions:** To our knowledge, this is the largest and most comprehensive series in the literature to specifically describe

demographics and outcomes associated with smokeless tobacco and tibia fractures. As suggested by previous literature, smoking is a risk factor for non-union, malunion or poor outcomes in general following reconstruction. Smokeless tobacco, on the other hand, does not appear to be a risk factor for complications during limb salvage. These results suggest that elements generated by the combustion of tobacco products, or its method of absorption, rather than tobacco itself is the cause of delayed fracture healing and nonunion in smokers.

**Notes:**

1105-1110

## Management Of External Fixation Devices For Staged Surgery

LCDR Colin Crickard, MD  
Rachel Seymour, PhD  
Madhav A. Karunakar, MD

**Introduction:** Temporizing external fixation has been described for multiple orthopedic trauma surgeries to provide soft tissue stabilization and allow for reduced inflammation in patients undergoing lower extremity surgery. Multiple authors have evaluated the ability to surgically prep an external fixator with varying degrees of success. Given this difficulty with residual bacteria on the external fixator there is significant concern with prepping one into a sterile field. There is also little consensus on the appropriate timing of external fixation removal in relation to skin prep and skin incision.

**Purpose:** To quantify the risk of infection, defined as culture positive wound infection requiring surgical debridement, resulting from differing timing of external fixation removal in relation to skin incision and final skin preparation.

**Methods:** A retrospective review of all patients enrolled in a database for complex proximal tibial fractures was performed. Inclusion criteria were defined as the presence of an Orthopedic Trauma Association (OTA) 41-C3 proximal tibial fracture and the placement of an external fixator for soft tissue

temporization. The primary outcome measure was soft tissue infection requiring surgical debridement. Secondary data regarding the presence or absence of compartment syndrome, open fracture, diabetes, tobacco use, as well as the subtype of OTA 41-C3 fracture were included along with demographic data such as patient age and BMI.

**Results:** 146 patients with OTA 41-C3 type proximal tibia fractures were identified. Of these patients 112 had placement of an external fixation for temporization of the soft tissues. Twenty-two patients had incomplete data regarding the removal of external fixation and were excluded. Nine patients had retention of the external fixator after definitive surgery for various reasons and were also excluded. The remaining eighty-one patients comprised the data study group. Of these eighty-one patients, thirty-eight had removal of the external fixator before skin incision and before the final skin preparation for surgery, defined as “pre-op”. Forty-four patients had external fixation removed intraoperatively after skin incision for the definitive surgery, defined as “intra-op”. The overall rate of infection in the “pre-op” group was 18.4% compared to 25% in the “intra-op” group. However, the difference in the rate of infection was not significant. In the “pre-op” removal group, age was associated with infection (53yrs vs 42yrs ( $p=0.018$ )). In the “intra-op” group there was a significant association between the presence of open fracture and the risk of infection (4 vs 1; ( $p=0.011$ ))). The mean BMI for the sample was 30, the same in both groups ( $p=0.787$ ).

**Conclusions:** In this consecutive series of OTA 41-C3 tibial plateau fractures there was not a significant association with infection and timing of removal of the external fixator in relation to definitive operative fixation. Significant differences were noted within the “pre-op” and “intra-op” groups respectively with regard to patient age and the presence of an open fracture.

**Notes:**

1110-1115

## Quantitative And Qualitative Assessment Of Exposure Of The Posterolateral Proximal Tibia By Four Approaches

Capt Sarah Pierrie, MD

Luke S. Harmer, MD, MPH, FRCSC

Madhav A. Karunakar, MD

Marc R. Angerame, MD

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Katherine M. Sample, BBA

LTC (Ret) Joseph R. Hsu, MD

**Introduction:** Posterior tibial plateau fractures represent a minority of proximal tibia fractures. Numerous surgical approaches and techniques have been recently described to address fractures of the posterolateral plateau, each with unique variations and limitations. However, quantitative and qualitative comparison of the exposure obtained by these approaches has not yet been performed. The purpose of this study is to evaluate the bony surface area and various anatomic landmarks revealed by four surgical approaches in a cadaveric model.

**Methods:** Four published surgical approaches—a posterolateral (PL) approach, fibula osteotomy (FO), posteromedial (PM) approach, and anterolateral (AL) approach—were performed on ten fresh-frozen cadavers. A randomized crossover design was used to determine the order of the surgical approaches. Once each exposure was obtained, a ruler was placed in the surgical field and calibrated digital images obtained. Ten bony and soft tissue landmarks were then identified and the surgeon's ability to see or palpate each landmark was recorded for each exposure.

**Results:** An average of  $3.87 \pm 2.67$  cm<sup>2</sup> was exposed by the PL approach, compared to  $6.87 \pm 1.65$  cm<sup>2</sup> by the FO,  $19.71 \pm 6.34$  cm<sup>2</sup> by the PM approach, and  $20.22 \pm 6.80$  cm<sup>2</sup> by the AL approach. There was no significant difference between the bony surface area exposed by the posteromedial and anterolateral approaches ( $p = 0.88$ ). In contrast, the difference in the area exposed by all other approaches was statistically significant ( $p$  less than 0.01 for all comparisons). There was no correlation between bony surface exposed and gender, body mass index, specimen height, or sequence of dissection. All far lateral landmarks (popliteal hiatus, lateral collateral ligament insertion, and common peroneal nerve) and posterior structures (posterior proximal tibiofibular joint [PTFJ] capsule,

tibial insertion of the posterior cruciate ligament, and anterior tibial artery) were consistently seen and touched using the PL approach and FO. Though exposure to lateral landmarks was less reliable through the PM approach, exposure increased as the surgeon moved posteriorly and medially. Lateral structures including the lateral collateral ligament insertion, anterior aspect of the PTFJ, and to a slightly lesser extent the popliteal hiatus were consistently visualized and palpated using the AL approach.

**Discussion and Conclusion:** Lateral and posterior structures on the proximal tibia are accessible through a PL approach and FO, though the bony surface area exposed by these techniques is relatively small. These approaches are likely to provide adequate exposure for repair of isolated posterolateral quadrant fractures, particularly when access to the PTFJ is required. In contrast, a PM approach provides a significantly larger surface area through which fractures can be reduced and stabilized. However, it affords very limited contact with far lateral structures and inconsistent exposure to posterior structures. The combination of the PM and AL approaches provides access from the tibial tubercle to the anterior ligaments of the PTFJ and then from the posterior aspect of this to the MCL—a wide exposure that would allow surgeons to address the majority of tibial plateau fractures, including those involving the posterolateral quadrant. Furthermore, these two approaches impose the least risk of injury to the peroneal nerve and the anterior tibial artery. This study demonstrates that it is critical that fracture surgeons understand the armament of exposures available and the structures that can be addressed through each one so that adequate bony exposure and access to important soft tissue structures can be obtained. Clinical series are still needed to evaluate the validity of our results as well as the safety of these approaches.

### Notes:

1125-1130

## Improving Outcomes In Patients With Ankle Fusions Following Trauma

MAJ Daniel J. Stinner, MD

\*Capt Andrew J. Sheean, MD

Jason M. Wilken, PhD, PT

Johnny G. Owens, MPT

LTC (Ret) Joseph R. Hsu, MD

**Introduction:** High-energy open fractures to the distal tibia, ankle, and foot can be extremely debilitating. Patients undergoing limb salvage that ultimately requires ankle arthrodesis have been shown to have poor outcomes. This prospective observational study demonstrates an improvement in outcomes in patients with ankle and/or hindfoot fusions following lower extremity trauma after participation in an initiative involving an advanced rehabilitation program combined with the use of a custom ankle-foot-orthosis.

**Methods:** We prospectively evaluated 23 patients with subtalar and/or ankle fusions who participated in the initiative. The program consisted of two phases of rehabilitation: an initial out-of-brace phase (4 weeks) followed by an in-brace phase (4 weeks). Validated physical performance tests and patient-reported outcome surveys were completed at weeks 0, 4, and 8.

**Results:** There were 9 unilateral ankle fusions, 11 subtalar fusions, 2 unilateral subtalar and ankle fusions, and 1 bilateral ankle fusion. Overall, the patients improved in all physical performance measures (n=% improvement) (four square step test (31%), shuttle run (40%), self-selected walking velocity (19%), stair climb (38%)) and on patient-reported outcomes. When isolating patients with ankle fusions (n=12), patients demonstrated improvement in all physical performance measures (four square step test (31%), shuttle run (34%), self-selected walking velocity (20%), stair climb (24%)) and on patient-reported outcomes. When evaluating patients with isolated subtalar fusions (n=11), patients demonstrated even greater improvement in all physical performance measures (four square step test (31%), shuttle run (45%), self-selected walking velocity (19%), stair climb (42%)) and patient-reported outcomes.

**Discussion and Conclusion:** Ankle arthrodesis following high-energy lower extremity trauma has been associated with poor outcomes, despite the use of commercially available orthotics and traditional physical therapy. This combined

advanced rehabilitation and custom bracing initiative resulted in improved functional outcomes in patients who underwent ankle and/or hindfoot fusions following lower extremity trauma.

### Notes:

1130-1135

## The Orthoplastic Team Approach To Salvage Of Infected Tibial Non-Unions With The Use Of Free Vascularized Fibula Graft And Taylor Spatial Frame

LCDR Scott M. Tintle, MD

Stephen J. Kovach III, MD

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**Introduction:** Infected non-unions with soft tissue defects present a formidable challenge for orthopaedic surgeons and reconstructive microsurgeons. The degree of debridement necessary for successful eradication of infection frequently leads to large segmental bone loss. This intercalary bone loss accompanied by soft tissue defects leads to poor outcomes and frequent amputation.

**Methods:** We performed a retrospective review of patients at our institution that presented to us with infected tibial non-unions from August 2011 until December of 2012. These patients were treated with a staged protocol to include debridement, antibiotic cement spacer placement, external fixation, and eventual vascularized free fibula osteocutaneous bone grafting and Taylor spatial frame (TSF) placement. We evaluated the patients' previous treatment, time from injury until TSF placement, time until weightbearing, time to union, time to frame removal, initial and final alignment of the leg, immediate and delayed complications.

**Results:** Eight patients were treated with our staged protocol over these sixteen months. Seven of these patients were transferred into our institution with infected non-unions. Two

patients required soft tissue coverage with free anterolateral thigh flaps prior to free fibula grafting. All eight patients were treated with osteocutaneous free flaps for simultaneous treatment of open wounds as well as to provide living intercalary bone graft. An average of 11.1 cm of fibula was transferred for an average 9.4 cm defect. The average time of follow up is 261 days (range 64-471). At this time, all patients have closed wounds, without signs of infection. Three of the 8 fractures have healed in acceptable alignment. The average time to union was 302 days. The use of the TSF has led to significantly improved alignment of the limb. The average time to ambulation was 6 weeks. There have been two complications. An acute venous thrombosis of a vein was noted on post op day one and was immediately revised with free flap salvage. There was one donor site infection that was treated with irrigation and debridement and skin grafting.

**Conclusions:** In conclusion, these are very complex injuries that require advanced care. Orthopaedic trauma surgeons with expertise in the use of circular frames as well as microsurgeons with expertise in vascularized bone grafting and soft tissue coverage are necessary to successfully salvage these limbs. An orthoplastic staged approach over a 12-18 month time period is crucial. The principles of providing adequate debridement, external fixation, adequate soft tissue coverage, vascularized bone, and finally, durable fixation are all imperative ingredients in this staged approach for success.

**Notes:**

**Methods:** Surgical case logs and medical records were reviewed to identify patients who underwent limb salvage surgery with circular fixation for high energy trauma or infectious complications. A subset of patients who underwent secondary hindfoot nailing either planned or due to complication were subsequently identified. Antibiotic coated nails were not used, but local antibiotics were injected into the canal with a calcium sulfate carrier immediately prior to nail passage to minimize the risk of infection in all cases. We cross referenced these patients with a prospectively collected database of lower limb injured patients that includes functional outcomes and validated physical performance measures. These patients participated in an integrated orthotic and rehabilitation clinical pathway.

**Results:** Six secondary hindfoot fusions with intramedullary devices after circular fixation were identified in five patients. Average follow-up was 20 months (6-46 months). Four of the six patients had previous osteomyelitis treated with bony resection. Five of the six had bone transport. Three of the six had a gradual deformity correction to hindfoot nail fusion as the final stage of reconstruction. There were no infectious complications after secondary hindfoot nailing. One patient went on to a trans-tibial amputation six months following hindfoot fusion nail due to chronic pain. There were no re-operations on the injured extremity after secondary nailing in the remaining 4 patients. Three of the four patients report 0 or minimal ankle pain when using their orthotic. One patient has discontinued use of his orthotic and continues to have chronic ankle pain.

**Discussion and Conclusion:** Secondary hindfoot nailing after circular fixation appears to be a reasonable reconstructive option. When combined with an integrated orthotic and rehabilitation clinical pathway, functional results can be quite good.

**Notes:**

1135-1140

## Secondary Hindfoot Nailing After Circular Fixation Limb Salvage

MAJ Daniel J. Stinner, MD  
LTC (Ret) Joseph R. Hsu, MD

**Introduction:** Very little data exists on secondary hindfoot fusion nailing after limb salvage with a circular fixator. Concerns persist over deep infection and poor functional outcome.

1140-1145

## Comparison Of Female And Male Casualty Cohorts From Conflicts In Iraq And Afghanistan

CPT Christina Hylden, MD

LTC Anthony E. Johnson, MD

MAJ Jessica C. Rivera, MD

**Introduction:** The purpose of this study is to compare female and male US Military casualties from the conflicts in Iraq and Afghanistan with a musculoskeletal diagnosis and investigate differences in demographics and injury characteristics between the sexes.

**Methods:** The Department of Defense Trauma Registry (DoDTR) was queried, resulting in 425 female and 14,982 male subjects who sustained musculoskeletal injuries from October 2003 (beginning of hostilities in Iraq) to December 2012. The female and male cohorts were compared and analyzed for significance in demographics (age, service, rank, and military operation) and injury characteristics (ISS, AIS, injury type, injury cause, and injury date).

**Results:** Statistical analysis of demographic data revealed differences in military branches with a higher proportion of injured females serving in the Army and a higher proportion of injured males serving in the Marine Corps. Female casualties were on average slightly younger ( $F=26.11$  years;  $M=27.83$  years). Sex differences were shown in injury characteristics: females on average showed higher Injury Severity Scores ( $F=9.68$ ;  $M=7.49$ ) and higher Abbreviated Injury Scores specific to the skeletal anatomic region ( $F=2.36$ ;  $M=2.06$ ). Females were less likely to be injured in battle and therefore less likely to be injured due to an explosive device, which was the most common mechanism of injury for all members injured during battle, both male and female. All of the described statistically significant differences showed a p value of less than 0.001.

**Discussion and Conclusion:** Comparing female to male US military casualties from the recent conflicts in Iraq and Afghanistan, the statistical analysis showed differences between the sexes in relation to injury characteristics. Females comprise 2.75% of the DoDTR casualties during the studied time-frame and are less likely to be involved in explosions or during battle. Thus, this population has received little attention in the literature to date. Despite lower rates of battle-related and explosion-type injuries, female casualties have

sustained higher ISSs. This finding is somewhat counterintuitive as explosion and battle injuries are expected to average higher severity scores. However, our data is consistent with previous evidence that the case fatality rate may be higher for females. Further investigation is required to determine what sustained injury patterns are leading high ISSs in our female casualties.

### Notes:

1145-1150

## Emergency Tourniquets For Civilians: Can Military Lessons In Extremity Hemorrhage Be Translated?

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**Introduction:** In the civilian setting, emergency tourniquet (TKT) use has been infrequent out of concern for TKT-related complications. In large part due to positive reports from the military on emergency TKT use, all ambulances serving our large county were equipped with commercial TKTs in September 2012. Few studies evaluate outcomes of emergency TKT use in the civilian setting. This study compares the outcomes of emergency TKT use to conservative hemorrhage control in the civilian setting and evaluates outcomes related to appropriate TKT placement.

**Methods:** We reviewed EMS and hospital records from September 2012 to November 2013. Inclusion criteria were EMS placement of an emergency TKT or documentation of uncontrolled extremity hemorrhage, penetrating extremity trauma, open fracture with active bleeding, or traumatic amputation. Deaths prior to patient transport were excluded. Main outcomes were death, hemorrhagic shock and vascular (arterial) injuries. Secondary outcomes were emergent hemorrhage control surgeries, blood transfusions, ISS, hospital admissions,

and TKT-related complications. Appropriateness of TKT use was assessed for each patient. TKT use was appropriate if there was documented pre-hospital shock, hemorrhage not controlled by conservative measures or evidence of vascular injury. TKT use was inappropriate if none of these indications were documented. ‘Missed’ or ‘delayed’ TKT use was noted if a patient did not receive a pre-hospital TKT but had continued hemorrhage on hospital arrival or presented in shock. The patient had a TKT placed in the trauma bay (‘delayed’) or never received a TKT (‘missed’). Comparison analyses were performed two ways. Primary analysis compared all TKT patients to non-TKT patients - patients who received trauma dressings and/or direct pressure for hemorrhage control. Secondary analysis compared all appropriate TKT patients to delayed/missed TKTs. This subset analysis intended to evaluate the effect of timing of TKT placement among patients with injuries that warranted a TKT.

**Results:** 56 patients met inclusion criteria: 24 TKT patients and 32 non-TKT patients. There were 46 traumatic injuries and 10 non-traumatic injuries (AV fistula or varicose vein bleeding). There were 4 fatalities (7.1%) including 3 TKT patients. 1 fatality, a TKT patient with a ruptured AV fistula, was attributed to extremity exsanguination. 3 of 4 deaths occurred in the ED. 46.4% (16/56) of all patients demonstrated signs of shock in the pre-hospital or ED setting. 75% (12/16) of patients in shock had a vascular injury ( $p=0.023$ ). 9.4% (3/32) of non-TKT patients should have received a TKT and were classified as ‘missed’. 1 ‘missed’ patient died in the ED. Among TKT patients, 62.5% (15/24) of TKTs were appropriate, 20.8% (5/24) were inappropriate and 16.7% (4/24) were ‘delayed’. Overall, there was a delayed/missed TKT rate of 12.5% (7/56). TKT (24 patients) vs. Non-TKT (32 patients): TKT patients had significantly higher rates of shock (50% vs. 12.5%;  $p=0.003$ ), vascular injury (68.2% vs. 25.8%;  $p=0.002$ ), hemorrhage control surgery (50% vs. 9.7%;  $p=0.004$ ), blood transfusion (37.5% vs. 12.5%;  $p=0.05$ ), and hospital admission (77.3% vs. 38.7%;  $p=0.005$ ). There was no difference in incidence of severe injuries (ISS>15) ( $p>0.05$ ). No TKT-related complications were reported (0/24). Appropriate TKT (15 patients) vs. Delayed/Missed (7 patients): Patients with ‘delayed/missed’ TKTs had higher incidences of shock (85.7% vs. 60%), inpatient admission (100% vs. 76.9%) and blood transfusions (71.4% vs. 40%). The sample size was too small to establish significance.

**Discussion and Conclusion:** The majority of TKTs were appropriately applied to civilians who had vascular injuries or required operative intervention for hemorrhage control.

With appropriate indications, an emergency TKT is a valuable instrument for hemorrhage control in the civilian pre-hospital setting and has a low rate of associated complications.

**Notes:**

**Tuesday, December 16, 2014**

**General Session 4: Trauma — Upper Extremity and Soft Tissue (Palomino Ballrooms 8-10)**

**Civilian Moderator:** Samir Mehta, MD

**Military Moderator:** MAJ Daniel J. Stinner, MD

1430-1435

**Norman T. Kirk Award**

**Early Complications And Outcomes In Combat Injury Related Invasive Fungal Infections: A Case-Control Analysis**

LT Louis R. Lewandowski, MD

Amy C. Weintrob, MD

David R. Tribble, MD, DrPH

CDR Carlos J. Rodriguez, DO

CPT Joseph Petfield, MD

COL Clinton K. Murray, MD

MAJ Daniel J. Stinner, MD

Faraz Shaikh, MS

LTC Benjamin K. Potter, MD

**Background:** Invasive fungal infections (IFIs) have become increasingly prevalent in combat trauma populations. In addition to increased mortality, clinicians have anecdotally noted that IFIs lead to residual limb shortening, additional days and operative procedures prior to initial wound closure, and a high early complication rate. Our objective was to evaluate the validity of these observations and identify risk factors that may impact the time to initial wound closure in a case-control analysis.

**Methods:** The study population included United States military personnel injured during combat operations (June 2009-August 2011). The IFI cases were identified based upon the presence of recurrent, necrotic extremity wounds with mold growth in culture and/or histopathology demonstrating invasive fungal elements. The non-IFI controls were matched on the basis of injury pattern and severity. Information regarding surgical history, time to initial wound closure, complications, amputation level changes, and loss of femur length were analyzed. Data are expressed as multivariate hazard ratios (HR; 95% confidence interval [CI]).

**Results:** Seventy-one IFI cases (112 fungal-infected extremity wounds) were identified and matched to 160 control patients (315 extremity wounds without fungal infections). Wounds with fungal infections resulted in a significantly ( $p<0.001$ ) higher number of operative procedures and longer duration to initial wound closure, along with a greater rate of early complications requiring additional surgery. Additionally, a significantly increased amount of residual limb shortening ( $p=0.009$ ) and changes in amputation level ( $p<0.001$ ) were observed among the IFI cases compared to controls. The IFI case wounds also demonstrated a higher rate of secondary or concurrent bacterial skin and soft-tissue infections (SSTIs;  $p<0.001$ ). A shorter duration to initial wound closure was significantly associated with wounds lacking IFIs (HR: 1.53; CI: 1.17, 2.01) and SSTIs (HR: 2.89; CI: 2.02, 4.11).

**Conclusions:** Our analysis indicates that IFIs adversely impact wound healing and patient recovery leading to more frequent proximal amputation revisions and higher early complication rates. Concurrent/secondary bacterial SSTIs also add to the complexity of IFI wounds and may further affect wound healing.

#### Notes:

1435-1440

## Observations On Pain Control And Long Length Acellular Allograft Use In The Early Treatment Of Combat Related Injuries Of The Sciatic Nerve

LT Patrick E. Jones, MD

\*2LT R. Michael Meyer, BS

Walter J. Faillace, MD, FACS

CAPT Patricia L. McKay, MD

LTC Leon J. Nesti, MD, PhD

**Object:** The goals of this study were to retrospectively observe and evaluate the outcome of pain reduction and long length, acellular, processed cadaver allograft use in the surgical repair of sciatic nerve injuries of patients injured in recent military conflicts. Traumatic injury to the sciatic nerve sustained in military conflict tends to be severe with protean consequences. This injury is often associated with widespread soft tissue and bone injuries, significant neurologic impairment, severe neuritic pain, and a prolonged recovery time. There is limited data that describes the treatment of these significant and devastating nerve injuries.

**Methods:** We retrospectively reviewed the surgical records of 5137 combat related extremity injuries at three institutions between June 2007 and June 2013 to identify those patients with combat-related sciatic nerve injury without amputation of the affected side. Patients included in this study underwent a thorough chart review including evaluation of inpatient and outpatient medical records, pain assessments, radiographs, surgical reports, and intraoperative photographs to determine severity of injury, and the timing from injury to surgery, to assess outcome. .

**Results:** Thirteen patients were identified as having combat related sciatic nerve injuries, all patients were male, mean age was 28 years. The mechanisms of injury were 9 gunshot wounds (69%), 2 rocket propelled grenade (RPG) blasts (15%) and 2 improvised explosive device (IED) blasts (15%). Intraoperative electrophysiologic monitoring was used to assess the integrity of nerve conductivity. Three patients (23%) with dense sensory-motor loss were found to have a neuroma in continuity, and required only neurolysis. Eight, patients (53%) with nerve transections and neuroma formation had long length (5-7 cm) cadaver allograft grafts placed, one patient had a sural nerve autograft (5 cm), and 1 patient underwent end to end direct nerve repair. Five (38%) patients

underwent surgery 21 to 30 days after the time of injury (early), and eight (61%) patients had surgery greater than 150 days after injury (standard). In comparing those patients who had early versus standard timing of nerve surgery, there was no difference in the amount of damaged nerve resected and both groups had equivalent reductions of pain and narcotic use at 6 weeks and 6 months postoperatively. There were no complications due to graft infection or rejection in either group.

**Conclusions:** Traditional teaching is to delay sciatic nerve injury repair for at least six months to provide the damaged nerve a period of self-recovery and to allow structural damage to the injured nerve to fully declare itself. Our experience demonstrates that combat related sciatic nerve injuries can be reliably operated on 21 to 30 days post injury, with great benefit toward reduction of severe neuritic pain, and long length cadaveric allografts may be successfully placed without infection or rejection.

**Notes:**

1440-1445

## Definitive External Fixation For Diaphyseal Fractures Of The Humerus: A Systematic Review

LCDR George C. Balazs, MD

\*CPT Michael A. Donohue, MD

CPT Jared A. Wolfe, MD

CDR Mark E. Fleming, DO

**Background:** Humeral shaft fractures account for 3-5% of all fractures, occurring with an overall incidence rate of 19 per 100,000 annually in the United States. Commonly accepted indications for operative treatment include open fractures, neurovascular injury, polytrauma, highly comminuted or segmental fractures, and clinically unacceptable alignment. Plating and intramedullary nailing are the most common operative treatment methods, with generally good functional results (87

- 90.9%) but also high complication rates (20.6 - 42%). External fixation is less commonly utilized, but holds theoretical benefits of decreased operative times and reduced complications. We sought to systematically review available literature on the results of definitive external fixation for humeral shaft fractures.

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

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

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

**Notes:**

1445-1450

## Determination Of Radiation Exposure From Intra-Operative Fluoroscopy Views In Orthopaedic Trauma

LCDR Michael Kuhne, MD

Kiley Libuit

Meir T. Marmor, MD

**Introduction:** Fluoroscopy is being increasingly used during orthopaedic trauma procedures. Despite this use, surgeon awareness is limited regarding radiation exposure to surgical personnel while obtaining different fluoroscopic images. The International Commission on Radiologic Protection recommends limiting annual occupational radiation exposure to 20 milliSieverts (mSv). For reference, a full body CT scan is approximately 10mSv of radiation. The purpose of this study is to measure radiation exposure to the surgeon and assistant during different fluoroscopic views. To increase understanding of the magnitude of radiation exposure, we aim to report radiation dose as a multiple of a baseline we defined as the dose received during imaging of the distal radius. Our hypotheses are that different fluoroscopic views increase the surgeon's radiation exposure, and secondly that the surgeon and first assistant receive differing amounts of radiation exposure during different images.

**Methods:** Our protocol analyzed 37 different fluoroscopic images using a 9" C-arm. Five real-time dosimetry badges were placed on two towers simulating a surgeon and a first assistant. Each tower was located 1 foot from the operating table. The tower representing the surgeon had 2 dosimeters and was placed on the side of the table opposite the C-arm (and during lateral fluoroscopic imaging, the C-arm radiation source was located next to the dosimeters). The tower for the assistant had 3 dosimeters and was placed ipsilateral to the C-arm (and during lateral imaging, the image intensifier was located next to the dosimeters). During upper extremity imaging, both towers were on the side opposite the C-arm. Radiation exposure from one minute of continuous fluoroscopy was recorded for each view in microSieverts ( $\mu$ Sv). For each image, the dosimeters for the surgeon and for the assistant were averaged. Doses were reported as a multiple of the distal radius radiation dose exposure.

**Results:** Four full body cadavers were available for imaging. The surgeon was exposed to 1.11  $\mu$ Sv/min during continuous radiation to the distal radius. The greatest radiation exposure

to the surgeon was during the lumbar spine lateral (192  $\mu$ Sv/min), hip lateral (162  $\mu$ Sv/min), and thoracic spine lateral (130  $\mu$ Sv/min) images which were 175, 147, and 118 times the dose received by imaging the distal radius, respectively. The exposure to the Assistant was lower at 7 (8  $\mu$ Sv/min), 21 (23  $\mu$ Sv/min), and 9 (10  $\mu$ Sv/min) times the radiation exposure received by imaging the distal radius, respectively. The next highest exposure to the surgeon was the AP pelvis (10  $\mu$ Sv/min) with 9 times the radiation dose of the distal radius. Doses were also increased as compared to the distal radius dose exposure in the following views (expressed in  $\mu$ Sv/min): Femur lateral (8), C-spine lateral (5), T-spine AP (5), C-spine AP (4), L-spine AP (4), Hip AP (4), Knee lateral (3), Femur AP (3), Tibia lateral (3), and Shoulder AP (3).

**Discussion/Conclusion:** Radiation exposure to the surgeon and the first assistant increased during certain fluoroscopic images. Lateral imaging of the lumbar spine, thoracic spine, and hip exposed the surgeon to more than 100 times the radiation dose received during imaging of the distal radius. The surgeon and first assistant do not receive equal amounts of radiation exposure. The surgeon standing next to the C-arm radiation source in the lateral view of the above images receives significantly more radiation than the assistant. Limitations of this study are that it is a cadaveric study with all specimens in the supine position. Exposure may differ for other positioning. Body habitus was not analyzed which may alter radiation dose. In certain configurations, the dosimeters were unable to be placed 1 foot away, thus introducing measurement error. Lastly, occasional dosimeter readings were not available for data collection and were excluded from averaging. This data provides orthopaedic surgeons with knowledge of the amount of radiation exposure for each fluoroscopic image allowing them to minimize their risk via increased awareness of fluoroscopic images with higher dose exposure.

### Notes:

1500-1505

## An Analysis Of Orthopaedic Research Produced During The Conflicts In Iraq And Afghanistan: The Top 20 Most Cited Articles

LCDR George C. Balazs, MD

\*CPT Jared A. Wolfe, MD

MAJ Jonathan F. Dickens, MD

CPT Alaina M. Brelin, MD

CDR John-Paul Rue, MD

LTC Benjamin K. Potter, MD

**Objective:** Operations Iraqi and Enduring Freedom (OIF/OEF) have produced thousands of American casualties and tens of thousands of combat wounded. Military orthopaedic surgeons have been at the forefront of wounded warrior care, and their research contributions have substantially expanded our knowledge base in a variety of areas. We sought to identify the 20 most frequently-cited peer-reviewed orthopaedic manuscripts related to these conflicts in order to better characterize the impact of recent combat-related orthopaedic research on the larger practice of medicine in both military and civilian settings, to identify the most prolific areas of investigation, and, potentially, to identify areas (via their absence from this list) of persistent or underexploited knowledge gaps.

**Methods:** In May 2014, we searched the Web of Science Citation Index Expanded using the terms orthopedic, military, combat, Iraq, war, Afghanistan, extremity, Army, soldier, and wounded, both alone and in combination. The resulting list was sorted by number of times each manuscript was cited, and was then manually searched for relevant original research performed by United States military orthopaedic surgeons relating to the care of musculoskeletal trauma sustained in OIF/OEF. Review articles that did not include original research were excluded. The 20 most-commonly cited studies were identified. Articles citing these studies were reviewed using both Web of Science and Google Scholar data, and the journal name and subject area recorded as well as the first author's affiliation (military versus civilian institution).

**Results:** The initial search identified 8,507 candidate articles. The 50 most frequently-cited articles by military orthopaedic surgeons were further investigated, and narrowed to the 20 most cited articles meeting the above criteria. Five studies examined the injury characteristics of combat casualties in various locations in the MEDEVAC chain, including the

overall rate of traumatic amputation as compared to previous conflicts. Eight studies dealt with the basic science of wound management, wound dehiscence, and formation of heterotopic ossification. Two studies examined the infectious complications of combat trauma including the characteristics of osteomyelitis after open lower extremity fractures. Two studies defined the clinical characteristics and risk factors for the formation of heterotopic ossification. Three studies described the long-term outcomes of combat injury including return to duty rates and degree of disability. Other research citing these studies has appeared in over 200 different journals and publications.

**Discussion/Conclusions:** Research based on casualties in Iraq and Afghanistan has broadened our understanding the epidemiology of combat wounded in modern warfare, the biological underpinnings of normal and pathological wound healing, proper management of severe soft tissue wounds, and the long-term disabilities associated with combat injuries. This research has had significant impact on a range of specialties in both the civilian and military medical communities.

### Notes:

1505-1510

## The Military Orthopaedic Trauma Registry: Quality Data Now Available

MAJ Jessica C. Rivera, MD

CPT Chad A. Krueger, MD

LTC Anthony E. Johnson, MD

**Introduction:** Following Extremity War Injury Symposium II, the Military Orthopaedic Trauma Registry, or MOTR, was developed to improve data driven management of combat orthopaedic injuries. Supported by the US Army Institute of Surgical Research's Department of Defense Trauma Registry (DoDTR), the MOTR was built by and for the military orthopaedist. As a quality improvement process, we aim to examine the data entered into MOTR and compare the quality and quantity of data obtainable from MOTR.

**Methods:** The medical records of 21 female amputees were abstracted and entered in the MOTR. We then examined the data points available for this small population from a recent data pull from DoDTR and other data repositories accessible to the military researcher in order to describe degree of agreement.

**Results:** General demographic and injury information including age, military rank, Injury Severity Score, and injury mechanism was found with great consensus between classic sources and MOTR. Classic sources provided diagnosis and procedure codes as a list but no additional details on timing, injury specifics or treatment specifics. The same codes were used in MOTR, however additional data including specific limb, AO fracture classifications, and associated injuries (e.g., nerve, vascular, soft tissue) per limb were available. Procedure codes were also the same; however MOTR allowed for construction of a treatment timeline for each limb and included specifics such as debridement timing, antibiotics, implant types, and dressing information. Orthopaedic specific complications were coded more frequently in MOTR clearly identified with a specific limb injury.

**Discussion:** During initial quality control checks, MOTR provides a greater volume and granularity of detail for orthopaedic specific injury and treatment information. The MOTR data will allow the orthopaedic research to construct accurate treatment timelines not previously possible from prior database sources.

#### Notes:

1510-1515

## Enhanced Casualty Care From A Global Military Orthopaedic Teleconsultation Program

CPT Matthew D. Laughlin, DO  
MAJ Brian R. Waterman, MD  
COL Philip J. Belmont Jr., MD  
Andrew J. Schoenfeld, MD  
COL Mark P. Pallis, DO

**Background:** Since its advent, telemedicine has facilitated access to subspecialty medical care for the treatment of patients in remote and austere settings. The United States military introduced a formal orthopaedic teleconsultation system in 2007, but few reports have explored its scope of practice and efficacy, particularly in a deployed environment during a time of conflict.

**Methods:** All teleconsultations placed to the orthopaedic service between April 2009 and December 2012 were obtained and retrospectively reviewed. Case files were abstracted and anatomical location of injury, type of injury, origin of consult (country or Navy Afloat), branch of service, and treatment recommendations, were recorded for descriptive analysis. The final result of the consult was also determined, with servicemembers transported from the combat theater or deployment location defined as medically evacuated. Instances where teleconsultations averted a medical evacuation were also documented as a separate outcome.

**Results:** Over a 32-month period, 597 orthopaedic teleconsultations were placed, with a plurality derived from Army (46%) and Navy (32%) personnel deployed in Afghanistan, Iraq, or with Navy Afloat. Approximately 51% of consults involved the upper extremity, including 197 hand injuries, followed by lower extremity (37%) and spine (7.8%) complaints. Fractures comprised over half of all injuries, with the hand and foot most commonly affected. The average response time for teleconsultations was 7.54 hours. A total of 56 servicemembers required immediate evacuation for further orthopaedic management, while at least 26 medical evacuations were prevented due to the teleconsultation system.

**Conclusions:** The teleconsultation system promotes early access to orthopaedic subspecialty care in a resource-limited, deployed military setting. The telemedicine network also appears to mitigate unnecessary aeromedical evacuations, reducing healthcare costs, lost duty time, and treatment

delays. These findings have important meaning for the future of telemedicine in both the military and civilian setting.

**Notes:**

1515-1520

## A Systemic Review Of Residency Application Data: Who Do You Want Taking Care Of You?

LT Nicholas Pulos, MD

Mara L. Schenker, MD

Keith D. Baldwin, MD, MSPT, MPH

Jaimo Ahn, MD, PhD

Samir Mehta, MD

**Introduction:** Orthopaedic surgery residency remains one of the most competitive fields for medical students. Program directors rely heavily on standardized examination criteria in selecting medical students. However, little is known about how pre-residency characteristics correlate with future resident performance. The aim of this study was to systematically review the relationship between residency application data and future performance in orthopaedic surgery residency.

**Methods:** EMBASE, ERIC, Medline, PsychINFO and Cochrane computerized literature databases and manual search of bibliographies were performed. Randomized controlled trials, and cohort studies (retrospective and prospective) evaluating the association between residency application data and subsequent residency performance were included. Descriptive and quantitative data were extracted. A meta-analysis was performed when the primary data permitted using Fisher's r to z transformation prior to entering into the meta-analysis software. Using Cohen's calibration for effect size, we classified an effect size of 0.10 as "small", 0.30 as "moderate", and 0.50 or greater as "large".

**Results:** Initial search identified 38,004 references. Of the 3,248 articles further inspected by title, 140 were excluded based on full article review, leaving 10 studies included in the final review (1 prospective, 8 retrospective, and 1 study

had both retrospective and prospective data). These studies included 1730 orthopaedic surgery residents (retrospective studies) or applicants (prospective studies). There was a relationship between higher orthopaedic in-training (OITE) scores and higher USMLE Step I scores (average effect size 0.39, moderate effect, 95% CI: 0.18 to 0.59, p<0.001). Of the additional studies that did not provide sufficient data for inclusion in the meta-analysis, three suggested a relationship between higher USMLE scores and higher in-training scores and one study demonstrated no relationship. Additional application criteria examined for relationship with higher OITE scores were: higher USMLE Step II scores (N=1, positive correlation), AOA status (N=1, no correlation; N=1, positive correlation), prior research experience (N=1, no correlation), and marital status (N=1, positive correlation). There was no significant relationship between ABOS Part I pass rates and higher USMLE Step I scores (average effect 0.28, moderate effect, 95% CI: -0.08 to 0.65, p=0.12). Of the additional studies that did not provide sufficient data for inclusion in the meta-analysis, one suggested a relationship between ABOS pass rates and USMLE Step I scores and four studies demonstrated no relationship. In studies that examined clinical aptitude, faculty ratings, or achievement of "chief resident" status, there was no correlation with previous examination scores (N=3); however, there was a correlation with those who obtained honors scores in clinical rotations (N=1), performed an away rotation at that institution (N=1), or were involved in varsity athletics (N=1). There was a positive correlation with pre-residency publications and in-residency publications (N=1).

**Conclusion:** Higher OITE scores were associated with higher USMLE Step I scores. However, no association was found between ABOS pass rates and higher USMLE Step I scores. Predictive validity of application criteria on non-cognitive outcomes (ACGME core competencies, other than the knowledge domain) are largely unknown in the orthopaedic education literature. Future studies are imperative to rigorously define "success" as an outcome in orthopaedic residency, and then critically examine how to screen for this in a large, highly qualified applicant pool.

**Notes:**

1520-1525

## Army Orthopaedic Surgery Residency Program Directors' Selection Criteria

CPT Jeffrey Hoffman, MD

COL Philip J. Belmont Jr., MD

COL (Ret) Edward D. Arrington, MD

COL (Ret) Tad L. Gerlinger, MD

John G. DeVine, MD

MAJ Justin D. Orr, MD

**Introduction:** Successful match into an orthopaedic surgery residency program remains highly competitive. U.S. Army orthopaedic surgery programs annually provide approximately 3% of all available accredited residency positions. To date, the factors associated with successful residency selection in U.S. Army orthopaedic surgical programs have been unreported. The current analysis includes survey data from all Army orthopaedic surgery residency program directors (PDs) to determine these factors.

**Methods:** PDs at all six Army orthopaedic surgery residency programs were provided seventeen factors historically considered critical to successful residency selection and asked to rank order the factors as well as assign a level of importance to each factor. These results were collated and overall mean rankings are provided for both assessments.

**Results:** PDs unanimously expressed that an applicant's performance during the on-site orthopaedic surgery rotation at the individual program director's institution was most important for selection. Respondents overwhelmingly reported that USMLE/COMLEX Step 1 and USMLE/COMLEX Step 2 scores were second and third most important, respectively. Conversely, gathered survey data demonstrated that little importance was placed on letters or recommendation and personal statements. PDs made no discriminations based on allopathic or osteopathic degrees.

**Conclusion and Discussion:** This is the first study to directly survey Army orthopaedic surgery residency PDs to determine the factors considered most important for successful residency selection. The three most important factors for Army orthopaedic surgery residency selection were clerkship performance at the individual PD's institution, USMLE/COMLEX Step 1 score, and USMLE/COMLEX 2 medical school class rank which are similar to previous reports concerning civilian orthopaedic surgery residency match process. Additionally, Army PDs consider both USMLE and COMLEX results as

Army orthopaedic surgery residencies have a higher percentage of successful applicants osteopathic medical school graduates.

### Notes:

Tuesday, December 16, 2014

### General Session 5: Hip and Knee Preservation/Reconstruction/Osteoarthritis (Palomino Ballrooms 8-10)

Civilian Moderator: Thomas P. Vail, MD

Military Moderator: COL Philip J. Belmont Jr., MD

1610-1615

### Founders Award

### Is Ketorolac The Next Intra-Articular Knee Injection For Osteoarthritis?

MAJ Jaime Bellamy, DO

LTC Brandon J. Goff, DO

LtCol Siraj A. Sayeed, MD

**Introduction:** Knee osteoarthritis (OA) can be a disabling disease that affects up to 9 million adults in the United States. Corticosteroid intra-articular knee injection has been the gold standard for injection therapy. However, corticosteroid injections give varying amounts and durations of pain relief. Ketorolac intra-articular knee injection has not been studied as an adjunct in the management of knee OA. 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 (36 knees) with a mean age of 52 years (range, 34 to 86 years) were randomized to receive

either a ketorolac or corticosteroid intra-articular knee injection in a double-blind, prospective study. Follow-up was conducted over 24 weeks. Degree of OA was evaluated on pre- and 24 week post-injection radiographs using the Kellgren-Lawrence (KL) grading scale. All injections were performed under ultrasound guidance. Patient outcome measures, visual analog scale (VAS), Western Ontario and McMaster University Osteoarthritis Index (WOMAC), Knee Society (KS) pain and function, Short Form 36 (SF-36), Tegner Lysholm (TL) and University of California Los Angeles (UCLA) scores, were compared. Age, gender, and body mass index (BMI), as well as, radiographic OA grade were correlated to VAS. Two-way, repeated measures ANOVA and Spearman-Rank Correlation were used for analysis. A p-value less than 0.05 was considered significant.

**Results:** Mean VAS for both ketorolac and corticosteroid decreased significantly from baseline at 2 weeks, 6.3 to 4.6 ( $p=0.003$ ) and 5.2 to 3.6 ( $p=0.003$ ), respectively, and remained decreased throughout the 24 weeks. Mean WOMAC score for both ketorolac and corticosteroid increased from baseline at 2 weeks, 49 to 53 ( $p=0.003$ ) and 53 to 68 ( $p=0.003$ ), respectively. There was no significant difference in KS pain and function, 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 initially and over time was similar between ketorolac and corticosteroid injection for knee OA. In regards to function, the WOMAC score was increased for both at 2 weeks, with no difference in other outcome measures. Ketorolac is a safe option for knee intra-articular injection.

*\*The FDA has not cleared this drug and/or medical device for the use described in the presentation (Refer to page 29).*

**Notes:**

1615-1620

## The Safety And Efficacy Of Simultaneous Bilateral Anterior Approach Total Hip Arthroplasty

CDR (Sel) Joseph Gondusky, MD

LCDR Kevin A. Pinkos, MD

Leera Choi, BA

Jay J. Patel, MD

Steven Barnett, MD

Robert S. Gorab, MD

**Introduction:** Simultaneous bilateral total hip arthroplasty (THA) has been performed successfully with good outcomes and low complication rates reported. Most published studies on the topic utilized anterolateral or posterior surgical approaches. The anterior approach (AATHA) is performed with the patient supine, obviating the need for patient re-positioning during bilateral surgery. We report our experience with simultaneous bilateral anterior approach total hip arthroplasty (AATHA).

**Methods:** We retrospectively reviewed prospectively collected patient data and perioperative records for all patients undergoing simultaneous bilateral AATHA with a minimum three-month follow-up to determine the short-term safety of the procedure.

**Results:** Over the period July 2007- December 2012, 75 patients (150 hips) underwent simultaneous bilateral AATHA. Mean follow-up was 26 months (range, 5-60 months). Patient demographics showed that 59% of the patients were male, with a mean age of 59 years and body mass index of 27. Seventy seven percent of patients were American Society of Anesthesiology class 2 (range, 1-3). Mean surgical time was 144 minutes (1.2 hours per hip). Mean blood loss was 565 ml. 83% of patients required postoperative transfusion, with mean transfusion of 2 units. Mean hospital length of stay was 2.75 days (range, 1-4 days). Ninety six percent of patients were able to ambulate on postoperative day one an average distance of 207 feet. Sixty eight percent of patients were discharged to home. The average Harris Hip Score improved from 50 to 97, and 98% of patients were very or extremely satisfied at last follow-up. All patients noted a return to preoperative level of activity or higher. Complications included one atraumatic minimally displaced trochanteric fracture occurring 2 weeks postoperatively, one pulmonary embolism postoperative day number

three treated without sequelae, one episode of postoperative atrial fibrillation, and four minor local wound complications. No intraoperative complications occurred, including no intraoperative fracture or neurovascular injury. Postoperatively, no readmission within 30-days, infection, motor nerve palsy, symptomatic sensory nerve palsy, aseptic loosening, dislocation, reoperation or death occurred.

**Discussion and Conclusion:** AATHA has the advantage of a single supine patient position for bilateral simultaneous surgery. Our study shows that simultaneous bilateral AATHA is safe and effective, with low complication rates and excellent clinical outcomes.

**Notes:**

post-operative cardiac complications, in primary unilateral total knee arthroplasty (TKA) and total hip arthroplasty (THA) patients.

**Methods:** The National Surgical Quality Improvement Program 2006-2011 dataset was queried for all primary unilateral TKAs and THAs. Demographic information, medical history, and surgical data were extracted, and 30-day post-operative cardiac complications (i.e., myocardial infarction and cardiac arrest) and mortality were the primary outcome measures. Patients were designated as having a history of cardiac disease if they had one or more of the following: new diagnosis or exacerbation of chronic congestive heart failure (CHF) within 30 days of surgery, history of angina within 30 days of the surgery, history of myocardial infarction within the past 6 months, and/or any percutaneous cardiac intervention or other major history of cardiac surgery. An analysis of the occurrence of all major cardiac complications and mortality within the 30-day timeframe was performed. Bivariate testing followed by multivariate analysis determined statistically significant predictors.

**Results:** Of 46,322 identified patients undergoing TKA or THA, the 30-day cardiac complication rate was 0.33%. There was not a significant difference among TKA and THA groups regarding the occurrences of myocardial infarction, cardiac arrest requiring cardiopulmonary resuscitation, or development of a major adverse cardiac event. Age  $\geq 80$ , hypertension requiring medication and a history of cardiac disease were the three most significant predictors for development of post-operative cardiac complications in both the TKA and THA groups. Among those patients sustaining a postoperative cardiac complication, the time of occurrence was within 3 days of surgery in 63% of TKA and 77% of THA patients.

**Conclusions:** Age  $\geq 80$  years, history of cardiac disease and hypertension requiring medication are significant risk factors for developing post-operative cardiac complications following primary unilateral TKA and THA. Consideration should be given to a pre-operative cardiology evaluation and co-management in the perioperative period for such individuals.

**Notes:**

1620-1625

## Incidence, Risk Factors And Occurrence For Thirty-Day Postoperative Myocardial Infarction And Cardiac Arrest Following Primary Total Knee And Hip Arthroplasty

CPT Gens P. Goodman, DO

COL Philip J. Belmont Jr., MD

CPT Nicholas Kusnezov, MD

MAJ Charles D. Magee, MD, MPH

Julia O. Bader, PhD

MAJ Brian R. Waterman, MD

Andrew J. Schoenfeld, MD

**Objective:** This study aimed to calculate the incidence rates and elucidate risk factors and time of occurrence for 30-day

1625-1630

## Factors Leading To Acetabular Component Malpositioning In A Cohort Of Military Hip Arthroplasty Patients

CPT Peter Formby, MD

CPT Gregory S. Van Blarcum, MD

CPT Adam Pickett, MD

MAJ Andrew W. Mack, MD

CDR Michael T. Newman, MD

**Introduction:** Proper placement of the acetabular cup during total hip arthroplasty has been demonstrated in the literature to have important implications in overall stability and wear rates of the components. There has been a trend towards a more horizontal cup to prevent the consequences of edge loading seen with more vertically placed cups. Several studies have looked at patient factors, such as obesity, and surgical technique and their effects on cup malpositioning. To our knowledge, however, there have been no studies comparing the effects of patient obesity and surgical approach on cup malpositioning in a military population.

**Methods:** We performed a retrospective review of all primary total hip arthroplasty cases performed at a single military institution from Feb 2013 to Apr 2014. All cases were performed by one of three fellowship trained arthroplasty surgeons who use two specific surgical approaches. The first post-operative clinic visit radiographs were reviewed (standing low AP pelvis) for cup inclination angle. Using 35-50 degrees as an acceptable acetabular inclination angle, we divided these patients into 2 groups, those whose inclination angle were within the acceptable range and those that were outside the acceptable range. We then compared these to determine factors leading to malpositioned cups. We also compared BMI and inclination angle to determine if there was a linear correlation.

**Results:** During the time period covered there were 142 total hip arthroplasties at our institution. We found that 95 were preformed through a posterior approach to the hip while 46 were preformed through an anterolateral approach. Of all the patients studied, we identified 22 that had malpositioned cups (16%). Both patient groups were similar demographically, and there was no statistical significance between surgical approach and inclination angle even though there was a trend toward significance of the hips done in the anterolateral approach. In the posterior approach patients there was a small ( $R^2=0.06$ )

but significant linear correlation ( $p=0.02$ ) between increasing inclination angle and BMI with a correlation between patients with a BMI  $> 40$  and malpositioned cups trending toward significance ( $p=0.06$ ).

**Discussion and Conclusions:** Positioning of the components in THA is important for stability, wear rates, and patient outcomes. In this cohort there was a small, but significant linear correlation between BMI and inclination angle in surgeons using the posterior approach, with a trend seen towards more vertical acetabular components. There did not seem to be a correlation among the patients who underwent an anterolateral approach. Further studies can be done to look at other surgical factors that may have an effect on this as well.

### Notes:

1635-1640

## Free Vascularized Fibular Grafts for Femoral Head Osteonecrosis: An Alternative Technique Utilizing a Buttress Plate for Graft Fixation

LCDR Scott M. Tintle, MD

Andrew Woodhouse, BS

MAJ Matthew L. Drake, MD

Gwo Chin Lee, MD

L. Scott Levin, MD, FACS

**Introduction:** Free vascularized fibular grafting has been shown in previous studies to be an effective means of treating osteonecrosis of the femoral head. This procedure tradition-

ally utilized a Kirschner wire to secure the autogenous donor bone within the graft site. Migration of the Kirschner wire, however, is the most common symptomatic graft site complication seen. The Kirschner wires can also make the site more difficult to perform a future hip arthroplasty.

**Methods:** An alternate technique for the fixation of the free fibular graft is described that uses a buttress plate instead of a Kirschner wire for fixation.

**Results:** In a cohort of 10 patients, this technique for fibular graft fixation has been successful with no complications.

**Conclusions:** This technique is a viable option that eliminates potential pin migration complications and allows for an easier conversion to a total hip arthroplasty should it be needed in the future.

**Notes:**

1640-1645

## Accuracy Of Ultrasound-Guided Intra-Articular Hip Injections Performed In The Orthopaedic Clinic

MAJ Todd Balog, MD

\*CPT Erik K. Turner, MD

MAJ (Ret) John M. Slevin, PA-C

Laura F. Lewis, PA

LTC Lisabeth A. Bush, MD

LTC Bryant G. Marchant, MD

**Introduction:** The purpose of this study is to determine the accuracy of intra-articular hip injections performed by ortho-

paedic surgeons and orthopaedic physician assistants in the clinic setting utilizing ultrasound guidance and to perform an RVU analysis of this office-based technique.

**Methods:** A prospective study was performed of all patients indicated by orthopaedic providers for a diagnostic or therapeutic intra-articular hip injection. These patients subsequently underwent an ultrasound guided injection performed by one staff orthopaedic surgeon or one of two orthopaedic physician assistants. Injections were performed either in their standard clinic or one of the physician assistant's weekly injection clinics. Omnipaque was added to the injection in addition to lidocaine and kenalog and they were performed under live ultrasound guidance utilizing a standard anterior technique. Patients were immediately transported to x-ray following the injection for a single AP pelvis radiograph. Patient diagnosis, BMI, procedural time, and a visual analog scale (VAS) score were recorded for each patient. Post-injection radiographs were reviewed by a senior orthopaedic resident, staff orthopaedic surgeon, and a musculoskeletal radiologist for accuracy of the injection.

**Results:** Forty-three consecutive patients underwent ultrasound guided hip injections. Seven of the patients underwent bilateral injections for a total of 50 hips injected. There were twenty-five male patients and eighteen female patients. The average age was forty-seven. The average BMI was 29.9. Pre-injection diagnosis included known osteoarthritis, femoroacetabular impingement, labral tear, and hip pain of unknown origin. There was no identifiable omnipaque on the post-injection radiograph of two patients, leaving 48 patients for analysis. Of the 48 hips, 46 were confirmed intra-articular for an accuracy of 96%. One injection was clearly extra-articular with contrast extravasating up the iliopsoas tendon sheath. One injection was indeterminate with contrast surrounding the capsule but not clearly in. This patient had previously undergone a hip arthroscopy with capsulotomy. The average procedural time was 2.6 minutes and the average VAS score was 1.9.

**Discussion:** Hip injections can be a valuable tool for clinical decision making. They have proven value in predicting patients who would likely benefit from hip arthroplasty and are especially useful in patients with atypical hip pain. Many hip arthroscopists also use them to help confirm a diagnosis of FAI prior to offering surgery. They can also provide therapeutic value to patients with mild degeneration and those who wish to delay eventual arthroplasty. As anatomic-based hip injection techniques have been shown to have a low accuracy rate, most patients are either referred to radiology depart-

ments for a fluoroscopic guided injection or are taken to the operating room by the orthopaedic surgeon for a fluoroscopic guided injection. The former requires referral to another department and results in the loss of revenue for the orthopaedic clinic while the latter utilizes valuable operating room time. As shown in this study, ultrasound guided hip injections performed in the orthopaedic clinic are both accurate and efficient. The average injection time was less than three minutes with an accuracy rate of 96%. The average VAS was 1.9 and over half of the injections were performed on the same day the patient was initially indicated for one. The remainder were performed during a weekly physician assistant injection clinic. In terms of productivity, a single ultrasound guided hip injection captures 7.74 RVUs compared to 10.62 for a knee scope with medial meniscectomy and 18.36 for an ACL reconstruction. There is obvious productivity benefit by performing these injections in the clinic. In conclusion, intra-articular hip injections have a proven clinical value. This study shows that they can be accurately performed in the orthopaedic clinic utilizing ultrasound guidance by both orthopaedic surgeons and orthopaedic physician assistants. The procedure itself is reproducible, quick, patient-friendly, and maintains the revenue generated from the procedure within the clinic without using valuable OR

**Notes:**

1645-1650

## Inadequacy Of Ibuprofen For Prevention Of Heterotopic Ossification After Hip Arthroscopy In A Military Population

Major Matthew Mai, MD  
Col. Robert Sullivan, MD  
LtCol. Patrick Brannan, MD  
Maj. Andrew Malin, MD  
Maj. Dustin Lybeck, MD

**Purpose:** Heterotopic ossification (HO) is a known complication following hip arthroscopy. Currently, there are no standard recommendations for prophylaxis of HO with either medication or length of prophylaxis. The purpose of this study

is to assess the prevalence and the adequacy of ibuprofen to prevent HO following hip arthroscopy in a military population.

**Methods:** 42 consecutive patients from December 2011 until April 2014 underwent hip arthroscopy by the senior author. There were 10 females and 32 males. The first 7 patients did not receive heterotopic ossification (HO) prophylaxis. 22 patients received HO prophylaxis with ibuprofen (600 mg three times a day) and 13 received prophylaxis with indomethacin (25mg twice a day). Follow up radiographs were taken at a minimum of 6 weeks post-operatively and amount of HO was assessed with the Brooker classification. 2 patients were lost to follow-up or did not receive radiographs.

**Results:** In the no prophylaxis group 5/7 patients had radiograph evidence of HO (Brooker 1-3). In the ibuprofen group, 6/20 (30%) had HO (Brooker 1-3). None of the patients receiving indomethacin for prophylaxis had radiograph evidence of HO at the last follow up. No patients exhibited signs of stomach irritation.

**Conclusions:** this patient population, ibuprofen alone is inadequate to prevent prophylaxis of heterotopic ossification. Because of the high rates of HO without prophylaxis and with ibuprofen alone, indomethacin is recommended for HO prophylaxis.

**Notes:**

1650-1655

## Return To Duty After Hip Arthroscopy In An Active Duty Population

CPT Jason Dutton, DO  
CPT E'Stephan J. Garcia, MD  
MAJ Joseph T. Lanzi Jr., MD  
CPT Nicholas Kusnezov, MD  
COL Mark P. Pallis, DO

**Introduction:** Retention rates after hip arthroscopy in an active duty population have not been studied. Multiple studies indicate that greater than 75% of high level athletes return

to sport after hip arthroscopy. The purpose of this study is to examine the retention rate after surgery and risk factors for failure of hip arthroscopy in an Active duty population.

**Methods:** A retrospective chart review was undertaken to ascertain the results of hip arthroscopy performed at William Beaumont Army Medical Center between 2000 and 2012. Two hundred and two patients who had undergone hip arthroscopy were identified. One hundred and ninety-eight were available for the study. All were active duty soldiers. Veteran's Affairs beneficiaries and active duty dependents were excluded. Data was collected from AHLTA, E-profiling system, and Physical Evaluation Board results. Risk factors were examined, to include: age, sex, rank, MOS, diagnosis, procedure, tobacco use, operative time, and retention rates.

**Results:** One hundred and ninety-eight patients were included in the study, 127 males and 71 females. There were 224 procedures identified, 18 revision procedures and 206 primary procedures. Thirteen Service members underwent bilateral hip arthroscopy. Eighty-six percent of the Service members in the study were enlisted, with 46% ranked E-4 and below. Only 13% of the study population included Officers and Warrant Officers. Forty-four percent of the surgeries were performed for femoroacetabular impingement (FAI). The most common procedure performed was acetabuloplasty followed by labral debridement. The complication rate was 13% overall, with 60% of those being transient peripheral nerve sensory disturbances. The major complication rate was less than 1% defined as femoral neck fracture, abdominal compartment syndrome, osteonecrosis, deep vein thrombosis/pulmonary embolus, and septic arthritis. On average of 21 months after surgery, 18% of the soldiers who underwent hip arthroscopy were deemed unfit for continued duty by the physical evaluation board. Seventy percent of those deemed unfit for duty were ranked E-4 and below. Fifty percent of those separated were tobacco users. The most common diagnosis for dismissal was hip pain to include osteoarthritis, chronic hip pain, and FAI.

**Discussion and Conclusion:** Over 80% of the service members who underwent hip arthroscopy were able to be retained on active duty service. Hip pain and post-traumatic stress disorder were the most common diagnoses for soldiers deemed unfit for duty. Hip arthroscopy appears to be a viable option for returning active duty service members to full duty status.

#### Notes:

1655-1700

## Open Versus Arthroscopic Treatment Of Femoroacetabular Impingement In A Military Population: A Retrospective Review

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CPT Chad A. Krueger, MD

MAJ Travis C. Burns, MD

**Introduction:** Femoroacetabular impingement is a known precursor to hip arthritis frequently occurring in young, active individuals. The gold standard for treatment involves reshaping the femoral head/neck junction and performing acetabular labral repair via either hip arthroscopy or open surgical dislocation. The purpose of this study is to evaluate the surgical treatment of FAI with respect to return to duty in a military population.

**Methods:** A retrospective analysis of active duty individuals who underwent hip arthroscopy or open surgical dislocation for the treatment of FAI was performed.. The medical record was used to determine retention status, deployment after surgery, change in military occupational specialty, disability rating.

**Results:** 27 and 32 patients underwent hip arthroscopy and open dislocation, respectively (mean age 31 , 50% female) by two surgeons 23% of patients were found fit for duty and returned to their preoperative MOS. 23% separated with benefits with 10% average disability rating due to hip symptoms. 46% permanently retired with 10% average disability related to hip symptoms. 6.8% of patients deployed after surgery. 34% of patients required revision surgery. There was no significant difference found between patients treated with hip arthroscopy and those treated with open surgical dislocation for any outcome measure.

**Conclusion:** There is no difference in retention status, deployment after surgery, change in MOS, or disability rating between active duty military individuals treated with hip arthroscopy versus open surgical dislocation.

#### Notes:

1710-1715

## Use Of Intravenous Perioperative Tranexamic Acid In Total Joint Arthroplasty: The Military Experience

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**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 post-operative 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 ( $P<0.05$ ).

**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.

### Notes:

1715-1720

## Component Malposition Does Not Adversely Affect Obese Total Knee Arthroplasty Patient Outcomes

James A. Keeney, MD

Denis Nam, MD

Ryan M. Nunley, MD

John C. Clohisy, MD

Robert L. Barrack, 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 obese patients with  $BMI >40 \text{ kg/m}^2$  (55 TKAs) or  $BMI >35 \text{ kg/m}^2$  (55 TKAs) compared with 110 TKAs performed for non-obese patients with  $BMI <30 \text{ kg/m}^2$ . 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:** Obese TKA patients were more likely than non-obese TKA patients to have femoral component malalignment (22% vs 10%,  $p=0.05$ ), malalignment of both components (7% vs 1%,  $p=0.04$ ), or femoral component overhang (29%

vs 9%,  $p<0.001$ ). Mean tibiofemoral angle was lower for morbidly obese than non-obese patients (2.8 vs 4.4 degrees,  $p<0.001$ ), but differences in tibial slope ( $p=0.17$ ) and femoral notching ( $p=0.63$ ) were not significant. Revision surgery rates also were not significantly different ( $p=0.33$ ). While objective differences in component alignment were noted, there were no significant differences in any functional outcome instrument related to obesity class, coronal plane component malalignment, or the presence of sagittal plane femoral component malposition.

**Conclusions:** Coronal plane malalignment and femoral component malposition are more common following TKA for obese than nonobese patients. However, early postoperative functional outcome scores and revision rates are not adversely affected by component malposition.

**Notes:**

1720-1725

## Functional Outcomes Of Total Knee Arthroplasty In The Active Duty Military

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 COL Philip J. Belmont Jr., MD  
 COL Robert Burks, PhD  
 MAJ Brian R. Waterman, MD

**Introduction:** Few studies report on the functional outcomes of total knee arthroplasty (TKA) performed in young, physically-active patients. Specifically, occupational outcomes and return to athletic activity after TKA in a larger, high-demand military cohort have been unreported.

**Methods:** All active-duty servicemembers undergoing primary TKA between October 2007 and March 2012 with minimum 2-year follow-up were isolated utilizing the Military Health System Management Analysis and Reporting Tool. The U.S. Department of Defense electronic health record was

queried for each servicemember to confirm accurate coding and the occurrence of a primary TKA during the study period. Demographic information to include sex, rank, age, military occupational specialty, unilateral versus bilateral primary TKA, and history of combat deployment were catalogued. Patient demographic variables were correlated with occupational outcomes including medical separation as confirmed by the U.S. Army Physical Disability Agency database and the ability to complete a post-operative combat deployment.

**Results:** A total of 181 primary TKAs, including 137 primary unilateral and 22 bilateral primary TKAs, were identified with a mean age of 45.7 years (range, 24-61). The average time interval between primary TKAs in the patients with bilateral TKAs was 7 months (range, 3.3-27.5 months). The majority of patients were male (76%),  $\geq 45$  years old (72%), senior military rank (74%), underwent a primary unilateral TKA (86%), and had history of a previous combat deployment (70%). At mean follow-up of 4.1 years (range, 2.01-6.67), 82% of patients remained on active duty or successfully completed their military service, while 18% of servicemembers were medically separated from the military due to the TKA. Age  $<45$  years 2.36 (95% CI: 1.14, 4.90) and junior military rank 2.26 (95% CI: 1.09, 4.71) were risk factors for medical separation. Twenty-six servicemembers successfully performed a post-operative combat deployment. The demographic variables of age  $\geq 45$  years 3.10 (95% CI: 1.29, 7.47) and a combat arms military occupational specialty 3.10 (95% CI: 1.29, 7.47) were associated with a servicemember performing a postoperative combat deployment.

**Conclusion:** At short-term follow-up, 82% of servicemembers undergoing TKA remained on active duty or successfully completed their military service. Age  $<45$  years and junior military rank were risk factors for medical separation from the military following TKA. All servicemembers who performed a post-operative combat deployment successfully completed it without complications.

**Notes:**

1725-1730

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

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**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  $\leq 55$  years old.

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

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

**Conclusion:** Young TKA patients with aligned knees, mild osteoarthritis and higher BMI may not experience the same

improvement as gender matched older TKA patients. Setting appropriate expectations and assessing for alternative sources of pain are appropriate for young patients without severe radiographic knee arthritis.

### Notes: